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Return and Liquidity Comovement in the Shanghai and Hong Kong Stock Connect

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Abstract

Using the liquidity and comovement measures, the study examines whether the Shanghai-Hong Kong Stock Connect drives the comovement in return and liquidity between Shanghai and Hong Kong stock exchange from 2017-2019. The study is bases on hourly trading activities of 100 Shanghai stocks and 100 Hong Kong stocks, and the effect of exchange rate (HKD/CHY), to analyse the comovement in return and liquidity between two stock exchanges from 2017-2019 by Malceniece et al., (2019)'s methodologies. The study finds that there is positive comovement in return and liquidity between Shanghai and Hong Kong stock exchanges after launch of Shanghai- Hong Kong Stock Connect. Then, the results indicate that comovement in return and liquidity between two markets has increased year on year. In addition, the study finds that comovement in return and liquidity between two markets are converted by the fluctuation of exchange rate (HKD/CHY). Further, the previous day's trading activities on Shanghai, Hong Kong and the US stock exchange affect return, volume, and bid-ask spreads at the first hour of the current trading day on Shanghai- Hong Kong Stock Connect. The result implies that the Shanghai- Hong Kong Stock Connect expand the correlation between Shanghai and Hong Kong stock exchange and increase capital inflow of foreign funds from Hong Kong stock exchange.

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Declaration

I declare that: this thesis presents work carried out by myself and does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; to the best of my knowledge, it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, is clearly acknowledged.

Ji Zhi 22/November/2021

1.Introduction

In connection with being the second largest economy in the world, the Chinese stock market has developed rapidly since being established in 1991. As of September 2020, there are 1,680 and 2,237 companies listed on the Shanghai (SHSE) and Shenzhen Stock Exchanges (SZSE), respectively. The Chinese government has cautiously implemented financial opening policy during the past several decades, which is attributable to the socialist market economy. According to Chong and Su (2006), prior to the introduction of the Shanghai-Hong Kong Stock Connect, foreign investment in the Chinese stock market was primarily in the Foreign Institutional Investors (QFII) and the Renminbi (RMB) Foreign Institutional Investors (RQFII) schemes. Compared to the stock markets of developed nations, China has a mature and significant capital market for cross-border investment and capital internationalization, entitled the Hong Kong Stock Exchange (HKSE). The Hong Kong stock market is the most important offshore RMB hub and the most developed capital market in the world. The SHSE and HKSE have significant differences, in terms of the participants in their markets, their respective trading rules and the efficiency of their particular markets. Sin (2015) contends that the Shanghai stock market has a status that makes it, in effect, between the weak form of efficient market and the semi-strong form of efficient market. I think that Chinese stock market has a significant improvement from the establishing of it. For example, the Chinese government increase foreign funds, make Securities Act and decrease administrative intervention from the government. However, compared with the US and European stock market, there are some problems in the Chinese financial market. For instance, the Chinese financial market has lots of retail investors who are the noise traders. Then, Chinese authority use light punishment when there is a counterfeiter in the Chinese stock market before making Securities Act.

In recent years, the contrast between the rapid development of the Chinese economy and the Chinese financial internationalization, which has fallen behind, has become apparent. The China Securities Regulation Commission (CSRC) initiated a new scheme to link the stock markets of Shanghai, Shenzhen, and Hong Kong. Consequently, the Shanghai-Hong Kong Stock Connect and the Shenzhen-Hong Kong Stock Connect were founded on November 17th, 2014, and December 5th, 2016, respectively. This permitted the Chinese mainland and Hong Kong investors who use Shanghai's, Shenzhen's, and Hong Kong's securities to invest in the stocks of the others' markets. Shanghai (or Shenzhen)- Hong Kong Stock Connect aims to attract foreign investors to invest in the Chinese mainland stocks.

Prior to the formation of the Shanghai-Hong Kong Stock Connect, the Chinese government decided to list certain blue-chip stocks on the HKSE as a strategy to attract foreign capital that would assuredly invest in them. There are 128 Chinese mainland stocks which are listed on both the Shanghai or Shenzhen Stock Exchanges (called A-stock), and on the HKSE (called H-stock). The A-price of cross-listed stocks is more expensive than the H-price of stocks and is referred to as the AH Premium. Therefore, the AH premium is an important symbol to investigate the comovement in return and liquidity between the Chinese mainland and Hong Kong stock markets. For instance, the Hang Seng China AH premium index was between 120 and 160 during the last 5 years, demonstrating that A shares are trading at a premium versus H shares (data from the HKSE.com[1]). Following this, the Shanghai- Hong Kong Stock Connect affected the AH premium. Hui and Chen (2018) confirmed that the AH premium of cross-listed stocks significantly increased at the commencement of Stock Connect.

Increasing research suggests that liquidity can predict stock returns. Although previous studies (such as Ma et al., 2019; and Hui & Chen, 2018) have documented that the Shanghai-Hong Kong Stock Connect resulted in the comovement between the stock markets, in practice, following the introduction of the Stock Connect, the stock market in Shanghai has greater pricing power than in Hong Kong. Then. comovement in liquidity and return can impact the market's stability and the degree of risk. Comovement in liquidity determines what extent of liquidity risk can be declined by portfolio of stocks, and comovement in return determines whether the portfolio of stocks significantly reduces single market or industrial risk. This study aims to investigate the comovement of return and liquidity of Shanghai and Hong Kong stocks listed on the Shanghai (and Shenzhen)-Hong Kong Stock Connect." The Connect is a unique setting that differs from the developed markets. For example, the Connect use the T+1 rule. This rule is that the investors cannot buy and sell these stocks in one day. We add the discussion of high frequency trading: Shanghai stock market use the T+1 rule, which differs with Hong Kong and other developed stock markets. High frequency trading methodology in Shanghai stock market is more difficult than Hong Kong stock market. The paper uses the high frequency trading data (hourly) and follows established methodology in the literature for the investigation.

The sample period of this thesis is from 2017-2019. The investigation comprises 200 constituent stocks (100 Shanghai stocks and 100 Hong Kong stocks) of CES300 index of the Stock Connect (CES300). There are several reasons for why the Shanghai-Hong Kong Stock

[1] The Official Website of HKSE (https://www.hkex.com.hk/?sc_lang=en) provides the index of AH premium.

Connect promotes the comovement in return and liquidity between Shanghai's and Hong Kong's stocks. (1). The Stock Connect substantially increases the trading volume of its constituent stocks. As of November 2019, foreign investors held approximately 882.8 billion Chinese Yuan (US$125.9 billion) of Shanghai and Shenzhen stocks (China Daily HK, 2019). The HKSE play a role in providing the inflow of foreign capital into the Shanghai stock market. (2). The Stock Connect provides Chinese mainland investors with a convenient channel to purchase blue-chip stocks which are listed in the HKSE. Some leading Chinese mainland stocks prefer to be listed in the Hong Kong Stock market rather than in the Shanghai and Shenzhen Stock Exchanges, such as Tencent, Geely, and the China Evergrande Group. Therefore, the Stock Connect provides a direct gateway for Chinese mainland investors to invest in the Hong Kong stock market. (3). The Stock Connect promotes the cross-correlation of the Shanghai and Hong Kong stock markets, and the long-term cross-correlation is more than the high frequency period (Ruan et al., 2018). It conforms with the aims of Shanghai-Hong Kong Stock Connect. (4). The Chinese mainland and Hong Kong financial markets use the Chinese Yuan (CHY) and the Hong Kong Dollar (HKD), respectively. Indeed, large flows can affect both the liquidity of the market and potentially, the exchange rate (if the flows are sufficiently large). Therefore, Chinese mainland investors may consider the currency risk in Southbound trading. (5). The Shanghai and HKSEs have different trading hours. The HKSE has six trading hours, whereas the SHSE only has four hours. This study examines that the last hour prior to closing of the Shanghai or Hong Kong stocks, which may drive each other stocks' volume, asking bids, spread and return, in the first hour of opening time.

Following the methodology of Malceniece et al., (2019), we investigated the trading activities of the Shanghai and Hong Kong stocks on the Stock Connect to determine as to whether they co-move in return and liquidity with the CES 300 Index. Several previous studies have researched the Shanghai-Hong Kong Stock Connect, with the focus being a small sample, cross-sectional relationship between the volatility of AH stocks and the dynamic price discovery of Shanghai, Shenzhen, and Hang Seng (composite) index (Hui and Chen, 2018; Burdekin and Siklos, 2018; Bian, Chan and Shi, 2020). Additionally, research was carried out regarding the comovement in return and liquidity between some independent stock markets. The respective scholars used the high frequency trading data to analyse the comovement in return and liquidity (Zhang and Jaffry, 2015; Chen, Chow and Wrong, 2019; Li and Chen, 2021). This analysis of this thesis differs from previous studies, as we used 200 stocks with their hourly frequency data and included the effect of the exchange rate risk in order to examine

the comovement in return and liquidity between Shanghai and Shanghai and Hong stocks. Moreover, we examined the Shanghai stock exchange where it is connected to the HKSE by the Shanghai-Hong Kong Stock Connect. Therefore, our studies when compared with the previous scholarship has a significant contrast, as we did not place an intermediate value to analyse the co-movement in return and liquidity.

In this study, I present three key findings. I find that the comovement of return and liquidity of the Shanghai and Hong Kong Stock Connect has increased during the study period. Secondly, and perhaps the most important finding in this paper, is that the exchange rate influences the extent of the comovement of return and liquidity on the Stock Connect. While we follow Malceniece et al., (2019) this is a unique feature of this market. Thirdly, trading activities in The United States equity markets have an effect on the comovement of return and liquidity on the Connect. This is an unexpected finding which is, again, different from Malceniece et al., (2019).

The remainder of this dissertation is organised as follows: Section 2 concludes the literature review which includes details concerning comovement in return and liquidity, the Shanghai-Hong Kong Stock Connect, trading across trading sessions and presents two hypotheses. Section 3 describes the data from the Shanghai and Hong Kong stock markets from 2017-2019, while Section 4 explains the methodologies, including midquote return measures, liquidity measures and comovement measures. Section 5 presents the empirical results and Section 6 imparts the conclusion.

2. How the Shanghai-Hong Kong Stock Connect works

2.1 The aim of establishing the Shanghai-Hong Kong Stock Connect

The Shanghai-Hong Kong Stock Connect plays an important role in regard to improving access to the Chinese mainland financial market. With regard to its geographic position and international financial influence, the HKSE could have an intermediated role in order to help foreign capital enter the Chinese financial market. The HKSE uses the trading rules which are based on European and United States stock exchanges. The foreign financial institutions could have familiar environments in the HKSE. Furthermore, the HKSE has the largest retail and wholesale financial products in RMB and RMB deposits (Li and Chen, 2021). Finally, the Shanghai and Hong Kong financial market did not directly buy and sell each other stocks before the establishing of the Shanghai-Hong Kong Stock Connect. There are some significant Chinese mainland companies which are listed in HKSE (Zhang and Jaffry, 2015). Therefore, the Chinese government aims to use the Shanghai-Hong Kong Stock Connect to expand its control of the Kong financial market.

According to the respective geographic region, Shanghai (and Shenzhen) is to the north of Hong Kong. When Hong Kong investors trade in Shanghai or Shenzhen stocks, this is referred to as Northbound trading. The opposite is Southbound trading where Shanghai and Shenzhen investors invest in Hong Kong stocks.

The Shanghai-Hong Kong Stock Connect is intended to improve the development of the Hong Kong Stock Connect. Notably, individual investors and institutions from the Chinese mainland provide the more liquidity in the HKSE. According to the data from the HKSE, the total trading value of Southbound trading is almost 3 trillion worth of transactions between Shanghai and HKSEs and exceeds a 2.5 trillion trading value between the Shenzhen and HKSEs (data from Statista.com). Moreover, the Chinese government seeks to attract foreign capital via Hong Kong and enhance the relationship between the Chinese mainland and global financial markets. Therefore, the HKSE could be the most important offshore RMB hub. Finally, the economy of Hong Kong is improved by the Shanghai-Hong Kong Stock Connect. The Shanghai-Hong Kong Stock Connect strengthens the intermediated behaviour between the Chinese mainland and global financial markets.

2.2 Trading mechanisms

2.2.1 The rules of limitation

The Chinese government aims to maintain the stability of the Shanghai and Hong Kong stock markets after the launch of the Shanghai-Hong Kong Stock Connect. CSRC enacted some limitations in order to control trading activities in the Shanghai-Hong Kong Stock Connect, such as the type of stock, the asset size of investors and a limited buying cap. Initially, the Hong Kong investors could only purchase some special Shanghai stocks at the beginning of the Shanghai-Hong Kong Stock Connect. Such as the Shanghai Stock Exchange 180 index constituent stocks, the Shanghai Stock Exchange 380 constituent index stocks and the AH stock companies as listed on the Shanghai stock exchange. Similarly, the Shanghai investors have limitations with regard to Hong Kong stocks that can be traded, such as the Hang Seng Composite Large Cap Index constituent stocks, the Hang Seng Composite Medium Cap Index constituent stocks and the AH stock companies as listed on the HKSE. Furthermore, the Shanghai-Hong Kong Stock Connect restricts the Shanghai and Hong Kong investors' eligibility. For example, Shanghai and Hong Kong stock investors must satisfy the requirement for the value of stocks>500,000 Yuan. Finally, the regulators also restricted the limit buying cap for both the Northbound trading and Southbound trading. For example, the daily trading volume of the Stock Connect has been capped at 13 billion (Northbound trading) and 10.5 billion CHY (Southbound trading), respectively. The 'cap' in question does not limit the maximum daily inflow, instead, it refers to the maximum daily balance between buying and selling. This means the daily cash flow and outflow may exceed the limit cap of the expected market.

2.2.2 Trading settlement

With regard to Northbound trading, the HKSE subsidiary, which carries out Northbound activities, is responsible for Hong Kong investors who trade stocks in the SHSE or SZSE. The settlement of SSE/SZSE's stocks occurs at the end of trading time when Hong Kong investors purchase the stocks in Northbound trading. However, the investors cannot buy and sell these stocks in one day. Due to the 'T+1' rule (trading day plus one business day), the money settlement of net payable amount of buying activities shall make payment to SHSE/SZSE before 12:00 noon on the next day of trading. The Hong Kong investors receive

the net cash inflows of selling activities after 12:30 p.m. on T+1. All Stock Connect stocks are traded in RMB.

