DEPARTMENT OF ECONOMICS

ISSN 1441-5429

DISCUSSION PAPER 16/16

Stock Market Development and Economic Growth: Empirical Evidence from China

Lei Pan[+] and Vinod Mishra[§]

Abstract:

It is important to understand the interplay between stock market and real economy to figure out the various channels through which financial markets drive economic growth. In the current study we investigate this relationship for Chinese economy, the fastest growing and largest emerging economy in the world. Using the methodology of unit root testing in the presence of structural breaks and using an ARDL model, we find that Global Financial Crises had a significant impact on both China's real sector and financial sector. Our findings also suggest that Shanghai A share market has a long run negative association with the real sector of the economy, however the magnitude of impact is tiny and can be ignored. We conjecture that this negative relationship is the proof of so called existence of irrational prosperity on the stock market and the bubbles in China's financial sector. We do not find any evidence of a relationship between stock market and real economy in the short run. Toda Yamamoto causality test supports the demand-driven hypothesis that economic growth spurs development of stock markets for China's B share market.

Keywords: China, Stock Market, Unit Root, Cointegration, Economic Growth

JEL Classification Numbers: O40, G10

[+] PhD Scholar, Department of Economics, Monash University. Email: lei.pan@monash.edu

[§] Department of Economics, Monash University. Email: vinod.mishra@monash.edu

1. Introduction

Staring from the pioneering work of Schumpeter (1911) and works of Mckinnon (1973) and Shaw (1973), a large amount of literature has looked at identifying causal relationship between financial sector development and economic growth. It is well recognized that financial market is vital for economic growth as it is an important source for mobilizing the otherwise idle savings in the economy and converting them into useful and productive capital. However, on the other hand when an economy grows, it generates a surplus, which fuels the growth of financial sector. Hence, the direction of causality between financial markets development and economic growth remains ambiguous and open for empirical scrutiny. Furthermore, finding the direction of this causal relationship has significant policy implications. For instance Olwenyand Kimani (2011) investigated this relationship for Kenya and found that causality is unidirectional from financial markets to economic performance. Consequently the study recommended that the government should eliminate any impediments to the growth of financial market (regulatory barriers etc.) and safeguard the interests of shareholders.

As the financial sector is very broad and its growth cannot be measured using a single indicator, many economists have focused on the nature of relationship between one sub-sector of financial markets and the growth in real economy. One such sub-sector that has attracted a lot of interests is the stock market. There is a big strand of literature looking at the relationship between the stock market and the real sector of economy. The empirical studies by Atjeand Jovanovich (1993), Korajczyk (1996), Levine and Zervos (1998) found a strong positive correlation between stock market and economic growth.

However not all studies are supportive of the positive relationship between stock markets and real economy. A study by Paramatiand Gupta (2011) for Indian economy, that used the data on Index of Industrial Production (IP) and market indices from Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) (two major stock markets in India) for the time span 1996 to 2009, found a significant bi-directional causality between the financial sector and the real sector using monthly data, however, the relationship vanished once they changed the data frequency to quarterly.

One potential reason why existing literature is ambiguous about this research question could be the measures used to proxy for stock market size and the size of real economy. Most of the existing studies use stock market index as a proxy for measuring the growth and development of stock market in a country. We argue that stock market index may not be a good measure of stock market size when looking at its association with economic growth. As stock index is weighted by market capitalization the movements in the index is mainly driven by prices of stocks of large multinational firms. The prices of stocks of such large multinationals may be influenced by a variety of reasons that may not be reflective of the financial markets of the country in question. This argument is especially relevant in the context of China where small and medium enterprises (SMEs) are regarded as the source of its economic miracle. In the last decade or so the SMEs have played an increasingly important role to ease the pressure on employment and optimize the economic structure. As per the figures quoted in Li (2002), SMEs account for around 80 percent of China's manufacturing employment and contribute more than 60 percent to China's GDP.

