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The effect of overseas investors on local market efficiency: evidence from the Shanghai/Shenzhen–Hong Kong Stock Connect

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Abstract

Using a recent stock market liberalization reform policy in China—the Stock Connect—as a quasi-natural experiment, this study examines the effect of stock market liberalization on market efficiency. Employing a dataset of 17,086 Chinese listed firms covering 2009 to 2018, we find that stock market liberalization improves the market efficiency of the Chinese mainland stock market. We further explore the potential channels through which the Stock Connect can enhance the efficiency of the A-share (A-shares refer to shares issued by Chinese companies incorporated in mainland China, traded in the Shanghai Stock Exchange and the Shenzhen Stock Exchange. They are denominated in Chinese RMB (the local currency). A-shares were restricted to local Chinese investors before 2003, are open to foreign investors via the Qualified Foreign Institutional Investor, RMB Qualified Foreign Institutional Investor, or the Stock Connect programs.) market. The findings show that liberalizing capital markets could benefit local market efficiency by increasing stock price informational efficiency and improving corporate governance quality. The additional analysis shows that stock market liberalization has a significant and positive impact on local market efficiency, enhancing firm value and reducing stock crash risk. We conduct various robustness checks to corroborate our findings. This study provides important policy implications for emerging countries liberalizing capital markets for foreign investors.

Keywords: Market efficiency, Stock Connect, Market liberalization, Overseas investors

JEL Classification: G14, G18, G34

Introduction

Liberalizing the stock market refers to the decision made by a country's government to grant permission to foreign investors to trade shares in that country's stock market (Henry 2000a, b). Since the late 1980s, many emerging countries have liberalized their capital markets. Nevertheless, the effects of foreign investors on liberalizing the stock markets remain controversial. On the one hand, the extant literature has documented the positive effects of stock market liberalization, including lower cost of capital (Bekaert and Harvey 2000), higher levels of real investments (Henry 2000a, b), a better information environment (Bae et al. 2006), improved corporate governance

of local firms (Ferreira and Matos 2008; Bae and Goyal 2010; Gul et al. 2010), strong productivity and economic growth (Bekaert et al. 2005, 2011; Gupta and Yuan 2009; Moshirian et al. 2021), enhanced market efficiency (Kim and Singal 2000; Cajueiro et al. 2009; Bae et al. 2012), and reduced litigation risk (Xiong et al. 2021). On the other hand, foreign investors can trade stocks in liberalized stock markets to change their portfolio compositions. Positive feedback trading by foreign investors can increase price volatility (Bae et al. 2004).

A government's main motivation for opening up its stock market is to create a more open and intentionally integrated financial market to produce and aggregate information efficiently (Chen et al. 2007). This may occur because foreign traders can transmit private information to market prices through their own speculative but informed trading (Bae et al. 2012). Foreign investors, especially sophisticated foreign institutional investors, tend to have advanced skills and in-depth investment knowledge (Grinblatt and Keloharju 2000) and can identify superior investment opportunities. Hence, foreign investor participation may lead to a better information environment in local markets (Piotroski and Wong 2012). In addition, the literature shows that stock market liberalization attracts foreign investors with stronger shareholder protection awareness, which effectively disciplines managers' opportunistic behaviors (Ferreira and Matos 2008; Aggarwal et al. 2011; Boone and White 2015; Pukthuanthong et al. 2017; Bai et al. 2022).

The following challenges may contribute to the divergent consequences of stock market liberalization. First, stock market liberalization is often accompanied by changes in the macro-economy, regulatory environment, and policies. It is difficult to separate the consequences of market liberalization from these confounding factors. Second, because countries keep their stock markets either entirely open or entirely closed, most extant studies use cross-country variations in market openness to study its consequences. However, such studies are affected by factors such as legal systems, enforcement quality, and culture. These omitted variables make it impossible to discriminate between the variables of interest and other factors. Third, a country's market liberalization is often a strategic decision and is potentially determined by its economic development and market maturity. This reverse causality problem severely undermines the extant empirical results. Finally, it is difficult to measure capital market openness accurately.

The Stock Connect program provides a natural experiment to test the consequences of market openness. Established in 1991, the Chinese stock market shares the features of many emerging markets. China has cautiously but steadily liberalized its financial sector, which includes opening stock markets (Bai and Chow 2017). To further enhance the degree of openness, the Chinese government launched the Stock Connect program (hereafter, Stock Connect) to liberalize its capital markets to global investors. The Shanghai–Hong Kong Stock Connect (hereafter, SH–HK Stock Connect) was launched in 2014, whereas the Shenzhen–Hong Kong Stock Connect was established in 2016 (hereafter, SZ–HK Stock Connect). Hong Kong and foreign investors can now trade A-shares listed on the Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE) through northbound trading, and mainland investors can participate in southbound trading on the Hong Kong Stock Exchange (SEHK). The unique collaboration

among the stock exchanges of Shanghai, Shenzhen, and Hong Kong provides an ideal setting to study the impact of the Stock Connect on market efficiency.

Several studies have examined the effect of stock market liberalization on local market efficiency (Bae et al. 2012; He et al. 2013; Huo and Ahmed 2017). However, the extant literature is plagued by endogeneity problems, and none of them identify the channels through which foreign investors affect local market efficiency. Focusing on Chinese A-share listed firms from 2009 to 2018, we examine market efficiency in a Chinese setting by highlighting the role of both the SH–HK Stock Connect and SZ–HK Stock Connect. In this study, we adopt one key proxy for stock market liberalization, namely, the Stock Connect (*HSSC*). Since Fama (1970) published his influential paper by reviewing the theoretical and empirical literature on market efficiency, a thorough assessment of market efficiency has been conducted.[1] The efficient market hypothesis (EMH) is one of the most important, and the bid/ask measure is based on this hypothesis. An appropriate measure of market efficiency should directly reflect expected returns and relevant risks (Liu and Chen 2020). Using daily high prices and daily low prices, we measure the market efficiency based on the bid-ask spread estimator developed by Corwin and Schultz (2012).

However, endogeneity concerns arise regarding the baseline results because unobservable firm characteristics are correlated with capital market liberalization. Using a difference-in-differences (DID) approach to alleviate this concern, our study shows a positive relationship between stock market liberalization and market efficiency. The results are robust to the inclusion of various control variables, including firm size, profitability (return on assets and loss), listage, leverage, turnover, cash volatility, analyst coverage, and audit opinion. The results are robust after controlling for the industry- or firm-fixed effects. Additionally, the results can be explained using different measures of stock market liberalization and market efficiency. We conducted various robustness checks to corroborate our findings and address endogeneity concerns.

The potential channels through which stock market liberalization affects market efficiency remain unexplored. We empirically examine two potential channels through which stock market liberalization could benefit local market efficiency: stock price information efficiency and corporate governance. First, the Stock Connect provides a more direct and efficient investment channel for global investors to access China's A-share markets, accelerating the process of incorporating value-relevant information into stock prices through informed trading (Bae et al. 2012). More sophisticated investors introduced by the Stock Connect program can alleviate mispricing and assess the intrinsic value of stocks. In addition, Edmans (2009) argues that overseas investors sell their equity stakes upon negative news, thus facilitating the capitalization of fundamentals into stock prices. Second, foreign investors can help improve market efficiency through enhanced corporate governance. A prominent explanation is that overseas investors tend to have stronger investor protection awareness than domestic investors (La Porta et al. 2000; Aggarwal et al. 2011), thereby requesting higher governance standards. Overseas

[1] A market, in which prices always "fully reflect" available information is called "efficient" (Fama 1970, p. 383). The market may be efficient if a "sufficient number" of investors have ready access to available information (p. 388).

investors can still discipline managers and strengthen corporate governance via "voting with their feet,"[2] thus improving market efficiency.

In "Further analysis: firm-level economic consequences" section, we conduct further analysis to examine what kind of firm-level economic consequences arise from the impact of stock market liberalization on the market efficiency. The results show that stock market liberalization significantly and positively affects local market efficiency and consequently enhances firm value. In addition, stock market liberalization has a significant and positive impact on local market efficiency and consequently reduces the crash risk of listed firms. These findings show that the liberalization of capital markets helps promote stable and healthy development.

This study contributes to the literature in several ways. First, market efficiency research is significant because of the variety and complexity of the stock market. Irregular volatility in stock prices can hamper market efficiency. Second, we provide new evidence of stock market liberalization by examining the impact of the implementation of the SH–HK Stock Connect and SZ–HK Stock Connect on the efficiency of the Chinese A-share market. Finally, this study provides important policy implications for further financial liberalization in China and other emerging countries.

The remainder of this paper is organized as follows. "Research context" section describes the research context. "Literature review and hypotheses development" section reviews the Literature and develops the hypotheses. "Data and methodology" section describes the research methodology and data. "Empirical results" section presents the empirical findings and explores plausible underlying economic channels through which the stock connection affects market efficiency. "Robustness checks" section presents the various robustness checks. Finally, "Conclusions" section concludes the paper.

Research context

The existing literature focuses on developed financial markets. It is important to extend market efficiency analyses to emerging markets as they develop quickly and become big players in the global economy. China, being the largest emerging financial market, has become a suitable research market to re-examine the effect of overseas investors on local market efficiency after the launch of the SH–HK Stock Connect and SZ–HK Stock Connect. The Chinese stock market was previously a typical retail market with a majority of individual investors, which has been characterized as having weak institutional settings (Allen et al. 2005) and poor investor protection (Gul et al. 2010). Moreover, listed firms in China tend to have concentrated ownership structures and insufficient corporate governance (Bai et al. 2004; Gul et al. 2010). Under such circumstances, the Stock Connect may perform arm's length monitoring to improve the firm's information environment in the Chinese A-share market. Therefore, to generate new insights and evaluate the effectiveness of the Stock Connect program in China, we empirically investigate the relationship between the presence of the Stock Connect and stock price information efficiency.

[2] The term "voting with their feet" in corporate governance setting indicates that overseas investors will sell their shares of a company if they are dissatisfied with the management's performance.

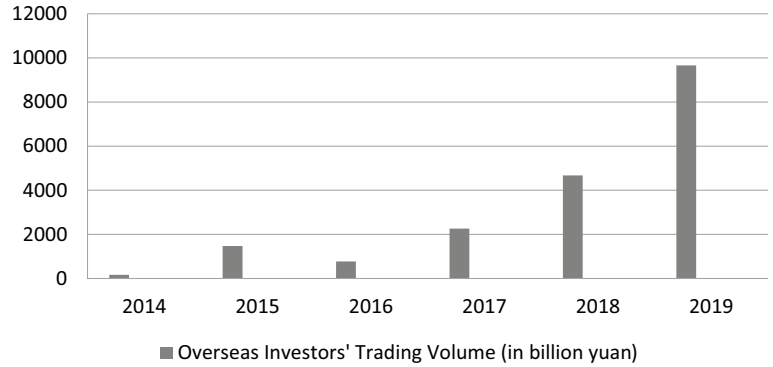

Fig. 1 Overseas investors' trading volume (in billion yuan)

China has gradually opened its stock market to overseas investors to integrate into the global economy. Before the Stock Connect, two platforms linked Chinese mainland stock markets with overseas stock markets. One is the Qualified Foreign Institutional Investors (QFII) mechanism in 2002, which allowed approved foreign institutional investors to invest in Chinese A-share markets. The other is the Qualified Domestic Institutional Investors (QDII) mechanism, which started in 2006 and allowed some approved domestic institutional investors to invest in the overseas stock market. The amount of investments via these two mechanisms kept growing and reached US$90.3 billion and US$90.0 billion, respectively, by March 29, 2017, according to the Chinese foreign exchange bureau.

The advantage of this setting is that the Chinese government piloted the Stock Connect programs with some A-shares listed on the SSE (initially 568 firms) and extended them to 892 firms by September 3, 2019. The SZ–HK Stock Connect, which started two years after the SH–HK Connect, covered 882 firms initially and 1212 firms by October 16, 2019. A total of 2104 shares were covered by Shanghai Connect and Shenzhen Connect by October 2019, comprising 56.76% of the total number of shares in the two stock markets. The unique structure of the Stock Connect, which links the stock exchanges of Shanghai, Shenzhen, and Hong Kong, is ideal for examining the impact of liberalizing the stock market. It provides a natural treatment and control group of A-shares that overseas investors can invest in.