With regard to Southbound trading, Chinese mainland investors are able to access the SSE and SZSE Subsidiary to buy or sell Hong Kong stocks in the HKSE. According to the rules of the Stock Connects, Southbound trading settles Hong Kong stocks and money with the investors on the third trading day. Following this, the investors are allowed to buy and sell stocks on the same day in the HKSE. Then, the investors must pay all frozen capital[2] in advance prior to the settlement of Hong Kong stocks during the trading times, as the Stock Connects implement a front-end control of trading capital. This is intended to guarantee that the investors have enough capital to execute the buying orders of stocks. The investors trade Hong Kong securities quoted in HKD, but they settle all trades with China-clear or its participants in RMB. For example, buying settlements at the exchange rate is used for paying cash outflow of buying trade activities of Hong Kong stocks in Southbound trading and the selling settlement exchange rate is appropriated for receiving from cash inflow of selling trade activities.

2.3 Institutional Settlement arrangement

The Shanghai-Hong Kong Stock Connect created the Shanghai and HKSEs. Following this, they created the project of the Shanghai-Hong Kong Stock Connect to the CSRC for approval. Then, the CSRC and Securities and Futures Commission (SFC) made a joint agreement which built a new scheme to connect Shanghai to HKSEs on 10, April 2014. The Shanghai and HKSEs manage the Shanghai-Hong Kong Stock Connects.

China-clear[3] is responsible for money settlements in regard to the settlement of arrangements for Southbound trading. After the closing time of the Stock Connects, the investors receive information concerning the cash outflow and inflow in RMB by which the China-clear needs to calculate the actual settlement exchange rate (HKD/CHY) for trading activities of Hong Kong stocks. China-clear requires the converting of RMB from its participants into HKD for settlements with the Hong Kong Stock Central Company Limited

[2] Frozen capital is defined by Chinese investors having pre-save the cash in the SHSE and SZSE subsidiaries when they decide to purchase Hong Kong stocks in the trading time. Next, the Chinese investors will receive the actual cash outflow after the closing trading time. Then, the investors will receive the residual frozen capital because the frozen capital is worth more than actual cash outflow.

[3] China-clear is the Chinese official institution which aims to calculate the exchange rate(HKD/CHY) settle cash inflow and outflow to complete the buying or selling stock trading in Southbound trading.

(HKSCC) when the cash outflow of buying activities exceeds the cash inflow of selling activities. China-clear also needs to receive HKD from HKSCC into RMB for the settlement with its participants while the cash inflow exceeds the cash outflow in the Southbound trading.

Otherwise, Hong Kong investors must open an RMB account for China Connect Clearing Participants in Northbound trading. China Connect Clearing Participants are the list of designated banks who can open RMB accounts. The Hong Kong Securities Clearing Company Limited aims to manage these RMB accounts and also operate the existing RMB Equity Trading Support Facility. The Northbound trading also implements the front-end control rule to pay all frozen capital from Hong Kong investors in their RMB account. The Hong Kong investors should ensure they have enough capital of Chinese Yuan in their RMB account. For this reason, the Northbound trading will not have the foreign exchange rate risk.

3. Literature review and hypothesis development.

This section provides the literature relevant to this study. First, it introduces research on comovement in return and liquidity in developed countries' stock markets. Then, it discusses the previous studies that studies the Shanghai- Hong Kong Stock Connect. Next, it explains trading across trading sessions and finally, it concludes with the hypothesis development. Shanghai- Hong Kong Stock Connect is an innovative program which attracts liquidity from HKSE and Chinese mainland investors investing in Hong Kong stocks. The comovement on return and liquidity between Shanghai and Hong Kong stocks differ with comovement between stock markets in other developed countries. Moreover, Shanghai- Hong Kong Stock Connect differs from other markets in terms of trading time, trading rules and trading participants.

3.1. Comovement in Return and Liquidity

The literature documents the relationship between stock return and liquidity and argues that stock returns are determined through the interaction of return with liquidity. Empirical evidence showed that the higher stock return is associated with lower liquidity of the stock (Amihud and Mendelson, 1986). In the pricing power of the stock market, the importance of liquidity is equivalent to the relationship between water and life. Less or more liquidity leads the investors to trade their stock at a discount or premium price. Other studies found a significantly positive correlation between illiquidity and return, because the informed investors lead the uninformed investors to create higher illiquidity costs (Eleswarapu and Reinganum, 1993; Brennan and

Subrahmanyam, 1996). Another study find that the increased liquidity alongside low bid-ask spreads and high stock turnover cause the lower returns of individual firms (Brennan, Chordia and Subrahmanyam, 1998).

Co-movement in liquidity and return examines the systemic risk and market stability because the extent to which comovement between stock returns and market return determine the diversification of portfolios, can reduce non-systematic risk. For example, co-movement in return determines the cross-sectional diversification of portfolios, stock return, and market risk (Barberis et al., 2005; Chordia, Roll and Subrahmanyam, 2000). Greenwood (2008) documented that the overweight stocks of Nikkei index are positively related to Nikkei index but negatively related to stocks outside of the index. Claessens and Yafeh (2013) based on the major stock market, reported that a stock adds to a market index to increase its beta and the large extent to which market return explain this stock's return.

Similarly, the comovement in liquidity determines the extent of fluctuation of liquidity which can reduce holding of portfolio. The liquidity-adjusted CAPM method shows that liquidity risk requires a positive risk premium (Acharya and Pedersen, 2005). Furthermore, global markets' risk level and stability is directly affected by the liquidity of large stock markets (Brockman et al., 2009). In the demand-side explanation, the correlated investors' styles and sentiment affect the fluctuation of liquidity, because correlated institutional investor exhibits the similar investment options of stocks and trading patterns (Koch et al., 2016). In the supply-side explanation, there is a negative relationship between negative market return and stock liquidity, and then the increase of liquidity provides significant stock return during a large drop of stock variation (Hameed et al., 2010).

Several research find that high frequency trading (HFT) affects comovement in return and liquidity between different stock exchanges. For example, the opportunistic HFT takes long and short position in the number of stocks when they occur relatively misprice (Chaboud et al., 2014). Moreover, Khandani and Lo (2011) presented that the HFT has destabilized performance when the stock market occurs unusual fluctuation, especially the "Quant Meltdown" of 2007. In addition, Foucault et al. (2016) argue that HFT has an ability to react more efficiently and quickly public information to increase or decrease stock prices. So, the stocks with more effective information are attracted more liquidity from the HFT traders, and then affect return comovement. Further, research on the co-movement returns concluded that high frequency trading has significantly increased co-movement in return between the Chi-X

Stock Exchange and the European Stock Exchanges (Malceniece, Malcenieks and Putniņs, 2019). They based on Amihud's measure to estimate the liquidity measure. Then, they followed Morck et al. (2000), Hameed et al. (2010), and Karolyi et al. (2012) to calculate comovement in return and liquidity between the Chi-X Stock Exchange and the European Stock Exchange. Finally, their paper also described that larger trading activities substantially increases liquidity, narrows approximate 50% bid-ask spreads, and rises volatility.

Previous studies fail to incorporate the effect of exchange rate risk on comovement between different stocks markets (Bonfiglioli and Favero, 2005 and Malceniece, Malcenieks and Putniņs, 2019) Exchange rate risk is an important factor for international stock market. For example, Eun and Resnick (1988) demonstrated that the exchange rate risk plays a significant role of portfolio allocation among the global stock exchange, even to be nondispersive. However, Jorion(1991) reported that exchange rate risk was statistically significant while it was an external risk or risk premium. Therefore, based on the studies of Eun and Resnick (1988) and Jorion(1991), Cheung; Kwan and Jason (1995) shows that there is a significant effect of fluctuation of exchange rate (CAD/USD) of Canadian stocks' price, but the US stocks' price are insignificant effect exchange rate risk in the same global environment.

3.2. Comovement between Shanghai and Hong Kong or the US stock markets before and after Shanghai-Hong Kong Stock Connect.

Along with the globalization, there is the increased trend of comovement between developed and emerging stock market, especially comovement between the US and Chinese mainland stock markets. Lin and Swanson, (2008) reported the US stock market had a strongly affect the equity return of emerging stock markets. However, before the 1997 Asian global financial crisis, the comovement between Chinese mainland and other developed stock market were unmeasurable because Chinese stock market are almost enclosed (Bailey, 1994). Moreover, the 2008 U. S. subprime mortgage crisis caused a significant fluctuation in the great majority of financial market. However, the Chinese financial market had a smaller fluctuation by the 2008 U. S. subprime mortgage crisis, because of its limitation of opening-up policy (Zhou, Zhang, and Zhang, 2012).

After establishing Shanghai- Hong Kong Stock Connect, some Scholars studied comovement on return and liquidity between SHSE and HKSE. They thought about that the Shanghai-Hong Kong Stock Connect increase liquidity from foreign capital through HKSE,

with reduce cost of capital. For instance, one study showed that the Stock Connect enhances high frequency volatility linkage between the Shanghai and Hong Kong stock markets and increases the capital linkage between them (Zhang and Jaffry, 2015). Chen, Chow and Wrong (2019) used cointegration, and linear and nonlinear causalities[4] to investigate whether the Shanghai–Hong Kong Stock Connect has any impact on the market capitalizations and market indices of the Hong Kong, Shanghai, and Shenzhen markets. After the implementation of two stock schemes, nonlinear causalities test of the three markets and the cointegration of the market indices were highly correlated; however, there was a declining trend from Hong Kong to Shanghai. On the other hand, the effect of the Qualified Foreign Institutional Investor (QFII), Qualified domestic Institutional Investor (QDII), and Renminbi Qualified Foreign Institutional Investor (RQFII) programs on comovement between Chinese mainland and other stock markets are positive and consistent (Yao et al. 2018)).

Several studies have examined the impact of the Shanghai–Hong Kong Stock Connect on A-H stock premium and the co-movement in return and liquidity between the Shanghai and Hong Kong stock markets. In my opinion, AH premium of Shanghai and Hong Kong stocks is a factor to examine the comovement between Shanghai and Hong Kong stocks, because the AH stocks have a large market-capitalization weight in Shanghai and HKSE. Research found that the Shanghai-Hong Kong Stock Connect affects the price cointegration[5] of the A- and H- prices of cross-listed stocks in the long-run, although it increased the AH premium of these stocks (Chan and Kwok, 2015). The results showed that both markets adjusted the equilibrium of A- and H- prices after implementation of the Stock Connect. However, the actual Northbound and Southbound cash flows only affect some samples in high uncertainty regimens and the Connect does not have a significant impact on the A-H premium (Burdekin and Siklos, 2018). An investigation of the impact of the AH premium of cross-listed stocks on their A-price or H-price determined that the Stock Connect has a positive effect on stocks listed on both the SHSE and HKSE (Bian, Chan and Shi, 2020). This is attributable to the positive correlation between Southbound trading net purchase and the AH premium lagged value, and to the lack of correlation between Northbound trading net purchase and the AH premium. Li and Chen (2021)

[4] Because the market capitalizations and market indexes are non-linear relationship if the regime change after crisis, Chen, Chow and Wrong (2019) adopted the non-parametric approach to capture nonlinear nature of relationship between two markets.

[5] Chan and Kwok (2015) used the cointegration test to carry out separately 68 AH stocks from per- or post-announcement of Shanghai-Hong Kong Stock Connect. It aims to analyse the increase or decrease of AH premium.

uses dynamic conditional correlation to study comovement between Shanghai, Hong Kong and the US stock markets after Shanghai (Shenzhen)- Hong Kong Stock Connects by t-copula–DCC–GARCH model[6]. They reported that the weekly price comovement are stronger among Shanghai, Hong Kong, or the US stocks after launch of Shanghai (Shenzhen)-Hong Kong Stock Connects, with insignificantly influence on comovement between Hong Kong and the US pair. In summary, previous studies based on the small sample (Hui and Chen, 2018) and markets index (Shanghai composites indexes, Shenzhen composites index and Hang Seng composite index) to analyse the correlation between Shanghai and Hong Kong stocks after Shanghai-Hong Kong Stock Connect. Next they focused on cross-sectional relationship between volatility of cross-listed stocks (Bian, Chan and Shi, 2020) and dynamic price discovery of Shanghai, Shenzhen and Hang Seng (composite) index (Ma et al, 2019).

3.3. Trading across trading sessions

Generally, stock trading takes place in three main sessions (pre-opening, continuous trading, and the closing sessions) in the stock exchanges. The call auction is used in the pre-opening and closing sessions. In the pre-open, the stock price potentially reflects the accumulation of global market information. For example, Brooks and Su (1997) investigated that the call auction in the pre-opening session had a higher liquidity than continuous trading. its efficiency is higher than in continuous auction market in the morning and high frequency trading time. Madhavan and Panchapagesan (2000) reported that call auctions provide a unique price of stock, the institutional traders prefer to trading stock in the call auction before the trading sessions. Further research of Kehr et al. (2001) found that Call auction reduced the transaction cost in the high frequency trading time at Frankfurt Stock Exchange. Therefore, the investors prefer call auction in the high frequency trading time (lower transaction cost) and continuous trading in the trading sessions (higher trading liquidity and price accuracy). Moreover, informed individual investors offered aggressive trading strategy in call auction of pre-opening time when there are earning and dividend announcement (Lee et al., 2010; Kaniel et al., 2012). On the contrary, the uninformed individual traders are recognized as "noise trader" in the pre-

[6] Li and Chen (2021) compared the standardization innovation and normal distribution, found that the standardization innovation shows shape of peak and fat tail. Therefore, they used t-copula–DCC–GARCH model with analysing dynamic conditional correlation to analyse comovement between Shanghai, Hong Kong and the US stock markets, because joint distribution of the marginal distributions of standardization innovations is subject to multivariate Student t distribution.

opening sessions and they are affected some firm-specific announcement and overconfident than institutional investors.

Asymmetric information plays an important role in regard to increasing trading volume in the high frequency trading time. There are some researchers who support this opinion, which includes, for example, Dufour and Engle (2000) who show that the informed investors trade stock quickly when they have insider information and that they aim to avoid divulging such information. Tkatch and Kandel (2006) present evidence that shows price concessions, made by traders to obtain a more direct execution, have a significant impact on high-frequency market dynamics. Asymmetric information provides details concerning abnormal trading volumes of specific stocks in a very short time (Sarkar and Schwartz, 2009).

In conclusion, the previous studies found that different trading sessions (pre-opening, continuous trading, and the closing sessions) should use different trading patterns (call-auctions or continuous orders). Previous scholarship argued that this could achieve the maximum liquidity. Moreover, asymmetric information also increases liquidity when informed investors quickly make trading orders in order to avoid disclosing insider information. The SHSE and the HKSE also use different trading patterns in different trading sessions. This study focuses on this in regard to the second hypothesis.