Another reason why stock market index is not the best proxy for capturing the size of stock market is to do with the way constituent stocks are selected for the index. In most cases committees decide which stocks are included in the index and the basket of stocks keep changing over time to reflect the market conditions. This approach leaves the possibility that the committee does not choose the best stocks that are representative of the stocks market in general. Moreover, with the changing structure and composition of such committees, there is also a possible of time-inconsistent decision making in the process of selection of stocks for inclusion in the index. Hence, one of the innovations of current paper is to focus on the stock market capitalization as the measurement of the size of stock market, which is an objective market wide measure.

While there is no general consensus in the empirical literature regarding the existence and nature of relationship between the stock market and the real economy, the existing literature seems to indicate that the nature of relationship differs from one country to another and also probably varies between countries, which at different levels of economic growth. Moreover, there is also a possibility of unobservable cultural or institutional factors that determine the existence and nature of relationship between stock markets and real economy.

In the light of above arguments, it seems that the best way to study the relationship between stock market and economy is analyses this data on a country-by-country basis. The second crucial issue is the choice of robust methodology. The existing literature seems to indicate that whether or not one find a causal relationship between stock market and real economy, is also dependent on the choice of methodology used for analyzing the data.

In this paper, we look at an emerging yet one of the largest economies in the world: China. China has experienced a remarkable economic growth since 1980s. There is a good amount of ongoing debate whether or not the factor accumulation or productivity improvement is the main economic force driving economic growth in China. However, the role of financial sector's contribution to China's economic development has largely been ignored.

There is only a small subset of literature that looks at this important question for China. Hasen, Wachtel and Zhou (2009) used a dynamic panel data framework using data for Chinese provinces to investigate the role of institutional components for a transition economy. Based on Blundell and Bond (1998) estimation they concluded that the financial markets are one of elements that are associated with stronger economic growth. Liang and Teng (2006) used bank credit ratio as the indicator of financial development under the assumption that size of financial intermediaries is positively related to the quality of financial services. Using the natural logarithm of real per capita GDP, bank credit ratio, real interest rate, natural logarithms of real per capita fixed capital and trade ratio and by adopting the Johansen cointegration test and Granger causality, they found evidence of unidirectional causality running from economic growth to financial development.

In current study, we look at the relationship between stock market development and real economy in China by using a new methodology, which specifically models for structural breaks in the series. The issue of structural breaks is very important for our analysis considering our sample period contains many global events (such as Asian Financial Crisis, Afghanistan and Iraq War, September 11 attacks on World Trade Center and 2008 Global Financial Crisis), which may have had impacted the Chinese economy and Chinese financial markets to a varying degree.

The study of structural breaks in time series analysis goes back to Perrons's (1989) paper, where he argued most macroeconomic series were not unit root process (as previously suggested by Nelson and Plosser (1982)), in fact they were trend stationary with structural breaks. It was concluded that a standard ADF type test would fail to reject the null hypothesis of unit root if a series contains one or more structural break. In the current study, we use Narayan et al (2016) test to look at the unit root properties of our data and identify possible structural breaks in the data. Next we employ ARDL model to investigate long-run cointegration and short-run dynamics rather than conducting the conventional cointegration analysis, which suffers the problem of lower power. In addition, we also apply a more powerful version of Granger causality test proposed by Toda Yamamoto (1995) to capture short-run causality pattern between the stock market and the real economy as well as the substitution effect of individual sector in Chinese stock markets. The finding of this study can be used as a benchmark for future studies exploring this important relationship between stock market development and economic growth using different measures and methodologies.

2. The Finance-Growth Nexus

As suggested by Fink et al. (2006), the relationship between financial market and real economy can take one of more of the five forms. These five forms are supply leading, demand driven, interdependence, no causal relation and negative causality from finance to growth.