The Chinese government stipulates that a single overseas investor's holdings of a single A-share firm must not exceed 10% of the firm's total tradable shares and that the total holdings of all overseas investors in a single A-share listed firm must not exceed 30%. Meanwhile, overseas investors are not allowed to nominate their own board members. Therefore, before the launch of Stock Connect programs, overseas investors have little impact on the efficiency of China's A-share market. Their functions in improving firms' corporate governance and information disclosure are limited. However, according to the Wind Database,[3] after the implementation of Stock Connect programs, overseas investors' trading volumes and shareholdings of Shanghai Connect and Shenzhen Connect firms have been increasing. As shown in Fig. 1, overseas investors' trading volume

[3] https://www.wind.com.cn/portal/en/WDS/database.html

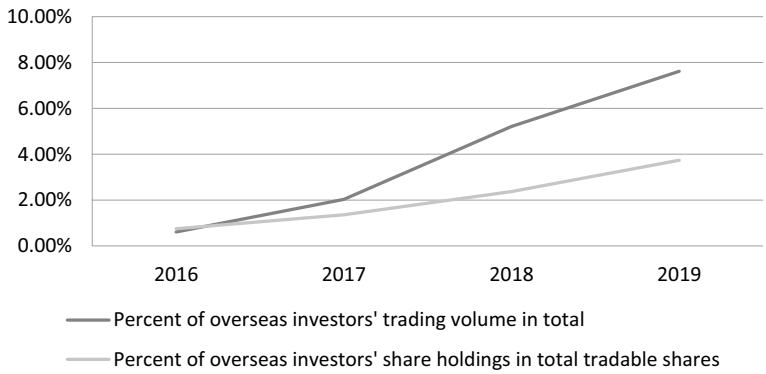

Fig. 2 Percentages of overseas investors' trading volume and share holdings

significantly increased from 167.5 billion yuan (US$24.1 billion) in 2014 to 9663.0 billion yuan (US$1393.1 billion) in 2019, comprising 7.62% of the total trading volume on the SSE and SZSE. As shown in Fig. 2, the percentage of overseas investors' average shareholdings in the total tradable shares of the Shanghai and Shenzhen Connect firms increased from 0.75% in 2016 to 3.74% in 2019.

Literature review and hypotheses development

Despite the various motivations for countries to liberalize their stock markets, an important research question is whether and to what extent financial market liberalization helps improve the efficiency of local capital markets. Market efficiency has been a controversial topic since the establishment of the EMH by Fama (1970). The EMH states that stock prices should instantly reflect all relevant information when the market is efficient. This theory has received significant support. According to the EMH, increased openness to more foreign institutional investors helps improve the information environment (Piotroski and Wong 2012), which facilitates investors and managers' decision-making processes in terms of resource allocation (Goldman 2004; Bae et al. 2006; Chen et al. 2007; Bond et al. 2012).

Bae et al. (2004) show that positive feedback trading by foreign investors can increase stock price volatility. However, Ben and Boughrara (2013) argue that financial market liberalization benefits the local stock market by reducing the volatility in stock returns and stabilizing the market. Boehmer and Wu (2013) propose that the intraday informational efficiency of prices increases with the greater shorting flow, and stock prices are more accurate when short sellers are more active. Studies on the development of market efficiency have been limited to the EMH. Developing markets are deemed to have less efficient information flow and less accurate institutional information, and therefore, more friction and asymmetric information. Kim and Singal (2000) show that stock prices are more likely to follow a random walk after financial openness in 14 emerging markets, which enhances their information efficiency of stock prices. Gul et al. (2010) demonstrate that cross-listed firms in China have lower stock price synchronicity (i.e., higher stock price information efficiency). Li et al. (2020) investigate the effects of investments by QFIIs in Chinese A-share stock markets and find a significant and positive relationship between stock price informativeness and stock ownership by foreign institutional investors.

The Stock Connect, a unique collaboration between the stock exchanges of Shanghai, Shenzhen, and Hong Kong, provides an ideal setting for studying the effect of overseas investors on local market efficiency. However, only a few studies have examined the impact of the Stock Connect, and they are limited to the SH–HK Stock Connect. For instance, Huo and Ahmed (2017) show that the SH–HK Stock Connect has increased the conditional variance of both stock markets and enhanced the market efficiency of the Chinese mainland stock market. Fan and Wang (2017) prove that the SH–HK Stock Connect effectively reduces the A-H share price gap. Xu et al. (2020) examine the impact of stock market openness on high-frequency market quality in China and conclude that market liberalization leads to a lower quoted spread, lower effective spread, and higher short-term volatility.

As an innovative stock market liberalization reform in China, the SH–HK Stock Connect and SZ–HK Stock Connect may affect market efficiency in two ways. First, overseas investors can increase the information content of share prices through informed trading, thereby improving market efficiency. According to Bae et al. (2012), overseas investors have an advantage in processing global private information. They can help incorporate such information into share prices, thus improving the informational efficiency of local stock markets. Moreover, most overseas investors are professional fund management companies or investment banks with considerable networking resources and trading professionals. They are mature and more experienced than local investors in making optimal investment decisions (Grinblatt and Keloharju 2000). These smart arbitragers are expected to squeeze out any mispricing in local market share prices and enable them to reflect more of the firm's fundamental value, thus improving local stock markets' informational efficiency.

Second, overseas investors, especially those from developed countries with better corporate governance practices, such as the United States (U.S.), can improve market efficiency by strengthening the corporate governance of firms, in which they invest via the "voting by feet" mechanism (Aggarwal et al. 2011). Bae et al. (2006) document that liberalizing emerging markets and increasing openness to foreign investors is associated with increased analyst coverage and decreased earnings management. Lee et al. (2016) argue that corporate governance improves the informational efficiency of prices by increasing transparency. Therefore, better corporate governance reduces agency problems and earnings manipulation and enables share prices to reflect a firm's fundamental value better, thereby improving local stock market efficiency.

To summarize, with the stock market being accessible to more foreign investors in Stock Connect programs, more private information is incorporated into the stock price of eligible firms through their trading activities. After implementing the Stock Connect, eligible firms would enhance the quality of information disclosure and improve corporate governance to attract sophisticated investors in Hong Kong.

Thus, we hypothesize:

H1 The implementation of the Stock Connect enhances local market efficiency.

Existing studies demonstrate that stock market openness to foreign investors induces a better information environment and enhances governance quality. Stock price

synchronicity in emerging markets is much higher than that in developed markets (Jin and Myers 2006). Previous studies show that synchronicity negatively correlates with stock price information efficiency (Morck et al. 2000; Durnev et al. 2003; Hutton et al. 2009).

Thus, we hypothesize:

H2 The implementation of the Stock Connect improves local market efficiency by enhancing stock price information efficiency.

H3 The implementation of the Stock Connect improves local market efficiency by improving corporate governance.

Data and methodology

Sample data

The SH–HK Stock Connect was initiated in 2014, and the SZ–HK Stock Connect was launched in 2016. Thus, the sample periods after the trading mechanisms were implemented are 2014–2018 and 2016–2018, respectively. To maintain symmetry in the sampling period around the two events, our sampling period begins in 2009 and ends in 2018. We start with all Chinese A-share listed firms and delete financial firms because their performance indicators are not comparable to those of other firms. We also exclude firms with missing financial performance data, firms with less than one year's financial performance data, firm–year observations with missing values, and all special treatment (ST) and suspension from trading (*ST) firms.[4] The data on the dynamic eligible firms traded under the Stock Connect programs are collected manually from the official website of the SEHK. Accounting and financial data have been obtained from the China Stock Market and Accounting Research (CSMAR) and Wind databases. To minimize the influence of outliers, we winsorize all continuous variables at the 1% and 99% levels. Finally, we obtain 17,086 observations, which represent an unbalanced panel, with the number of firms ranging from 710 in 2018 to 2339 in 2017.

Variable definitions

Proxy for market efficiency

Using daily high and low prices, we measure market efficiency based on the bid-ask spread estimator developed by Corwin and Schultz (2012). They argue that "the high–low spread estimator is ideal for large samples, and the high–low spread estimator is derived under very general conditions. It is not ad hoc and can be applied to a variety of markets with different market structures…It is important to note that the high–low spread estimator captures liquidity more broadly than just the bid-ask spread" (p. 719).

We use annual averages of the daily bid/ask spreads to match the sampling frequency of our other variables. The higher the bid/ask spread, the lower the market efficiency. To maintain the consistency of the sign, we use the reversed number of bid/ask spreads to

[4] The short name of a stock receiving special treatment (continuous losses over two years) or delisting risk warning (continuous losses over three years) will be prefixed with "ST" or "*ST." Accordingly, the listed company will be called ST company or *ST company if its issued stock receives ST or *ST, respectively, to indicate the risk of the stock to investors.

proxy for market efficiency. Corwin and Schultz (2012) argue that the ratio of daily high-to-low prices for a day reflects both the fundamental volatility of a stock and its bid/ask spread. The component of the high-to-low price ratio that is due to volatility increases proportionately with the length of the trading interval, whereas the component of the high-to-low price ratio that is due to bid-ask spreads does not. Following Corwin and Schultz (2012), we construct the following simultaneous equations to solve for bid-ask spreads and volatility.

$$E\left\{\sum_{j=0}^{1}\left[\ln\left(\frac{H_{t+j}^{0}}{L_{t+j}^{0}}\right)\right]^{2}\right\}=2k_{t}\sigma_{HL}^{2}+4k_{2}\sigma_{HL}\ln\left(\frac{2+S}{2-S}\right)+2\left[\ln\left(\frac{2+S}{2-S}\right)\right]^{2},\quad(1)$$

$$E\left\{\left[\ln\left(\frac{H_{t,t+1}^{0}}{L_{t,t+1}^{0}}\right)\right]^{2}\right\}=2k_{t}\sigma_{HL}^{2}+2\sqrt{2}k_{2}\sigma_{HL}\ln\left(\frac{2+S}{2-S}\right)+\left[\ln\left(\frac{2+S}{2-S}\right)\right]^{2},\quad(2)$$

where S is the bid-ask spread; ${H^0}_{t+j}$ and ${L^0}_{t+j}$ are the daily high price and daily low price of a stock observed at $t+j$ trading days, respectively; ${H^0}_{i,t+1}$ and ${L^0}_{i,t+1}$ are the daily high and low prices, respectively, of a stock observed on two consecutive trading days; σ_{HL} is volatility; and k_1 and k_2 are coefficients. For the estimation of the bid/ask spread and volatility, please see Corwin and Schultz (2012).

Let

$$\beta=E\left\{\sum_{j=0}^{1}\left[\ln\left(\frac{H_{t+j}^{0}}{L_{t+j}^{0}}\right)\right]^{2}\right\},\quad\gamma=E\left\{\left[\ln\left(\frac{H_{t,t+1}^{0}}{L_{t,t+1}^{0}}\right)\right]^{2}\right\}.$$

Solving Eqs. (1) and (2), we have

$$\mathrm{S}=\frac{2(\mathrm{e}^{\alpha}-1)}{1+\mathrm{e}^{\alpha}},$$

where

$$\alpha=\frac{\sqrt{2\beta}-\sqrt{\beta}}{3-2\sqrt{2}}-\sqrt{\frac{\gamma}{3-2\sqrt{2}}}.$$

Following Corwin and Schultz (2012), using the daily high prices and low prices of two consecutive trading days, we calculate the first annual bid/ask spread variable (*DailySprd1*) by solving the simultaneous equations for intraday bid/ask spreads and taking the annual average. Using the traditional method, we calculate the second intraday bid-ask spread variable (*DailySprd2*) as a robustness check for the market efficiency construct by dividing the difference between the daily high and low prices by their average and taking the annual average of these daily differences.

Proxy for stock market liberalization

We define stock market openness as a dummy variable that is one when the A-share listed firms are eligible for trading under either the SH–HK Stock Connect or the SZ–HK Stock Connect and zero otherwise.

