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Stock market development and economic growth: Empirical evidence from China

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ABSTRACT

The interplay between the stock market and the real economy is crucial in the various channels through which financial markets drive economic growth. In the current study, we investigate the effects of this relationship on the Chinese economy, which is the fastest growing and largest emerging economy in the world. The methodology incudes unit root testing in the presence of structural breaks and the Autoregressive distributed lag (ARDL) model. The results of the analysis showed that the global financial crisis from 2007 to 2012 had a significant impact on both the real sector and the financial sector in China. Our findings also suggest that the Shanghai A share market has had a long-run negative association with the real sector of the economy; however, the magnitude of impact has been miniscule. These findings indicate that this negative relationship is proof of the so-called existence of irrational prosperity in the stock market and the economic bubble in China's financial sector. The findings did not show any evidence of a relationship between the stock market and the real economy in the short run. Toda Yamamoto causality test showed that economic growth has spurred the development of the Shenzhen B share market. Furthermore, the equally weighted index showed that stock market liquidity and stock market sectoral indices were alternative measures of stock market activities. The results were robust to the alternative measures of stock market activities. The results also indicate that state-owned monopolies play an important role in China's economic performance because they stimulate the economy in the short run.

1. Introduction

Beginning with the pioneering work of Schumpeter (1911) and the works of McKinnon (1973) and Shaw (1973), a large body of literature has attempted to identify the causal relationship between the development of the financial sector and economic growth. It is well recognised that the financial market is vital for economic growth because it promotes the mobilisation of otherwise idle savings in the economy and converts them into useful and productive capital. However, when an economy grows, it generates a surplus, which fuels the growth of financial sector. Hence, the direction of causality between financial market development and economic growth remains ambiguous and open to empirical scrutiny. Furthermore, the direction of this causal relationship has significant implications for policy. For instance, Olwenyand and Kimani (2011) investigated this relationship in Kenya and found that causality was uni-directional from financial markets to economic performance. Consequently, their study recommended that governments should eliminate any impediments to the growth of the financial market (regulatory barriers etc.) and safeguard the interests of shareholders.

Because the financial sector is very broad, and its growth cannot be measured by single indicator, many economists have focused on the nature of the relationship between one sub-sector of the financial market and the growth in the real economy. The sub-sector that has attracted the most interest from researchers is the stock market. A large strand in the literature examines the relationship between the stock market and the real sector of the economy. For example, empirical studies by Atjeand and Jovanovich (1993), Korajczyk (1996), and Levine and Zervos (1998) found a strong positive relationship between the stock market and economic growth.

As argued in Levine (1991), liquidity created by the stock markets make investment less risky as it allows investors to buy or sell equity without locking in their savings for a long investment horizon, while, at the same time provide long term capital to companies raised through equity. However, it can be argued that the liquidity created by stock market may also have negative impact on the long run economic

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growth in the real economy. Demirgüç-Kunt and Levine (1996) identified three possible channels through which this effect may propagate. First, a higher rate of return on stock market will encourage investment as more investors will engage with stock market, however on the other hand it can be argued that a higher rate of return may decrease savings rate, as investors will consume a higher proportion of their income (income effet) and prepone future consumption with today's consumption (substitution effect), thereby reducing the overall amount of money invested in the economy and consequently reducing the level of capital accumulation. Second, a highly liquid stock market, reduces the level of uncertainty associated with investing in stock market, which makes investment more attractive for investors, but at the same time it also discourages precautionary savings {The component of saving that is achieved by postponing the consumption, due to the uncertainty regarding the future.}, thereby causing an ambiguous impact on the overall saving rate and overall investment in the economy. A third channel would be the creation of investor myopia (focus only on short terms gains and losses and the cost of long run returns) due to very liquid stock market. A very liquid stock market allows investor to quickly and without much cost, sell their portfolio of ill managed company stocks, thereby reducing incentives for demanding greater accountability from mangers running the firm, which in turn may lead to weakning of corporate governance in the economy and hurt economic growth in the long run.

An important reason that the existing literature is ambiguous regarding the nature of this relationship is the variation in the measures used to proxy the size of the stock market and the size of the real economy. Most previous studies used the stock market index as a proxy in measuring the growth and development of the stock market in a country. In the current study, we argue that the stock market index is not a good measure of stock market size with regard to its association with economic growth. Because stock market indices are usually weighted by market capitalisation, the index is mainly driven by the stock prices of large multinational firms, which is the case in the Chinese stock markets examined in the present study. The stocks prices of large multinationals could be influenced by a variety of reasons that may not reflect the financial markets of the country in question.

Specifically, in the context of Chinese economy, it has been argued that small and medium enterprises (SME) are the source of its impressive economic growth. In the last decade or so, SMEs have played an increasingly important role in easing the pressure on employment and optimising the economic structure in China. Li (2002) found that SMEs accounted for around 80 percent of China's manufacturing employment and contributed more than 60 percent to China's GDP. Hence, using the market index as a proxy of the size of Chinese stock market may be an inappropriate and misleading indictor.

Another reason that the stock market index is not the best proxy for capturing the size of stock market is the way in which constituent stocks are selected for the index. In most cases, committees decide which stocks are included in the index, which changes over time to reflect market conditions. In this approach, the committee might not choose the stocks that are the most representative of the stocks market in general. Moreover, because of the changing structure and composition of such committees, it is possible that untimely or lagging decisions could be made in the process of selecting stocks for inclusion in the index. Hence, one contribution of the current study is that it uses stock market capitalisation as an objective measure of the size of the stock market. We use an equally weighted index to proxy the performance of China's stock market as a check for the robustness of the relationship between China's financial sector and its real sector. The term equally weighted refers to a type of weighting scheme in which every stock in the index has the same weight regardless of the size of the company. We use the equally weighted index as our proxy for two reasons: First, in contrast to the market capitalisation weighting index, the equally weighted index does not overweight overpriced stocks and underweight under-priced stocks. Therefore, pricing errors are random. Second, the equally weighted index places more weight on small firms, which is especially suitable in the case of China's economy.

Although there is no consensus in the empirical literature regarding the existence and nature of the relationship between the stock market and the real economy, the extant literature indicates that the nature of the relationship differs from one country to another and probably varies between countries that are at different levels of economic growth. Moreover, it is also possible that unobservable cultural or institutional factors determine the existence and nature of the relationship between the stock market and the real economy. Therefore, the best way to study the relationship between stock market and economy could be to analyse data on a country-by-country basis. The second crucial issue is the choice of a robust methodology. The extant literature indicates that determining whether a causal relationship exists between the stock market and the real economy depends on the methodology used to analyse the data.

In the present study, we examine an emerging economy that is one of the largest economies in the world: that of China. We focus on China's economy for two reasons: First, China has experienced remarkable economic growth since the 1980s. There is a great amount of ongoing debate regarding whether the factors of accumulation or improved productivity are the main forces driving the economic growth in China. However, the financial sector's contribution to China's economic development has largely been ignored. Second, according to Owen and Griffiths (2006), stock markets move approximately six months ahead of inflection points in the real economy. Hence, in this study, we aim to determine whether China's stock market can forecast its economic performance six months ahead of the inflection points in its real economy.

Only a small subset of the literature considers this important question in the case of China's economy. Hasan et al. (2009) used a dynamic panel data framework of Chinese provinces to investigate the role of institutional components in a transitional economy. Based on Blundell and Bond's (1998) estimation, financial markets are one element that is associated with strong economic growth. Liang and Teng (2006) used the bank credit ratio as the indicator of financial development based on the assumption that the size of financial intermediaries is positively related to the quality of financial services. Using natural logarithm of real per capita GDP, bank credit ratio, real interest rate, natural logarithm of real per capita fixed capital and trade ratio and the Johansen cointegration test and the Granger causality test, they found evidence of uni-directional causality running from economic growth to financial development. Zhang et al. (2012) used data collected in 286 cities over the period 2001–2006 in conventional cross-sectional regressions and first differenced and system GMM estimations. Their results suggested that traditional financial development indicators had a positive impact on economic growth.

In this study, we use a new measure of stock market development to examine its relationship with the real economy in China. The methodology used in this study contributes to the literature by modelling for structural breaks and heteroscedasticity in the data in testing for the presence of the unit root in the series. We employ an Autoregressive distributed lag (ARDL) model and the Toda Yamamoto causality test to determine the nature of the relationship between stock market development and the real economy in China.

The rest of the paper is organised as follows. The following section presents a brief review of the relevant literature and discusses the major theoretical and empirical studies that have explored the stock market in terms of economic growth. Section 3 presents an overview of the Chinese stock market, followed by Section 4, in which we present a theoretical model that links the real economy with the stock market in the Chinese context. Section 5 discusses the empirical results. Section 6 summarises the robustness checks preformed to cross-validate the results by using difference measures of stock market activity and different methodologies. Some policy implications of our analysis are discussed in Section 7, and a conclusion is provided in Section 8.