The supply-leading theory was proposed by Mckinnon (1973) and Shaw (1973), who argued that the accumulation of financial assets improves economic growth, thereby financial market development causing positively influencing economic growth. The demand-driven hypothesis proposed by Friedman and Schwartz (1963) on the other hand argued that economic growth leads to the appearance and establishment of financial centers and hence concluded that financial development endogenously determined by the growth in real economy. Lucas (1988) suggested that there is no causal relationship between financial sector and economic growth. However, this hypothesis point was applicable only under the neo-classical assumption of no transaction costs and perfect information (Graff, 2000, as cited in Fink, et al., 2006). Lucas (1988) theory attracted a lot of criticism as most of the economists today agree that it is not possible to have frictionless markets agency problems and transaction costs. Moreover, there is a large empirical literature that has already provided enough empirical evidence suggesting a positive relationship between economic growth and finance. The debate has now moved on to identifying the channels through which financial markets are linked to the real economy and the nature and direction of any possible causality between the two.

According to Pagano (1993, as cited in Bekaert et al., 1995), there are three main channels through which financial development and economic growth are linked together. First; the financial development increases the proportion of savings that are funneled to investments; Second; financial development changes the saving rate, which influences investment and Third; financial development also increases the capital allocation efficiency. Most of the existing literature argues that the most important is the second and last channel, through which the financial market interacts with the real economy, i.e. by efficiently allocating the capital (Beakaert and Harvey, 1997).

Some economists, however, remain skeptical and consider there is a hardly any relationship between stock market and economic activity. Beakaert and Harvey (1997a) argued that the view is not surprising and gave some reasonable explanations, pointing to the apparent fallacy in this view. The key reasoning behind skepticism can be summarized as information asymmetry present between the investors of a firm and its managers. Generally managers have much more information about the firm’s performance than investors. Managers have a better idea of when the firm equity is mispriced in the stock market. As a result, managers only issue new equity if firm’s shares are overpriced. As investors know this, they are reluctant to invest in new equities. Naturally, this explains why many corporations do not rely on new equity to finance their investments. Nonetheless, Beakaert and Harvey (1997b), while acknowledging this opinion as correct, pointed the fact that this narrow view of the functioning of stock markets ignores some other important functions of stock market that direct relate to the economic growth. Beakaert and Harvey (1997b) argued that stock market efficiently helps individuals diversify firm-specific risks, which increases the attractiveness when investing in firms. Another role stock market can play is reducing the moral hazard problem. Specifically, as stock price is a wonderful benchmark of a firm's performance, using it as a peg for manager's compensation will reduce their incentives for engaging in unproductive actions. As the stock market price is a reflection of managers' performance, it may decline dramatically because of the careless working attitude of managers. Under such situation, the managers may be replaced by stockholders. More broadly this last contribution of the stock market can be summarized as something that reduces the transaction costs of public offering and creates opportunities for the appearance of optimal ownership structure in the economy.

Arestis et al. (2001) found that the liquidity of stock market is closely related to the economic growth. They argued that a liquid stock market makes financial assets less risky because it allows investors to sell quickly and change their financial position if they find their stock's value has deceased. Less risky assets improve capital allocation, which is an essential channel of economic growth. However, a study by Demirgüç-Kunt and Levine (1996) warned of the negative impact of liquidity on economic growth through three main channels. They argued that too much liquidity would increase investment returns and then reduced the saving rates, this will cause precautionary savings to decline significantly as less uncertainty brought by the greater liquidity, would start to have impact. Moreover, stock market encourages investor myopia, adversely influences corporate governance and hence hinders the economic growth.