3.4 Hypothesis development

This study differs from previous research regarding comovement on return and liquidity, and the Shanghai-Hong Kong Stock Connect being an innovative mechanism. The existing literature concentrates on the comovement of markets in developed counties, such as the Chi-X and European stock markets, and the United States and German stock markets. They are based on high frequency trading in order to measure the comovement in return and liquidity. However, the Shanghai-Hong Kong Stock Connect is a 'bridge' scheme that links the two Stock Connects. This study can directly measure the comovement between their stocks and ignore the high frequency trading. Furthermore, a previous comparable study (Malceniece, Malcenieks and Putniņs, 2019) does not document the effect of exchange rates on comovement of return and liquidity. The Shanghai and Hong Kong stocks' price based on different currencies. Therefore, it is essential to incorporate the exchange rate (HKD/CHY) in the measurement of comovement in return and liquidity in the Shanghai-Hong Kong Stock Connect.

Unlike other comparable studies that have investigated trading activities on the Connect (Chen, Chow and Wrong, 2019; Bian, Chan and Shi, 2020), this study uses intraday trading data in order to measure the comovement between Shanghai and Hong Kong stocks. Furthermore, a study (Burdekin and Siklos, 2018) based on the Shanghai-Hong Kong Stock Connect analyses the fluctuation of the Shanghai and Hong Kong composites indexes to measure AH premium (Ma et al, 2019). However, this study uses individual stocks rather than index to measure the comovement on the Shanghai- Hong Kong Stock Connect. This enables this research to investigate how individual stocks comove with the indexes on the Connect itself. As a result, this study uses a larger sample and higher frequency trading data than the studies. The analysis could have objective and representative results when other researchers wish to realise the comovement in return and liquidity in the Shanghai-Hong Kong Stock Connect.

Based on the above discussions, this study proposes the first Hypothesis as follows.

Hypothesis 1: Do trading activities from the Shanghai and Hong Kong Stocks impact comovement in liquidity and return?

From when the Shanghai-Hong Kong Stock Connect was launched, the trading activities from Southbound and Northbound flow has increased in last 3 year. Learning from the previous study, comovement between the Shanghai and Hong Kong stock markets have been promoted by the Shanghai-Hong Kong Stock Connect. Li and Chen, 2021 show the United States stock market significantly impacts the co-movement between the Hong Kong and the United States stocks after the Shanghai-Hong Kong stocks.

The HKSE is a global stock exchange, and its pricing power is affected by the global stock market. The Shanghai stocks have attracted considerable international capital after the Shanghai-Hong Kong Stock Connect. Therefore, there is a rising market size and increasing liquidity that has impacted both markets. Additionally, according to the previously cited papers, Shanghai stocks have more pricing power and play a dominant role after the implementation of the Shanghai-Hong Kong Stock Connect. Both Shanghai and Hong Kong stocks or global stock markets should have significant effects on each other's stocks and trading activities (volume, bid-ask spread and return). Based on the above discussion, we formulate our second hypothesis as follows:

Hypothesis 2: Can Shanghai or Hong Kong stocks drive each other's volume of stock, asking bids and spread and return?

4. Data

Our sample consists of 200 constituent stocks of CES300 index of the Stock Connect[7]. We obtained the intraday data at hourly frequency from the Thomson Reuters Tick History database. The types of data include volume, close bid, and ask prices of stocks and exchange rates. SHSE and HKSE use different currency to quote the stock prices. Therefore, we need to convert HKD to CHY of each Hong Kong Stock. Our sample period is from January 1, 2017, to December, 31, 2019 at an hourly frequency. Our final sample comprises 100 Shanghai stocks and 100 Hong Kong stocks and 936510 stock-hour observation.

We divided the sample to three terciles based on daily volume of each stock. There are 65, 68 and 66 stocks in low (T1), medium (T2) and high tercile (T3), respectively. For instance, T3 has 51 Shanghai stocks and 15 Hong Kong Stocks. There are seven AH stocks. Similarly, T1 includes only 11 Shanghai stocks and 54 Hong Kong Stocks.

Shanghai Stock Exchange has shorter trading hours than Hong Kong Stock. The auction period of Shanghai stock exchange is from 9:15am to 9:25am. The HKSE has two auction periods: from 9:00am to 9:30am and 16:00pm to 16:10pm. Continuous trading periods of Shanghai Stock Exchange is from 9:30am to 11:30am and from 13:00pm to 15:00pm. However, HKSE has longer continuous trading periods: from 9:30am to 12:00noon and from 13:00pm to 16:00pm.

5. Research Methodology

To test co-movement of return and liquidity, I mainly follow Malceniece, Malcenieks, and Putniņs (2019) methodology. The study subsamples[8] the data in to two representing the Shanghai and Hong Kong stocks on the Stock Connect to calculate the co-movement measures. I describe each measure in the following sections.

5.1. Midquote return measure:

Ince and Porter (2006) defines stock level midquote return as the log transformation of daily midquote return.

$$R_{i,h,t} = 10{,}000 * \log \frac{(bid_{i,h,t} + ask_{i,h,t})}{(bid_{i,h+1,t} + ask_{i,h+1,t})} \quad (1)$$

[7] The CES300 index comprises 100 stocks each of Shanghai, Shenzhen and Hong Kong stock exchanges.
[8] There are 3 subsamples, each one has 100 Shanghai, 100 Shenzhen and 100 Hong Kong stocks.

$R_{i,h,t,}$ is midquote stock return of stock *i* and hour *h* of day *t.* $ask_{i,t,h}, bid_{i,t,h}$ represent ask and bid quotes at the end of each hour.

5.2. Liquidity measure:

The study uses Amihud (2002) illiquidity measure of daily observations to derive the main liquidity measure. a stock that daily absolute stock return divides the (CHY) daily trading volume. $|R_{i,t,d}|/Vold_{i,t,d}$ is measure indicates price impact of trading volume and it reflects positive relationship between absolute return and expected market illiquidity. Given that, the illiquidity measure of each stock-day observations is defined as:

$$ILLIQ_{i,t} = log\left(1 + \sum_{h=1}^{H}\left(\frac{1}{H}\frac{|R_{i,t,h}|}{Vold_{i,t,h}}\right)\right) \quad (2)$$

$ILLIQ_{i,t}$ is the illiquidity of stock *i,* day *t.* $|R_{i,t,h}|$ is absolute midquote return (or absolute stock return) of a stock *i* and hour *h* of day *t.* Similarly, $Vold_{i,t,h}$ represents hourly consolidated volume. The log transformation makes the distribution of $ILLIQ_{i,t}$ closely to normal distribution. I invert the illiquidity measure multiplying *ILLIQ* by -1 as in Malceniece et al (2019), which is interpreted as liquidity:

$$LIQ_{i,t} = -1ILLIQ_{i,t} \quad (3)$$

In addition to the main measure, I use relative spread as an alternative measure in robustness tests

I follow Viljoen, Westerholm, and Zheng. (2014) to calculate relative spread measure. The relative spread of each $stock_t$ uses spread between ask_t *and* bid_t which is divided by $midquote_t$, $midquote_t$ is midpoint of sum of Ask_t and Bid_t divided by 2. I modify the measure as in Malceniece et al (2019) to include intraday hourly data frequency as follows:

$$\text{The } SPREAD_{i,t} = \sum_{h=1}^{H}\left(\frac{1}{H}10{,}000\frac{ask_{i,t,h} - bid_{i,t,h}}{(ask_{i,t,h} + bid_{i,t,h})/2}\right) \quad (4)$$

$SPREAD_{i,t}$ is the relative spread of stock *i,* day *t.* $ask_{i,t,h}, bid_{i,t,h}$ represent ask and bid quotes at the end of each hour. The denominator is the midquote end of the respective hour. The measure is calculated in basis points. Lower spread leads to increase in trading supplying more liquidity to market. The bid and ask of stock are quoted minimum ticks of continuous order.

5.3. Co-movement measure:

Following Morck et al. (2000), Hameed et al. (2010), and Karolyi et al. (2012), I measure co-movement in liquidity and return using the linear regression for each stock liquidity and return on market liquidity and return. I follow Morck, Yeung, and Yu (2000) to define regression of return of daily observation:

$$r_{i,t} = \alpha_t^r + \sum_{i=-1}^{1} \beta_{i.j}^r \, r_{m,t+j} + \sum_{i=-1}^{1} \beta_{i.j}^r \, x_{t+j} + \varepsilon_{i,t}^r \quad (5)$$

where $r_{i,t}$ is the daily midquote return for stock i, day t. $r_{m,t}$ is the market return, which is the return of CES300 index on the Stock Connect. Then x_{t+j} is daily exchange rate: Hong Kong Dollar and Chinese Yuan (HKD/CHY). The Hong Kong Dollar is pegged to the US Dollar at fixed exchange rates. However, Chinese Yuan is pegged floating exchange rate with the U.S. dollar. The exchange rate (HKD/CHY) may affect the investors' profit on the Stock Connect when it has larger fluctuation. The China-Clear uses this exchange rate for the settlement of northbound trading by Hong Kong investors.

This study measures the co-movement in return using the residuals of regression of equation 6. The high R^2 indicates higher degree of co-movement of stock return. I log transform $R^2$to explain the co-movement in return as in equation 7 below:

$$R_{i,t}^{2,r} = ln(\frac{R^2}{1-R^2}) \quad (6)$$

I follow the similar methodology as in Malceniece et al. (2019) and Karolyi et al. (2012), to calculate liquidity comovement measure. I incorporate day-of-the-week seasonality effect of each stock *i* in the equation 8 to calculate liquidity. In addition, I measure the effect of exchange rate; HKD/CHY in volume of each stock.

$$LIQ_{i,t} = \beta_i LIQ_{i,t-1} x_{t+j} + \sum_{i=1}^{5} \gamma_{i,j} D_j + \omega_{i,t}^{LIQ} \quad (7)$$

$$\widehat{\omega}_{i,t}^{LIQ} = \alpha_t^{LIQ} + \sum_{i=-1}^{1} \beta_{i,j} \, \widehat{\omega}_{m,t+j}^{LIQ} + \varepsilon_{i,t}^{LIQ} \quad (8)$$

$$R_{i,t}^{2,LIQ} = \ln(\frac{R^2}{1-R^2}) \quad (9)$$

$LIQ_{i,t}$ is the liquidity of stock i, day t. x_{t+j} is the exchange rate adjustment. D_j represent day-of -the-week dummy. I calculate $\widehat{\omega}_{i,t}^{LIQ}$, which is the equally-weighted average of all individual stocks' liquidity residuals using equation 8, Finally, I use $R^2$of residual of the equation 9 and to calculate the liquidity comovement measure: $R_{i,t}^{2,LIQ}$.

6. Discussion of results

In this section, I present the main results of the study and robustness check. The key findings indicate that Shanghai and Hong Kong stocks co-move with the Shanghai and Hong Kong Stock- Connect from 2017 to 2019. I report the descriptive statistics in Section 6.1, the co-movement in return and liquidity on the Hong Kong and Shanghai Stock Connect in Section 6.2. Then, I discuss co-movement in return, liquidity, volume and spread over the years in Section 6.3 and an examination of which market is dominant in the co-movement in Section 6.4. Finally, I discuss several robustness checks in Section 6.5.

6.1. Descriptive statistics

Table 1 presents summary statistics for six variables for each stock-day observation for 99 Shanghai and 100 Hong Kong stocks in this study. The daily midquote return, price-impact liquidity and time-weighted quoted bid-ask spread is calculated in hourly intervals. The daily volume, return and number of trades of stocks are the sum of hourly data. The standard deviation of midquote returns of each Hong Kong or Shanghai stock is calculated in hourly intraday interval. The sample is divided into three terciles, T1-T3 based on trading volume. T1(T3) contains stocks with the lowest (highest) average daily traded volume during the sample period.

Table 1 reports that stocks in 3rd tercile have the lowest stock returns among all samples, despite having the highest liquidity, number of trades, and trade volume. For example, 3rd tercile had 0.83 daily midquote return which is the lowest than 2nd tercile (1.57) and 1st tercile (1.71). However, 3rd tercile had highest daily trading volume (89.17 million) than 2nd tercile (20.09 million) and 1st tercile (4.49 million). It indicates that stocks with higher trading volume tercile accompanied by lower trading return, which is consistent with Malceniece et al. (2019) claim that, higher risk is associated with a greater probability of higher return.

Shanghai stocks have higher daily midquote return (2.14) and trading volumes (51.89 million) than Hong Kong stocks' daily midquote return (0.86) and trading volumes (22.38 million). According to Acharya and Pedersen (2005) and Anthonisz and Putninš (2017), investors require discounts when the market is more illiquid. The above result it is an evident that Shanghai stocks are more liquid than Hong Kong stocks. This may be, because of positive daily midquote return and higher daily trading volume of Shanghai stocks. Overall, this result indicates that higher stock returns associated lower trading volume.

Table1-Definitions of variables and descriptive statistics.

This table reports daily midquote return, liquidity Spread, number of trades, trading volume and standard deviation. The sample includes 200 stocks in the SHSE and HKSE (HKSE). The sample period is from January 1, 2017, to December 31, 2019, with 132273 stock-day observations. The variables are calculated for the full sample (Pooled) as well as terciles of stocks based on volume Chinese yuan. All the variables are calculated in hourly intervals and aggregated to daily. $R_{i,t}$ is the daily midquote return of each stock in daily observation. $Liq_{i,t}$ is liquidity of each stock daily calculated by Amihud's illiquidity measure. $Spread_{i,t}$ is relative spread of stock i time day. The measure is expressed in basis point and calculated as a ratio of difference between bid and ask divided by $midquote_t$. $Trade_{i,t}$ and $Volume_{i,t}$ are number of trades and trading volume (Chinese Yuan CHY in millions) of each stock in each stock day observations. $Voliatilty_{i,t}$ is measure by Standard deviation midquote returns (bps). Terciles are constructed using full sample to ensure terciles are similar in the distribution of stocks from each sub-sample stock. T1 (T3) contains stocks with the lowest (highest) average daily traded CHY volume during the sample period.