2. Literature review

2.1. The finance–growth Nexus in theory

In the extant literature, five different models are proposed to link financial performance with economic growth. The first is Keynes' model, which assumes that people have three motives for holding money: the transactions motive, the precautionary motive and the speculative motive. In Keynes' model, individuals consider that some interest rates are normal at a particular time. When interest rates decrease below the normal level, people expect them to rise in the future. Therefore, interest rates remain constant if there is a rise in the money supply because no one purchases additional bonds, which is the well-known phenomenon of the "liquidity trap", which has essential implications for the equilibrium level of output. In Keynes' model, the investment is determined only by the real interest rate. If the real interest rate rises, investments will be lower than savings at the level of full employment and the liquidity trap, which leads to the accumulation of inventory. To restore equilibrium, the aggregate output will decrease. Consequently, in Keynes' model, high interest rates do not constitute a continuing driving force of economic growth. Nevertheless, the model has been criticised because it assumes short-term orientation and price rigidity.

Second is the neoclassical model. According to this model, the operations of the capital market are assumed to be costless. Money has no direct effect on the accumulation of capital. The main assumption of the neoclassical model is that money and capital are substitutes. Therefore, the real return on money decreases the demand for physical capital, which implies that the demand for real money is negatively related to the real rate of return on capital but positively associated with the real rate of money.

The third category includes the models proposed by McKinnon (1973) and Shaw (1973), which concentrate on different aspects of the influences on increasing interest rates. McKinnon (1973) criticised the assumptions of both Keynes' model and the neoclassical model that capital markets function competitively with a single interest rate that regulates the market. McKinnon (1973) focused on the relationship between the deposit rate and investment, whereas the model developed by Shaw (1973) stressed the important role of borrowing and lending activities. The key difference between the two models resides in their assumptions about how finance is raised. In McKinnon's outside money model, finance is raised internally. In this model, outside money refers to money held outside the monetary base, such as gold. In contrast, in Shaw's inside money model, all funds are externally raised. In this model, the term inside money refers to debt that is used as money. In general, the majority of projects are financed by a mixture of self-owned funds, or outside money, and borrowed funds, or inside money. Hence, the two models can be regarded as complementary.

The fourth model is the well-known IS-LM model. The IS-LM hypothesis, which was proposed by Hicks (1973), provides a framework that helps to link interest rates and real output in the goods and services market and the money and asset market. The IS-LM model enables deep insights into economic fluctuations. In the present study, we extend this model to develop the theoretical framework described in Section 4.

The last and relatively recent model is the endogenous growth model, which was proposed in the seminal work of Lucas (1988). Financial development can lead to faster economic growth through technological growth because more innovative projects can be undertaken as the financial system expands. In neoclassical models, because technological growth is assumed exogenous, financial development cannot have a long-term impact on economic growth. The endogenous framework treats technological growth as an endogenous variable that explains financial intermediations as having both level and growth effects. The model proposed by Pagano (1993) demonstrated the essential role of financial factors in economic growth. However, similar to most endogenous growth models, Pagano's model is limited to financial intermediation activities and does not consider the role of the stock market and other components of the financial sector.

2.2. Review of empirical evidence

The empirical studies in the literature provide extensive evidence of a positive relationship between financial markets and economic performance. However, Levine (1997) argued that this relationship does not necessarily imply that the development of financial markets is always exogenous to economic growth. The evidence that financial development encourages economic growth was provided by Goldsmith (1969). Although the study sample included 35 countries and the study period was from 1860–1963, this work has been criticised because it did not control for several relevant factors, and it did not draw any conclusions regarding causality or the relative importance of various transmission channels. King and Levine (1993a) provided a starting point for intense empirical research on the finance–growth nexus. Based on the nature of data used, the empirical research on this subject can be divided into three groups: pure cross-country evidence, time series studies and panel data studies.

With regard to cross-country studies, in their study of 80 countries during the period 1960–1989, King and Levine (1993b) showed that the initial level of financial development was a good predictor of the economic growth rate. Many subsequent studies have used their measures of financial development (banking variables) with some modifications. Although King and Levine (1993b) used banking variables as the proxy for financial development, later studies attempted to investigate the relationship between stock market performance and economic performance. Atje and Jovanovic (1993) found that the stock market had positive effects on economic growth. Levine and Zervos (1998) subsequently confirmed their findings. Although the research based on pure cross-country analyses has made a significant contribution to the literature, it has been criticised. Economists that performed cross-country studies usually used instrument variables to control for the bias associated with endogeneity. However, according to Ahmed (1998), the instrument variable approach cannot be used to solve the potential reverse causality problem in the relationship economic growth to financial activities when data are averaged over a long period. Shortages in grouping countries have also been demonstrated by Harris (1997). Employing the same data source, Harris showed that Atje and Jovanovic's (1993) results were not robust. Moreover, Garrestsen et al. (2004) found that the positive relationship between stock market and economic performance discovered by Levine and Zervos (1998) disappeared when legal and other societal factors were controlled for. Based on this review, the general conclusion is that the findings of cross-country studies are not consistent. They are sensitive to the selection of the sample countries, independent variables, time span and methodology.

The earliest time series study of the finance–growth nexus was conducted by Gupta (1984). His results suggested a uni-directional causality from the development of the financial system to economic growth. Recently, Neusser and Kugler (1998) used financial sector GDP and manufacturing GDP as proxies for financial market development and economic growth, respectively. The results supported the supply-leading view that financial markets play a vital role in economic growth. Their findings were consistent with numerous subsequent studies (e.g., Choe and Moosa, 1999; Xu, 2000; Rousseau and Vuthipadadorn, 2005). However, because of data constraints, the sample period used in most time-series research was short. The problem is particularly serious in developing countries where data are difficult to obtain. High-quality time-series research requires a lengthy study period to account for persistent dynamics, which is the common feature of most macroeconomic series.

In recent years, because of the shortcomings of cross-sectional studies, researchers have employed panel data techniques to study the relationship between financial development and economic growth. A plethora of studies (e.g., Beck. et al., 2000; Rousseau and Wachtel, 2000; Beck and Levine, 2004) confirmed that financial development had a significant positive influence on economic growth. Because of several problems, such as limited data points and spurious regression, Christopoulos and Tsionas (2004) suggested that the causality pattern could be examined by applying panel unit root and panel cointegration tests. They found only a uni-directional causality running from the development of financial systems to economic growth. Other research (e.g., Rajan and Zingales, 1998; Fisman and Love, 2003; Allen et al., 2005) investigated the topic at the micro level by using firm or industry level data to supplement cross-country studies. However, the conclusions drawn from the panel regressions were also criticised. Pesaran and Smith (1995) argued that the omitted variable or heterogeneity bias could not be resolved when the error terms included country-specific effects, which could lead to biased estimation results and inconsistent conclusions.

3. Overview of Chinese stock market

China has experienced an astounding economic surge over the past few decades. Its equity market has drawn much attention because of its rapid expansion and high volatility. China's economic reform started in the late 1970s, which gave birth to its capital market (Shanghai Stock Exchange, 2010). With a gradually improved legal system and trading rules, China's capital market has reached the international standard. In terms of its stock market, China now has the third largest market capitalisation in the world (Shanghai Stock Exchange, 2010). There are two stock exchanges in mainland China: Shanghai and Shenzhen. The equities traded on these stock exchanges are recognised as A shares and B shares. The key difference between the two categories is that the former are measured in RMB and the latter are measured in foreign currency: in US dollars on the Shanghai stock exchange and in Hong Kong dollars on the Shenzhen stock exchange. A shares are ordinary shares with good liquidity, and they account for the largest proportion of listed company shares. However, domestic investors in mainland China can only invest in A shares. B shares have restrictions: only domestic investors in Hong Kong, Macau, Taiwan and other countries are allowed to invest in these shares. This regulation was in place until 2001 when the Chinese government removed it and allowed mainland China residents who held valid foreign exchange deposits to invest in B shares. In 2003, designated foreign institutions were allowed to invest in A shares. Neither A shares nor B shares are real stocks; trading is handled through electronic billing.

The main reason that the Chinese government regulates the stock market is to protect the stability of the financial market and prevent over speculation. To achieve this goal, the Chinese government implemented two policies: the “T+1” trading rule in the A share market and the “T+3” trading rule in the B share market. Investors in the A share market have to wait until the next trading day if they want to sell shares that they purchased today. While, investors in the B share market will have to wait until the third day after they buy shares. Second, the Chinese government limits the stock price spread, that is, the fluctuations in the price of a security on the current day cannot exceed the 10% upper or lower limit of the closing price on the previous day. Both stock market exchanges have surprising amounts of trading volumes and trading values each day. Almost 11 billion deals in terms of the number of shares worth 96 billion RMB are made daily on the Shanghai stock exchange (Shanghai Stock Exchange, 2015), and 9.8 billion trades values at 120 billion RMB are made daily on the Shenzhen stock exchange (Shenzhen Stock Exchange, 2015).