Another important factor that determines the role of stock market in the overall economic growth is the level of volatility in the stock market. As argued by Arestis et al (2001), most of the investors are risk adverse, who generally are not comfortable with investing in a market characterized by high fluctuations in the price level. The idea was also propagated by Keynes (1936), he pointed out that as the stock market improves, the number of speculators also increases and when stock markets are dominated by speculators, it ceases to function as stock market and start resembling more and more like a casino. In an ideal world making money through a casino should be expensive compared to other forms of investment. Hence a stock market dominated by speculators functioning like casino should be no different. However, Arestis et al (2001) using quarterly data on real GDP, stock market capitalization ratio, ratio of domestic bank credit to nominal GDP and eight-quarter moving standard deviation of the end-of-quarter change of stock market prices for 5 industrialized countries (Germany, US, Japan, UK, France) for the period 1970 - 1990 demonstrated that a certain degree of volatility is desirable for the market, as it reflects new information flows into an efficient market. However, most empirical evidence suggests that the observed level of volatility is excessive, which is likely to cause allocation inefficiency and reducing the economic growth. Prakash (2012) investigated Indian stock market and found the market had been extremely volatile , he conjectured that the oligopolistic manipulations and scams were the main reasons for high volatility in Indian stock market. Indian stock market indeed witnessed two major scams in 1992 and 2000 caused by stockbrokers Harshad Mehta and Ketan Parekh respectively and these lead to stock market lose its credibility. Therefore, it can be seen that the excessive fluctuations may be a warning of an economy's health.

One central conclusion that one can draw by looking at the existing literature is that there is no universal agreement among various researchers about the relationship between financial development and economic growth. At the best one can say that under some strong assumptions and restricted conditions, an efficient capital market is positively related to the economic development, and the relationship is bi-directional in nature. There are a couple of reasons why conclusions regarding this important question are still ambiguous. One of the main reasons is possibly the fact that most researches only studied the correlation between real economy and the financial sector, however, correlation does not imply causation. Hence, there is need to study the causal nature of this relationship. Another problem is that most of the previous studies have included financial sector development as an argument in the augmented production function and assumed economic growth as the dependent variable, with causality test runs from financial sector to the real sector. Nonetheless, as discussed earlier, the direction of the relationship is unclear in the existing literatures. In other words, the problem of misspecification bias cannot be ruled out in some of the past studies. In this paper, we utilize Toda Yamamoto approach to test for short-run causality between stock market development and growth in the real economy. Furthermore, we also test the demand driven and supply leading hypothesis as well as the substitution effect within Chinese stock markets.

3. Description of Chinese Stock Market

China has experienced an astounding economic surge over the past few decades. Its equity market draws lots of 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 (SSE), 2010). With the gradually improved legal system and trading rules, China's capital market has reached the international standard nowadays. In terms of its stock market, China has now become the third largest market capitalization in the world (SSE, 2010). There are two stock exchanges in the mainland: Shanghai and Shenzhen. The equities traded on these stock exchanges are recognized as A share and B share. The key difference between the two categorizations is that the former are measured in RMB and latter in foreign currency, specifically, US dollars in Shanghai stock exchange and Hong Kong dollars in Shenzhen exchange. A shares are the ordinary shares with good liquidity and account for the largest proportion of offered company shares. However, the domestic investors from mainland China can be the only investors for A shares. On the other hand, B shares are limited and only domestic investors from Hong Kong, Macau, Taiwan and international investors are allowed to invest. This regulatory restriction lasted until 2001, when in order to boost B share market, Chinese government removed the restrictions and made it open to mainland China residents who hold a valid foreign exchange deposits (SSE, 2010). Finally, in 2003, designated foreign institutions were allowed to invest in A shares. Neither A shares nor B shares are real stocks, trading is handled via electronic billing. Chinese government endeavors to protect stability of the stock market and prevent over speculation. Hence, two main policies are implemented by the government to achieve this goal: First, "T+1" trading rule in A share market and "T+3" trading rule in B share market, which means investors in A share market has to only wait for the next trading day if they want to sell the shares they purchased today. On the other hand the investors in B share market will have to wait till 3rd day after the day investors buy shares. Second, Chinese government sets the limit for stock price spread, that is, the fluctuation of price of a security on current day cannot exceed the 10% upper or lower limit of closing price on the previous day. Both stock market exchanges have surprising trading volumes and trading values each day. Almost 11 billion deals in terms of number of shares worth of 96 billion RMB happens on Shanghai stock exchange (SSE, 2015) and 9.8 billion trades with the value of 120 billion RMB on Shenzhen exchange per day respectively. (Shenzhen Stock Exchange (SZSE), 2015).