Code	Descriptive	mean pool	T1	T2	T3	SHSE	HKSE	SD within
$R_{i.}$	Daily midquote return using consolidated quotes (bps)	1.48	1.71	1.57	0.83	2.14	0.86	0.57
$Liq_{i,t}$	Price impact-based liquidity measure, calculated as the negative log of Amihud's ILLIQ	-0.05	-0.11	-0.03	-0.01	-0.03	-0.01	0.04
$Spread_{i,t}$	Time-weighted relative quoted spread for stock i in the consolidated order book (bps)	14.35	16.40	15.43	13.42	14.51	13.42	1.29
$Trade_{i,t}$	Daily number of trades in stock i consolidated across all trading venues	13.82	4.47	12.76	24.92	23.68	4.35	9.98
$Volume_{i,t}$	Daily traded HKD and CHY volume, consolidated across all trading venues	36.83	4.49	20.09	89.17	51.89	22.38	33.53
$Voliatilty_{i,t}$	Standard deviation of hourly intraday midquote returns (bps)	94.14	79.15	81.76	108.87	105.33	83.09	14.24

6.2. Comovement return and liquidity on stock Shanghai and Hong Kong Stock Connect

This section presents the co-movement of return and liquidity over the course of trading days. The co-movement is estimated regressing equations (6) and (8), and then log transforming $R^2$of residuals. However, the variables reported in Table 2 represent values before the logit transformation for simplicity. The co-movement measures relate to the hypothesis one that trading activities of Shanghai and Hong stocks impact on co-movement in return and liquidity on the Stock Connect. The use of volume weighting and a bid-ask spread and by regression daily bid-ask spread of each stock and equally weighted average of bid-ask spread in all sample results robust test measure of liquidity. The last four columns to the right of Table represents market level estimations of variables; mean market returns (in bps), market liquidity (negative log of Amihud's ILLIQ metric), market volatility (average monthly standard deviation of daily midquote returns in bps), and market-wide average traded volume (in million per stock-day observation), calculated as equally weighted averages of the respective variable for all stocks in the sample.

Table 2 reports detail information about co-movement in return and liquidity between Shanghai and Hong Kong stocks. The 2nd and 3rd tercile representing higher volume stocks shows stronger co-movement terms regarding returns, volume, and spread. A higher trading volume stock with higher correlations or co-movement in liquidity positively correlated to co-movement in spreads and returns. The Hong Kong stocks show stronger co-movement terms (return 0.4534, liquidity 0.0983 and spread 0.1181) compared to the Shanghai stocks in returns (0.3930), liquidity (0.0912), and spread (0.0037). Several reasons can lead to the this behaviour Firstly, the positive correlation between liquidity and returns, because investors prefer to sell stocks in future will consider transaction costs, which is consistent with (Amihud and Mendelson 1986; Vayanos,1998)). Where there are two stocks and one has lower bid-ask spread and higher turnover than the other, it is thus plausible that the more liquid stock would have a higher price at the current time, and hence offer lower expected stock returns. Then, the market-wide liquidity decreases as the expected returns increase. This may trigger a negative market return. (Domowitza, Hanschb and Wangc, 2005). Therefore, the above results suggest that stronger co-movement in returns will lead to stronger co-movement in liquidity.

The trading activities of Shanghai and Hong Kong stocks can impact on co-movement in return and liquidity of each other stocks, because all three terciles of both Shanghai and Hong Kong stocks have stronger co-movement in return and liquidity than Shanghai stocks and T3 has stronger co-movement in return and liquidity than Hong Kong stocks. Co-movement in return and liquidity between Shanghai and Hong Kong stocks are more than co-movement in return and liquidity of either Shanghai or Hong Kong stocks. For example. There are 0.4785 of comovement in return between Shanghai and Hong Kong stocks. The values of comovement in return in Shanghai stocks or Hong Kong stocks are 0.39 and 0.45 of. Therefore, the results confirm my first hypothesis and are consistent with Malceniece, Malcenieks, and Putniņs (2019).

Table 2 Co-movement of stocks on SHSE and HKSE – with exchange rate.

This table shows comovement of return and liquidity on SHSE and HKSE. I subsample data into Terciles average daily volume. Terciles are constructed using full sample to ensure they are similar in the distribution of stocks from each sub-sample stock. T1 (T3) contains stocks with the lowest (highest) average daily traded Chinese yuan (CHY) volume during the sample period. The table reports the mean and standard deviation (SD) of co-movement in returns (R_r^2), in price-impact based liquidity (R_{liq}^2), in quoted spreads (R_{spread}^2) and in daily volume (R_{vol}^2). The last four columns report means of market returns (in bps), market liquidity (negative log of Amihud's ILLIQ metric), market volatility (average monthly standard deviation of daily midquote returns in bps), and market-wide average traded volume (in CHY million per stock-day observation), calculated as equally weighted averages of the respective variable for all stocks in the sample.

		r_i^2		r_{LIQ}^2		r_{vol}^2		r_{spread}^2		market Return	market liquidity	market volatility	market volume
		mean	SD	Mean	SD	mean	SD	mean	SD				
All day	total pool	0.4239	0.2144	0.0946	0.1159	0.2296	0.2490	0.0863	0.1190	1.2256	-0.0448	66.7646	23.8876
	T1	0.4148	0.2012	0.0952	0.1168	0.1343	0.1666	0.0781	0.1025	1.4654	-0.0446	65.7403	23.7471
	T2	0.4299	0.2167	0.0961	0.1152	0.2233	0.2161	0.0834	0.1108	1.2408	-0.0448	66.6618	23.8864
	T3	0.4785	0.2222	0.0943	0.1132	0.3012	0.2423	0.0979	0.1409	0.9537	-0.0449	67.0575	23.9255
	SHSE	0.3930	0.2239	0.0912	0.1152	0.2995	0.2347	0.1137	0.1424	0.8051	-0.0446	66.8837	24.0464
	HKSE	0.4534	0.2005	0.0983	0.1149	0.1299	0.1512	0.1181	0.1553	1.6288	-0.0448	66.7474	23.5396

6.3. Comovement and market variables over the years

This section examines whether the co-movement of markets shows any particular patterns over the time, This investigation necessary for an important for reasons. The market landscape has changed since the inception of the connection. Shenzhen market was added to the connection on December 5th, 2016. In addition, Shanghai- Hong Kong stock connect was aimed to increase correlation between Shanghai and Hong Kong stocks. The result of the comovement in return and liquidity between SHSE and HKSE year on year can proof that the Stock Connect is successful or not. When Shanghai- Hong Kong stock connect is achieve its aim, the comovement in return and liquidity between SHSE and HKSE could be increase over the time. Therefore, this change may have potentially impacted on trading activities on the Shanghai-Hong Kong Stock Connect year on year.

The co-movement in return and liquidity between the Shanghai and Hong Kong stocks, through from 2017 to 2019 are depicted in Table 3. Table 3 reveals that the trend of co-movement in return and liquidity between Shanghai and Hong Kong stocks increased over the years. For example, the co-movement in return of all sample raised from 0.338 to 0.431 from 2017-2019. These results indicate that the Shanghai- Hong Kong Stock Connect is considerably more correlated between Shanghai and Hong Kong stocks by each year. Then, it also shows that stronger co-movement in return is along with strong co-movement in liquidity, which is consistent with the results reported in Table 2. Overall, the result shows co-movement in return and liquidity between Shanghai and Hong Kong stocks is more correlated from 2017-2019.

Table 3 Co-movement of stocks on SHSE and HKSE over the years – with exchange rate.

This table present comovement of return and liquidity on SHSE and HKSE in each year. I subsample data into Terciles average daily volume. Terciles are constructed using full sample to ensure they are similar in the distribution of stocks from each sub-sample stock. T1 (T3) contains stocks with the lowest (highest) average daily traded Chinese yuan (CHY) volume during the sample period. The table reports the mean and standard deviation (SD) of co-movement in returns (R_r^2), in price-impact based liquidity (R_{liq}^2), in quoted spreads (R_{spread}^2) and in daily volume (R_{vol}^2). The last four columns report means of market returns (in bps), market liquidity (negative log of Amihud's ILLIQ metric), market volatility (average monthly standard deviation of daily midquote returns in bps), and market-wide average traded volume (in CHY million per stock-day observation), calculated as equally weighted averages of the respective variable for all stocks in the sample. The sample includes 200 stocks in the SHSE and HKSE and sample period is from January 1, 2017, to December 31, 2019, with 132273 stock-day observation.

Year	Sample	r_i^2		r_{LIQ}^2		r_{vol}^2		r_{spread}^2		market Return	market liquidity	market volatility	market volume
		mean	SD	mean	SD	mean	SD	mean	SD				
2017	TP	0.338	0.178	0.062	0.104	0.179	0.203	0.078	0.116	2.58	-0.039	60.30	21.33
	T1	0.312	0.173	0.056	0.068	0.088	0.118	0.069	0.091	2.30	-0.047	60.32	21.29
	T2	0.342	0.183	0.058	0.086	0.111	0.152	0.073	0.112	2.75	-0.027	60.32	21.34
	T3	0.347	0.177	0.071	0.113	0.255	0.226	0.084	0.127	2.06	-0.024	60.26	21.38
	SHSE	0.322	0.173	0.062	0.108	0.265	0.229	0.071	0.114	2.05	-0.023	60.27	21.41
	HKSE	0.353	0.182	0.076	0.100	0.097	0.129	0.084	0.118	2.95	-0.050	60.33	21.16
2018	TP	0.371	0.204	0.089	0.121	0.249	0.228	0.089	0.121	-1.71	-0.050	70.53	22.21
	T1	0.368	0.196	0.074	0.085	0.173	0.185	0.083	0.108	-1.04	-0.039	70.53	21.99
	T2	0.386	0.204	0.092	0.108	0.252	0.220	0.086	0.114	-1.92	-0.008	70.49	22.34
	T3	0.394	0.203	0.099	0.101	0.325	0.250	0.100	0.138	-1.15	-0.003	70.56	22.46
	SHSE	0.350	0.207	0.092	0.120	0.297	0.243	0.082	0.123	-1.08	-0.018	70.46	22.43
	HKSE	0.396	0.201	0.101	0.115	0.202	0.201	0.097	0.118	-2.80	-0.027	70.60	21.93
2019	TP	0.431	0.224	0.109	0.114	0.269	0.247	0.093	0.107	2.89	-0.049	66.13	24.60
	T1	0.418	0.206	0.835	0.093	0.178	0.205	0.089	0.117	2.44	-0.059	66.10	24.24
	T2	0.436	0.224	0.102	0.113	0.252	0.257	0.096	0.120	2.77	-0.038	66.14	24.56
	T3	0.454	0.227	0.110	0.118	0.295	0.260	0.108	0.148	3.15	-0.033	66.17	24.93
	SHSE	0.410	0.207	0.089	0.104	0.327	0.273	0.087	0.103	2.08	-0.038	66.10	24.94
	HKSE	0.458	0.231	0.111	0.148	0.182	0.191	0.011	0.148	2.80	-0.047	66.17	24.27

6.4. Who dominance co-movement during closing hour and opening hour

In the previous section, I examine co-movement in returns and liquidity between Shanghai and Hong Kong stocks was examined. This showed that the co-movement in returns is positively correlated with the co-movement in liquidity. In this section, the Two-Stage Least Squares Estimation is used to analyse Shanghai and Hong Kong stocks to determine whether each market drives the other's stock volume, bid-ask spread, and returns. Then, I discuss whether the Global stock markets can impact the return, volume and bid-ask spreads on Shanghai and Hong Kong stocks at the first hour of the current trading day. According to Robert, Sze and Kee (2001), the US stock market played a leader role in the Pacific-Rim markets from December 1985 to December 1996. I follow Asani and RobertA (2009), they estimate the simultaneous equation system to analyse relationship between exogenous of bid-ask spread or order arrivals and sidedness. Moreover, Shanghai (Shenzhen), – Hong Kong Stock Connects did not significantly enhance the daily price co-movement between the Chinese mainland and Hong Kong or the US stock markets (Li and Chen, (2021)). Therefore, given the effect of US equity markets on trading activities in markets around the world, an adjustment was added to Panel B to allow for such effects on the connections between the returns and volumes of the S&P500 index from 2017 to 2019.

We examine in section 6.2 that the returns, volumes, and bid-ask spreads of Hong Kong stocks and Shanghai stocks at the last hour of previous trading day are exogenous. Daily returns and volumes of the S&P500 index before the opening time on the trading day are exogenous. These exogenous variables impact on the returns, volumes, and bid-ask spreads of Hong Kong stocks and Shanghai stocks at opening time of the current trading day

In Panel A of Table 4, in the first regression, the returns ($R_{i,HK,t}$ and $R_{i,SH,t}$), volumes ($V_{i,HK,t}$ and $V_{i,SH,t}$), and bid-ask spreads ($S_{i,HK,t}$ and $S_{i,SH,t}$) of Hong Kong stocks and Shanghai stocks at the first hour of opening time on the current trading day were regressed on the instrumental variables of return ($R_{i,HK,t-1}$ and $R_{i,SH,t-1}$), volumes ($V_{i,HK,t-1}$ and $V_{i,SH,t-1}$), and bid-ask spreads ($S_{i,HK,t-1}$ and $S_{i,SH,t-1}$) for Hong Kong and Shanghai stocks at the last hour of closing time of the previous day. Each observation is thus a one-hour interval i on day t. The value of $R_{US,t}$ is the midquote return of the S&P500 index on day t, while $V_{US,t}$ is the daily volume of the S&P500 index. This facilitates recalculation of the following equations:

$$R_{i,HK,t} = a_0 R_{i,HK,i-1} + \sum_{n=1}^{n} IV\left(a_1 S_{i,HK,t} + a_2 V_{i,Hk,t} + a_3 R_{i,SH,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t} + R_{US,t} + V_{US,t}\right)$$

$$S_{i,HK,t} = a_0 S_{i,HK,i-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 V_{i,Hk,t} + a_3 R_{i,SH,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t} + R_{US,t} + V_{US,t}\right)$$

$$V_{i,HK,t} = a_0 V_{i,HK,i-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 R_{i,SH,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t} + R_{US,t} + V_{US,t}\right)$$

$$R_{i,SH,t} = a_0 R_{i,SH,i-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 V_{i,HK,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t} + R_{US,t} + V_{US,t}\right)$$

$$S_{i,SH,t} = a_0 S_{i,SHi-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 V_{i,HK,t} + a_4 R_{i,SH,t} + a_5 V_{i,SH,t} + R_{US,t} + V_{US,t}\right)$$

$$V_{i,SH,t} = a_0 v_{i,SHi-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 V_{i,HK,t} + a_4 R_{i,SH,t} + a_5 S_{i,SH,t} + R_{US,t} + V_{US,t}\right)$$

Table 4 presents the simultaneous equation results for returns, volumes, and bid-ask spreads for Shanghai and Hong Kong stock in all periods. According to Ataiger and Stock (1997), two-stage least square estimates and confidence intervals of endogenous variable are unrealizable while its F-value is lower than 10 present with more than 329,000 observations. The results show that Shanghai stock return is weak variables with their F-values are lower than 10 percent. This means that the estimate and confidence intervals of the Shanghai stocks' returns in Panel A are unreliable in the second stage regressions. The F-value of the Hong Kong stocks' returns was greater than 10 present in the Second stage regression when the instrumental variables of S&P 500 returns and volumes were added, suggesting that global information can affect Hong Kong returns in the first hours of opening time in the current trading day. In particular, the instrumental variables of the S&P500 showed increased F-values for the endogenous variables of return of Hong Kong stocks, with F-values greater than 10 in both 2018 and 2019 (13.31 and 14.56, respectively).