4. Conceptual framework and theoretical model

The conceptual framework of this study is the IS-LM model proposed by Hicks (1973). Krugman and Obstfeld (2003) argued that the IS-LM model offers multiple explanations for the financial market–economic growth nexus by linking several markets. For instance, in the extension of IS-LM model proposed by Blanchard (1981), it was assumed that the demand for investment depended on Tobin's average q rather than the real interest rate, which implies feedback on security prices, economic performance, thus linking the real sector and the financial sector. In contrast, the LM model demonstrates the mechanism of payback from economic activities to the financial system. Blanchard (1981) argued that shocks to macroeconomic variables lead to the jumps in stock prices while keeping the level of output constant, which disregards the influence of feedback on outputs. Hence, output gradually adjusts when the stock market is stable.

In a mature economy such as the US, there is generally a high degree of correlation between the performance of the stock market and the real economy. However, in the context of a large emerging economy such as China, the double-digit growth in the real Gross domestic product (GDP) is often accompanied by stock market doldrums. In the present study, we modify the IS-LM framework to explain the relationship between the financial sector and the real economy in China.

Stock markets affect the money demanded by the combined effects of transaction, exchange, asset integration and substitution, which further influence the stock of money in the real economy. Therefore, we introduce the stock market variable q in the LM equation. Because the stock market can affect consumption and investment through Tobin's Q and the wealth effect, thus further influencing aggregate demand and national income. Consequently, q is also incorporated in the IS model. The specification of our new IS-LM model is as follows:

The goods market

$$Y = K_G A - K_G bi + eq$$

The money market:

$$\frac{M}{P} = kY - hi + fq$$

where Y is national income, $\frac{M}{P}$ stands for money supply, i represents interest rate, A refers to autonomous spending, e and f are the income and money demand coefficient of stock market, respectively. The terms K_G, b, k, h are parameters.

Proposition 1:. *The degree of linkage between a country's stock market activities q and its economic performance Y is: (1) positively related to the money demand coefficient of interest rate h and the income coefficient of stock market e; (2) negatively related to the income coefficient of interest* K_G b and the money demand coefficient of stock market f.

Proof.. Find the internal equilibrium, that is, identify the simultaneous equilibrium in both the goods market and the money market.

In the LM model, solve for i:

$$i = \frac{k}{h}Y + \frac{f}{h}q - \frac{M}{Ph}$$

Substitute the result into IS model; then the equation becomes:

$$Y = K_G A - K_G b\left(\frac{k}{h}Y + \frac{f}{h}q - \frac{M}{Ph}\right) + eq$$

solve for Y:

$$Y + \frac{b}{h}K_G kY = K_G A - bK_G\left(\frac{f}{h}q - \frac{M}{Ph}\right) + eq$$

$$\frac{h + bkK_G}{h}Y = K_G A - bK_G\left(\frac{f}{h}q - \frac{M}{Ph}\right) + eq$$

multiply h on both sides:

$$(h + bkK_G)Y = K_G Ah + bK_G\frac{M}{P} + q(he - K_G bf)$$

Table 1
Summary statistics for all variables of interest.

Variables	Observations	Mean	Std. Dev	Min	Max
Industrial Production index	203	112.63	4.21	102.10	123.20
SHA	203	103394.10	82806.86	10171.11	359145
SHB	203	610.74	299.49	88.12	1480.70
SZA	203	28113.19	16786.36	8375.95	89865.48
SZB	203	675.90	305.90	90.42	1387.62
MSCI China A Equal Weighted Index	125	3231.16	1296.42	736.49	7796.07
SHA Liquidity	203	82300000	104000000	2339516	599000000
SHB Liquidity	203	588561.70	623399.40	3330	4050068
SZA Liquidity	203	50100000	63500000	1637611	367000000
SZB Liquidity	203	575388.60	537310.40	0	4699495
Automobile	125	11355.03	6291.48	2246.34	25815.62
Bank	125	15845.63	3457.62	6647.70	23044.07
Consumer Goods	125	6951.83	2765.58	2195.34	12729.01
Consumer Service	125	15124.76	5131.89	6415.27	28569.69
Health Care	125	6805.18	2519.23	2794.44	12398.50
Mining	125	49877.28	20714.42	14558.80	102826.20
Real Estate	125	16147.92	5765.05	4332.23	35373.71
Technology	125	4379.11	2960.94	1299.10	12735.59
Telecommunication	125	9848.46	2540.74	4203.02	17307.89
Utility	125	10235.39	2521.51	6617.38	20351.52

Notes: SHA and SZA represent market capitalisation of A shares outstanding in Shanghai and Shenzhen stock exchange respectively. SHB and SZB denote market capitalisation of B shares in Shanghai and Shenzhen stock exchange respectively. The term SHA Liquidity and SZA Liquidity represent monthly number of transactions on Shanghai and Shenzhen A share market respectively. The term SHB Liquidity and SZB Liquidity denote monthly number of transactions on Shanghai and Shenzhen B share market respectively. Automobile, Bank, Consumer Goods, Consumer Service, Health Care, Mining, Real Estate, Technology, Telecommunication and Utility refer to the corresponding sector stock market index.

$$Y = \frac{\{K_G Ah + bK_G \frac{M}{P} + q(he - K_G bf)\}}{h + bkK_G}$$

Because the Chinese government introduced policies, such as issuing additional stocks and reducing holding-shares and launching the open-ended fund, a considerable amount of money will be needed in the Chinese stock market in the future. Hence, the money demand coefficient of stock market *f* is high. Moreover, the roles of Q and the wealth effect are limited, which leads to a low-income coefficient of stock market *e*. Both effects result in tightening the money supply in the Chinese economy, which further blocks economic growth. Hence, we expect a weakened relationship between China's real sector and its financial sector.

5. Data and empirical methodology

5.1. Data

To examine the development of the stock market, we collected monthly data on the market capitalisation of A shares on the Shanghai stock exchange (hereafter SHA), the market capitalisation of A shares on the Shenzhen stock exchange (hereafter SZA), the market capitalisation of B shares on the Shanghai stock exchange (hereafter SHB), and the market capitalisation of B shares on the Shenzhen stock exchange (hereafter SZB), which represent the total value of each kind of share listed on the corresponding stock market. The market capitalisation data were measured in 100 million RMB. While stock market capitalisation is observable at higher frequencies, the most commonly used indicator of economic growth, the GDP, is observed only at quarterly or lower frequencies. Because reducing the stock market capitalisation data to a lower frequency would lead to the loss of information and an aggregation bias, we use another frequently observable variable as the proxy for economic growth. The most widely used proxy for the GDP observed monthly is the index of industrial production (IP). Therefore, we collected data on China's IP index for the same period as the stock market capitalisation data, which were used as a measure of economic growth.

To check the robustness of our results, we first used the monthly Morgan Stanley Capital International (MSCI) China: An Equally Weighted Index to measure for China's stock market performance. This index uses an alternative weighting scheme. The index has the same constituents as its parent index, the MSCI China A Index, which includes all large and middle capitalisation securities listed on the Shanghai and Shenzhen exchanges. However, in this index, all the stocks are weighted equally, which removes the influence of each constituent's current price. The index is rebalanced quarterly. We also examined the link between the liquidity of China's stock market and its real economy. Three measurements are widely used in the literature to assess stock market liquidity. The first is the "tightness" of the market, which is usually represented by the bid–ask spread. The second is the "depth" of the market, which is measured by the number of transactions per day. The third is the "resilience" of the market, which is interpreted as the power of the market to pull the price back to its old or new equilibrium aftershocks. Because of data limitations, in this study, we collected the number of transactions per day on each on both A share and B share markets to measure stock market liquidity. Because the frequency of all other variables was monthly, we selected the number of transactions on the first working day of each month as the proxy for monthly stock market liquidity. Furthermore, we collected monthly data from the stock market sectoral index on 10 main sectors of the Chinese economy in order to examine the relationship between China's equity market at the sectoral level and its real economy. The 10 main sectors used in this study are as follows: automobiles, banks, consumer goods, consumer services, health care, mining, real estate, technology, telecommunications and utility.

The period of stock market capitalisation, IP index and the number of monthly transactions is from January 1999 to November 2015. The period for the equally weighted index and stock market sectoral index was from July 2005 to November 2015. The data on stock market capitalisation, the IP index and sectoral indices were collected from the DataStream database. The data on the number of monthly transactions were collected from the China Stock Market & Accounting Research (CSMAR) Database. Table 1 presents the summarised statistics of all variables of interest.

5.2. Unit root properties of data

To examine the level of integration in the data, we first tested for the presence of the unit root in each time series of interest. We applied the Augmented Dickey-Fuller (ADF) test with the null hypothesis that

Table 2
Conventional unit root tests results for variables of interest.