Regression model framework

To examine H1, we propose the DID as follows: we construct the following DID regression model:

$$DailySprd_{i,t} = \beta_0 + \beta_1 HSSC_{i,t} + \beta_2 Controls_{i,t} + \gamma_i + \eta_t + \varepsilon_{i,t}, \quad (3)$$

where the dependent variable, market efficiency, is measured using *DailySprd.* The *DailySprd1* and *DailySprd2* are calculated using Eqs. (1) and (2), respectively. The independent variable of *HSSC*, a dummy variable, equals 1 if the listed firm is eligible for trading in the SH–HK or SZ–HK Stock Connect and zero otherwise. Following the literature, we control for a set of variables that are important determinants of market efficiency. The control variables include firm size (*Size*), leverage (*Lev*), profitability (*return on assets and loss*), cash flow volatility (*Cash_vol*), listage (*Age*), type of audit opinion (*Opinion*), number of analysts following (*Analyst*), share turnover (*Turnover*), and dummies for year and industry.

The *Size* is the natural logarithm of the total assets of firm *i* in year *t*. The *Lev* is the book leverage calculated as the total liability divided by the total assets of firm *i* in year *t*. The *ROA* is the return on assets calculated as the net income divided by the total assets of firm *i* in year *t*. The *Loss*, a dummy variable, equals 1 if a firm reports negative net income in the year and 0 otherwise. The *Cash_vol* is the standard deviation of cash flow over the past three years. The *Opinion*, a dummy variable, equals 1 if the auditor's opinion for year t shows standard "unqualified opinion" and 0 otherwise. The *Analyst* is the natural logarithm of the number of financial analysts covering a listed firm in year *t*. The *Turnover* is computed as the daily number of shares traded divided by the total number of tradable shares. In addition, we control for the year (γ) and industry-fixed effects (η). In all model specifications, the standard errors are clustered by firms. This study focuses on financial data that are normally numerical or tabular, and clustering has been widely used to deal with such data types (Kou et al. 2014, 2022; Li et al. 2021a, b). All key variables and definitions are provided in "Appendix".

Empirical results

Descriptive statistics

Table 1 Panel A presents the summary statistics of the main variables employed in this study, including the number of observations, standard deviation, mean, median, 25th percentile, and 75th percentile. The sample includes Chinese listed firms in the A-share market during the period from 2009 to 2018. Market efficiency is measured by *DailySprd1* and *DailySprd2.* The mean (median) value of *DailySprd1* and *DailySprd2* are − 0.045 (− 0.043) and − 0.040 (− 0.038), respectively. The standard deviation of *DailySprd1* and *DailySprd2* are 0.013 and 0.011, respectively, suggesting that the bid-ask spreads differ among the listed firms. The *HSSC* has a mean value of 0.246 and a standard deviation of 0.431, which means that 24.6% of the listed companies are eligible for trading under the SH–HK or the SZ–HK Stock Connect as the underlying stocks.[5] The

[5] Our sample covers the period from 2009 to 2013; the SH–HK and SZ–HK Stock Connects had not yet been initiated at that time. Hence, our calculated percentage of firms covered by the Stock Connect program may differ from those in the extant literature.

Table 1 Descriptive statistics

Variables	N	Mean	Median	1st Quartile	3rd Quartile	SD
Panel A: Summary statistics for the full sample						
DailySprd1	17,086	−0.045	−0.043	−0.051	−0.036	0.013
DailySprd2	17,086	−0.040	−0.038	−0.046	−0.032	0.011
HSSC	17,086	0.246	0.000	0.000	0.000	0.431
Size	17,086	22.185	22.026	21.287	22.929	1.286
Lev	17,086	0.456	0.455	0.293	0.617	0.208
ROA	17,086	0.056	0.050	0.028	0.081	0.055
Cash_vol	17,086	18.689	18.577	17.702	19.562	1.451
Loss	17,086	0.086	0.000	0.000	0.000	0.280
Age	17,086	2.166	2.398	1.609	2.773	0.722
Opinion	17,086	0.932	1.000	1.000	1.000	0.251
Analyst	17,086	1.585	1.609	0.693	2.565	1.144
Turnover	17,086	5.511	4.522	2.697	7.363	3.872
TobinQ	17,086	2.117	1.568	0.871	2.668	1.956
$NCSKEW_{t+1}$	17,052	−0.276	−0.238	−0.644	0.137	0.715

Variables	HSSC = 0 Non-eligible firms			HSSC = 1 Eligible firms			Mean-Diff	Median-Diff
	N	Mean	Median	N	Mean	Median		
Panel B: The summary statistics of eligible firms and non-eligible firms in Stock Connect program								
DailySprd1	12,885	−0.046	−0.044	4201	−0.040	−0.038	−0.006***	503.512***
DailySprd2	12,885	−0.041	−0.039	4201	−0.036	−0.034	−0.006***	517.966***
Size	12,885	21.904	21.759	4201	23.046	22.894	−1.142***	2.1e+03***
Lev	12,885	0.455	0.452	4201	0.461	0.462	−0.006	4.174**
ROA	12,885	0.054	0.049	4201	0.062	0.055	−0.008***	35.848***
Cash_vol	12,885	18.469	18.374	4201	19.360	19.239	−0.891***	856.230***
Loss	12,885	0.096	0.000	4201	0.053	0.000	0.043***	74.680***
Age	12,885	2.094	2.303	4201	2.390	2.565	−0.297***	219.348***
Opinion	12,885	0.950	1.000	4201	0.877	1.000	0.073***	
Analyst	12,885	1.479	1.386	4201	1.908	2.079	−0.429***	375.494***
Turnover	12,885	5.761	4.807	4201	4.747	3.662	1.014***	263.115***

	DailySprd1	DailySprd2	HSSC	Size	Lev	ROA	Cash_vol	Loss	Age	Opinion	Analyst	Turnover
Panel C: Spearman and Pearson correlations												
DailySprd1	1.00	1.00***	0.22***	0.28***	0.03***	0.09***	0.20***	−0.08***	0.13***	−0.04***	0.05***	−0.61***
DailySprd2	1.00***	1.00	0.22***	0.27***	0.03***	0.08***	0.19***	−0.07***	0.13***	−0.04***	0.04***	−0.60***
HSSC	0.20***	0.21***	1.00	0.39***	0.01*	0.06***	0.26***	−0.07***	0.18***	−0.13***	0.16***	−0.14***
Size	0.25***	0.24***	0.38***	1.00	0.45***	0.07***	0.77***	−0.10***	0.30***	0.02**	0.39***	−0.36***
Lev	0.04***	0.03***	0.01	0.44***	1.00	−0.24***	0.45***	0.16***	0.32***	−0.04***	−0.05***	−0.10***
ROA	0.10***	0.09***	0.06***	0.07***	−0.26***	1.00	0.05***	−0.47***	−0.10***	0.06***	0.44***	−0.16***
Cash_vol	0.18***	0.18***	0.26***	0.80***	0.44***	0.06***	1.00	−0.04***	0.27***	0.00	0.27***	−0.28***
Loss	−0.08***	−0.07***	−0.07***	−0.10***	0.17***	−0.56***	−0.04***	1.00	0.07***	−0.12***	−0.21***	0.08***
Age	0.11***	0.11***	0.18***	0.28***	0.34***	−0.08***	0.27***	0.08***	1.00	−0.10***	−0.19***	−0.15***
Opinion	−0.04***	−0.05***	−0.13***	0.02**	−0.05***	0.08***	0.00	−0.12***	−0.09***	1.00	0.10***	0.05***
Analyst	0.05***	0.04***	0.16***	0.41***	−0.06***	0.41***	0.29***	−0.22***	−0.18***	0.10***	1.00	−0.20***
Turnover	−0.54***	−0.54***	−0.11***	−0.32***	−0.10***	−0.15***	−0.24***	0.07***	−0.17***	0.04***	−0.18***	1.00

Table 1 (continued)

Panel A presents the summary statistic of main variables used in this study, including the number of observations, standard deviation, mean, median, 25th percentile, 75th percentile. The sample includes Chinese A-share listed firms during 2009 and 2018. Market efficiency is measured by the intraday bid-ask spreads (*DailySprd1 and DailySprd2*). *HSSC* indicates the recent stock market liberalization (the Stock Connect), a dummy variable which is defined as 1 when the A-share listed firms are eligible for trading under either Shanghai-HK Stock Connect or Shenzhen-HK Stock Connect and zero otherwise.

Panel B shows the summary statistics of eligible firms in Stock Connect program and non-eligible firms as well as the group differences. The results show that there is a substantial difference of market efficiency between the eligible firms and non-eligible firms. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel C displays the Spearman and Pearson correlations matrix for variables of the full sample in the regression analysis. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

descriptive statistics indicate that 4201 listed firms are covered by the Stock Connect programs, which significantly affect the bid-ask spreads of A-share listed firms.

Table 1 Panel B shows the summary statistics of eligible firms covered by the Stock Connect program, non-eligible firms, and group differences. The mean (median) of market efficiency (*DailySprd1*) are − 0.046 (− 0.044) for non-eligible firms and − 0.040 (− 0.038) for eligible firms. The mean (median) of market efficiency (*DailySprd2*) are − 0.041 (− 0.039) for non-eligible firms and − 0.036 (− 0.034) for eligible firms. The mean differences for *DailySprd1* and *DailySprd2* between the ineligible and eligible firms are − 0.006 and − 0.006, respectively, and both are statistically significant at the 1% level. The median differences in *DailySprd1* and *DailySprd2* between the two groups are 503.512 and 517.966, respectively, and both are significant at the 1% level. The results show a substantial difference in market efficiency between eligible and non-eligible firms; for instance, the market efficiency of listed firms traded in Stock Connect programs is higher than that of non-eligible listed firms. This preliminarily supports our main hypothesis (H1) that stock market liberalization enhances market efficiency.

Table 1 Panel C reports the Spearman and Pearson correlation matrices for the variables used in the regression analysis. The Spearman correlation coefficients between stock market liberalization (*HSSC*) and market efficiency (intraday bid-ask spreads, *DailySprd1* and *DailySprd2*) are 0.22 and 0.22, respectively, both of which are significant at the 1% level. The Pearson correlations between *HSSC* and *DailySprd1/DailySprd2* are 0.20 and 0.21, respectively; both are statistically significant at the 1% level. As expected, the implementation of the Stock Connect program is significantly positively correlated with our measures of market efficiency (*DailySprd1* and *DailySprd2*). This also preliminarily supports our main hypothesis. As a precautionary measure, we also check whether high correlations exist among the other independent variables to ensure that multicollinearity is not a major concern in our regression analysis.