4. Description of Data

For the stock market development, we collected monthly A share's and B share's market capitalization data from January 1991 to November 2015 from Shanghai and Shenzhen stock exchange, which represents the total value of each kind of listed shares on the corresponding stock market. While the stock market capitalization is observable at high frequency, the most commonly indicator of economic of growth i.e. GDP is only observed at quarterly or lower frequencies. Reducing the stock market capitalization data to lower frequency, would have lead to loss of information and have introduced some serious flaws due to aggregation bias, hence we decided to use another more frequently observable variable as proxy for economic growth. As mentioned in Cuche & Hess (1999), this is a common practice in economic analysis. The most commonly used proxy for GDP and usually observed monthly is index of industrial production (IP). Hence, we collect China's IP index for the same period as the stock market data to use as a measure of economic growth. The market capitalization data are measured in 100 million RMB. All the data was collected from DataStream.

5. Empirical Methodology

Perron (1989) pointed out, if data generating process is trend stationary and there are structural breaks during the period under consideration, then ADF test is more likely to commit a Type 2 error and regard trend stationary process with structural breaks as a non-stationary process following random walk. In other words, the effectiveness of the traditional ADF unit root test will drop dramatically if structural breaks are present but are not considered while testing for unit roots. There are lots of unit root test with structural breaks, however, one of the problems employing ADF-type test is because their critical values are derived under the null hypothesis of no structural breaks, which can lead to size distortions in the existence of a unit root with structural breaks. Consequently, the possibility of Type 1 error increases when we applying ADF-type methodology, that is, mistakenly judge a time series data with a unit root in the presence of structural break as a stationary series.

We adopt Lee and Strazicich's (2003) minimum Lagrange Multiplier test in this paper to test unit root with two structural breaks. The advantage of this test is it can solve the problems of size distortion mentioned earlier and rejection of the null hypothesis clearly indicates trend stationary.

5.1 Lee & Strazicich (2003) Minimum LM Unit Root Test with Two Breaks

Assuming the, following data-generating process can be used to specify the minimum LM test.

$$y_t = \delta' Z_t + X_t, \quad X_t = \beta X_{t-1} + \varepsilon_t \qquad (1)$$

where Z_t is a matrix of exogenous variables and the term ε_t ~ iid N $(0, \sigma^2)$. The null hypothesis of a unit root is $\beta = 1$. The data-generating process is reduced to Schmidt and Phillips (1992) minimum LM test if $Z_t = [1, t]'$, where the series with no structural break, but an intercept and a trend.

The specification of minimum LM test with two structural breaks follows Perron's nomenclature, Model A and Model C, where the former known as the crash model. The following specification of Z_t is used to represent the model with two structural breaks in the intercept AA, where AA is the two break counterpart of model A.

$$Z_t = [1, t, D_{1t}, D_{2t}] \qquad (2)$$

where D_{1t}= 1 for $t \geq T_{B1} + 1$, otherwise equals 0, D_{2t}= 1 for $t \geq T_{B2} + 1$, otherwise equals 0. Here T_{B1} and T_{B2} refer to the structural break points in the intercept. Additionally, H_0 and H_A are as followings:

$$H_0 : y_t = \mu_0 + d_1 B_{1t} + d_2 B_{2t} + y_{t-1} + v_{1t}$$
$$H_A : y_t = \mu_1 + \gamma t + d_1 D_{1t} + d_2 D_{2t} + v_{2t} \qquad (3)$$

where v_{1t} and v_{2t} are error terms. The specification of Model CC is shown below:

$$Z_t = [1, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t}] \qquad (4)$$

where $DT_{1t} = t - T_{B1}$ for $t \geq T_{B1}$, otherwise equals 0, $DT_{2t} = t - T_{B2}$ for $t \geq T_{B2}$ otherwise equals 0. In this case, the null hypothesis and alternative hypothesis are as followings:

$$H_0 : y_t = \mu_0 + d_1 B_{1t} + d_2 B_{2t} + d_3 D_{1t} + d_4 D_{2t} + y_{t-1} + v_{1t}$$
$$H_A : y_t = \mu_1 + \gamma t + d_1 D_{1t} + d_2 D_{2t} + d_3 DT_{1t} + d_4 DT_{2t} + v_{2t} \quad (5)$$