Series	Test Statistic			
	ADF Level	KPSS	ADF First Difference	KPSS
Industrial Production Index	−2.13	0.37***	−11.14***	0.04
SHA	−2.58	0.09	−11.07***	0.04
SHB	−2.61	0.05	−12.61***	0.04
SZA	−2.06	0.10	−12.19***	0.04
SZB	−3.15	0.10	−11.56***	0.03
MSCI China A Equal Weighted Index	−2.36	0.12*	−11.91***	0.07
SHA Liquidity	−4.48***	0.12*	−17.87***	0.05
SHB Liquidity	−5.04***	0.06	−23.62***	0.08
SZA Liquidity	−1.27	0.23***	−14.23***	0.11
SZB Liquidity	−5.92***	0.13*	−23.43***	0.11
Automobile	−4.34***	0.08	−8.20***	0.07
Bank	−3.66**	0.15**	−9.77***	0.04
Consumer Goods	−3.54**	0.10	−8.52***	0.04
Consumer Service	−2.15	0.10	−9.28***	0.04
Health Care	−2.33	0.12*	−12.16***	0.05
Mining	−1.85	0.23***	−9.78***	0.03
Real Estate	−2.70	0.08	−9.26***	0.05
Technology	−0.36	0.28***	−8.29***	0.12
Telecommunication	−2.68	0.13*	−5.55***	0.04
Utility	−2.20	0.09	−9.96***	0.06

Notes: SHA and SHB represent market capitalisation of A shares outstanding in Shanghai and Shenzhen stock exchange respectively. SHB and SZB denote market capitalisation of B shares in Shanghai and Shenzhen stock exchange respectively. The term SHA Liquidity and SZA Liquidity represent monthly number of transactions on Shanghai and Shenzhen A share market respectively. The term SHB Liquidity and SZB Liquidity denote monthly number of transactions on Shanghai and Shenzhen B share market respectively. Automobile, Bank, Consumer, Goods, Consumer Service, Health Care, Mining, Real Estate, Technology, Telecommunication and Utility refer to the corresponding sector stock market index. The maximum number of lags selected to do ADF test are 12. Both ADF and KPSS statistic are generated by a model with a constant and a trend. The KPSS test uses the automatic bandwidth selection technique of Newey-West using Bartlett Kernel computing the spectrum. *, **, *** Denote statistical significance at 10%, 5% and 1%, respectively.

the series was not stationary and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test with the null hypothesis that the variable was stationary in order to determine the order of integration. The reason that we used two tests with opposite null hypotheses is that the combined results of both tests could provide us with a definite conclusion regarding the stationarity of the time series under consideration. The results of the unit root tests are provided in Table 2.

Table 2 shows that in some cases, the ADF and KPSS tests yielded conflicting results. For all variables, the ADF test statistic did not reject the null at the level, but it rejected the null hypothesis when the variables were first differenced, which implied that all the series were integrated in the order of one. In contrast, KPSS ascertained that the IP was $I(1)$ but found the remaining variables stationary. The confirmatory analysis of the results of both stationarity tests showed that only the IP was confirmed to be in the order of integration one, whereas the order of integration was inconclusive for all the other variables.

Another related aspect of unit root testing is the presence of large shocks or structural breaks in the series. According to Perron (1989), if the data-generating process is trend stationary and there are structural breaks during the period under consideration, then the ADF test is more likely to commit a Type 2 error that regards the trend stationary process with structural breaks as a non-stationary process following a random walk. In other words, the effectiveness of the traditional ADF unit root test will decrease dramatically if structural breaks are present but are not considered in testing for unit roots.

Hence, we also employed Narayan et al.’s (2016) unit root test with two structural breaks. The advantage of using this test is that it can solve the problems of size distortion mentioned earlier, and the rejection of the null hypothesis clearly indicates trend stationarity. Moreover, it accounts for the time-varying nature of heteroscedasticity, which is often present in high-frequency financial data.

5.2.1. *Narayan et al. (2016) unit root test with two structural breaks*

Andreou and Ghysels (2002) demonstrated the importance of structural breaks as another stylised fact in time series data. Most previous research on the unit root properties of a time series assume independent and identical (*i.i.d.*) errors. However, this assumption is not suitable in high frequency data, which is often characterised by heteroscedasticity. Based on the literature, the Dicky Fuller test is sensitive to heteroscedasticity and when both Autoregressive conditional heteroscedasticity (ARCH) and Generalised autoregressive conditional heteroscedasticity (GARCH) parameters approaches to the unity problem are complicated. Some econometricians consider that the problem is partially caused by the inconsistency of OLS estimators under such circumstances.

In this study, we use the most recent unit root test proposed by Narayan et al. (2016), which deals with non *i.i.d.* errors and incorporates two structural breaks following a GARCH (1, 1) process to check the robustness of the results of our unit root test. The test uses a maximum likelihood estimator to estimate both autoregressive and GARCH parameters. It is the only test that specifically considers the heteroscedasticity problem.

The specification of the model is the following. Consider a GARCH (1, 1) unit root model:

$$y_t = \alpha_0 + \pi y_{t-1} + D_1 B_{1t} + D_2 B_{2t} + \varepsilon_t \tag{1}$$

where for $t \geq T_{Bi}$, $B_{it} = 1$; otherwise, it equals 0. T_{Bi} stands for structural break points and $i = 1, 2$. Furthermore, D_1 and D_2 are break dummy coefficients. Term ε_t follows the first order GARCH model, denoted as GARCH (1, 1).

$$\varepsilon_t = \eta_t \sqrt{h_t},\ h_t = \mu + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} \tag{2}$$

where $\mu > 0$, α and β are non-negative numbers, and η_t is a sequence of *i.i.d.* random variables with zero mean and unit variance. The critical value at the 5% level for endogenous structural breaks is based on the table provided in Narayan et al. (2016).

The results of Narayan et al.’s (2016) unit root test are presented in Table 3. All results rejected the unit root null at a significance level of 5%. In terms of break dates, we observed that the first break in the IP series appeared in 2005, and the second break appeared in 2011. In the A share market, the first break was detected in 2005, and the second break appeared in 2013. In the B share market, the first and second breaks appeared form 2000–2001 and 2006–2009, respectively.

In general, all identified breaks were associated with major domestic or international shocks that affected the Chinese economy. The breaks that appeared in the period 2007–2012 were most likely linked to the Global Financial Crisis (GFC), indicating that it had a significant impact on the Chinese economy in general and its stock market in particular. The break during the period 2000– 2001 was likely related to the September 11 terrorist attacks in the US. The results showed that China's B share market was influenced by this tragedy, which is plausible because the B share market only allowed Hong Kong, Macau, Taiwan and international investors to trade at that time. The findings of our tests were consistent with the anecdotal evidence of the reaction of China's B share market to the September 11 incident. China's B share market suffered a huge recession immediately after the September 11 terrorist attacks, whereas the A share market boomed because most investors chose to invest financial assets in the A share market to avoid the risks associated with the terrorist attacks. Furthermore, the most plausible interpretation is that China's real economy and the major part of the financial sector exhibited a stationary property after allowing structural breaks because of the timely interventions undertaken by Chinese government in the aftermath of the major shocks. For example, the State Council of the People's Republic of China approved a plan to invest 4 trillion yuan in

Table 3
Results for Narayan et al. (2016) GARCH unit root test with two structural breaks in intercept for all variables of interest.

Variables	Test statistic	TB1	TB2
Industrial Production index	−14.23*	Jan-05	Oct-11
SHA	−6.09*	Dec-05	Jul-13
SHB	−6.49*	Mar-01	Sep-06
SZA	−4.78*	May-06	Jul-13
SZB	−10.61*	Dec-00	Mar-09
MSCI China A Equal Weighted Index	−3.61	Dec-06	Sep-14
SHA Liquidity	−6.35*	Jan-04	Oct-06
SHB Liquidity	−9.20*	Mar-02	Jan-06
SZA Liquidity	−6.15*	Dec-06	Jan-13
SZB Liquidity	−16.24*	Jan-06	Jan-08
Automobile	−3.73	Apr-09	Nov-12
Bank	−3.43	Apr-07	May-11
Consumer Goods	−3.79*	Jan-07	Apr-09
Consumer Service	−3.09	Apr-09	Oct-11
Health Care	−4.94*	Apr-08	Oct-13
Mining	−4.40*	Dec-06	Jul-13
Real Estate	−4.37*	Oct-06	Oct-12
Technology	−3.49	Aug-10	Aug-13
Telecommunication	−7.19*	Dec-08	Sep-12
Utility	−4.73*	Aug-06	Sep-14

Notes: SHA and SHB represent market capitalisation of A shares outstanding in Shanghai and Shenzhen stock exchange respectively. SHB and SZB denote market capitalisation of B shares in Shanghai and Shenzhen stock exchange respectively. The term SHA Liquidity and SZA Liquidity represent monthly number of transactions on Shanghai and Shenzhen A share market respectively. The term SHB Liquidity and SZB Liquidity denote monthly number of transactions on Shanghai and Shenzhen B share market respectively. Automobile, Bank, Consumer, Goods, Consumer Service, Health Care, Mining, Real Estate, Technology, Telecommunication and Utility refer to the corresponding sector stock market index. TB1 and TB2 are dates of structural breaks. The 5% critical value for the unit root test statistic is −3.76, obtained from Narayan et al. (2016) [Table 3 for N = 250 and GARCH parameters [α, β] chosen as [0.05, 0.90]]. Narayan et al. (2016) only provide critical values for 5% significance level.