Baseline regression results: stock market liberalization and market efficiency

Table 2 reports the baseline results of the effects of SH–HK Connect and SZ–HK Connect on the efficiency of the Chinese A-share market. To examine the impact of recent stock market liberalization on the market efficiency of China's A-share market, we regress the market efficiency measures (*DailySprd1* and *DailySprd2*) on the *HSSC* using the DID analysis in Eq. (3). The dependent variables, *DailySprd1* and *DailySprd2* (intraday bid-ask spreads), are calculated by Eqs. (1) and (2), respectively. The higher the bid-ask spread, the lower the market efficiency. We reverse the number to explain market efficiency. The *HSSC* equals 1 if the listed firm is eligible for trading in the SH–HK or SZ–HK Stock

Table 2 Baseline regression results: the stock market liberalization and market efficiency

	(1) DailySprd1	(2) DailySprd1	(3) DailySprd2	(4) DailySprd2
HSSC	0.0046***	0.0019***	0.0039***	0.0016***
	(21.08)	(9.86)	(20.31)	(9.43)
Size		0.0023***		0.0021***
		(22.74)		(22.37)
Lev		−0.0058***		−0.0052***
		(−13.71)		(−13.50)
ROA		0.0024		0.0019
		(1.57)		(1.39)
Cash_vol		−0.0002**		−0.0001**
		(−2.41)		(−2.24)
Loss		0.0003		0.0003
		(1.28)		(1.31)
Age		0.0002		0.0001
		(1.53)		(1.06)
Opinion		−0.0002		−0.0002
		(−0.69)		(−0.76)
Analyst		−0.0012***		−0.0012***
		(−16.74)		(−18.42)
Turnover		−0.0008***		−0.0008***
		(−51.32)		(−51.74)
_cons	−0.0536***	−0.0894***	−0.0488***	−0.0802***
	(−87.16)	(−51.65)	(−88.88)	(−51.35)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	17,086	17,086	17,086	17,086
adj. R^2	0.660	0.757	0.663	0.758

This table presents the baseline results of the effects of Shanghai-HK Connect and Shenzhen-HK Connect on market efficiency in the Chinese stock market. The dependent variable is market efficiency (*DailySprd1* and *DailySprd2*), which is calculated by Eqs. (1) and (2). The higher the bid-ask spread, the lower the market efficiency. We reversed the number to explain market efficiency. *HSSC*, a dummy variable, equals to 1 if the listed firm is eligible for trading in the SH-HK or SZ-HK Stock Connect and zero otherwise. *Size* is the natural logarithm of total assets of firm *i* in year *t*. *Lev* is the book leverage calculated as total liability divided by total assets of firm *i* in year *t*. *ROA* is the return on assets calculated as net income divided by total assets of firm *i* in year *t*. *Loss*, a dummy variable, equals to 1 if a firm reports negative net income in the year and equals 0 otherwise. *Cash_vol* is the Standard deviation of cash flows for the past three years. *Opinion*, a dummy variable, equals to 1 if auditor's opinion for the year t shows standard "unqualified opinion" and 0 otherwise. *Analyst* is the natural logarithm of the number of financial analysts who cover a listed firm in year *t*. We also control the year and industry fixed effects. Columns (1) and (3) show the results without control variables while columns (2) and (4) with control variables. Robust standard errors in parentheses are clustered by firm level

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively

Connect and zero otherwise. Columns (1) and (3) in Table 2 show the relationship between *HSSC* and *DailySprd1* (*DailySprd2*) without considering the control variables, whereas Columns (2) and (4) display the regression results with control variables. The coefficients of *HSSC* are 0.0019 and 0.0016 in Columns (2) and (4), respectively, and both are statistically significant at the 1% level. We document a significantly positive relationship between the Stock Connect programs and market efficiency measures ($p < 0.01$).

With respect to the control variables, we report findings that are consistent with those of existing studies. For example, the positive coefficient of firm size (*Size*) indicates that larger firms tend to have more stock price informational efficiency because they usually have more public exposure; thus, their stock prices contain more efficient information. It

appears that foreign investors tend to hold stocks with larger firm size and higher return on assets, which is in line with previous studies on foreign investors' stock preferences (Dahlquist and Robertsson 2001). In addition, the coefficient of leverage (*Lev)* is significantly negative at the 1% level, consistent with the literature. Cash flow volatility (*Cash_vol*) is significantly negative, with market efficiency at the 5% level, which indicates that the more volatile the cash flows, the lower the market efficiency. The *Analyst* coefficient is significantly negative with *DailySprd1* and *DailySprd2*, indicating that more analysts following the underlying stocks traded in the Stock Connect programs may be beneficial to reduce the firm's intraday bid-ask spreads. This is consistent with the findings of Bae et al. (2008) and Li (2020) that analysts are active participants in the information distribution process and influence investors' decisions. Our findings reveal that stock market openness to overseas investors enhances the efficiency of the A-share market in China, supporting our hypothesis H1.

Channel analysis

The economic mechanisms underlying the positive effect of stock market liberalization on market efficiency remain unexplored. Previous studies have demonstrated that stock market openness to foreign investors induces a better information environment and enhances governance quality. Two potential channels through which the Stock Connect can improve the market efficiency of the underlying stocks are stock price information efficiency and governance quality. Following Bae et al. (2006) and Gul et al. (2010), we adopt the interaction terms *HSSC*SYN* and *HSSC*DA* to investigate how cross-sectional variations in stock price informational efficiency and corporate governance quality change our baseline results.

Synchronicity: stock price informational efficiency

Prior studies use stock price synchronicity as an alternative measure to proxy for the informational efficiency of stock prices. This shows that stock price synchronicity negatively correlates with information efficiency (Morck et al. 2000; Durnev et al. 2003; Hutton et al. 2009). Emerging markets' stock price synchronicity is much higher than that of developed markets (Jin and Myers 2006) for two reasons. First, the lack of incentives for investors and property rights protection in emerging markets discourages trading based on firm-level information (Morck et al. 2000). Second, disclosure rules in emerging markets cannot be effectively implemented (Jin and Myers 2006).

An important channel for market liberalization improves market efficiency through foreign investors' global information advantage and better arbitrage techniques (Grinblatt and Keloharju 2000; Bae et al. 2012). The Stock Connect can accelerate the process of incorporating value-relevant information into stock prices via informed trading (Bae et al. 2012). More sophisticated investors introduced by the Stock Connect can alleviate mispricing and assess the intrinsic value of stocks. Edmans (2009) finds that overseas investors sell their equity stakes to negative news, thus facilitating the capitalization of fundamentals into stock prices.

Measurement of stock price synchronicity

Morck et al. (2000) propose that stock price synchronicity, defined as the R^2 from regressions based on a single-factor market model for stock returns, can be used as a measure of the relative amount of firm-specific information reflected in stock returns. Durnev et al. (2003) confirm that the R^2 measure is associated with the informativeness of U.S. firms' stock prices. Larger R^2 values (greater stock price synchronicity) in the return regressions reflect more marketwide information and are less informationally efficient. Thus, stock price synchronicity is inversely related to informational efficiency. Based on previous studies, we construct Eq. (4) to measure the synchronicity of share prices using R^2 from the regression model.

$$R_{it} = \alpha + \beta \times R_{mt} + \varepsilon. \tag{4}$$

In Eq. (4), R_{it} and R_{mt} are the firm and market returns on trading day t of the sample period, respectively. The returns of the Shanghai and Shenzhen stock markets are measured by the composite index returns of the two stock markets. The economic meaning of the R^2 in the model is part of the individual firm's share price movement, which can be explained by market movement. Therefore, the larger the R^2, the less firm-specific information contained in the firm's share prices; that is, shares with lower stock price synchronicity indicate higher stock price information efficiency.

As R^2 ranges between (0,1), which does not satisfy the requirement of least squares regression analysis, drawing on Morck et al. (2000), we transform it as follows:

$$RSQ_i = \log\left(\frac{R_i^2}{1 - R_i^2}\right). \tag{5}$$

Following the literature, we construct Eq. (6) to investigate how stock price synchronicity influences the relationship between stock connections and market efficiency. We incorporate an interaction term between the Stock Connect and stock price synchronicity (*HSSC*SYN*) in the regression. We focus on the sign and significance of the coefficient (β_2) of the interaction term (*HSSC*SYN*) in Eq. (6) to examine whether the positive effect of the Stock Connect on market efficiency results from lowering stock price synchronicity (i.e., higher stock price information efficiency).

$$DailySprd_{i,t} = \beta_0 + \beta_1 HSSC_{i,t} + \beta_2 HSSC_{i,t} * SYN_{i,t} + \beta_3 Controls_{i,t} + \gamma_i + \eta_t + \varepsilon_{i,t}, \tag{6}$$

where *DailySprd*1 is the annual average of intraday bid-ask spreads calculated by solving the simultaneous equations using daily high and low prices on two consecutive trading days, and *DailySprd2* is the annual average of intraday bid-ask spreads calculated by dividing the difference between the daily high and low prices by their average. The higher the bid/ask spread, the lower the market efficiency. We use the reversed number as a proxy for market efficiency. The *HSSC* equals 1 if the sample firm is eligible for trading under the Stock Connect program and 0 otherwise. The $Controls_{i,t}$ represents a set of control variables—firm size (*Size*), profitability (*ROA and Loss*), leverage (*Lev*), cash flow volatility (*Cash-vol*), listage (*Age*), type of audit opinion (*Opinion*), number of analysts following (*Analyst*), and share turnover (*Turnover*). The γ *and* η control for year- and

Table 3 Stock connect and market efficiency: the role of stock price informational efficiency

	(1) DailySprd1	(2) DailySprd2
HSSC	0.0020***	0.0017***
	(9.75)	(9.50)
SYN	0.0017***	0.0015***
	(26.78)	(25.70)
HSSC × SYN	0.0003***	0.0003***
	(2.62)	(2.99)
Size	0.0020***	0.0018***
	(19.79)	(19.47)
Lev	−0.0050***	−0.0044***
	(−11.84)	(−11.67)
ROA	0.0059***	0.0050***
	(3.86)	(3.62)
Cash_vol	−0.0001**	−0.0001*
	(−1.97)	(−1.80)
Loss	0.0006***	0.0005***
	(2.67)	(2.67)
Age	0.0001	0.0001
	(1.35)	(0.87)
Opinion	−0.0008**	−0.0007**
	(−2.12)	(−2.15)
Analyst	−0.0010***	−0.0011***
	(−14.54)	(−16.27)
Turnover	−0.0008***	−0.0007***
	(−49.82)	(−50.14)
_cons	−0.0829***	−0.0746***
	(−47.69)	(−47.39)
Industry	Yes	Yes
Year	Yes	Yes
N	17,086	17,086
adj. R^2	0.775	0.776

Following Bae et al. (2006) and Morch et al. (2000), we adopt the interaction terms *HSSC*SYN* to investigate how cross-sectional variations in stock price informational efficiency change our baseline results. Stock price synchronicity is inversely related to stock price informational efficiency. We use stock price synchronicity as an alternative measure of stock price informativenss, defined as the R^2 from regressions based on a single factor market model for stock returns. Higher values of R^2 (i.e., greater stock price synchronicity) reflect more market-wide information and less firm-specific information. Robust standard errors in parentheses are clustered by firm level

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively

industry-fixed effects, respectively. All errors in all regressions are robust and clustered at the firm level.

The market efficiency is measured by *DailySrpd1* in Column (1) and *DailySrpd2* in Column (2). As Table 3 shows, the estimated coefficients of the interaction term (*HSSC*SYN*) are 0.0003 and 0.0003, respectively, and both are statistically significant at the 1% level. We find a significant positive relationship between *HSSC* × *SYN* and market efficiency, indicating that the Stock Connect reduces the synchronicity of eligible firms' share prices. This finding validates our expectations and supports H2. In other words, the Stock Connect reduces the bid-ask spreads of underlying stocks by reducing their synchronicity, thereby improving the market efficiency of Chinese A-shares.

Corporate governance

Enhancing market efficiency by improving corporate governance is considered controversial in China because the Chinese government limits the percentage of shares that overseas investors can hold. However, we argue that overseas investors could improve the corporate governance quality of the listed firms that they invested in by the "voting by feet" mechanism. Bae et al. (2006) document that liberalizing emerging markets and increasing openness to foreign investors is associated with increased analyst coverage and decreased earnings management. A stock connection can facilitate corporate discipline and lead to higher-quality disclosure and governance standards. We argue that the introduction of more foreign investors by the Stock Connect could help improve stock market efficiency through enhanced corporate governance.

Hence, we construct Eq. (7) to investigate how corporate governance influences the relationship between stock connections and market efficiency. We include an interaction term (*HSSC*DA*) between the stock connect programs and discretionary accruals in Eq. (7). Following Jones (1991), we use the absolute value of firms' discretionary accruals as a proxy for corporate governance. The higher the value of *DA*, the lower the quality of corporate governance. We focus on the sign and significance of the coefficient (λ2) of the interaction term (*HSSC*DA*) to reveal whether the Stock Connect programs affect market efficiency because of improved governance quality.

$$DailySprd_{i,t} = \lambda_0 + \lambda_1 HSSC_{i,t} + \lambda_2 HSSC_{i,t} * DA_{i,t} + \lambda_3 Controls_{i,t} + \gamma_i + \eta_t + \varepsilon_{i,t}, \tag{7}$$

where *DailySprd* is the proxy for market efficiency. *HSSC* equals 1 if the sample firm is eligible for trading under the Stock Connect program and 0 otherwise. $Controls_{i,t}$ represents a set of control variables: firm size (*Size*), profitability (*ROA and Loss*), leverage (*Lev*), cash flow volatility (*Cash-vol*), listage (*Age*), type of audit opinion (*Opinion*), number of analysts following (*Analyst*), and share turnover (*Turnover*). γ *and* η control for year- and industry-fixed effects, respectively. A significant and negative estimated coefficient λ2 from Eq. (7) supports H3.