The two breaks minimum LM unit root test can be modeled based as followings:

$$\Delta y_t = \delta' \Delta Z_t + \phi S_{t-1} + u_t \qquad (6)$$

where $S_t = y_t - \psi_x - Z_t \delta$, t = 2, …, T; δ is the coefficient of regression of Δy_t and ΔZ_t. Moreover, ψ_x equals y_1 - $Z_1\delta$, y_1 and Z_1, which stands for the first observation for y_t and Z_t respectively. The H_0 is represented as ϕ = 0. And the LM statistics are showed as follow:

$$\rho = T\,\phi \qquad (7)$$

T = t statistics testingH_0: ϕ = 0

Furthermore, two error variances are defined and assumed to be positive:

$\sigma^{2,sub\&epsilon} = \lim T^{-1}E(\varepsilon^{2,sub\ 1} + ... + \varepsilon^{2,sub\ T})$, T →∞

$\sigma^2 = \lim T^{-1}E(\varepsilon_1 + \ldots + \varepsilon_T)^2$, T→∞

The locations of break points are determined endogenously through a grid search to locate the minimum t-statistics and are showed as below:

$$LM_\rho = \inf_\lambda \rho(\lambda)$$

$$LM_T = \inf_\lambda T(\lambda) \qquad (8)$$

A trimming region provided by [kT, (1-k)T] is used to eliminate the break points. Based on the literature, currently there is no universal rule to calculate k. Consequently, in this paper, we use the option k = 0.15, which is same as in the Lee and Strazicich's original paper in 2003. Furthermore, the critical values in this test are determined by the relative break locations, which are, λ_1 and λ_2.

INSERT TABLE 1 HERE

Table 1 shows the results of LM unit root test with two structural breaks. Based on the above table, model AA provides a strong evidence that almost all the series do not have a unit root except for Shenzhen A share market, while the model with break in intercept and trend seems to provide an opposite inference, where it shows all financial market series are non-stationary except for industrial production. In order to ensure the stationarity results, we conduct the following robustness check.

5.2 Narayan et al. (2016) Unit Root Test with Two Structural Breaks

Andreou and Ghysels (2002) demonstrated the importance of structural break as another stylized fact of time series data. Most of the existing research about unit root properties of a time series assumes independently and identically (iid) errors. However, this is not suitable for high frequency data, which is often characterized by heteroskedasticity. According to the literature, DF test is sensitive to heteroskedasticity and when both ARCH and GARCH parameters approaches to unity the problem becomes complicated. Some economists consider the problem is partially caused by the inconsistency of OLS estimators under such circumstance. In 1998, Ling and Li proved the limiting distribution of maximum likelihood estimator for GARCH errors is more efficient than OLS estimators.

In this study, we use the most recent unit root test proposed by Narayan et al (2016) dealing with non iid errors and incorporate two structural breaks following a GARCH (1, 1) process as our robustness check. The test uses maximum likelihood estimator to estimate both autoregressive and GARCH parameters and it is the only test specifically considers the heteroskedasticity problem.

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

$$y_t = \alpha_0 + \pi y_{t-1} + D_1 B_{1t} + D_2 B_{2t} + \varepsilon_t \qquad (9)$$

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

$$\varepsilon_t = \eta_t \sqrt{h_t}, \quad h_t = \mu + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1} \qquad (10)$$

where $\mu > 0$, α and β are non-negative numbers and η_t is a sequence of iid random variables with zero mean and unit variance.

The critical value at 5% level for endogenous structural break is based on the table provided in Narayan et al (2016).