[*] Denotes statistical significance at 5%

infrastructure and social welfare projects to minimise the impact of the GFC on the Chinese economy during the period 2007–2012, which is known as the "2008–2009 Chinese economic stimulus plan". The plan stabilised both China's real economy and stock market.

5.3. Relationship between economic growth and the stock markets

5.3.1. Autoregressive distributional lag (ARDL) model

We used the ARDL model, also known as bounds , which was proposed by Pesaran and Shin (1998) and Pesaran, Shin and Smith (2001) to investigate the reaction of the Chinese economy to the performance of the stock markets during the study period. We employed the ARDL approach for several reasons. First, although tests such as the residual-based Engel and Granger (1987), the maximum likelihood-based Johansen (1991, 1995) and the Johansen-Juselius (1990) are commonly used to check for cointegration, the ARDL model was preferred because of the problem of lower power. Second, the ARDL model allows for I(0) variables in the model. Third, because the ARDL model has only a single equation, it is easy to interpret. Fourth, the ARDL model uses a sufficient number of lags to capture the data-generating process in a general-to-specific modelling framework (Laurenceson and Chiai, 2003). Finally, the ARDL model manages both long-run cointegration and short-run dynamics.

The specification of our ARDL model is as follow:

$$\mathrm{IP}_t = \alpha_0 + \sum \beta_i \mathrm{SHA}_{t-i} + \sum \gamma_j \mathrm{SHB}_{t-j} + \sum \delta_k \mathrm{SZA}_{t-k} + \sum \theta_l \mathrm{SZB}_{t-l} + \epsilon_t \tag{3}$$

We established the above model by following the traditional view that the stock market is an indicator of a country's economy. The stock market has been regarded as a leading indicator of the economy. It is believed that a large decrease in stock prices indicates future economic recession and that increased stock prices predict a forthcoming economic boom (e.g., Comincioli'95, 1996).

In Eq. (3) i, j, k and l are the number of lags of the independent variable included in the model, and the optimal numbers of lags are decided using information criteria. The ARDL model estimates $(p+1)^k$ regression equations to obtain the optimal lags for each variable, where p is the maximum number of lags required, and k is the number of regressors in the regression equation. Four methods were used decide the optimal ARDL model: the Akaike Information Criterion (AIC), Schwartz Bayesian Criterion (SBC), Hannan-Quinn Criterion and adjusted R-squared. Based on the balanced consideration of all factors, such as coefficient significance, goodness of fit of the model, serial correlation and model stability, ARDL (3, 0, 6, 8, 2) was selected as our benchmark specification.

After ensuring the number of lags used in the model, we formulated and estimated an unrestricted error correction model as follows:

$$\begin{aligned}\triangle \mathrm{IP}_t = \alpha &+ \sum \beta_i \triangle \mathrm{IP}_{t-i} + \sum \gamma_j \triangle \mathrm{SHA}_{t-j} + \sum \delta_k \triangle \mathrm{SHB}_{t-k} + \sum \theta_l \mathrm{SZA}_{t-l} \\ &+ \sum \eta_m \mathrm{SZB}_{t-m} + \mu_0 \mathrm{IP}_{t-1} + \mu_1 \mathrm{SHA}_{t-1} + \mu_2 \mathrm{SHB}_{t-1} + \mu_3 \mathrm{SZA}_{t-1} \\ &+ \mu_4 \mathrm{SZB}_{t-1} + \epsilon\end{aligned} \tag{4}$$

The first step was to determine whether our ARDL (3, 0, 6, 8, 2) model was free of serial correlation by using the Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM) test. The result of the test is shown in panel A of Table 4. Based on both F statistic and observed

Table 4
Results of ARDL unrestricted error correction model.

Panel A: Breusch-Godfrey Serial Correlation LM Test

Test Statistic		p-value
F-statistic	0.27	0.99
Observed R-squared	3.65	0.96

Panel B: ARDL Bounds Testing Results for Industrial Production Index and Market Capitalisation

Test Statistic		Lower Bound	Upper Bound
F-statistic	16.66	2.86	4.01

Panel C: ARDL Long-run Coefficients for Market Capitalisation

Variables	Coefficient	Standard Error	t-statistic	Probability
SHA	−0.00002	0.00001	−2.03007**	0.04
SHB	0.00023	0.00139	0.16432	0.87
SZA	0.00004	0.00005	0.81830	0.41
SZB	0.00243	0.00161	1.50761	0.06

Notes: Panel B: Lower bound and upper bound listed in the table are 5% significance level critical value bounds. Panel C: SHA and SHB represent market capitalisation of A shares outstanding in Shanghai and Shenzhen stock exchange respectively. SHB and SZB denote market capitalisation of B shares in Shanghai and Shenzhen stock exchange, respectively.

Table 5
ARDL restricted error correction model estimation results.

Panel A: Breusch-Godfrey Serial Correlation LM Test Results				
Test Statistic			**p-value**	
F-statistic		0.85	0.59	
Observed R-squared		10.34	0.41	

Panel B: Short run coefficients

Variables	Coefficient	Standard Error	t-statistic	Probability
C	−0.206187	0.238481	−0.86458	0.39
D(IP(−1))	−0.635997	0.113319	−5.61244	0.00
D(IP(−2))	−0.351983	0.114841	−3.06497	0.00
D(IP(−3))	−0.164460	0.093347	−1.76182	0.08
D(SHA)	−0.000013	0.000042	−0.30174	0.76
D(SHB)	−0.005082	0.007126	−0.71317	0.48
D(SHB(−1))	−0.005750	0.006815	−0.84371	0.40
D(SHB(−2))	−0.009303	0.006424	−1.44822	0.15
D(SHB(−3))	−0.005462	0.004711	−1.15934	0.25
D(SHB(−4))	−0.001815	0.004923	−0.36863	0.71
D(SHB(−5))	−0.001061	0.004279	−0.24799	0.80
D(SHB(−6))	−0.005413	0.004565	−1.18561	0.24
D(SZA)	0.000063	0.000169	0.370141	0.71
D(SZA(−1))	0.000067	0.000116	0.579205	0.56
D(SZA(−2))	0.000124	0.000121	1.023570	0.31
D(SZA(−3))	0.000055	0.000120	0.458582	0.65
D(SZA(−4))	0.000056	0.000122	0.458281	0.65
D(SZA(−5))	0.000093	0.000097	0.967665	0.34
D(SZA(−6))	0.000115	0.000095	1.216129	0.23
D(SZA(−7))	0.000108	0.000078	1.380495	0.17
D(SZA(−8))	0.000093	0.000084	1.112690	0.27
D(SZB)	0.001143	0.006003	1.076856	0.85
D(SZB(−1))	0.006828	0.006340	1.076856	0.28
D(SZB(−2))	0.010065	0.006385	1.576359	0.12
ECT(−1)	−0.187128	0.089005	−2.102430	0.04

Notes: C is the constant term. D before each variable denotes first differenced operator and the numbers in the parenthesis behind each variable represent number of lags taken. IP stands for industrial production index. SHA and SZA represent market capitalisation of A shares outstanding in Shanghai and Shenzhen stock exchange respectively. SHB and SZB denote market capitalisation of B shares in Shanghai and Shenzhen stock exchanges, respectively. ECT stands for error correction term.

R-squared, the serial correlation test did not reject the null hypothesis of no serial correlation in our ARDL model at a significance level of 5%, which implied that there was no serial correlation in the residual. Next, we determined whether our model was stable by employing the Cusum test, which showed that it was stable at a significance level of 5%. After ensuring that our model had neither serial correlation nor instability, we proceeded to the bounds test.

The bounds test proposed by Pesaran et al. (2001) is used to discover the existence of long-run equilibrium among variables of interest. Specifically, it is an F-test with the null hypothesis that $\mu_0 = \mu_1 = \mu_2 = \mu_3 = \mu_4 = 0$ as shown in Eq. (4). Based on Pesaran et al. (2001), the lower bound is used when all variables are $I(0)$, and the upper bound is used when all variables are $I(1)$. If the F-statistic is below the lower bound, there is likely to be no cointegration among the variables of interest. If the F-statistic is higher than the upper bound, the existence of cointegration is implied. If the F-statistic falls between the lower bound and the upper bound, then the evidence of cointegration is inconclusive. The result of the bounds test is shown in Panel B of Table 4. The F-statistic of 16.66 was larger than the upper bound value of 4.01 at the significance level of 5%. Therefore, the null hypothesis of no long-run relationship was rejected. This result indicated an a long-run association between the Chinese economy and its stock markets.