The regression results are presented in Table 4. The coefficients of the interaction term (*HSSC*DA*) are − 0.0042 and − 0.0036, respectively, in Columns (1) and (2), respectively, and both are statistically significant at the 5% level, which is consistent with our assumption. A significant and negative relationship between *HSSC*DA* and market efficiency (*DailySprd1 and DailySprd2*) shows that increasing stock market liberalization is associated with decreased earnings management in listed firms (i.e., improving governance quality), thereby enhancing market efficiency.

In summary, market efficiency has improved after implementing SH–HK and SZ–HK Connect. Increased stock price informational efficiency and enhanced corporate governance quality lead to a more efficient A-share market. Increased market efficiency indicates that new information is incorporated faster into the prices. However, economic significance—whether the stock market liberalization policy reform is economically meaningful—is a limitation of this study. Regarding economic significance, the estimated effect of the Stock Connect on intraday bid-ask spreads is around 20 basis points, which is less than 1/5 of one standard deviation of the unconditional daily spread, according to the information from Columns (2) and (4) in Table 2. The

Table 4 Stock connect and market efficiency: the role of corporate governance

	(1) DailySprd1	(2) DailySprd2
HSSC	0.0020***	0.0017***
	(9.03)	(8.63)
DA	−0.0019***	−0.0017***
	(−4.14)	(−4.04)
HSSC × DA	−0.0042**	−0.0036**
	(−2.51)	(−2.37)
Size	0.0024***	0.0021***
	(21.75)	(21.44)
Lev	−0.0063***	−0.0056***
	(−13.92)	(−13.73)
ROA	0.0022	0.0018
	(1.38)	(1.23)
Cash_vol	−0.0001*	−0.0001*
	(−1.87)	(−1.76)
Loss	0.0004	0.0004
	(1.64)	(1.61)
Age	0.0002*	0.0001
	(1.82)	(1.34)
Opinion	−0.0004	−0.0003
	(−0.91)	(−0.88)
Analyst	−0.0012***	−0.0012***
	(−16.02)	(−17.68)
Turnover	−0.0008***	−0.0008***
	(−49.49)	(−49.77)
_cons	−0.0903***	−0.0811***
	(−48.60)	(−48.48)
Industry	Yes	Yes
Year	Yes	Yes
N	15,763	15,763
adj. R^2	0.758	0.759

Following Gul et al. (2010), we adopt the interaction terms *HSSC*DA* to investigate how cross-sectional variations in corporate governance quality change our baseline results. Based on Jones (1991), we use the absolute value of the firms' discretionary accruals as a proxy for corporate governance. The higher the value of *DA*, the lower the corporate governance quality

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively

effects of the interaction terms (*HSSC*SYN* and *HSSC*DA*) are statistically significant but not large enough, as shown in Columns (1) and (2) of Tables 3 and 4. This study may be challenged by whether these reforms were economically meaningful, because we use the annual average of intraday bid-ask spreads to measure market efficiency.[6]

Following Corwin and Schultz (2012), this study uses the high–low spread estimator, which is not computer-time intensive and is ideal for large samples. The high–low

[6] *DailySprd1*: Annual average of intraday bid-ask spreads calculated by solving the simultaneous equations using daily high and low prices on two consecutive trading days. The higher the bid-ask spread, the lower the market efficiency. We use the reversed number to proxy for market efficiency. *DailySprd2*: Annual average of intraday bid-ask spreads calculated by dividing the difference between the daily high and low prices with their average. The higher the bid-ask spread, the lower the market efficiency. We use the reversed number to proxy for market efficiency.

spread estimator is derived under general conditions. It is not ad hoc and can be applied to various markets with different structures. Corwin and Schultz (2012, p. 721) document that the high–low estimator outperforms alternative measures in capturing the cross-sections of both spread levels and month-to-month changes in spreads. Thus, it is useful for researchers to study market efficiency. Simulations reveal that the high–low spread estimator is very accurate under ideal conditions. However, when significant overnight returns and prices are observed sporadically, the high–low spread estimator tends to underestimate spreads (p. 756). Therefore, we assume that the changes following the Stock Connect programs had a sizable economic effect on eligible listed firms, despite the change in average spreads being small. Owing to concerns about the small economic effect, we further analyze the economic consequences of stock market liberalization's impact on market efficiency.

Further analysis: firm-level economic consequences

In this section, we conduct further analysis to examine the firm-level economic consequences resulting from the impact of stock market liberalization on market efficiency. Columns (1) and (2) in Table 5 show that stock market liberalization has a significant and positive impact on local market efficiency and consequently enhances firm value (*Tobin Q*). The results in Columns (3) and (4) show that Stock Connect programs play a significant role in enhancing local market efficiency and consequently reduce the stock price crash risk of A-share listed firms ($NCSKEW_{t+1}$).[7] Our results are consistent with the findings of Wen et al. (2019), allowing more sophisticated international investors to access the Chinese stock market through the Stock Connect scheme to mitigate a firm's stock price crash risk. Retail investors may not be well informed about all stock information because they are restricted by the costs of information searching and processing (Ying et al. 2015).[8] These findings show that the liberalization of capital markets helps promote stable and healthy development.

Robustness checks

Although we find consistent results using the two measures of market efficiency, endogeneity concerns remain. Regardless of their country of origin, investors prefer to hold and trade stocks with more informative or efficient prices, as the information is costly to collect. Therefore, it is plausible that foreign investors self-select into the strategy of holding stocks with higher levels of stock price information efficiency. It is also possible that unobservable factors drive foreign investors' holdings and stock price information efficiency. We address this endogeneity concern and strive to obtain consistent estimations by performing regression analyses based on the propensity score matching (PSM) approach, the placebo test, and the Heckman two-step estimation.

[7] The stock price crash risk is measured as the "negative coefficient of skewness." A large NCSKEW value of a stock indicates a high price crash risk of the stock.

[8] According to Gao and Yang (2018), individual investors account for more than 60% of the securities market in China.

Table 5 Further analysis: firm-level economic consequences

	(1) TobinQ	(2) TobinQ	(3) $NCSKEW_{t+1}$	(4) $NCSKEW_{t+1}$
HSSC	1.1862***	1.1345***	−0.2209***	−0.2130***
	(11.53)	(11.32)	(−4.37)	(−4.26)
DailySprd1	−66.2750***		1.9255**	
	(−24.42)		(2.15)	
HSSC × DailySprd1	26.9079***		−2.8484***	
	(10.75)		(−2.61)	
DailySprd2		−72.4783***		1.7608*
		(−24.20)		(1.79)
HSSC × DailySprd2		29.0258***		−3.0079**
		(10.61)		(−2.49)
Size	−0.7819***	−0.7857***	−0.0795***	−0.0788***
	(−21.30)	(−21.37)	(−8.57)	(−8.49)
Lev	−1.6852***	−1.6765***	0.0697*	0.0679*
	(−11.65)	(−11.59)	(1.90)	(1.85)
ROA	7.7476***	7.7364***	−0.2293*	−0.2289*
	(13.03)	(12.98)	(−1.68)	(−1.68)
Cash_vol	0.0781***	0.0790***	−0.0137**	−0.0138**
	(4.48)	(4.53)	(−2.03)	(−2.04)
Loss	0.7742***	0.7751***	0.0122	0.0122
	(11.44)	(11.45)	(0.50)	(0.50)
Age	0.1231***	0.1201***	−0.0363***	−0.0362***
	(3.97)	(3.87)	(−4.06)	(−4.05)
Opinion	−1.1993***	−1.2010***	−0.0271	−0.0270
	(−6.71)	(−6.72)	(−0.74)	(−0.74)
Analyst	0.2001***	0.1940***	0.0928***	0.0925***
	(11.39)	(10.99)	(14.21)	(14.11)
Turnover	−0.0838***	−0.0838***	−0.0109***	−0.0111***
	(−16.25)	(−16.26)	(−6.12)	(−6.24)
_cons	15.8095***	15.9060***	2.0394***	2.0106***
	(22.33)	(22.48)	(12.12)	(11.98)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	17,086	17,086	17,052	17,052
adj. R^2	0.546	0.545	0.078	0.078

Following previous studies, we adopt the negative coefficient of skewness of firm-specific weekly returns ($NCSKEW_{t+1}$) to measure stock crash risk

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively

Propensity score matching (PSM)

To mitigate the possible selection bias owing to the selection of eligible firms, we adopt the PSM methodology to match data one to one by eligible firms and non-eligible firms and divide the matching data into treatment and control groups. Specifically, we construct a control sample using the nearest neighbor propensity score one-to-one matching strategy with a set of firm characteristics, including firm size (*Size*), book leverage (*Lev*), profitability (*ROA* and *Loss*), number of years listed (*Age*), number of analysts following (*Analyst*), auditor opinion (*Opinion*), and share turnover (*Turnover*). Finally, we

Table 6 Robustness checks: propensity-score matching method

	(1) DailySprd1	(2)	(3) DailySprd2	(4)
HSSC	0.0022***	0.0021***	0.0019***	0.0018***
	(6.69)	(7.21)	(6.34)	(7.03)
Size		0.0028***		0.0025***
		(16.80)		(16.44)
Lev		−0.0077***		−0.0069***
		(−10.44)		(−10.31)
ROA		0.0009		0.0001
		(0.35)		(0.03)
Cash_vol		−0.0004***		−0.0003***
		(−3.31)		(−3.07)
Loss		0.0005		0.0005
		(1.21)		(1.26)
Age		0.0006***		0.0005***
		(3.50)		(3.18)
Opinion		0.0003		0.0002
		(0.46)		(0.30)
Analyst		−0.0010***		−0.0010***
		(−8.64)		(−9.85)
Turnover		−0.0009***		−0.0008***
		(−31.73)		(−31.52)
_cons	−0.0511***	−0.0965***	−0.0465***	−0.0862***
	(−45.69)	(−32.46)	(−46.66)	(−32.06)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	5012	5012	5012	5012
adj. R^2	0.682	0.785	0.687	0.787

To mitigate the possible selection bias due to the selection of eligible firms, we adopt the methodology of propensity-score matching (PSM) to match data one to one by eligible firms and non-eligible firms and divide matching data into treatment group and control group. Specifically, we construct a control sample by nearest neighbour propensity score one-to-one matching strategy with a set of firm characteristics, including firm size (Size), book leverage (Lev), profitability (ROA and Loss), cash flows volatility(Cash_vol), listage, audit opinion, analyst following and share turnover. Finally, we obtain the sample comprising 5012 firm-year matching observations. Table 6 reports the results of DID analysis using PSM method

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively

obtain a sample comprising 5012 firm–year matching observations. Table 6 reports the results of the DID analysis using the PSM matching data. As Columns (2) and (4) show, the coefficients of *HSSC* for the dependent variables *DailySprd1* and *DailySprd2* are 0.0021 and 0.0018, respectively, and both are statistically significant at the 1% level. The kernel density of the treatment and control groups in Fig. 3 is closer after PSM, suggesting that the matching process removes any meaningful firm-level differences between the two groups. The results show that opening up the Chinese A-share market has improved market efficiency, supporting our main hypothesis (H1).