The explanatory variables include all exogenous variables and instrumental variables, with each dependent variable being an endogenous variable affected by its instrumental variable and other dependant variables according to the second-stage regression statistics. For example, the dependent variable of Hong Kong stock returns at the first hour of opening time in the current trading day was calculated using the instrumental variable of Hong Kong stock returns along with other endogenous variables. These endogenous variables include volume and bid-ask spreads of Hong Kong stocks and returns, the volume and bid-ask spreads of Shanghai stocks

at the first hour of opening time in the current trading day and daily return and volume of S&P 500 in Panel A.

In the second stage regression, I will only present regressions where the instrument is derived from a first stage regression where the F-statistic is greater than 10 precent where the instrument is not weak is used. Firstly, there is evidence of co-determination between returns and volume in the S&P 500 index and the endogenous variable return on Hong Kong stocks in the period between the previous trading day's last hour and a given trading day's first hour between 2017 and 2019 (Panel A). The returns for Hong Kong stocks are affected by factors of slightly negative effect of S&P500 returns and significantly negative effect by S&P500 volumes, with these results holding at both the 1% and 5% levels of significance. In addition, I found that the dependent variable of Shanghai stocks' spread is also slightly negatively affected by Hong Kong stocks' spread and then the dependent variable of Hong Kong stocks' volume is not significantly affected by these instrumental variables in any period, with their significance levels are lower than 95%, reaffirming that the spread of Shanghai stocks at the first hour in one trading day is affected by the spread of Shanghai stocks in the last hour of the previous trading day. The dependent variable Hong Kong stock volume is not significantly affected by these instrumental variables in any period, however, with these links showing significance levels lower than 95%. Nevertheless, Hong Kong stocks' volumes during the last hour of the previous day and Shanghai stocks' spreads in the first hour of a given day show a positive relationship with the dependent variable Hong Kong stock volume.

In each year, the endogenous variables of volume and spread in Hong Kong and Shanghai stocks were shown to be affected by the respective instrumental variables of volume and spread in Hong Kong and Shanghai stocks in 2017 and 2018. All instrumental variables of volume and spread for Hong Kong and Shanghai stocks positively influenced endogenous variables of volume and spread, with rates of 0.15 (in 2017) and 0.12 (in 2018) between instrumental variable and endogenous variables among Hong Kong stocks' spread and 0.41 (in 2017) and 0.45 (in 2018) between instrumental variable and endogenous variables among Shanghai stock volumes. The endogenous variables reflecting the returns for Hong Kong stocks were only affected by the S&P 500 returns in 2018 and 2019, where the F-value of Hong Kong stock returns was greater than 10. The S&P 500 returns thus only slightly increased the endogenous variables representing Hong Kong stocks from 2017 to 2019.

This section indicates that there is only Shanghai stocks' return which is not affected by exogenous variables in the first stage regression. Then, it suggests that global stock market impacted on the Shanghai and Hong Kong stock markets during the first hour of the trading day. For example, S&P 500 return and volume figures are thus effective instrumental variables for calculating the returns of Hong Kong stocks in section 6.4. In addition, the results indicate that the volume and spread of Shanghai and Hong Kong stocks can be affect by their instrumental variables in each year. However, in the return parts, there are only Hong Kong stocks' return can be affected by its instrumental variables in 2018 and 2019. There are a few explanatory factors can drive their endogenous variables, such as between the instrumental variable and endogenous variables of Hong Kong stocks' spread and between the instrumental variable and endogenous variables of Shanghai stocks' volume.

Table 4 Simultaneous Equation Results: return, volume and bid-ask spread.

The table shows the autocorrelation at lag one for return, volume and bid-ask spread of Hong Kong (HK) and Shanghai (SH) stocks in all periods. The First Stage Regression Statistics are shown for hourly trading at the first hour (FH) of opening time on the current trading day and at the last hour (LH) of closing time on the previous trading day. In the first stage, the endogenous variables EV = Return, Spread and Volume} are regressed on instrumental variables IV, which are the prior hour of EV. The second-stage regression for one-hour interval ***i*** day ***t***. Panel B are shown for hourly trading activities in the opening time of the first hour in the current day and in the closing time of the last hour of in the previous day. In the first stage, the endogenous variables EV = Return, Spread and Volume} are regressed on instrumental variables IV, which are the prior hour of EV and the daily data of index and volume of S&P 500 index in the US stock exchange. The second-stage regression for one-hour interval ***i*** day ***t***. The sample comprises 100 Hong Kong stocks and a matched sample of 100 Shanghai stocks during January 3, 2017 to December 31, 2019. ** (*) indicates, at the 1% (5%) level or less, whether the coefficient estimates are significantly different from zero

Panel A: During the lunch break between 12:00 and 13:00

	First Stage Regression Statistics											
Explana-tory variable	Return_HK_FH		Spread_HK_FH		Volume_HK_FH		Return_SH_FH		Spread_SH_FH		Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_ HK_LH	-0.011	-0.95	0.000	-1.68	-0.002*	2.05	-0.006	-0.34	0.000[9]	1.260	0.000	-0.28
Spread_ HK_LH	0.059	0.38	0.094	39.13	0.031*	-2.16	0.057	0.24	-0.018**	-10.140	0.068**	3.22
Volume_ HK_LH	-0.007	-0.23	0.003**	6.54	0.113**	2.21	0.028	0.67	-0.002**	-5.480	-0.007	-1.76
Return_S H_LH	-0.01	-1.5	0.000	-1.7	0.000	0.79	-0.024*	-2.39	-0.003**	-4.930	-0.006**	-7.43
Spread_S H_LH	-0.274	-1.21	-0.025**	-7.55	-0.018	0.13	-0.604	-1.8	0.651**	251.960	0.995**	33.31
Volume_ SH_LH	-0.024	-0.93	0.001**	2.94	-0.008	-0.89	-0.0942*	-2.42	0.012**	40.590	0.47**	135.42
S&P500 return	-0.01**	-5.6	-0.002**	-6.01	0.001**	-3.62	0.000	-0.06	0.001**	4.6	-0.003**	-2.15
S&P500 volume	-8.45**	-8.87	0.052**	3.64	0.3977**	3.15	-3.659**	-2.59	0.003	0.32	-0.13	-1.03

[9] In table 4, the Est-value equals to 0, because I only keep the 3-digit.

F-value, Pr > F	13.31	<.0001	227.68	<.0001	265.64	<.0001	3.4	0.001	9827.92	<.0001	2994.27	<.0001

Table 4-Continue

	Second stage Regression Statistics											
	Dependent Variable: Return_HK_FH		Dependent Variable: Spread_HK_FH		Dependent Variable: Volume_HK_FH		Dependent Variable: Return_SH_FH		Dependent Variable: Spread_SH_FH		Dependent Variable: Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LH	-0.009	-0.65	-	-	-	-	-	-	-	-	-	-
Spread_HK_LH	-	-	0.091**	20.35	-	-	-	-	-	-	-	-
Volume_HK_LH	-	-	-	-	0.117**	9.55		-	-	-	-	-
Return_SH_LH	-	-	-	-	-	-	-0.02	-1.01	-	-	-	-
Spead_SH_LH	-	-	-	-	-	-	-	-	0.622**	69.18	-	-
Volume_SH_LH	-	-	-	-	-	-	-	-	-	-	0.467**	25.37
Return_HK_FH	-	-	0.022	0.62	0.251	0.6	0.478	0.29	-0.017	-0.39	-0.083	-0.15
Spread_HK_FH	0.403	0.2	-	-	0.261	0.48	0.249	0.09	-0.21**	-3.62	0.994	1.29
Volume_HK_FH	-0.17	-0.54	0.027**	2.980	-	-	0.255	0.61	-0.014	-1.25	-0.129	-0.87
Return_SH_FH	0.411	1.32	-0.003	-0.15	-0.104	-0.52	-	-	0.016	0.8	0.276	1.000
Spread_SH_FH	-0.072	-0.14	-0.039**	-3.31	0.034	0.25	-0.465	-0.55	-	-	1.787**	9.820
Volume_SH_FH	0.028	0.3	0.005	1.84	-0.027	-0.93	-0.160	-1.3	0.029**	9.84	-	-
S&P500 return	-0.01**	-4.6	0.000	0.14	0.004	0.72	0.006	0.28	0.001	-0.21	-0.001	-0.180
S&P500 volume	-6.89**	-4.21	0.219	0.9	2.12	0.73	0.245	0.02	-0.057	-0.19	0.17473	0.050

F-value, Pr > F	9.72	<.0001	71.2	<.0001	22.39	<.0001	3.080	0.002	1218.57	<.0001	288.86	<.0001

Table 4-Continue

Panel B: the break time between the last hour of closing time on the previous trading day and returns at the first hour of opening time in the current trading day in 2017

First Stage Regression Statistics

Explanatory variable	Return_HK_FH		Spread_HK_FH		Volume_HK_FH		Return_SH_FH		Spread_SH_FH		Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LH	0.007	0.36	-0.001*	-2.37	-0.001	-0.83	-0.001	-0.05	0.001	0.12	-0.001	-0.47
Spread_HK_LH	0.071	0.27	0.151**	38.57	0.042**	3	-0.01	-0.03	-0.021**	-6.37	0.054	1.31
Volume_HK_LH	-0.014	-0.24	0.001	0.62	0.324**	105.19	0.036	0.45	-0.001	-1.62	-0.025**	-2.84
Return_SH_LH	-0.001	-0.12	-0.002	-1.36	0.001	1.24	-0.016	-1.01	-0.002	-1.54	-0.004*	-2.5
Spread_SH_LH	-1.06**	-2.8	-0.031**	-5.62	0.026	1.3	-0.598	-1.14	0.589**	126.57	0.955**	16.58
Volume_SH_LH	-0.029	-0.77	0.001**	2.68	-0.013**	-6.72	-0.129*	-2.46	0.009**	19.34	0.408**	70.59
S&P500 return	0.077**	3.88	0.001	0.29	-0.001	-0.06	0.015	0.54	0.001	0.59	0.001	0.28
S&P500 volume	-6.08**	-3.41	-0.047	-1.8	-0.097	-1.04	-1.025	-0.42	-0.015	-0.71	0.092	0.34
F-value, Pr > F	4.63	<.0001	197.59	<.0001	1392.95	<.0001	1.41	0.1852	2360.09	<.0001	768.33	<.0001

Table 4-Continue

	Second stage Regression Statistics											
	Dependent Variable: Return_HK_FH		Dependent Variable: Spread_HK_FH		Dependent Variable: Volume_HK_FH		Dependent Variable: Return_SH_FH		Dependent Variable: Spread_SH_FH		Dependent Variable: Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LH	0.007309	0.38	-	-	-	-	-	-	-	-	-	-
Spread_HK_LH	-	-	0.153*	5.49	-	-	-	-	-	-	-	-
Volume_HK_LH	-	-	-	-	0.322**	31.81		-	-	-	-	-
Return_SH_LH	-	-	-	-	-	-	-0.017	-1.03	-	-	-	-
Spead_SH_LH	-	-	-	-	-	-	-	-	0.566**	11.89	-	-
Volume_SH_LH	-	-	-	-	-	-	-	-	-	-	0.418**	11.78
Return_HK_FH	-	-	-0.089	-0.35	-0.102	-0.31	-0.23	-0.06	-0.004	-0.07	-0.104	-0.11
Spread_HK_FH	0.266	0.15	-	-	0.333	1.38	0.00	0	-0.14**	-3.53	0.69	0.98
Volume_HK_FH	-0.061	-0.32	-0.005	-0.2	-	-	0.074	0.23	-0.003	-0.57	-0.105	-1.13
Return_SH_FH	0.101	0.15	0.022	0.33	-0.028	-0.32	-	-	0.009	0.7	0.243	0.9
Spread_SH_FH	-1.672	-2.05	-0.204	-0.47	-0.073	-0.13	-0.929	-0.14	-	-	1.728	1.02
Volume_SH_FH	-0.006	-0.02	0.009	0.4	-0.049	-1.66	-0.309	-1.57	0.025**	5	-	-
S&P500 return	0.075**	3.39	0.007	0.34	0.008	0.33	0.033	0.11	0.001	0.07	0.005	0.07
S&P500 volume	-5.99**	-3.15	-0.57	-0.37	-0.73	-0.36	-2.402	-0.1	-0.037	-0.13	-0.245	-0.04

F-value, Pr > F	4.55	<.0001	4.69	<.0001	238.7	<.0001	1.36	0.207	1023.83	<.0001	130.6	<.0001

Table 4-Continue

Panel C: the break time between the last hour of closing time on the previous trading day and returns at the first hour of opening time in the current trading day in 2018

First Stage Regression Statistics

	Return_HK_FH		Spread_HK_FH		Volume_HK_FH		Return_SH_FH		Spread_SH_FH		Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LH	-0.001	-0.01	0.001	0.47	0.001	0.56	-0.017	-0.52	0.001	0.41	-0.001	-0.46
Spread_HK_LH	0.025	0.47	0.008**	9.29	0.157**	31.97	0.053	0.7	-0.003*	-5.08	-0.004	-0.71
Volume_HK_LH	-0.023	-1.74	-0.001*	-2.33	-0.002	-1.43	-0.024	-1.3	-0.001**	-3.3	-0.01	-6.68
Return_SH_LH	-0.337	-0.78	-0.037**	-5.51	0.101*	2.55	-0.963	-1.55	0.681**	160.96	0.994**	19.69
Spread_SH_LH	0.005	0.09	0.002*	2.39	0.001	0.2	-0.062	-0.81	0.012**	22.26	0.472**	76.17
Volume_SH_LH	0.089**	9.23	-0.001	-0.79	0.000041	0.05	0.0013	0.1	-0.001	-1.59	0.001	0.05
S&P500 return	-10.1**	-6.03	0.02974	1.14	0.516**	3.38	-1.988	-0.83	0.001	0.04	0.025	0.13
S&P500 volume	1.01	0.4194	98.59	<.0001	152.14	<.0001	1.14	-1.54	5975.24	<.0001	1575.8	<.0001
F-value, Pr > F	13.310	<.0001	227.68	<.0001	265.64	<.0001	3.4	0.001	9827.92	<.0001	2994.27	<.0001