We then extracted a long-run multiplier between the dependent and independent variables from the unrestricted error correction model, and we obtained the long-run coefficients in Eq. (3), which are presented in Panel C of Table 4. These results indicated that the Shanghai A share market had a long-run relationship with and only a slightly negative impact on the real economy, which could be ignored. Specifically, in the long run, an increase of 1 basis point in the market capitalisation of the Shanghai A share market (which is roughly one hundred million yuan) caused a decline in the industrial production index of 0.00002 points. This effect was small yet significant because it indicated that China is a very large country, and its stock markets still constitutes only a tiny fraction of the entire economy. The movement was not enough to have a sizeable effect on the overall economic performance of the country.

The most likely explanation for the negative impact of the stock market on the economy is the specific institutional characteristics of the Chinese economy during the sample period used in this study. Specifically, the Chinese government tried to push investors to take advantage of speculation opportunities in the stock market via consensus. For example, the People's Bank of China (PBC) declared an increase in its interest rate at the end of 2014. Moreover, the Chinese government took this opportunity to launch a registration system so that many unprofitable SMEs could be listed on the stock market. In fact, the goal of the government was to promote the economic transition by using citizens' bank deposits to fund the development of SMEs. Therefore, the government used the growth of China's A share markets to achieve its objectives rather than to reflect economic growth. Second, the phenomena that occurred in China could be classified as irrational prosperity, which refers to a situation in which the operation of market is driven by an irrational human mentality rather than rational economic rules. In general, the irrational prosperity of financial markets often implies a high degree of real economy shrinkage. The reasons are straightforward: if people find it profitable to make money in the real economy, they will invest their money based on successful experiences in the past, such as buying new equipment and expanding the scale of reproduction rather than spending money by invisible behaviour that is full of uncertainty. In other words, the results indicate that the Shanghai A stock market was negatively affected by the issue of irrational prosperity, which led to the financial bubble.

Table 6
Toda Yamamoto causality test results between china's stock market and the real economy.

Causality Pattern	Test Statistic	p-value	Causality Pattern	Test Statistic	p-value
Demand-driven Hypothesis			**Supply-leading Hypothesis**		
IP to SHA	0.15	0.93	SHA to IP	2.46	0.29
IP to SHB	4.67	0.32	SHB to IP	2.57	0.63
IP to SZA	0.83	0.93	SZA to IP	2.99	0.56
IP to SZB	9.01	0.03	SZB to IP	6.57	0.09
IP to Equal Weighted Index	1.56	0.67	Equal Weighted Index to IP	2.99	0.39
IP to SHA Liquidity	1.26	0.53	SHA Liquidity to IP	0.25	0.88
IP to SHB Liquidity	6.23	0.10	SHB Liquidity to IP	4.37	0.22
IP to SZA Liquidity	1.99	0.57	SZA Liquidity to IP	0.11	0.99
IP to SZB Liquidity	16.07	0.00	SZB Liquidity to IP	5.59	0.13
IP to Automobile	11.99	0.15	Automobile to IP	9.20	0.33
IP to Bank	4.22	0.24	Bank to IP	1.30	0.73
IP to Consumer Goods	7.39	0.29	Consumer Goods to IP	3.73	0.71
IP to Consumer Service	1.22	0.75	Consumer Service to IP	0.87	0.83
IP to Health Care	2.93	0.40	Health Care to IP	2.82	0.42
IP to Mining	5.49	0.14	Mining to IP	2.70	0.44
IP to Real Estate	0.95	0.81	Real Estate to IP	1.12	0.77
IP to Technology	2.13	0.83	Technology to IP	0.20	1.00
IP to Telecommunication	4.59	0.33	Telecommunication to IP	17.44	0.00
IP to Utility	7.71	0.17	Utility to IP	12.92	0.02

Notes: IP stands for industrial production index. Equal Weighted Index refers to MSCI China: An Equally Weighted Index. SHA and SHB represent market capitalisation of A shares outstanding in Shanghai and Shenzhen stock exchange respectively. SHB and SZB denote market capitalisation of B shares in Shanghai and Shenzhen stock exchange respectively. The term SHA Liquidity and SZA Liquidity represents the number of monthly transactions on the Shanghai and Shenzhen A share markets, respectively. The terms SHB Liquidity and SZB Liquidity denote the number of monthly transactions on the Shanghai and Shenzhen B share markets, respectively. Automobile, Bank, Consumer, Goods, Consumer Service, Health Care, Mining, Real Estate, Technology, Telecommunication and Utility refer to the corresponding sector stock market index.

Based on the results of the bounds testing, a restricted error correction model (ECM) was used to determine the short-run coefficients. The analysis was conducted according to the following steps: First, we lagged the residuals from Eq. (3) by one period. Then we added the lagged residual to Eq. (4) as the error correction term to construct the restricted error correction model. The specifications of the ARDL (3, 0, 6, 8, 2) restricted ECM are as follows:

$$\triangle \text{IP}_t = \alpha + \sum \beta_i \triangle \text{IP}_{t-i} + \sum \gamma_j \triangle \text{SHA}_{t-j} + \sum \delta_k \triangle \text{SHB}_{t-k} + \sum \theta_l \text{SZA}_{t-l} + \sum \eta_m \text{SZB}_{t-m} + \varphi \text{ECT}_{t-1} + \epsilon \quad (5)$$

where ECT stands for the error correction term. Before checking the estimation results, we further examined whether the model passed the serial correlation test and the model stability test. Panel A in Table 5 shows the results of the serial correlation test of the ARDL-restricted ECM. Based on the statistical results of both tests, the null hypothesis of no correlation in the restricted ECM model was not rejected. The stability of the restricted model was confirmed by the Cusum test. The estimation results of the restricted error correction model are shown in Table 5.

No significant short-run coefficients were found between the financial sector and the real economy, which suggests that there was short-run association between China's stock market and its economy. The last item in Table 5 shows the speed of adjustment. Because the value was negative and statistically significant, we concluded that the model would converge to a long-run equilibrium at a rate of 18.71 percent.

5.3.2. *Toda Yamamoto's (1995) Causality Test*

The most widely known approach used to examine the causal relationship between two variables is the Granger (1969) causality test. The test is easy to conduct, and it has been employed to answer the question of causality in variety of circumstances. However, it also has several limitations. First, the bivariate Granger causality test does not consider the effects of other variables, and may suffer from a possible specification bias. Second, time series data are usually non-stationary, which can lead to spurious regressions. Gujarati (2006) also argued that the F test is not valid when it integrates variables because the test's statistics do not follow a standard distribution under this circumstance. Although researchers can check the significance of individual coefficients using the t-statistic, they may not able to test Granger causality via F-statistic.

In this study, we employed Toda Yamamoto's (1995) version of causality testing, which overcomes the problems mentioned above, to examine the direction of causality between China's real economy and its financial sector. This procedure is superior to the conventional Granger causality test because it does not require pre-testing for cointegration, therefore preventing pre-test bias. Moreover, the approach can be applied to series with different orders of integration. In addition, the Toda Yamamoto test can fit a standard autoregressive model and levels of variables rather than in first differences, are required in the Granger causality test. Thus, the Toda Yamamoto test minimises the risk of wrongly identifying the order of the integration of variables.

In applying Toda Yamamoto's version of the Granger causality test, we used a bivariate VAR that included all variables of interest in the following model specifications.

$$X_t = \varpi + \sum_{i=1}^{m} \theta_i X_{t-i} + \sum_{i=m+1}^{dmax} \theta_i X_{t-i} + \sum_{i=1}^{m} \delta_i Y_{t-i} + \sum_{i=m+1}^{dmax} \delta_i Y_{t-i} + v_{1t} \quad (6)$$

$$Y_t = \psi + \sum_{i=1}^{m} \phi_i Y_{t-i} + \sum_{i=m+1}^{dmax} \phi_i Y_{t-i} + \sum_{i=1}^{m} \beta_i X_{t-i} + \sum_{i=m+1}^{dmax} \beta_i X_{t-i} + v_{2t} \quad (7)$$

where X and Y are combinations of pairs constructed by the variables of interest in different series, excluding cases, such as both X and Y are the IP index. The items $\varpi, \theta, \delta, \phi, \beta$ are parameters of the model, *dmax* stands for the maximum order of integration in the model; $v_{1t} \sim N(0, \sum_{v1})$ and $v_{2t} \sim N(0, \sum_{v2})$ are residuals, where $\sum_{v1}$ and $\sum_{v2}$ represent covariance matrices of v_{1t} and v_{2t}, respectively. In addition, the null hypothesis of the test could be expressed because there *is* no causality in the direction from X to Y, that is, H_0: $\delta_i = 0, \forall\ i = 1, 2, \ldots, m$.