INSERT TABLE 2 HERE

The results of Narayan et al. (2016) unit root test are presented in table 2.We find all series reject the unit root null at 5% significance level, which ascertains most of our findings earlier. Nevertheless, still a minor difference exists between the two tests. In the former case, we cannot reject the null for series SZA. In case of a contradiction we go ahead with the results of Narayan et al (2016) test as it provides a better fit to the data by considering both structural breaks and heteroskedasticity in a unified framework.

In terms of break period, combining the results of the two unit root tests, we notice that the first break in Industrial Production (IP) series appears around 2005 to 2006 and the second break appears in 2011-12. For A share market, we find that the first break is detected in 2007 - 2008 and second break appears in 2012- 2013 period. In B share market, the first and second break appears during 2000 - 01 and 2007 – 09 respectively.

In general, all the identified breaks are possibly linked to a domestic or international shock to the Chinese economy. The breaks appearing in the period 2007 - 12 are most likely linked to the Global Financial Crisis (GFC), indicating that GFC had a significant impact on Chinese economy in general and its stock market in particular. The break during 2000 to 2001 is likely to be related to September 11 terrorist attacks in United States (US) and we find China's B share market is influenced by this unforgettable tragedy, which is plausible since B share markets are only allowed for Hong Kong, Macau, Taiwan and international investors to enter at that time.

5.3 Autoregressive Distributional Lag (ARDL) Model

As our results suggest there is no unit root in almost all series, it is proper to use Autoregressive Distributional Lag Model (ARDL) also known as bounds testing proposed by Pesaran and Shin (1998) and Pesaran, Shin and Smith (2001) to investigate how Chinese economy reacts to performance of stock markets. There are several advantages and reasons why we employ this approach. First, although tests such as residual based Engle-Granger (1987), maximum likelihood based Johansen (1991; 1995) and Johansen-Juselius (1990) are commonly used to check for cointegration, due to the problem of lower power, ARDL model is preferred. Second, ARDL allows I(0) variables in the model. Third, ARDL has only one single equation, which makes it easy to interpret. Fourth, ARDL model takes sufficient number of lags to capture the data generating process in a general-to-specific modeling framework (Laurenceson and Chiai, 2003). Last, ARDL can manage both long-run cointegration and short-run dynamics.

The specification of our ARDL model is as follow:

$$IP_t = \alpha_0 + \sum \beta_i \, SHA_{t-i} + \sum \gamma_j \, SHB_{t-j} + \sum \delta_k \, SZA_{t-k} + \sum \theta_l \, SZB_{t-l} + \epsilon_t \quad (11)$$

We establish the above model by following traditional view that stock market is an indicator of a country's economy. Many economists believe that large decrease in stock prices is a warning of future economic recession and raising stock prices predict a forthcoming economic boom (see for example Comincioli' 1995, 1996). It was argued that reason behind observed lack of correlation between economic growth and stock market could be because of that fact that stock market is capable of anticipating economic growth and hence becomes its leading indicator.

In equation (11) j, k, l and i are number of lags of independent variable included in the model and the optimal numbers of lags were decided using information criteria. ARDL model estimates $(p + 1)^k$ regression equations to obtain 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. We use 8 lags as our maximum lag since it is most commonly used. In this study, the total number of regressions estimated based on ARDL approach is 52488. There are four methods to decide the optimal ARDL model: Akaike Information Criterion (AIC), Schwartz Bayesian Criterion (SBC), Hannan-Quinn Criterion and adjusted R-squared. Both first and third criterion suggest ARDL (3, 0, 0, 0, 0), while the second recommends ARDL (2, 0, 0, 0, 0) and the latter advices ARDL (3, 0, 6, 8, 2). Based on a balanced consideration of almost all the aspects such as coefficient significance, goodness of fit of the model, serial correlation and model stability, where we will discuss the last two issues latter, ARDL (3, 0, 6, 8, 2) is selected as our benchmark.