Table 4-Continue

Second stage Regression Statistics												
Explanatory variable	Dependent Variable: Return_HK_FH		Dependent Variable: Spread_HK_FH		Dependent Variable: Volume_HK_FH		Dependent Variable: Return_SH_FH		Dependent Variable: Spread_SH_FH		Dependent Variable: Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LH	0.016	0.4	-	-	-	-	-	-	-	-	-	-
Spread_HK_LH	-	-	0.116**	5	-	-	-	-	-	-	-	-
Volume_HK_LH	-	-	-	-	0.142**	15.54		-	-	-	-	-
Return_SH_LH	-	-	-	-	-	-	6.935	0	-	-	-	-
Spead_SH_LH	-	-	-	-	-	-	-	-	0.659**	41.72	-	-
Volume_SH_LH	-	-	-	-	-	-	-	-	-	-	0.451**	12.45
Return_HK_FH	-	-	0.025	0.48	0.088	0.41	297.37	0	0.018	0.51	0.309	0.62
Spread_HK_FH	-4.114	-0.8	-	-	1.997**	2.29	833.72	0	0.039	0.27	1.401	0.66
Volume_HK_FH	0.051	0.07	0.047**	3.63	-	-	-84.84	0	-0.018	-1.78	-0.144	-0.94
Return_SH_FH	0.946	1.07	-0.008	-0.18	-0.047	-0.25	-	-	-0.008	-0.27	0.081	0.18
Spread_SH_FH	0.403	0.24	-0.067	-1.72	0.262	1.76	220.92	0	-	-	1.824**	4.38
Volume_SH_FH	0.1414	0.61	0.004	0.68	-0.02	-0.59	-11.82	0	0.023**	4.26	-	-
S&P500 return	0.088**	5.38	-0.002	-0.51	-0.007	-0.39	-26.43	0	-0.002	-0.57	-0.027	-0.62
S&P500 volume	-8.083*	-2.36	0.242	0.55	1.248	0.68	3007.38	0	0.168	0.58	3.331	0.79
F-value, Pr > F	7	<.0001	25.44	<.0001	55.8	<.0001	0	1	722.64	<.0001	109.35	<.0001

Table 4-Continue

Panel D: the break time between the last hour of closing time on the previous trading day and returns at the first hour of opening time in the current trading day in 2019												
First Stage Regression Statistics												
Explanatory variable	Return_HK_FH		Spread_HK_FH		Volume_HK_FH		Return_SH_FH		Spread_SH_FH		Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LH	-0.043*	-2.29	-0.001	-1.11	-0.007**	-3.67	-0.002	-0.07	0.001	1.45	0.001	0.57
Spread_HK_LH	0.411	1.62	0.023**	6.34	-0.037	-1.41	-0.03	-0.07	-0.03**	-9.57	0.077*	2.502
Volume_HK_LH	-0.022	-0.55	0.002**	3.32	-0.015**	-3.55	0.004	0.05	-0.001	-1.37	0.001	0.2
Return_SH_LH	-0.007	-0.64	0.001	1.04	0.001	0.63	-0.032	-1.8	-0.001**	-3.71	-0.006**	-4.04
Spread_SH_LH	0.472	1.31	-0.009	-1.76	-0.245**	-6.54	-0.347	-0.59	0.666**	147.22	0.937**	19.67
Volume_SH_LH	-0.052	-1.12	-0.001	-0.06	-0.011*	-2.36	-0.08	-1.05	0.0172**	29.54	0.556**	90.76
S&P500 return	0.106**	10.15	0.001	0.14	0.001	0.71	0.02	1.17	-0.001	-0.63	0.001	1.05
S&P500 volume	3.651*	2.2	-0.011	-0.45	0.361*	2.09	-7.501**	-2.76	0.016	0.79	-0.227	-1.03
F-value, Pr > F	14.56	<.0001	8.84	<.0001	12.05	<.0001	1.87	0.0607	3627.86	<.0001	1357.66	<.0001

Table 4-Continue

Second stage Regression Statistics												
Explanatory variable	Dependent Variable: Return_HK_FH		Dependent Variable: Spread_HK_FH		Dependent Variable: Volume_HK_FH		Dependent Variable: Return_SH_FH		Dependent Variable: Spread_SH_FH		Dependent Variable: Volume_SH_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat

Return_HK_LH	0.006	0.11	-	-	-	-	-	-	-	-	-	-
Spread_HK_LH	-	-	-0.003	-0.1	-	-	-	-	-	-	-	-
Volume_HK_LH	-	-	-	-	0.002	0.11		-	-	-	-	-
Return_SH_LH	-	-	-	-	-	-	-0.059	-0.13	-	-	-	-
Spead_SH_LH	-	-	-	-	-	-	-	-	2.395	0.04	-	-
Volume_SH_LH	-	-	-	-	-	-	-	-	-	-	0.565	2.46
Return_HK_FH	-	-	0.038	0.87	0.21	1.35	-1.769	-0.06	-0.894	-0.03	1.528	0.12
Spread_HK_FH	31.335	1.15	-	-	-6.216	-1.28	51.103	0.06	21.265	0.03	-40.279	-0.1
Volume_HK_FH	5.606	0.83	-0.189	-0.96	-	-	8.946	0.06	4.314	0.03	-7.674	-0.12
Return_SH_FH	0.456	0.83	-0.016	-0.73	-0.091	-0.8	-	-	0.401	0.03	-0.482	-0.08
Spread_SH_FH	3.477	1.15	-0.121	-1.07	-0.661	-2.27	5.137	0.06	-	-	-3.319	-0.08
Volume_SH_FH	-0.018	-0.1	0.001	0.17	0.006	0.17	-0.28	-0.11	0.094	0.04	-	-
S&P500 return	0.092**	4.36	-0.004	-0.82	-0.0196	-1.24	0.199	0.07	0.082	0.03	-0.144	-0.12
S&P500 volume	5.337	1.17	-0.202	-0.79	-1.149	-0.84	-3.842	-0.06	4.995	0.03	-7.055	-0.1
F-value, Pr > F	6.53	<.0001	0.66	0.73	1.44	0.176	0.66	0.725	0.36	0.9438	5.62	<.0001

6.5. Robustness check

In this section, I examine the validity of the results reported in the previous sections. First, the study calculates the comovement in return and liquidity between SHSE and HKSE without effect of exchange rate. Second, the study indicates that the Shanghai and Hong Kong stocks can drive each other return, volume and bid-ask spread during the lunchtime break except the effect of the US stock market. Third, we divide the hour trading data of Shanghai and Hong Kong stocks to morning and afternoon. Then, it calculates comovement in return and liquidity between SHSE and HKSE in the morning and afternoon effect.

6.5.1. Effects of exchange rates

This section discusses whether the daily exchange rate (HKD/CHY) affects co-movement in returns and liquidity between the SHSE and HKSE. As noted in the introduction, the China-clear calculates a transaction exchange rate that is then used to calculate the Northbound trading returns of Hong Kong stocks. The fluctuation of the HKD/CHY exchange rate may thus be an independent factor affecting the observed co-movement in returns and liquidity. An independent variable of exchange rate (x_{t+j}) was thus added to equations (6) and (8). The data from Table 2, Daily liquidity of Hong Kong stock multiples exchange rate (HKD/CHY), was also used in equation (8). This allowed the listing of an independent variable of exchange rate (x_{t+j}) in Table 6, with the Hong Kong Dollar used to calculate co-movement in volumes and market volumes.

Table 5 shows that the co-movement in returns and liquidity assessed without exchange rates are lower than the co-movements in returns and liquidity with exchange rate, as Hong Kong stocks offer higher daily midquote returns without exchange rates. All samples and terciles in Table 2 show greater co-movement in returns and liquidity than those in Table 5. However, Shanghai and Hong Kong stocks show similar levels of co-movement in returns and liquidity in both. Table 5 shows generally higher market returns and volatility than Table 2. Finally, when the full trading volume is adjusted to consistent use of the Hong Kong dollar in Table 5, the same co-movements in volume and spread are seen as in Table 2. As the exchange rate (HKD/CHY) is equal to 1/exchange rate (CHY/HKD), when swapping from CHY to HKD in terms of trading volume and spread, the same co-movement in volume and spread is seen in Table 2 and Table 6. Overall, Table 6 shows lower co-movement in returns and liquidity than

Table 2 with the exchange rate excluded; similar co-movement in volume and spread is seen between the tables.

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Table 5 Descriptive statistics of variables for SHSE and HKSE without the effect of exchange rates.

Terciles are constructed using full sample to ensure terciles are similar in the distribution of stocks from each sub-sample stock. T1 (T3) contains stocks with the lowest (highest) average daily traded CHY volume during the sample period. The table reports the mean and standard deviation (SD) of co-movement in returns (R_r^2), in price-impact based liquidity (R_{liq}^2), in quoted spreads (R_{spread}^2) and in daily volume (R_{vol}^2). The last four columns report means of market returns (in bps), market liquidity (negative log of Amihud's ILLIQ metric), market volatility (average monthly standard deviation of daily midquote returns in bps), and market-wide average traded volume (in HKD million per stock-day observation), calculated as equally weighted averages of the respective variable for all stocks in the sample. The sample includes 200 stocks in the Shanghai and HKSE and is from January 1, 2017, to December 31, 2019, with 132273 stock-day observation.

		r_i^2		r_{LIQ}^2		r_{vol}^2		r_{spread}^2		Market return	Market liquidity	Market volatility	Market volume
		mean	SD	mean	SD	mean	SD	mean	SD				
All day	total pool	0.3939	0.1869	0.0856	0.1069	0.2294	0.2479	0.0863	0.1190	1.5256	-0.0388	73.7646	27.145
	T1	0.3548	0.1624	0.0816	0.1048	0.1346	0.1886	0.0781	0.1025	1.6654	-0.0386	72.7403	26.985
	T2	0.3912	0.1813	0.0876	0.1055	0.2243	0.2171	0.0834	0.1108	1.4076	-0.0388	73.6618	27.143
	T3	0.4285	0.2066	0.0893	0.1071	0.3120	0.2426	0.0979	0.1409	1.0537	-0.0389	73.8575	27.188
	SHSE	0.3897	0.2086	0.0921	0.1153	0.2985	0.2367	0.1137	0.1424	0.8005	-0.0386	77.8537	27.325
	HKSE	0.4482	0.2154	0.0983	0.1820	0.1288	0.1521	0.1181	0.1553	1.7988	-0.0388	73.0736	26.749

6.5.2. Lunchtime dynamics

In this section, I discuss the hypothesis (2) whether Shanghai and Hong Kong stocks can drive each other return, volume and bid-ask spread when I ignore the global stock market. The trading hours of Shanghai and Hong Kong stock markets in the afternoon coincide with a break period for The US and European stock markets. Therefore, I examine the returns, volumes, and bid-ask spreads of the Hong Kong and Shanghai stocks before the lunch break and after lunch break. For this investigation, I divided the stocks into two subsamples, Shanghai and Hong Kong Stocks in Panel A. In the first stage, the returns, volumes, and bid-ask spreads of the Hong Kong and Shanghai stocks at the first trading hour after lunch break were regressed on the contemporary variables of returns, volumes, and bid-ask spreads at closing time in the last trading hour before lunch break. where $R_{i,HK,t}$, $S_{i,HK,t}$, and $V_{i,HK,t}$ are the return, spread, and volume for stock i on the HKSE on hour t and $R_{i,SH,t}$, $S_{i,SH,t}$ and $V_{i,SH,t}$ are the return, spread, and volume for stock i in the Shanghai stock exchange on the same hour. Each observation is thus a one-hour interval i on day t.

$$R_{i,HK,t} = a_0 R_{i,HK,i-1} + \sum_{n=1}^{n} IV\left(a_1 S_{i,HK,t} + a_2 V_{i,Hk,t} + a_3 R_{i,SH,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t}\right)$$

$$S_{i,HK,t} = a_0 S_{i,HK,i-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 V_{i,Hk,t} + a_3 R_{i,SH,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t}\right)$$

$$V_{i,HK,t} = a_0 V_{i,HK,i-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 R_{i,SH,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t}\right)$$

$$R_{i,SH,t} = a_0 R_{i,SH,i-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 V_{i,HK,t} + a_4 S_{i,SH,t} + a_5 V_{i,SH,t}\right)$$

$$S_{i,SH,t} = a_0 S_{i,SHi-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 V_{i,HK,t} + a_4 R_{i,SH,t} + a_5 V_{i,SH,t}\right)$$

$$V_{i,SH,t} = a_0 v_{i,SHi-1} + \sum_{n=1}^{n} IV\left(a_1 H_{i,HK,t} + a_2 S_{i,Hk,t} + a_3 V_{i,HK,t} + a_4 R_{i,SH,t} + a_5 S_{i,SH,t}\right)$$

Unlike section 6.4, Table 6 only presents the simultaneous equation results for returns, volumes, and bid-ask spreads over the lunch breaks for all period each year (2017, 2018, and 2019). Table 7 thus ignores the instrumental variables S&P500 returns and volumes, as the European and the US stock markets are generally inactive while the SHSE and HKSE break

for lunch between 12:00 and 13:00. Ignoring the return and volume of S&P 500 leads to F-values of Shanghai and Hong Kong stock returns which were both less than 10. It is demonstrating that Shanghai and Hong Kong stock returns are weak instrumental variables.

In the second-stage regressions, only three types of data had significance levels higher than 95% in Panel A of Table 6; there are positively effect between spread of Shanghai stocks in the last hour before lunchtime or slightly positive between volume of shanghai stocks in the first time after lunchtime and dependent variable of Shanghai stocks' spread in all period and each year, with the rate of 0.695 (in all periods), 0.695 (in 2017), 0.654 (in 2018) and 0.672 (in 2019). Then the dependent variable of Shanghai stocks' volume is positively affected by volume of shanghai stocks in the last hour after lunchtime, with the rate of 0.026 (in all periods), 0.031 (in 2017) and 0.029 (in 2019). Therefore, these rates represent that the instrumental and exogenous variables slight impact on the dependent variable between the break of lunchtimes. From 2017 to 2019, the instrumental variables Shanghai stock volume and Hong Kong stock spread were thus seen to slightly affect the spread of Shanghai stocks during the first hour in the afternoon based on first-stage regression statistics. The results also show that the dependent variables representing the volume and spread of Hong Kong and Shanghai stocks are affected by the relevant instrumental variables in the second stage. For example, there is a positive link between Shanghai stocks' spread in the last hour in the morning and the spread of those stocks in the first hour of the afternoon for the period 2017 to 2019, The explanatory variables showed similar effects on dependent variables across the period 2017 to 2019, with explanatory variables showing significance at the 95% level. In this section, I think that the spread and volume of Shanghai and Hong Kong stocks can drive each other spread and volume. Ignoring the US and European stock markets, the return of Shanghai and Hong Kong stocks cannot be affected by return, spread and volume of these stocks

Table 6 Simultaneous Equation Results: return, volume and bid-ask spread in During the lunch break in all periods and each year.