We first found the short-run causality pattern between the stock markets and the real economy in China to determine which hypotheses could be supported: demand-driven, supply-leading or neither. Specifically, the supply-leading theory, which was proposed by McKinnon (1973) and Shaw (1973), assumes that the accumulation of financial assets improves economic growth; therefore, financial market development leads to economic growth. In contrast, the demand-driven hypothesis proposed by Friedman and Schwartz (1963) assumes that economic growth leads to the appearance and establishment of financial centres; therefore, financial development is endogenously determined by the growth in the real economy. The results of Toda Yamamoto's causality test are presented in Table 6.

Table 6 shows that both the demand-driven and supply-leading hypotheses were supported only in the relationship between the Shenzhen B share market and the real economy. Specifically, China's economic growth had positive effects on the B share market in a period of approximately three months and vice versa. This result is consistent with the findings reported in Owen and Griffiths (2006). However, in our analysis, a bi-directional, rather than uni-directional, causality was obtained. In the literature, there is almost no explanation that the economy could be a leading indicator of stock market performance. A possible reason is the transaction costs to the stock market. Investors are usually charged a percentage of transaction fees in order to stay in the stock market. In other words, only investors who can afford the entry cost are allowed to invest in the stock market. In fact, the majority of B share investors are in Hong Kong, the GDP per capita income of which has been larger than in the Chinese mainland for many years. Therefore, compared to A share investors, as economic growth increases, more new B share investors will be able to afford the entry cost, which will further stimulate the performance of B share markets.

We also tested for the existence and direction of causality in Chinese stock markets, which is known as the substitution effect. The results are reported in Table 7.

The results shown in Table 7 confirmed the existence of bi-directional causality between the Shanghai A share market and the Shanghai B share market. It is reasonable to expect that the growth of the A share market may promote a boom in the B share market because the size of the A share market is much bigger than the B share market. However, few previous studies have tried to explain the reasons behind B share market Granger causing A share market. However, these phenomena were caused by the manipulation of the B share market. There are two possible reasons that manipulation would be more likely to appear in the B share market. The first reason is the difference in the stock prices of the two markets, which has been regarded as the legacy of history. Specifically, for the same company stock, the price on the A share market is usually 40% higher than the price on the B share market. Moreover, the stock price discount on the B share market is much larger than on the A share market. Hence, higher stock prices can be achieved more easily by the manipulation by the market makers, which further misleads investors regarding the performance of B share market. The second reason is that because the B share market is half the size of the A share market, the effect of market manipulation on the former is much stronger than on the latter.

Table 7
Toda Yamamoto causality test results between china's stock markets.

Causality Direction	No. of Lags	Test Statistic	p-value
SHA to SHB	8	14.21	0.08
SHB to SHA	8	18.42	0.02
SHA to SZA	8	8.28	0.41
SZA to SHA	8	11.41	0.18
SHA to SZB	2	1.03	0.60
SZB to SHA	2	0.27	0.87
SHB to SZA	8	10.79	0.21
SZA to SHB	8	7.22	0.51
SHB to SZB	2	0.37	0.83
SZB to SHB	2	12.68	0.00
SZA to SZB	1	2.23	0.14
SZB to SZA	1	0.15	0.69
SHA Liquidity to SHB Liquidity	2	0.41	0.81
SHB Liquidity to SHA Liquidity	2	1.48	0.48
SHA Liquidity to SZA Liquidity	8	31.36	0.00
SZA Liquidity to SHA Liquidity	8	28.07	0.00
SHA Liquidity to SZB Liquidity	2	0.40	0.82
SZB Liquidity to SHA Liquidity	2	0.24	0.89
SHB Liquidity to SZA Liquidity	3	3.43	0.33
SZA Liquidity to SHB Liquidity	3	0.28	0.96
SHB Liquidity to SZB Liquidity	3	10.32	0.02
SZB Liquidity to SHB Liquidity	3	23.47	0.00
SZA Liquidity to SZB Liquidity	3	0.23	0.97
SZB Liquidity to SZA Liquidity	3	3.14	0.37

Notes: SHA and SHB represent the market capitalisation of A shares outstanding on the Shanghai and Shenzhen stock exchanges, respectively. SHB and SZB denote market capitalisation of B shares in Shanghai and Shenzhen stock exchange respectively. The terms SHA Liquidity and SZA Liquidity represent the number of monthly transactions on the Shanghai and Shenzhen A share markets, respectively. The terms SHB Liquidity and SZB Liquidity denote the number of monthly transactions on the Shanghai and Shenzhen B share markets, respectively.

6. Robustness of the results

As discussed earlier, SMEs have made a significant contribution to China's economic growth. In addition, the size of China's A share market is much larger than the size of the B share market. Therefore, as a robustness check, and to reflect China's specific case, we also used the MSCI China: A Equally Weighted Index to proxy the performance of the Chinese stock market because this index puts more weight on SMEs. However, using this alternative measure of stock market performance did not qualitatively alter our results.

Levine (1991) argued that stock market liquidity influences the real economy rather than market size. Hence, in the second robustness check, we used the number of monthly transactions as a proxy for stock market liquidity to check the robustness of our results. The results of this analysis are reported in Tables 1, 2, 3, 6 and 7. The results showed that using market liquidity as a measure of stock market performance validated the existing results.

To perform the third robustness check and to determine the relative importance of various industries in China's incredible economic growth, we used stock market sectoral indices to conduct our analysis. Tables 2 and 3 present the results of the conventional and Narayan et al.'s (2016) unit root test of each stock market sectoral index. The results showed that only the technology sector was non-stationary in China. This result confirmed the stationarity results that showed that China's financial sector was stationary. Moreover, the results indicated that the influence of the shock on the technology sector was permanent, which confirms the possible reasons that the Shenzhen A share market was non-stationary. Based on the results of the robustness check of stationarity, we concluded that in general, China's stock market was stationary. Nevertheless, if China's financial sector were examined separately, some proportions of China's stock market would be non-stationary (e.g., China's A share market, its subset the Shenzhen A share market and the technology sector).

We identified the break dates by using three different proxies for China's stock market performance (equally weighted index, stock market liquidity and sectoral indices) as a robustness check, however, the locations of break dates where consistent across various measures.

6.1. Other determinants of economic performance

An anonymous reviewer of this paper pointed out that the output represented by IP was also determined by other relevant variables, such as the exchange rate, fiscal policy and monetary policy. Hence, we used a multivariate VAR model as an alternative model to test the robustness of the relationship between China's financial sector and its real economy. Because the outputs of an economy can be influenced by the exchange rate, monetary policy and fiscal policy, we proxied these factors in the estimation of VAR model. We used the RMB to USD spot rate, which is denoted by *exrate* in the model, as a proxy for the exchange rate. The monetary policy was proxied by money supply (M1). We controlled for fiscal policy by using revenue, which was

Table 8
Granger causality wald test results following the VAR estimation.

Equation	Excluded	Chi2	Prob > chi2
Industrial Production index	SHA	27.067	0.008
	SHB	16.649	0.163
	SZA	34.44	0.001
	SZB	18.876	0.092
	Exchange Rate	13.15	0.358
	Money Supply (M1)	27.446	0.007
	Tax Revenue	28.512	0.005
SHA	Industrial Production index	16.645	0.163
	SHB	43.598	0.000
	SZA	25.461	0.013
	SZB	26.68	0.009
	Exchange Rate	22.663	0.031
	Money Supply (M1)	41.574	0.000
	Tax Revenue	36.228	0.000
SHB	Industrial Production index	30.65	0.002
	SHA	42.845	0.000
	SZA	40.141	0.000
	SZB	17.993	0.116
	Exchange Rate	30.178	0.003
	Money Supply (M1)	44.166	0.000
	Tax Revenue	30.89	0.002
SZA	Industrial Production index	23.895	0.021
	SHA	29.393	0.003
	SHB	35.106	0.000
	SZB	26.429	0.009
	Exchange Rate	18.22	0.109
	Money Supply (M1)	32.805	0.001
	Tax Revenue	34.989	0.000
SZB	Industrial Production index	67.738	0.000
	SHA	44.85	0.000
	SHB	18.3	0.107
	SZA	46.615	0.000
	Exchange Rate	34.168	0.001
	Money Supply (M1)	30.336	0.002
	Tax Revenue	21.392	0.045
Exchange Rate	Industrial Production index	13.091	0.362
	SHA	23.208	0.026
	SHB	26.53	0.009
	SZA	29.648	0.003
	SZB	14.507	0.270
	Money Supply (M1)	46.627	0.000
	Tax Revenue	42.056	0.000
Money Supply (M1)	Industrial Production index	10.65	0.559
	SHA	45.587	0.000
	SHB	35.13	0.000
	SZA	36.921	0.000
	SZB	29.036	0.004
	Exchange Rate	34.396	0.001
	Tax Revenue	210.24	0.000
Tax Revenue	Industrial Production index	18.581	0.099
	SHA	53.807	0.000
	SHB	26.181	0.010
	SZA	32.67	0.001
	SZB	22.75	0.030
	Exchange Rate	62.781	0.000
	Money Supply (M1)	129.69	0.000