Placebo test

The SH–HK and SZ–HK Stock Connects were launched in 2014 and 2016, respectively, which paved the way for opening up mainland China's stock market further. We use a

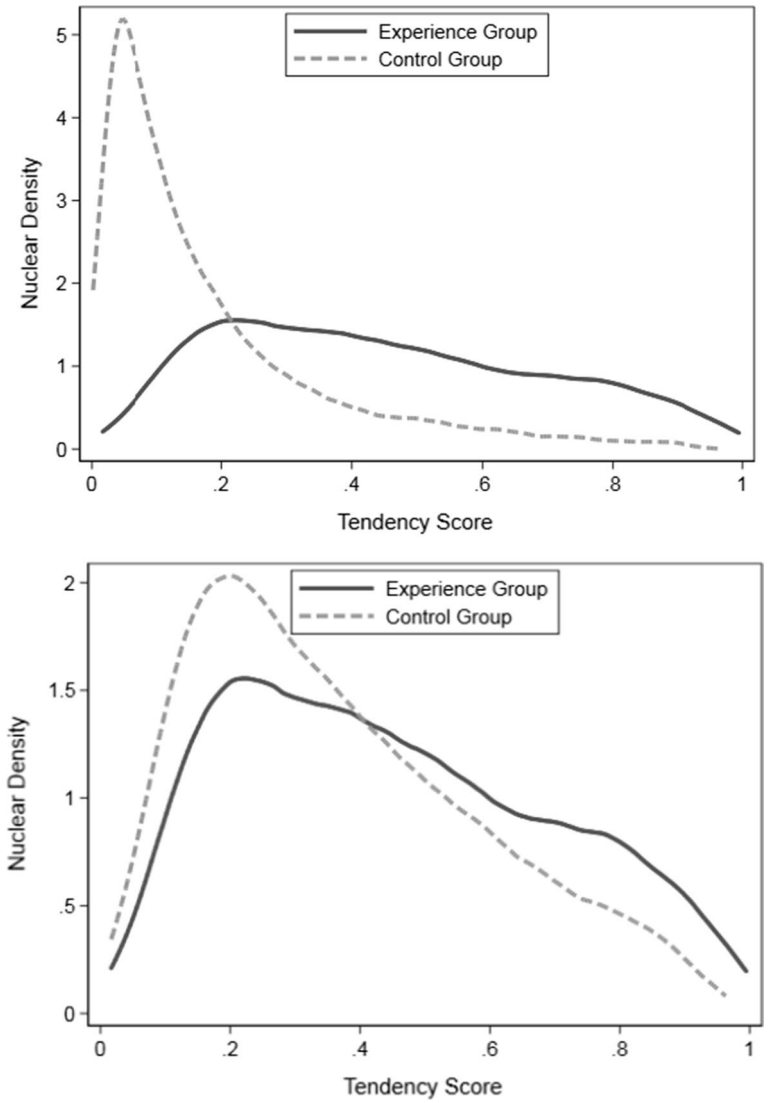

Fig. 3 Before and after PSM

placebo test to examine whether the enhancement of stock market efficiency is directly because of the implementation of the Stock Connect rather than other factors. The selection of eligible shares traded in stock connection schemes remains unchanged. However, we move backward two years from the official launch time of the Stock Connects and assume that the SH–HK Stock Connect started in 2011 or 2012 and the SZ–HK Stock Connect started in 2013 or 2014. If securities market efficiency is enhanced by implementing the Stock Connect rather than the other factors, we cannot provide consistent findings via a placebo test. Table 7 shows the results of the placebo test. The coefficients of *HSSC* lagged for two years in Columns (1) and (2) are − 0.0001 and − 0.0001, respectively, and both are statistically insignificant. Our findings indicate that liberalizing the stock market plays an important role in improving market efficiency.

Table 7 Robustness checks: Placebo test

	(1) DailySprd1	(2) DailySprd2
$HSSC_{t-2}$	−0.0001	−0.0001
	(−0.44)	(−0.36)
Size	0.0025***	0.0023***
	(25.14)	(24.66)
Lev	−0.0061***	−0.0054***
	(−14.39)	(−14.15)
ROA	0.0030*	0.0024*
	(1.94)	(1.75)
Cash_vol	−0.0002***	−0.0002**
	(−2.59)	(−2.42)
Loss	0.0003	0.0003
	(1.42)	(1.45)
Age	0.0003**	0.0002*
	(2.41)	(1.90)
Opinion	−0.0003	−0.0003
	(−0.82)	(−0.88)
Analyst	−0.0012***	−0.0012***
	(−16.42)	(−18.12)
Turnover	−0.0008***	−0.0008***
	(−51.11)	(−51.56)
_cons	−0.0935***	−0.0838***
	(−55.66)	(−55.24)
Industry	Yes	Yes
Year	Yes	Yes
N	17,086	17,086
adj. R^2	0.754	0.756

This table displays the results of the placebo test

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively

Heckman two-step estimation

To ensure regression model fit and overcome any potential sample selection bias, we conduct the Heckman two-step estimation. In the first step, we add relevant variables to the equations that could affect the selection of underlying stocks eligible for trading under the Stock Connect program. We consistently incorporate a set of control variables: firm size, profitability (ROA and loss), leverage, audit opinion, listage, analyst coverage, cash flow volatility, and share turnover. We also control for year- and industry-fixed effects. In the second step, the outcome equation is estimated using ordinary least squares (OLS), in which the outcome equation includes both the explanatory variables and the constructed value of the inverse Mills ratio. As shown in Table 8, the coefficients of *HSSC* in Columns (2) and (3) are 0.0017 and 0.0015, respectively, both of which are statistically significant at the 1% level. This suggests that our main findings are robust, and H1 is supported.

Table 8 Robustness checks: Heckman two-step estimation

	(1) HSSC	(2) DailySprd1	(3) DailySprd2
HSSC		0.0017***	0.0015***
		(8.63)	(8.53)
Size	0.7458***	0.0026***	0.0022***
	(18.84)	(12.93)	(11.79)
Lev	−1.1979***	−0.0064***	−0.0055***
	(−7.77)	(−11.43)	(−10.69)
ROA	2.0450***	0.0064***	0.0050***
	(4.03)	(3.18)	(2.77)
Cash_vol	−0.0428*	−0.0003***	−0.0002***
	(−1.68)	(−3.10)	(−2.87)
Loss	0.0850	0.0008**	0.0007**
	(1.03)	(2.56)	(2.47)
Age	0.2633***	0.0006***	0.0005***
	(7.00)	(4.19)	(3.53)
Opinion	0.0357	−0.0000	−0.0001
	(0.27)	(−0.03)	(−0.31)
Analyst	0.1250***	−0.0011***	−0.0012***
	(5.36)	(−11.83)	(−13.62)
Turnover	0.0084	−0.0008***	−0.0007***
	(1.61)	(−37.70)	(−37.97)
IMR		0.0001	−0.0002
		(0.28)	(−0.66)
_cons	−23.6797***	−0.0944***	−0.0793***
	(−29.54)	(−15.25)	(−14.04)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	10,511	10,511	10,511
adj. R^2	0.404	0.801	0.803

To ensure that our regression model fits the data and to overcome potential sample selection bias, we conduct the Heckman two-step estimation. In the first step,we add relevant variables in the equations that could affect the selection of underlying stocks eligible for trading under the Stock Connect programs. Consistently, we incorporate a set of control variables—firm size, profitability (ROA and Loss), leverage, audit opinion, listage, analyst coverage, cash flows volatility, and share turnover. We also control for year and industry fixed effects. In the second step, the outcome equation is estimated by ordinary least squares (OLS), in which the outcome equation includes both the explanatory variables and the constructed value of the inverse Mills ratio

***, **, and * denote significance at the 1%, 5%, and 10% level, respectively

Alternative measures of market efficiency

The size of the spread is not necessarily the only criterion for market efficiency. Hence, we use alternative proxies to measure market efficiency. According to Hou and Moskowitz (2005), the faster the adjustment speed of share prices based on market information, the higher the market efficiency. In line with this study, we construct an indicator of share price delays and use the adjustment speed of share prices based on market information to measure market efficiency. The method is as follows.

First, we regress the current period and the last four periods' market returns on the individual firms' current period returns:

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \sum_{k=1}^{4} \delta_{i,k} r_{m,t-k} + \varepsilon_{i,t}, \tag{8}$$

where $r_{i,t}$ denotes the return on stock i at week t, and $r_{w,t}$, and $r_{m\text{-}k}$ are the contemporaneous and lagged returns on the world market portfolio and the local market portfolio, respectively, for k = 0, 1, 2, 3, 4. The advantage of this specification is that the relationship between individual stock returns and world market returns is measured after controlling for local market returns. Thus, we measure the relation of stock returns with the component of world market returns that are orthogonal to local market returns. We obtain the world market portfolio returns and the local market portfolio returns from Datastream. We require at least 20 weekly observations for each stock each year.

The first delay measure that we use is adopted from Hou and Moskowitz (2005), who examine the impact of market frictions on cross-sectional return predictability. It measures the fraction of variation in individual stock returns, which is explained by the lagged world (local) market returns in Eq. (9). Specifically, it is computed as one minus the ratio of the R^2 statistic (R_r^2) obtained from a restricted version of regression Eq. (9), in which the coefficients of the lagged world (local) market returns are set equal to zero, to the R^2 obtained without imposing such restrictions (R_{ur}^2):

$$Delay = 1 - R_r^2 / R_{ur}^2 \tag{9}$$

Chordia et al. (2005) construct the absolute value of the intraday trade-to-trade quote midpoint autocorrelation to measure the autocorrelation of share prices. The smaller the absolute value, the higher the pricing efficiency because prices reflect information more fully. Following Chordia et al. (2005), we measure market efficiency by constructing the absolute value of autocorrelation between daily returns based on daily close prices and their one-period lags. The expression for *AR_abs* is as follows:

$$AR\_abs = \left|\mathrm{Corr}\left(r_{i,t}, r_{i,t-1}\right)\right| \tag{10}$$

We substitute *Delay* and *AR_abs* for *DailySprd1* or *DailySprd2* as proxies for market efficiency and rerun the regression for the baseline model. As shown in Table 9, the coefficients of *HSSC* when *Delay* is the dependent variable are 0.0053 and 0.0018, which are significant at the 1% and 5% levels, respectively. The coefficients of *HSSC* when the dependent variable is *AR_abs* are 0.0093 and 0.0037, respectively; both are significant at the 1% level. These regression results confirm that the implementation of Shanghai/Shenzheng–Hong Kong Stock Connect enhances the Chinese A-share market efficiency.

Alternative measures of HSSC

The Chinese government sometimes changes the list of firms covered by the Stock Connect programs. For example, a firm may be a covered firm in the first half of the year but is then removed from the list in the latter half of the year or put into a special list, where shares can only be sold but not bought. The firms in these two samples create noise in the regression results. Therefore, we construct alternative measures of the dummy variable for firms covered in the SH–HK Stock Connect and SZ–HK Stock Connect. *HSSC1* excludes firms from the list of firms covered by the Shanghai/Shenzhen–HK Stock

Table 9 Robustness checks: alternative measures of market efficiency

	(1) Delay	(2) Delay	(3) AR_abs	(4) AR_abs
HSSC	0.0053***	0.0018**	0.0093***	0.0037***
	(6.11)	(2.08)	(6.94)	(2.65)
Size		0.0048***		0.0042***
		(10.20)		(5.55)
Lev		−0.0125***		−0.0191***
		(−5.65)		(−6.30)
ROA		−0.0167**		0.0297***
		(−2.20)		(2.70)
Cash_vol		−0.0009***		0.0002
		(−2.82)		(0.35)
Loss		−0.0032***		−0.0025
		(−2.68)		(−1.20)
Age		−0.0015***		−0.0018**
		(−3.38)		(−2.45)
Opinion		0.0152***		0.0159***
		(5.75)		(4.60)
Analyst		−0.0005		0.0014***
		(−1.53)		(2.79)
Turnover		0.0001		0.0000
		(0.60)		(0.03)
_cons	−0.0208***	−0.1094***	−0.0649***	−0.1617***
	(−7.74)	(−12.55)	(−15.87)	(−12.72)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	17,086	17,086	17,086	17,086
adj. R^2	0.061	0.082	0.256	0.270

We substitute*Delay* and *AR_abs* for DailySprd1 or DailySprd2 as the proxies for market efficiency. Based on Chordia et al. (2005), we measure market efficiency by constructing the absolute value of autocorrelation between daily returns based on daily close prices and their one-period lags (*AR_abs*)

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively

Connect. *HSSC2* excludes both firms that are removed and firms that are placed on the special list. We then regress *DailySprd1* and *DailySprd2* on these two dummy variables. Table 10 shows that the coefficients of *HSSC1* for *DailySprd1* and *DailySprd2* are 0.0019 and 0.0016, respectively, and both are significant at the 1% level. The coefficients of *HSSC2* for *DailySprd1* and *DailySprd2* are 0.0015 and 0.0012, respectively, both of which are significant at the 1% level. The results further confirm that capital market liberalization plays a significant and positive impact on local market efficiency.