The table shows the autocorrelation at lag one for return, volume and bid-ask spread of Hong Kong (HK) and Shanghai (SH) stocks in all periods and each year. Panel A (from 2017 to 2019), Panel B (2017), Panel C (2018) and Panel D(2019), are shown for hourly trading activities in the opening time of the first hour (FH) after lunch break (LB) and in the closing time of the last hour (LH) of before lunch break (LB) from 2017-2019, in 2017, in 2018 and in 2019. In the first stage, the endogenous variables EV = Return, Spread and Volume} are regressed on instrumental variables IV, which are the prior hour of EV. The second-stage regression for one-hour interval ***i*** day ***t***. The sample comprises 100 Hong Kong stocks and a matched sample of 100 Shanghai stocks during January 3, 2017 to December 31, 2019. ** (*) indicates, at the 1% (5%) level or less, whether the coefficient estimates are significantly different from zero

Panel A: During the lunch break between 12:00 and 13:00

First Stage Regression Statistics

Explanatory variable	Return_HK		Spread_HK		Volume_HK		Return_SH		Spread_SH		Volume_SH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	-0.002	-0.43	-0.003**	-2.6	-0.002**	-3.39	-0.001	-0.09	0.001	0.39	0.001	0.58
Spread_HK_LB_LH	-0.258*	-2.24	0.139**	43.07	0.132**	7.29	-0.309	-1.83	-0.01**	-3.29	0.041	1.45
Volume_HK_LB_LH	0.026	1.02	0.001**	5.29	0.182**	44.77	-0.077*	-2.05	0.001	0.79	-0.002	-0.24
Return_SH_LB_LH	-0.004	-1.01	-0.001	-0.6	0.001	0.27	-0.011*	-2.04	0.001	1.3	-0.008**	-9.54
Spread_SH_LB_LH	-0.111	-1.26	-0.049**	-19.7	-0.114**	-8.09	-0.014	-0.1	0.725*	297.31	1.013**	45.4
Volume_SH_LB_LH	0.004	0.16	0.001	1.34	0.005	1.18	-0.014	-0.37	0.026**	36.58	0.949**	148.74
F-value, Pr > F	1.36	0.226	409.94	<.0001	380.17	<.0001	2.23	0.037	16856.7	<.0001	4871.56	<.0001

Table 6-Continue

	Second stage Regression Statistics											
	Dependent Variable: Return_HK_LB_FH		Dependent Variable: Spread_HK_LB_FH		Dependent Variable: Volume_HK_LB_FH		Dependent Variable: Return_SH_LB_FH		Dependent Variable: Spread_SH_LB_FH		Dependent Variable: Volume_SH_LB_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	-0.001	-0.280	-	-	-	-	-	-	-	-	-	-
Spread_HK_LB_LH	-	-	0.187	0.750	-	-	-	-	-	-	-	-
Volume_HK_LB_LH	-	-	-	-	0.119	0.820	-	-	-	-	-	-
Return_SH_LB_LH	-	-	-	-	-	-	-0.007	-0.480	-	-	-	-
speadS_LB_LH	-	-	-	-	-	-	-	-	0.695**	17.330	-	-
voluemS_LB_LH	-	-	-	-	-	-	-	-	-	-	0.9402**	6.630
Return_HK_LB_FH	-	-	0.260	0.210	1.011	0.410	1.000	0.270	0.039	0.150	-1.727	-0.200
Spread_HK_LB_FH	-1.434	-1.200	-	-	2.049	0.690	0.195	0.030	-0.091	-0.250	-0.500	-0.040
Volume_HK_LB_FH	0.319	1.450	-0.052	-0.140	-	-	-0.575	-0.760	-0.020	-0.230	0.847	0.290
Return_SH_LB_FH	0.337	0.910	-0.084	-0.190	-0.358	-0.390	-	-	-0.046	-0.470	1.406	0.420
Spread_SH_LB_FH	-0.220	-1.150	-0.038	-0.240	0.149	0.230	0.086	0.080	-	-	1.252	0.720
Volume_SH_LB_FH	0.015	0.450	0.000	0.000	-0.011	-0.200	-0.018	-0.260	0.0262**	7.930	-	-
F-value, Pr > F	1.090	0.363	3.840	0.001	7.190	<.0001	1.520	0.168	1864.97	<.0001	41.670	<.0001

Table 6-Continue

Panel B: During the lunch break between 12:00 and 13:00 in 2017

First Stage Regression Statistics

	Return_HK		Spread_HK		Volume_HK		Return_SH		Spread_SH		Volume_SH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	0.001	0.23	-0.001	-1.4	-0.001	-1.79	-0.006	-0.6	-0.001	-0.32	-0.001	-0.53
Spread_HK_LB_LH	-0.419*	-2.41	0.08**	15.95	0.332**	14.1	-0.575*	-2.02	-0.014*	-2.7	-0.037	-0.79
Volume_HK_LB_LH	0.001	0.01	-0.006**	-7.15	-0.036**	-7.91	-0.021	-0.38	-0.001	-1.1	-0.025**	-2.87
Return_SH_LB_LH	-0.004	-0.69	0.001	0.2	0.001	0.72	-0.009	-1.02	-0.001	-0.26	-0.006**	-4.49
Spread_SH_LB_LH	0.179	1.21	-0.04**	-9.56	-0.178*	-8.82	0.142	0.58	0.734**	165.12	1.065**	26.9
Volume_SH_LB_LH	0.017	0.4	-0.001	-0.7	-0.023**	-4.14	-0.002	-0.03	0.022**	18.02	0.869**	78.33
F-value, Pr > F	1.48	0.1821	62.88	<.0001	57.78	<.0001	1.14	0.3378	5086.71	<.0001	1374.72	<.0001

Table 6-Continue

	Second stage Regression Statistics											
	Dependent Variable: Return_HK_LB_FH		Dependent Variable: Spread_HK_LB_FH		Dependent Variable: Volume_HK_LB_FH		Dependent Variable: Return_SH_LB_FH		Dependent Variable: Spread_SH_LB_FH		Dependent Variable: Volume_SH_LB_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	0.004	0.45	-	-	-	-	-	-	-	-	-	-
Spread_HK_LB_LH	-	-	0.022	0.84	-	-	-	-	-	-	-	-
Volume_HK_LB_LH	-	-	-	-	-0.012	-0.6		-	-	-	-	-
Return_SH_LB_LH	-	-	-	-	-	-	-0.018	-0.35	-	-	-	-
speadS_LB_LH	-	-	-	-	-	-	-	-	0.695**	47.98	-	-
voluemS_LB_LH	-	-	-	-	-	-	-	-	-	-	0.768**	6.07
Return_HK_LB_FH	-	-	0.017	0.2	0.017	0.2	-1.504	-0.14	-0.001	-0.02	0.734	0.38
Spread_HK_LB_FH	-5.611	-0.183	-	-	-0.218	-0.3	-81.177	-0.34	-1.325	-0.79	18.415	0.65
Volume_HK_LB_FH	0.801	0.121	0.199**	4.07	-	-	15.868	0.35	0.265	0.78	-3.028	-0.52
Return_SH_LB_FH	0.412	0.681	-0.003	-0.08	0.057	0.26	-	-	-0.006	-0.14	0.295	0.35
Spread_SH_LB_FH	-0.007	-0.022	-0.019	-1.1	0.019	0.23	-0.684	-0.33	-	-	1.506**	5.52
Volume_SH_LB_FH	0.037	0.221	0.004	1.83	-0.019	-1.04	0.392	0.32	0.031**	3.72	-	-
F-value, Pr > F	0.99	0.428	29.66	<.0001	12.46	<.0001	0.22	0.9712	1276.38	<.0001	81.12	<.0001

Table 6-Continue

Panel C: During the lunch break between 12:00 and 13:00 in 2018												
First Stage Regression Statistics												
	Return_HK		Spread_HK		Volume_HK		Return_SH		Spread_SH		Volume_SH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	-0.01	-1.2	-0.001	-2.06	-0.003	-2.65	0.017	1.31	0.001	0.41	0.002	1.19
Spread_HK_LB_LH	-0.435	-1.75	0.13**	19.25	0.214**	5.88	-0.197	1.55	0.005	0.88	0.13*	2.49
Volume_HK_LB_LH	0.063	0.88	0.003	1.46	0.299**	28.55	-0.043	-0.61	0.001	0.64	0.069**	4.59
Return_SH_LB_LH	-0.006	-0.86	0.001	0.47	-0.001	-0.57	0.005	-0.46	0.001	1.79	-0.011**	-7.22
Spread_SH_LB_LH	-0.006	-0.04	-0.066**	-14.35	-0.093**	-3.8	-0.17	0.52	0.731**	179.51	0.914**	25.66
Volume_SH_LB_LH	-0.01	-1.2	-0.001*	-2.06	-0.003	-2.65	0.017	1.31	0.002	0.41	0.002	1.19
F-value,Pr > F	1.01	0.4194	98.59	<.0001	152.14	<.0001	1.14	-1.54	5975.24	<.0001	1575.8	<.0001

Table 6-Continue

	Second stage Regression Statistics											
	Dependent Variable: Return_HK_LB_FH		Dependent Variable: Spread_HK_LB_FH		Dependent Variable: Volume_HK_LB_FH		Dependent Variable: Return_SH_LB_FH		Dependent Variable: Spread_SH_LB_FH		Dependent Variable: Volume_SH_LB_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	0.014	0.19	-	-	-	-	-	-	-	-	-	-
Spread_HK_LB_LH	-	-	0.089	0.87	-	-	-	-	-	-	-	-
Volume_HK_LB_LH	-	-	-	-	0.291**	7.39		-	-	-	-	-
Return_SH_LB_LH	-	-	-	-	-	-	-0.005	-0.28	-	-	-	-
speadS_LB_LH	-	-	-	-	-	-	-	-	0.654*	3.81	-	-
voluemS_LB_LH	-	-	-	-	-	-	-	-	-	-	1.359	0.57
Return_HK_LB_FH	-	-	-0.061	-0.35	-0.039	-0.06	-1.474	-0.97	-0.171	-0.35	5.686	0.2
Spread_HK_LB_FH	-5.553	-0.86	-	-	1.229	0.41	-6.699	-1.01	-0.757	-0.32	27.073	0.2
Volume_HK_LB_FH	0.089	0.13	0.015	0.42	-	-	0.262	0.42	0.028	0.27	-0.648	-0.14
Return_SH_LB_FH	-1.503	-0.37	-0.061	-0.51	-0.183	-0.35	-	-	-0.114	-0.3	4.138	0.19
Spread_SH_LB_FH	-0.641	-0.55	-0.097**	3.42	-0.064	-0.2	-0.661	-0.87	-	-	4.625	0.28
Volume_SH_LB_FH	-0.167	-0.39	-0.004	-0.22	0.005	0.07	-0.125	-1.01	0.01	0.19	-	-
F-value, Pr > F	0.21	0.9745	6.88	<.0001	40.72	<.0001	0.49	0.817	66.72	<.0001	1.14	0.3382

Table 6-Continue

Panel D: During the lunch break between 12:00 and 13:00 in 2019

First Stage Regression Statistics

	Return_HK		Spread_HK		Volume_HK		Return_SH		Spread_SH		Volume_SH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	0.002	0.33	-0.001	-1.07	-0.002	-1.61	-0.011	-1.03	0.001	0.59	0.001	0.19
Spread_HK_LB_LH	-0.029	-0.16	0.216**	42.66	0.051	1.55	-0.171	-0.62	-0.017**	-3.33	0.0574	1.15
Volume_HK_LB_LH	0.039	0.96	0.021**	18.45	0.396**	54.54	-0.149*	-2.42	0.003*	2.24	-0.001	-0.13
Return_SH_LB_LH	-0.001	-0.28	-0.001	-1.56	0.001	0.55	-0.026**	-2.98	0.001	0.63	-0.007**	-4.71
Spread_SH_LB_LH	-0.427	-2.9	-0.042**	-10.31	-0.115**	-4.39	0.025	0.11	0.71**	168.82	1.071**	26.23
Volume_SH_LB_LH	0.024	0.6	0.002	1.53	0.004	0.57	0.052	0.84	0.029**	25.48	1.01**	91.31
F-value,Pr > F	1.58	0.1475	410.02	<.0001	504.68	<.0001	2.85	0.009	5765.89	<.0001	1890.58	<.0001

Table 6-Continue

	Second stage Regression Statistics											
	Dependent Variable: Return_HK_LB_FH		Dependent Variable: Spread_HK_LB_FH		Dependent Variable: Volume_HK_LB_FH		Dependent Variable: Return_SH_LB_FH		Dependent Variable: Spread_SH_LB_FH		Dependent Variable: Volume_SH_LB_FH	
	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat	Est	T-stat
Return_HK_LB_LH	0.003	0.42	-	-	-	-	-	-	-	-	-	-
Spread_HK_LB_LH	-	-	0.214**	31.89	-	-	-	-	-	-	-	-
Volume_HK_LB_LH	-	-	-	-	0.425**	3.86	-	-	-	-	-	-
Return_SH_LB_LH	-	-	-	-	-	-	-0.007	-0.48	-	-	-	-
speadS_LB_LH	-	-	-	-	-	-	-	-	0.672**	19.09	-	-
voluemS_LB_LH	-	-	-	-	-	-	-	-	-	-	0.908**	7.97
Return_HK_LB_FH	-	-	0.007	0.09	-0.791	-0.37	1.001	0.27	-0.007	-0.09	1.101	0.42
Spread_HK_LB_FH	-0.187	-0.22	-	-	0.068	0.08	0.195	0.03	-0.099	-3.23	0.782	0.7
Volume_HK_LB_FH	0.132	0.94	0.056**	6.16	-	-	-0.575	-0.76	0.009	0.84	-0.085	-0.23
Return_SH_LB_FH	0.052	0.23	0.01	1.42	0.011	0.06	-	-	-0.011	-1.5	0.218	0.86
Spread_SH_LB_FH	-0.653	-2.58	-0.051	-1.03	-0.699	-0.48	0.086	0.08	-	-	2.196	1.39
Volume_SH_LB_FH	0.039	0.88	0.002	0.68	0.042	0.44	-0.018	-0.26	0.029**	13.59	-	-
F-value,Pr > F	1.57	0.151	322.58	<.0001	24.23	<.0001	0.28	0.9487	4249.93	<.0001	106.23	<.0001

6.5.3. Co-movement and market variables in the morning and afternoon

This section examines whether co-movement in return and liquidity on the Shanghai and Hong Kong stocks have differences between in the morning and afternoon, because HKSE has longer daily trading hours than the Shanghai Stock Exchange,[10]. Equations (7) and (9) estimate co-movement terms and market variables in the morning and afternoon. All trading times were thus assigned to one of these two trading periods, with the morning sub-sample running from 9:00 to 12:00 and the afternoon sub-sample running from 13:00 to 16:00. Therefore, I discuss whether co-movement in return and liquidity between Shanghai and Hong Kong stocks may be different in the morning and afternoon.