Notes: SHA and SHB represent market capitalization of A shares outstanding in Shanghai and Shenzhen stock exchange respectively. SHB and SZB denote market capitalization of B shares in Shanghai and Shenzhen stock exchange respectively.

denoted by *tax* in the model. Both M1 and tax revenue were measured in 100 million RMB. These three control variables were collected from the DataStream database. A VAR model with the following specifications was estimated:

$$\begin{bmatrix} IP_t \\ SHA_t \\ SHB_t \\ SZA_t \\ SZB_t \\ exrate_t \\ M1_t \\ tax_t \end{bmatrix} = \alpha_0 + A_1 \begin{bmatrix} IP_{t-1} \\ SHA_{t-1} \\ SHB_{t-1} \\ SZA_{t-1} \\ SZB_{t-1} \\ exrate_{t-1} \\ M1_{t-1} \\ tax_{t-1} \end{bmatrix} + \ldots + A_k \begin{bmatrix} IP_{t-k} \\ SHA_{t-k} \\ SHB_{t-k} \\ SZA_{t-k} \\ SZB_{t-k} \\ exrate_{t-k} \\ M1_{t-k} \\ tax_{t-k} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \\ \varepsilon_{5,t} \\ \varepsilon_{6,t} \\ \varepsilon_{7,t} \\ \varepsilon_{8,t} \end{bmatrix} \quad (8)$$

where α_0 is a vector of intercept terms and each of A_1 to A_k is an 8×8 matrix of coefficients.

The most basic model was lag length. The maximum lag length allowed in this model is 12. Both the likelihood ratio test and Akaike's information criterion showed that the optimal lag length was 12. Consistent with the widely accepted practice, and to conserve space, we did not include a table of coefficients for the VAR model. However, the results of the Granger causality test of each variable in each equation in the VAR model are presented in Table 8.

Because each variable of interest, including the industrial production index, is interrelated with other variables in the model, we tested to determine the existence of a causal relationship between the economic output and the stock markets. In Table 8, the top panel shows that despite the presence of a strong causal relationship between economic output and monetary and fiscal proxies, there is strong evidence in favour of a causal relationship between the A share market and the industrial production index. However, when we focused our attention on the SHA, SHB, SZA and SZB equations, we observed that with the exception of SZA, there was a causal relationship between the real economy and the stock market in all other cases. The results of the VAR modelling confirmed our earlier finding of a causal relationship between the A share market and the real economy, and they provided partial evidence for the bi-directional causality from the stock market to the real economy.

We also observed that the proxies of monetary and fiscal policy had a bi-directional causal relationship with economic growth as well as with stock market growth. This result confirmed that both the real economy and the financial markets responded to the monetary and fiscal policy shocks and that the policymakers tweaked the policy variables in response to the economic indicators in the real economy and financial markets. Moreover, in line with our expectations, we observed that the Granger exchange rate affected the B share market in both stock exchanges, but it did not greatly affect the A share market.

7. Policy implications

In recent years, the Chinese stock market has suffered numerous shocks. The most recent is known as the 2015–16 Chinese stock market turbulence, which began with a stock market bubble on 12 June 2015. One third of the value of A shares traded on the Shanghai stock exchange were lost during the one month of turmoil. Major aftershocks started on 24 August (i.e., "Black Monday") when the Shanghai stock market index fell by 30 percent over three weeks. There were many reasons for the downturn of the stock market in China. It was caused by not only external factors but also internal problems in the stock market.

The external factors include the following: uncertainties in the economic structure and financial risks, which affects investors' confidence. From the perspective of development, China currently is a middle-income country, and it faces multiple risks and challenges as a growing economy. However, from the perspective of economic growth, China's economic development has slowed in recent years although the trend to growth continues. Nevertheless, Chinese economic transformation is still plagued by uncertainties because of governmental procedures and the overcapacity problem in traditional industries. Risks caused by real estate bubbles, heavy corporate debt burdens, local debt defaults and so on are gradually joining the challenges currently faced by the Chinese economy. Because all these factors affect investors' confidence, some investors, including overseas investors, have negative expectations for the Chinese economy.

Internal factors are mainly the following. First, the profit margins of enterprises are low, and the quality of the listed companies should be improved. The overall profitability of the listed companies in China declined in recent years. Because the majority of listed companies belong to traditional industries with low profitability, which negatively affect the overall valuation of listed companies. The ownership structure of listed companies should be further optimised. Corporate governance needs to be strengthened. In addition, there is a lack of flexibility and innovation. The mechanism used to reward investors should be enhanced. The phenomenon that focuses on financing and ignores investment still exists. Second, the constitution of the investors is inequitable, which has led to a serious shortage of long-term supply of funds. China's stock market is a typical retail market. Individual investors account for more than 80% of the volume of market trading. Although individual investors can promote the liquidity of the stock market, the transactions are too frequent. There is much speculative buying and selling but little rational long-term investment. Moreover, individual investors are prone to herd behaviour, which exacerbates market volatility. In developed countries, pension funds and other institutional investors comprise 70%–80% of the total investment in the stock market, which plays a key role in stabilising the stock market. Third, the cost of violating rules is low, which affects market confidence. Insider trading, market manipulation, illegal disclosures and other violations of law are common among investors, which drastically lowers the confidence of potential investors and negatively affects their perception of market fairness.

The number of external and internal problems has gradually increased during the past 40 years of China's economic growth. It is inevitable that in China's current stage of development. only the implementation of reforms could solve these deep-seated problems and contradictions. By accelerating the transformation and upgrading of the economy and screening the market mechanism to nurture and promote the growth of new industries (such as technology sector), a solid foundation could be provided to ensure the prosperity of the stock market.

Specifically, the following policy directions could be used to steer the Chinese stock market towards long-term stability and efficiency. First, the quality of listed companies and their investment value should be enhanced. Initial public offerings (IPO) should be promoted to allow more high-tech innovative firms with better corporate governance access capital markets. The ownership structure of listed companies should be improved to boost state-owned enterprise reforms and increase the vitality of blue chip stocks. Second, the supply of funds to stock markets should be increase to accelerate the entry of long-term capital into the stock market. Reforms to the pension system would stabilise long-term capital sources for the stock market and form a real long-term institutional investor group to promote rational investment, value investment and so on. Third, the supervision system should be strengthened to crack down on violations of law, thus enhancing creditability of stock market and protecting the legitimate rights and interests of investors, especially small and medium investors, to increase their confidence in China's stock markets. Finally, the continued adherence to the policy of opening China's stock market to the world could lead to the sustainable growth of the stock market. Allowing foreign investors to enter the Chinese stock market would promote the process of internationalising the Chinese stock market.

8. Conclusions

This study was an initial attempt to investigate both the long run and the short-run equilibrium relationship between the stock market and the real economy in China by considering the issue of structural breaks and causality. Based on the results of our analysis, we conclude that attempts to explore the reasons for a country's economic growth presents a complicated and comprehensive problem. It is difficult to stimulate economic development in a large economy by relying only on simple factors such as stock markets.

We incorporated endogenous breaks in the unit root tests and found that almost all series were mean reverting. The GFC had a significant influence on both China's real economy and its stock markets. The performance of the B share market was also affected by the September 11 terrorist attack on the World Trade Center, which is plausible because only Hong Kong, Macau, Taiwan and international investors were allowed to enter the market at that time. In order to capture both long-run cointegration and short-run dynamics, we applied the ARDL model instead of the ordinary Johansen cointegration analysis. We found that only the Shanghai A share market showed a long-run stochastic trend with the real economy and a small but negative influence on the real economy. The reason for this minor influence is probably the fact that China is a very large country, and the stock market still constitutes only a small fraction of the entire economy, which is not enough to have a sizeable effect on the overall economic development of the country. In terms of the negative relationship between the stock market and the economy, a possible explanation could be that the stock market is a tool used by the Chinese government to achieve its specific goals rather than a real reflection of the economic growth and the potential existence of irrational prosperity on the A share markets, which could cause a financial bubble. In terms of a short-run relationship, there was no evidence to support this kind of association between China's financial sector and the real sector. Furthermore, the Toda Yamamoto approach was employed to test the finance growth nexus empirically. The demand-driven hypothesis was supported only in the Shenzhen B share market. The Shenzhen B share market and the real economy supported the view that any economic growth would influence the financial market, which represents the causal relationship between the growth in the real output of the economy and the growth of stock markets. We posit that the main reason for this result is the transaction costs of the stock markets. We also examined the substitution effect in different stock markets and found a bi-directional causal link between China's A share markets and B share markets. As a robustness check, we used equally weighted index, stock market liquidity and stock market sectoral indices as alternative measures of stock market activities. The results were robust to these alternative measures. Moreover, the results showed that the state-owned monopoly industries played a vital role in China's economic performance because they stimulated economic growth in the short run.

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