Different sample range

Before the Stock Connect launch, overseas investors could access the Chinese A-share market through the QFII mechanism, the B-share market, or the A-share and H-share cross-listed markets.[9] Overseas investors already influenced the A-shares covered by

[9] Similar to A-shares, Chinese B-shares are listed on Shanghai and Shenzhen stock exchanges, whereas H-shares are listed on the Hong Kong stock exchange. Shanghai-listed B-shares are dominated in U.S. dollars, and Shenzhen-listed B-shares and H-shares are dominated in Hong Kong dollars. B-shares are open to foreign investors, H-shares are available both to Hong Kong and international investors.

Table 10 Robustness checks: alternative measures of stock market liberalization

	(1) DailySprd1	(2) DailySprd2	(3) DailySprd1	(4) DailySprd2
HSSC1	0.0019***	0.0016***		
	(9.90)	(9.47)		
HSSC2			0.0015***	0.0012***
			(7.97)	(7.49)
Size	0.0023***	0.0021***	0.0024***	0.0021***
	(22.75)	(22.37)	(23.19)	(22.82)
Lev	−0.0058***	−0.0052***	−0.0059***	−0.0052***
	(−13.71)	(−13.50)	(−13.87)	(−13.67)
ROA	0.0024	0.0019	0.0024	0.0019
	(1.56)	(1.39)	(1.57)	(1.40)
Cash_vol	−0.0002**	−0.0001**	−0.0002**	−0.0001**
	(−2.41)	(−2.24)	(−2.44)	(−2.28)
Loss	0.0003	0.0003	0.0003	0.0003
	(1.28)	(1.31)	(1.33)	(1.36)
Age	0.0002	0.0001	0.0002*	0.0001
	(1.52)	(1.06)	(1.85)	(1.38)
Opinion	−0.0002	−0.0002	−0.0002	−0.0002
	(−0.69)	(−0.75)	(−0.71)	(−0.77)
Analyst	−0.0012***	−0.0012***	−0.0013***	−0.0012***
	(−16.74)	(−18.42)	(−16.88)	(−18.54)
Turnover	−0.0008***	−0.0008***	−0.0008***	−0.0008***
	(−51.32)	(−51.74)	(−51.47)	(−51.88)
_cons	−0.0894***	−0.0802***	−0.0904***	−0.0811***
	(−51.66)	(−51.37)	(−52.20)	(−51.88)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	17,086	17,086	17,086	17,086
adj. R^2	0.757	0.758	0.756	0.757

We construct alternative measures of the dummy variable for firms covered in Shanghai-HK Stock Connect and Shenzhen-HK Stock Connect. *HSSC1* excludes firms that are removed from the list of Shanghai Connect and Shenzhen Connect. *HSSC2* excludes firms that are removed or those are put on the special list

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively

these mechanisms through share price synchronicity, transparency, and corporate governance improvement before the Shanghai and Shenzhen Connects. Our tests have not eliminated the influence of these mechanisms. Therefore, to strengthen the robustness of our conclusions, we delete A-shares held by QFII, which also have B-shares, and those cross-listed as H-shares and rerun the baseline models. As shown in Table 11, the coefficients of *HSSC* are all significantly positive at the 1% level after deleting A-share listed firms held by QFII, those also listed as B-shares, and those cross-listed as H-shares. Our conclusions remain valid.

Table 11 Robustness checks: different sample range

	Delete QFII		Delete A + B shares		Delete A + H shares		Delete QFII, A + B shares, A + H shares	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DailySprd1	DailySprd2	DailySprd1	DailySprd2	DailySprd1	DailySprd2	DailySprd1	DailySprd2
HSSC	0.0020***	0.0017***	0.0019***	0.0016***	0.0021***	0.0018***	0.0023***	0.0020***
	(10.29)	(9.89)	(10.00)	(9.59)	(10.89)	(10.49)	(11.40)	(11.06)
Size	0.0023***	0.0020***	0.0024***	0.0021***	0.0023***	0.0020***	0.0022***	0.0020***
	(21.19)	(20.82)	(22.58)	(22.23)	(21.00)	(20.63)	(19.51)	(19.18)
Lev	−0.0053***	−0.0047***	−0.0060***	−0.0053***	−0.0056***	−0.0050***	−0.0053***	−0.0047***
	(−12.19)	(−11.99)	(−13.80)	(−13.59)	(−13.03)	(−12.81)	(−11.86)	(−11.65)
ROA	0.0016	0.0013	0.0023	0.0018	0.0023	0.0018	0.0013	0.0010
	(0.99)	(0.88)	(1.49)	(1.31)	(1.47)	(1.31)	(0.82)	(0.71)
Cash_vol	−0.0002***	−0.0002***	−0.0002**	−0.0002**	−0.0002**	−0.0001**	−0.0002***	−0.0002***
	(−2.73)	(−2.59)	(−2.49)	(−2.36)	(−2.24)	(−2.09)	(−2.70)	(−2.62)
Loss	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
	(1.02)	(1.09)	(1.37)	(1.40)	(1.31)	(1.32)	(1.18)	(1.22)
Age	0.0000	0.0000	0.0002**	0.0002	0.0002	0.0001	0.0001	0.0001
	(0.45)	(0.00)	(2.03)	(1.53)	(1.49)	(1.07)	(1.09)	(0.63)
Opinion	−0.0003	−0.0003	−0.0003	−0.0003	−0.0001	−0.0001	−0.0002	−0.0002
	(−0.88)	(−0.93)	(−0.75)	(−0.83)	(−0.25)	(−0.33)	(−0.45)	(−0.53)
Analyst	−0.0013***	−0.0013***	−0.0013***	−0.0013***	−0.0013***	−0.0012***	−0.0014***	−0.0013***
	(−17.01)	(−18.62)	(−17.59)	(−19.25)	(−16.60)	(−18.26)	(−17.68)	(−19.25)
Turnover	−0.0008***	−0.0007***	−0.0008***	−0.0008***	−0.0008***	−0.0008***	−0.0008***	−0.0007***
	(−48.32)	(−48.70)	(−51.39)	(−51.77)	(−50.87)	(−51.26)	(−47.98)	(−48.32)
_cons	−0.0875***	−0.0785***	−0.0895***	−0.0802***	−0.0882***	−0.0791***	−0.0869***	−0.0778***
	(−48.48)	(−48.22)	(−50.63)	(−50.33)	(−48.52)	(−48.26)	(−44.18)	(−43.99)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	15,451	15,451	16,432	16,432	16,531	16,531	14,434	14,434
adj. R^2	0.758	0.760	0.759	0.760	0.756	0.758	0.760	0.762

Conclusions

In this study, the implementation of the Stock Connect (including the SH–HK Connect and SZ–HK Connect) has been considered as a quasi-natural experiment to examine the impact of stock market liberalization on market efficiency. Our sample comprises firm–year observations of Chinese listed firms in the A-share market from 2009 to 2018. We find that the market efficiency of eligible firms has experienced significant enhancement after implementing the Stock Connect compared to that of non-eligible firms. We further explore the potential channels through which stock market liberalization can improve local market efficiency. The findings show that implementing the Stock Connect reduces stock price synchronicity (i.e., improves stock price informational efficiency) and improves corporate governance, thereby enhancing the efficiency of the Chinese A-share market (i.e., reducing intraday bid-ask spreads). The additional analysis indicates that stock market liberalization has a significant and positive impact on local market efficiency, ultimately enhancing firm value and reducing stock crash risk. Our findings remain robust even after conducting various robustness checks.

This study complements the existing literature that examines market efficiency in a Chinese setting by highlighting the roles of both the SH–HK and SZ–HK Connects. It provides direct evidence that stock market liberalization improves local market efficiency. It is important for policymakers and academics to understand the consequences

of liberalizing the capital market for foreign capital and investors. This study further indicates that the SH–HK and SZ–HK Connects enhance the importance of mainland capital markets by improving market efficiency. With the integration of the world economy, the Chinese government and financial regulators should continue to deepen capital market reforms, which can optimize investor structure and strengthen investor protection.

Appendix

See Table 12.

Table 12 Variable definitions

Variable type	Variable name	Variable	Variable definitions
Dependent variable	Market efficiency	DailySprd1	Annual average of intraday bid-ask spreads calculated by solving the simultaneous equations using daily high prices and daily low prices on two consecutive trading days. The higher the bid-ask spread, the lower the market efficiency. We use the reversed number to proxy for market efficiency
		DailySprd2	Annual average of intraday bid-ask spreads calculated by dividing the difference between the daily high price and the daily low price with their average. The higher the bid-ask spread, the lower the market efficiency. We use the reversed number to proxy for market efficiency
Independent variable	Stock market liberalization	HSSC	Based on prior literature (Henry 2000a, b; Fan and Wang 2017), *HSSC* is defined as a dummy variable. If the listed firm is eligible for trading under either the SH-HK or SZ-HK Stock Connect scheme, *HSSC* equals 1 and equals 0 otherwise. The Stock Connect schemes represent recent stock market liberalization toward more openness and transparency in China
Control Variable	Firm Size	Size	Natural logarithm of total assets at year-end
	Leverage	Lev	Total liabilities/Total assets
	Return on Assets	ROA	Net operating income divided by total assets
	Cash flow volatility	Cash_vol	The standard deviation of cash flows in the last three years
	Firm Loss	Loss	Dummy variable, equals 1 when the firm's net profit is negative in the year and equals 0 otherwise
	Years listed	Age	Natural logarithm of the number of years the firm is listed
	Audit Opinion	Opinion	Dummy variable, equals 1 if auditor's opinion for the year *t* shows standard "unqualified opinion" and equals 0 otherwise
	Analyst Following	Analyst	Natural logarithm of the number of financial analysts who cover a listed firm in a given year
	Turnover	Turnover	Turnover ratio, computed as daily number of shares traded/total number of tradable shares
	Year	Year	Year fixed effects, matrix of dummies that's one for the year from January 1 to December 31 and zero otherwise
	Industry	Industry	Industry fixed effects. China Securities Regulation Commission modified the industry classification in 2012. To ensure comparability, we use the new classification and manually adjusted the industry classifications of listed firms before 2012

Abbreviations

CSMAR	China Stock Market and Accounting Research
DID approach	Difference-in-difference approach
EMH	Efficient market hypothesis
PSM	Propensity score matching
OLS	Ordinary least squares
QDII	Qualified Domestic Institutional Investors
QFII	Qualified Foreign Institutional Investors
RMB	Chinese Renminbi (the local currency in China)
RQFII	RMB Qualified Foreign Institutional Investor
SH-HK Stock Connect	Shanghai-Hong Kong Stock Connect
SZ-HK Stock Connect	Shenzhen-Hong Kong Stock Connect
SSE	Shanghai Stock Exchange
SZSE	Shenzhen Stock Exchange
SEHK	Hong Kong Stock Exchange
ST	Special Treatment
*ST	Suspension from Trading

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Author contributions
Dr. YM—Conception and design of the work, drafting the article. Dr. LYX—Data collection, analysis and interpretation. Dr. LJX—Revision, robustness tests, analysis and interpretation. Dr. MB—Drafting and revising the article. All authors read and approved the final version of the manuscript.

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Availability of data and materials
Data is available upon request.

Declarations

Competing interests
We declare that we have no competing interests that could have appeared to influence the work reported in this paper.