Two tables were then developed to analyse the co-movement in return and liquidity and market variables (return, liquidity, volume and spread) for each year for the morning sub-sample and afternoon sub-sample. Table 7 shows the co-movement in return and liquidity and market variables for theSHSE and HKSE in the morning for four periods: all three years (2017 to 2019), 2017, 2018, and 2019. Table 7 thus illustrates that there are differences between these periods, but that all terciles show some co-movement in the returns. T3 had the highest co-movement in returns across the period, while T2 had the highest co-movement in returns in 2017 and 2019. In contrast, T1 had the highest co-movement in returns in 2018. According to this data, T2 also had the highest number of AH stocks in both 2017 (10) and 2019 (9), while T1 had the highest number of AH stocks in 2018 (10). This suggests that AH stocks could influence co-movement in returns when Shanghai and Hong Kong stocks have lower trading volumes in the morning. Moreover, examining the liquidity co-movement measures also suggests that the highest trading volume among the terciles is not related to the highest co-movement in liquidity in each year. This suggests that global information affects both Shanghai and Hong Kong stocks, including political news, economic policy, and global emergencies. As discussed in section 5.3, the results show that the US S&P 500 index volume and returns affect the volume and spread of both Shanghai and Hong Kong stocks as trading opens for the day, though for Hong Kong stocks, this effect occurs only in the opening hour of such trading time.

[10] The continuous trading periods of the Shanghai Stock Exchange are from 9:30 to 11:30 and from 13:00 to 15:00, while the HKSE has longer continuous trading periods, from 9:30 to 12:00 and 13:00 to 16:00.

Table 7 Co-movement in return and liquidity on SHSE and HKSE the Morning effect.

Terciles are constructed using full sample to ensure terciles are similar in the distribution of stocks from each sub-sample stock. T1 (T3) contains stocks with the lowest (highest) each average morning and afternoon CHY volume during the sample period. The table reports the mean and standard deviation (SD) of co-movement in returns (r_i^2), in price-impact based liquidity (r_{liq}^2), in quoted spreads (r_{spread}^2) and in each morning and afternoon volume (r_{vol}^2). The last four columns report means of market returns (in bps), market liquidity (negative log of Amihud's ILLIQ metric), market volatility (average monthly standard deviation of daily midquote returns in bps), and market-wide average traded volume (in CHY million per stock-day observation), calculated as equally weighted averages of the respective variable for all stocks in the sample. The sample includes 200 stocks in the Shanghai and HKSE and is from January 1, 2017, to December 31, 2019, with 132273 stock-day observation.

Year	Sample	r_i^2		r_{LIQ}^2		r_{vol}^2		r_{spread}^2		Market Return	Market Liquidity	Market Volatility	Market volume
		mean	SD	mean	SD	mean	SD	mean	SD				
2017-2019	total pool	0.365	0.194	0.069	0.098	0.131	0.154	0.073	0.111	-0.172	-0.011	50.455	6.022
	T1	0.364	0.188	0.062	0.104	0.095	0.117	0.066	0.093	-0.185	-0.011	50.423	6.005
	T2	0.370	0.194	0.066	0.091	0.126	0.147	0.063	0.093	-0.172	-0.011	50.388	6.043
	T3	0.372	0.200	0.069	0.100	0.172	0.182	0.091	0.138	-0.159	-0.011	50.558	6.049
	SHSE	0.339	0.196	0.062	0.086	0.165	0.180	0.075	0.117	-0.151	-0.011	50.466	6.074
	HKSE	0.391	0.189	0.069	0.098	0.098	0.115	0.071	0.103	-0.193	-0.011	50.445	5.973
2017	total pool	0.309	0.170	0.064	0.100	0.124	0.152	0.068	0.112	1.301	-0.010	43.402	5.601
	T1	0.308	0.167	0.066	0.091	0.088	0.105	0.062	0.094	1.334	-0.010	43.425	5.582
	T2	0.314	0.175	0.060	0.100	0.112	0.143	0.064	0.110	1.291	-0.010	43.431	5.612
	T3	0.306	0.170	0.065	0.109	0.175	0.185	0.079	0.130	1.278	-0.010	43.349	5.628
	SHSE	0.279	0.165	0.059	0.105	0.162	0.181	0.069	0.113	1.249	-0.010	43.392	5.634
	HKSE	0.338	0.170	0.068	0.094	0.088	0.106	0.067	0.111	1.351	-0.010	43.412	5.551

2018	Total pool	0.398	0.197	0.067	0.094	0.124	0.151	0.076	0.115		-0.012	56.197	5.949
	T1	0.408	0.187	0.076	0.105	0.096	0.121	0.069	0.087	-3.117	-0.012	56.194	5.915
	T2	0.392	0.198	0.065	0.089	0.125	0.149	0.067	0.097	-3.065	-0.012	56.151	5.934
	T3	0.393	0.205	0.061	0.087	0.152	0.174	0.093	0.152	-3.040	-0.012	56.252	5.975
	SHSE	0.360	0.201	0.055	0.080	0.152	0.174	0.078	0.129	-2.984	-0.012	56.153	5.956
	HKSE	0.435	0.186	0.079	0.104	0.098	0.119	0.074	0.100	-3.160	-0.012	56.240	5.864
2019	total pool	0.385	0.200	0.076	0.104	0.143	0.158	0.075	0.104	1.257	-0.011	56.033	6.522
	T1	0.369	0.194	0.081	0.102	0.104	0.119	0.064	0.084	1.257	-0.011	55.953	6.500
	T2	0.397	0.202	0.074	0.097	0.139	0.156	0.067	0.092	1.243	-0.011	56.076	6.541
	T3	0.387	0.205	0.073	0.110	0.185	0.184	0.095	0.128	1.270	-0.011	56.069	6.546
	SHSE	0.373	0.204	0.071	0.108	0.180	0.184	0.077	0.109	1.278	-0.011	55.983	6.577
	HKSE	0.396	0.196	0.080	0.100	0.106	0.118	0.073	0.099	1.236	-0.011	56.083	6.469

Table 8 similarly shows the co-movements and market variables for the SHSE and HKSE and terciles in the afternoons for four periods: all three years (2017-2019), 2017, 2018, and 2019. After the launch of the Shanghai-Hong Kong Stock Connection, the co-movement terms of Shanghai stocks showed an increasing trend from 2017 to 2019. The co-movement in the returns of Shanghai stocks increased from 0.2735 to 0.2840 in the afternoons. In addition, the highest trading volume, T3, showed the highest co-movement in returns and liquidity in each year and all periods between 2017 and 2019. The trend of co-movement in returns and liquidity, according to the results in table 8, is the same as that found by Malceniece et al. (2019). Comparing these results with those in table 8, the co-movement terms between Shanghai and Hong Kong stocks are shown to be mainly affected by data from the other exchange in the afternoon rather than more global information.

On conclusion, the table 7 and table 8 shows that higher trading volume tercile has higher co-movement in return, liquidity, volume and spread in the afternoon sub-sample, but in the morning sub-sample. I discuss that there are other factors which can affect volume, spread and return of Shanghai and Hong Kong stocks in the morning sub-sample.

Table 8 Co-movement in return and liquidity on SHSE and HKSE in the afternoon effect.

Terciles are constructed using full sample to ensure terciles are similar in the distribution of stocks from each sub-sample stock. T1 (T3) contains stocks with the lowest (highest) each average morning and afternoon CHY volume during the sample period. The table reports the mean and standard deviation (SD) of co-movement in returns (r_i^2), in price-impact based liquidity (r_{liq}^2), in quoted spreads (r_{spread}^2) and in each morning and afternoon volume (r_{vol}^2). The last four columns report means of market returns (in bps), market liquidity (negative log of Amihud's ILLIQ metric), market volatility (average monthly standard deviation of daily midquote returns in bps), and market-wide average traded volume (in CHY million per stock-day observation), calculated as equally weighted averages of the respective variable for all stocks in the sample. The sample includes 200 stocks in the Shanghai and HKSE and is from January 1, 2017, to December 31, 2019, with 132273 stock-day observation.

Year	Sample	r_i^2		r_{LIQ}^2		r_{vol}^2		r_{spread}^2		Market Return	Market Liquidity	Market Volatility	Market Volume
		mean	SD	mean	SD	mean	SD	mean	SD				
2017-2019	total pool	0.270	0.160	0.054	0.081	0.066	0.097	0.058	0.094	3.41	-0.0182	76.70	16.72
	T1	0.264	0.155	0.054	0.081	0.067	0.098	0.057	0.084	3.37	-0.0182	76.74	16.49
	T2	0.268	0.161	0.055	0.079	0.065	0.094	0.057	0.095	3.45	-0.0182	76.64	16.82
	T3	0.278	0.165	0.056	0.083	0.067	0.101	0.058	0.102	3.42	-0.0183	76.73	16.83
	SHSE	0.282	0.168	0.055	0.086	0.068	0.103	0.059	0.107	3.45	-0.0182	76.67	16.92
	HKSE	0.258	0.152	0.054	0.075	0.065	0.092	0.056	0.079	3.37	-0.0182	76.73	16.52
2017	total pool	0.267	0.161	0.058	0.094	0.066	0.108	0.062	0.105	4.52	-0.0180	77.19	15.73
	T1	0.262	0.156	0.054	0.075	0.069	0.115	0.059	0.098	4.50	-0.0180	77.21	15.71
	T2	0.266	0.156	0.059	0.084	0.060	0.087	0.060	0.095	4.53	-0.0181	77.20	15.73
	T3	0.273	0.170	0.066	0.100	0.069	0.119	0.068	0.122	4.52	-0.0181	77.17	15.76
	SHSE	0.273	0.172	0.058	0.103	0.071	0.123	0.068	0.124	4.55	-0.0180	77.15	15.77
	HKSE	0.261	0.148	0.059	0.084	0.062	0.090	0.056	0.083	4.49	-0.0181	77.24	15.61
2018	total pool	0.270	0.161	0.054	0.077	0.061	0.086	0.055	0.095	3.94	-0.0202	84.86	16.27
	T1	0.261	0.161	0.054	0.078	0.064	0.092	0.053	0.074	3.72	-0.0201	84.88	16.07
	T2	0.275	0.157	0.055	0.078	0.060	0.083	0.049	0.088	4.03	-0.0202	84.83	16.41
	T3	0.274	0.165	0.056	0.085	0.060	0.083	0.062	0.116	4.12	-0.0202	84.87	16.49
	SHSE	0.288	0.167	0.056	0.080	0.062	0.086	0.055	0.112	4.13	-0.0202	84.77	16.48
	HKSE	0.252	0.154	0.052	0.073	0.061	0.085	0.054	0.074	3.76	-0.0202	84.95	16.06

2019	total pool	0.273	0.159	0.054	0.081	0.071	0.097	0.056	0.081	1.90	-0.0184	76.23	18.08
	T1	0.258	0.151	0.052	0.071	0.070	0.095	0.053	0.074	2.00	-0.0183	76.24	17.74
	T2	0.279	0.161	0.052	0.072	0.068	0.100	0.056	0.087	1.85	-0.0184	76.20	18.02
	T3	0.281	0.165	0.055	0.086	0.097	0.097	0.060	0.082	1.85	-0.0184	76.26	18.38
	SHSE	0.284	0.166	0.053	0.074	0.072	0.096	0.055	0.081	1.84	-0.0183	76.21	18.36
	HKSE	0.261	0.152	0.050	0.068	0.071	0.099	0.058	0.081	1.97	-0.0184	76.26	17.80

6. Conclusion

This work examined whether launching a programme connecting the SHSE and HKSE drove co-movement in returns and liquidity between 2017 and 2019. A series of co-movement measures were estimated based on 200 blue-chip Shanghai and Hong Kong stocks as a way to analyse the time-variance comovement between Shanghai and Hong Kong stock exchanges in all periods.

Overall, in agreement with prior theoretical work and literature, this study suggests that the Stock Connect has increased the trading volume of Shanghai and Hong Kong stocks by improving co-movement in returns and liquidity. For example, the higher trading volume tercile has the strongest comovement in return and liquidity than other terciles. In addition, the co-movement in returns and liquidity between Shanghai and Hong Kong stocks are increased over the years.

The findings, however, we sensitive to the inclusion of exchange, it indicates that the co-movement in return and liquidity decrease in such circumstances. Moreover, the main findings illustrated in morning subsample and afternoon sub-sample in the robustness check that increased trading time for Hong Kong stocks in the morning has a lower effect on co-movement in returns and liquidity than additional trading time in the afternoon.

The study examines that the previous day trading activities on Shanghai, Hong Kong and the US stock exchange influence return, volume, and bid-ask spreads at the first hour of the current trading day on Shanghai- Hong Kong Stock Connect. However, examining the results for the endogenous variables of returns for Shanghai stocks, the evidence of codetermination is weaker for all periods, suggesting that Shanghai stock returns are not affected significantly by previous values from Shanghai, Hong Kong, and US stocks. The study aims to investigate the effect of the US stock exchange, moreover, it is robust to using return, volume, and bid-ask spreads of Shanghai and Hong Kong stocks during the lunch break. The result indicates that the return of Hong Kong stocks cannot be affected by return, spread and volume of Shanghai and Hong Kong stocks in the lunch breaks while the study ignore the US stock exchanges.

Finally, the Chinese government is currently attempting to further develop the country's stock markets, with the aim of attracting long-term funds to invest in Chinese financial markets. The Shanghai and Shenzhen-Hong Kong Stock Connections, which were created on November 17, 2014 and December 5, 2016, were among the most significant contributors to this objective in

recent years. This dissertation thus examined the situations arising from the Shanghai and Hong Kong Stock Connection, allowing future research to examine these Chinese financial markets more efficiently based on these results. The study represents that comovement in return and liquidity between SHSE and HKSE is increased over the time. it achieves the objectives of Shanghai- Hong Kong Stock Connect. However, several problems have arisen alongside the opening of the Chinese stock markets. In particular, global financial risk is a major problem in Chinese financial markets, due to the necessity of and issues with foreign capital inflows. Chinese regulators should thus pay close attention to developing a better system of risk management and improving the ethical basis of both the relevant financial institutions and their own development.

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