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References

Aggarwal R, Erel I, Ferreira M, Matos P (2011) Does governance travel around the world? Evidence from institutional investors. J Financ Econ 100(1):154–181
Allen F, Qian J, Qian MJ (2005) Law finance and economic growth in China. J Financ Econ 77(1):57–116. https://doi.org/10.1016/j.jfineco.2004.06.010
Amihud Y (2002) Illiquidity and stock returns: cross-section and time-series effects. J Financ Mark 5(1):31–56
Atkins AB, Dyl EA (1990) Price reversals, bid-ask spreads, and market efficiency. J Financ Quant Anal 25(4):535–547
Bae K-H, Chan K, Ng A (2004) Investibility and return volatility. J Financ Econ 71(2):239–263
Bae K-H, Stulz RM, Tan H (2008) Do local analysts know more? A cross-country study of the performance of local analysts and foreign analysts. J Financ Econ 88(3):581–606. https://doi.org/10.1016/j.jfineco.2007.02.004
Bae K-H, Ozoguz A, Tan H, Wirjanto TS (2012) Do foreigners facilitate information transmission in emerging markets? J Financ Econ 105(1):209–227
Bai Y, Chow DYP, (2017) Shanghai-Hong Kong Stock Connect: An analysis of Chinese partial stock market liberalization impact on the local and foreign markets. J Int Financ Markets Institut Money 50:182–203. https://doi.org/10.1016/j.intfin.2017.09.006
Bai M, Bai F, Qin Y (2022) Emerging economies openness and efficiency. Manag Decis Econ 43(3):659–672
Balakrishnan K, Vashishtha R, Verrecchia RE (2019) Foreign competition for shares and the pricing of information asymmetry: evidence from equity market liberalization. J Account Econ 67(1):80–97
Bae KH, Bailey W, Mao CX (2006) Stock market liberalization and the information environment. J Int Money Financ 25(3):404–428. https://doi.org/10.1016/j.jimonfin.2006.01.004
Bae K-H, Goyal VK (2010) Equity market liberalization and corporate governance. J Corporat Financ 16(5):609-621. https://doi.org/10.1016/j.jcorpfin.2010.08.008

Bekaert G, Harvey CR (2000) Foreign speculators and emerging equity markets. J Financ 55(2):565–613. https://doi.org/10.1111/0022-1082.00220
Bekaert G, Harvey CR, Lundblad C (2005) Does financial liberalization spur growth? J Financ Econ 77(1):3–55
Bekaert G, Harvey CR, Lundblad C (2011) Financial openness and productivity. World Dev 39(1):1–19
Ben Rejeb A, Boughrara A (2013) Financial liberalization and stock markets efficiency: New evidence from emerging economies. Emerg Market Rev. 17:186–208. https://doi.org/10.1016/j.ememar.2013.09.001
Boehmer E, Wu J (2013) Short selling and the price discovery process. Rev Financ Stud 26:287–322
Boone AL, White JT (2015) The effect of institutional ownership on firm transparency and information production. J Financ Econ 117(3):508–533. https://doi.org/10.1016/j.jfineco.2015.05.008
Bond P, Edmans A, Goldstein I (2012) The real effects of financial markets. Annual Rev Financ Econ 4(1):339–360. https://doi.org/10.1146/annurev-financial-110311-101826
Cajueiro DO, Gogas P, Tabak BM (2009) Does financial market liberalization increase the degree of market efficiency? The case of the Athens stock exchange. Int Rev Financ Anal 18(1-2):50-57. https://doi.org/10.1016/j.irfa.2008.11.004
Chan K, Hameed A, Kang W (2013) Stock price synchronicity and liquidity. J Financ Mark 16(3):414–438
Chen Q, Goldstein I, Jiang W (2007) Price informativeness and investment sensitivity to stock price. Revi Financ Stud 20(3):619–650. https://doi.org/10.1093/rfs/hhl024
Chordia T, Roll R, Subrahmanyam A (2005) Evidence on the speed of convergence to market efficiency. J Financ Econ 76(2):271–292
Corwin SA, Schultz P (2012) A simple way to estimate bid-ask spreads from daily high and low prices. J Financ 67(2):719–760
Dahlquist M, Robertsson, G (2001) Direct foreign ownership, institutional investors, and firm characteristics. J Financ Econ 59:413–440. https://doi.org/10.1016/S0304-405X(00)00092-1
Durnev A, Morck R, Yeung B, Zarowin P (2003) Does greater firm-specific return variation mean more or less informed stock pricing? J Account Res 41(5):797–836. https://www.jstor.org/stable/3542377
Edmans A (2009) Blockholder Trading Market Efficiency and Managerial Myopia. J Financ 64(6):2481–2513. https://doi.org/10.1111/j.1540-6261.2009.01508.x
Fama EF (1970) Efficient capital markets: a review of theory and empirical work. J Finance 25(2):383–417. https://doi.org/10.2307/2325486
Fan QL, Wang T (2017) The impact of Shanghai–Hong Kong Stock Connect policy on A-H share price premium. Financ Res Lett 21:222–227. https://doi.org/10.1016/j.frl.2016.11.014
Ferreira MA, Matos P (2008) The colors of investors' money: The role of institutional investors around the world. J Financ Econ 88(3):499–533. https://doi.org/10.1016/j.jfineco.2007.07.003
Gao B, Yang CP (2018) Investor trading behavior and sentiment in futures markets. Emerg Market Financ Trade 54:707–720. https://doi.org/10.1080/1540496X.2016.1262760
Goodell JW, Li MS, Liu DS, Peng HF (2022) Depoliticization and market efficiency: evidence from China. Financ Res Lett. https://doi.org/10.1016/j.frl.2022.102712
Goldman E (2004) The impact of stock market information production on internal resource allocation. J Financ Econ 71(1):143–167. https://doi.org/10.1016/S0304-405X(03)00177-6
Grinblatt M, Keloharju M (2000) The investment behavior and performance of various investor types: a study of Finland's unique data set. J Financ Econ 55(1):43–67
Gul FA, Kim JB, Qiu AA (2010) Ownership concentration foreign shareholding audit quality and stock price synchronicity: Evidence from China. J Financ Econ 95(3):425–442. https://doi.org/10.1016/j.jfineco.2009.11.005
Gupta N, Yuan K (2009) On the Growth Effect of Stock Market Liberalizations. Rev Financ Stud 22(11):4715–4752. https://doi.org/10.1093/rfs/hhp001
He W, Li D, Shen J, Zhang B (2013) Large foreign ownership and stock price informational efficiency around the world. J Int Money Financ 36:211–230
Henry PB (2000a) Do stock market liberalizations cause investment booms? J Financ Econ 58(1–2):301–334. https://doi.org/10.1016/S0304-405X(00)00073-8
Henry PB (2000b) Stock market liberalization, economic reform, and emerging market equity prices. J Financ 55(2):529–564
Hou K, Moskowitz TJ (2005) Market frictions, price delay, and the cross-section of expected returns. Rev Financ Stud 18(3):981–1020
Huo R, Ahmed DA (2017) Return and volatility spillovers effects: evaluating the impact of Shanghai-Hong Kong stock connect. Econ Model 61:260–272
Hutton AP, Marcus AJ, Tehranian H (2009) Opaque financial reports, R2, and crash risk. J Financi Econ 94(1):67–86. https://doi.org/10.1016/j.jfineco.2008.10.003
Jin L, Myers S (2006) R2 around the world: New theory and new tests. J Financ Econ 79(2):257–292. https://doi.org/10.1016/j.jfineco.2004.11.003
Jones JJ (1991) Earnings management during import relief investigations. J Account Res 29(2):193–228
Kemme DM, McInish TH, Zhang J (2022) Market fairness and efficiency: evidence from the Tokyo Stock Exchange. J Bank Finance. https://doi.org/10.1016/j.jbankfin.2021.106309
Kim EH, Singal V (2000) Stock Market Openings: Experience of Emerging Economies. J Busi 73(1):25–66. https://doi.org/10.1086/209631
Kou G, Peng Y, Wang G (2014) Evaluation of clustering algorithms for financial risk analysis using MCDM methods. Inf Sci 275:1–12. https://doi.org/10.1016/j.ins.2014.02.137
Kou G, Yüksel S, Dinçer H (2022) Inventive problem-solving map of innovative carbon emission strategies for solar energy-based transportation investment projects. Appl Energy 311:118680. https://doi.org/10.1016/j.apenergy.2022.118680
La Porta R, Lopez-de-Silanes F, Shleifer A, Vishny R (2000) Investor protection and corporate governance. J Financ Econ 58(1–2):3–27. https://doi.org/10.1016/S0304-405X(00)00065-9

Lee C, Chung KH, Yang S (2016) Corporate governance and the informational efficiency of prices. Financ Manag 45(1):239–260
Li KM (2020) Does information asymmetry impede market efficiency? Evidence from analyst coverage. J Bank Finance 118:105856. https://doi.org/10.1016/j.jbankfin.2020.105856
Li T, Kou G, Peng Y, Yu PS (2021a) An integrated cluster detection, optimization, and interpretation approach for financial data. IEEE Trans Cybern. https://doi.org/10.1109/TCYB.2021.3109066
Li Y, Liu J, Wang H, Wang P (2021b) Stock market liberalization, foreign institutional investors, and informational efficiency of stock prices: evidence from an emerging market. Int J Financ Econ 26(4):5451–5471. https://doi.org/10.1002/ijfe.2074
Li QY, Liu XQ, Chen J, Wang HX (2022) Does stock market liberalization reduce stock price synchronicity? Evidence from the Shanghai-Hong Kong Stock Connect. Int Rev Econ Financ 77:25–38. https://doi.org/10.1016/j.iref.2021.09.004
Liao H, Yin L, Wu S, Yang C (2017) Spillover effects among the main stock markets in China's capital market opening process. J Finance Econ 5(2):22–38
Liu L, Chen Q (2020) How to compare market efficiency? The Sharpe ratio based on the ARMA-GARCH forecast. Financ Innov 6:38. https://doi.org/10.1186/s40854-020-00200-6
Morck R, Yeung B, Yu W (2000) The information content of stock markets: why do emerging markets have synchronous stock price movements? J Financ Econ 58(1–2):215–260. https://doi.org/10.1016/S0304-405X(00)00071-4
Moshirian F, Tian X, Zhang B, Zhang W (2021) Stock market liberalization and innovation. J Financ Econ 139(3):985–1014. https://doi.org/10.1016/j.jfineco.2020.08.018
Piotroski JD, Wong TJ (2012) Institutions and information environment of Chinese listed firms. In: Fan JPH, Morck R (eds) Capitalizing China. University of Chicago Press, pp 201–242
Pukthuanthong K, Turtle H, Walker T, Wang J (2017) Litigation risk and institutional monitoring. J Corporat Financ 45:342–359. https://doi.org/10.1016/j.jcorpfin.2017.05.008
Roll R (1988) R-Squared. J Finance 43(2):541–566
Sharpe WF (1963) A simplified model for Portfolio analysis. Manag Sci 9(2):277–293
Sohn S, Jiang N (2016) Stock market liberalization and price discovery: evidence from the Shanghai-Hong Kong Stock connect. Available at SSRN 2850967
Wen F, Xu L, Ouyang G, Kou G (2019) Retail investor attention and stock price crash risk: evidence from China. Int Rev Financ Anal 65:101376. https://doi.org/10.1016/j.irfa.2019.101376
Xiong LY, Deng H, Xiao LJ (2021) Does stock market liberalization mitigate litigation risk? Evidence from Stock Connect in China. Econ Model 102:105581. https://doi.org/10.1016/j.econmod.2021.105581
Yao S, He H, Chen S, Ou J (2018) Financial liberalization and cross-border market integration: evidence from China's stock market. Int Rev Econ Financ 58:220–245
Ying QW, Kong DM, Luo DL (2015) Investor attention, institutional ownership, and stock return: empirical evidence from China. Emerg Market Finan Trade 51(3):672-685. https://doi.org/10.1080/1540496X.2015.1046339
Yu X, Yu Y (2021) Does the capital market opening improve the price discovery efficiency of stock market? An empirical research based on Shanghai-Hong Kong Stock Connect. Math Probl Eng. https://doi.org/10.1155/2021/5658597
Xu K, Zheng X, Pan D, Xing L, Zhang X (2020) Stock market openness and market quality: evidence from the shanghai–hong kong stock connect program. J Financ Res 43:373–406. https://doi.org/10.1111/jfir.12210

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