After ensuring number of lags used in the model, we formulate and estimate an unrestricted error correction model as following:

$$\Delta IP_t = \alpha + \sum \beta_i \Delta IP_{t-i} + \sum \gamma_j \Delta SHA_{t-j} + \sum \delta_k \Delta SHB_{t-k} + \sum \theta_l SZA_{t-l} + \sum \eta_m SZB_{t-m} + \mu_0 IP_{t-1} + \mu_1 SHA_{t-1} + \mu_2 SHB_{t-1} + \mu_3 SZA_{t-1} + \mu_4 SZB_{t-1} + \epsilon \quad (12)$$

The first thing that we need to check is whether our ARDL (3, 0, 6, 8, 2) model is serially correlated by using Breusch-Godfrey Serial Correlation Lagrange Multiplier (LM) test. The result of the test is shown in table 3.

INSERT TABLE 3 HERE

As can be seen from the above table, based on both F statistic and observed R-squared, the serial correlation test cannot reject the null of no serial correlation of until 10 lags case in our ARDL (3 0, 6, 8, 2) model at 5% significance level, which implies there is no serial correlation in the residual. Next, we check our model is stable or not by employing Cusum test and the result is illustrated in the following figure.

INSERT FIGURE 1 HERE

As can be seen from the figure, the model is found stable in a Cusum test at 5% significance level. After ensuring our model neither has serial correlation nor unstable, bounds testing can be done in the next step.

Bounds test proposed by Pesaran et al. (2001) is used to discover the existence of long-run equilibrium among variables of interest. In specific, it is an F-test with the null that $\mu_0 = \mu_1 = \mu_2 = \mu_3 = \mu_4 = 0$ in equation (12). Based on Pesaran et al. (2001), lower bound is used when all variables are I(0) and upper bound is used when all variables are I(1). If the F-statistics is found below the lower bound, it indicates variables are I(0) and there is likely to be no cointegration among variables of interest. If the F-statistics is higher than upper bound, it implies the existence of cointegration. And if the F-statistic falls between lower bound and upper bound, then the cointegration evidence is inconclusive. The result of bounds test is shown in the table below.

INSERT TABLE 4 HERE

Table 4 shows the F-statistic is 16.66, which is larger than the upper bound value 4.01 at 5% significance level. Hence, we reject the null hypothesis that no long-run relationship and conclude there is a long-run association between Chinese economy and its stock market.

We extract long-run multiplier between the dependent and independent variables from the unrestricted error correction model and obtain the long-run coefficients of equation (11), which are presented in Table 5 below.

INSERT TABLE 5 HERE

These results indicate that Shanghai A share market has a long-run relationship and a negative impact on the economy though the negative influence is very small and can be ignored. In specific, in the long run, an increase of 1 basis point of market capitalization of Shanghai A share market (which is roughly one hundred million yuan) will cause industrial production index decline by 0.00002 points. This effect is small and yet significant, indicating that the fact that China is a very large country and the stock market still constitutes only a tiny fraction of the whole economy, which is not enough to make measurable impact on the overall economic performance of the country. The most likely explanation of negative impact of stock market on the economy can be attributed to specific institutional characteristics of Chinese economy during the sample period of this study. More specifically the Chinese government tried to push investor towards taking on speculation opportunities in the stock market via consensus, government policies such as the People's Bank of China (PBC) declared increase of interest rate at the end of 2014. Moreover the government took this opportunity to launch a registration system so that a large number of not yet profitable SMEs can be listed on stock market. In fact, the ultimate goal of the government was to promote economic transition through making civilians' deposits as the fund for SMEs' development. Therefore, it can be seen that, the prosperous of Chinese A share markets is a channel that government utilized to achieve its objectives rather than a real reflection of economic growth. Second, the phenomenon that happened this time in China can be classified as irrational prosperity, which refers to the operation of market, is driven by the mentality of human rather than the normal rules. In general, irrational prosperity of financial markets often implies a high degree of real economy shrinking. The reasons is straightforward: if people feel profitable to make money in the real economy, they will invest their money based on the successful experience in the past such as buying new equipment, expanding scale of reproduction rather than putting money in an invisible behavior that full of uncertainty. In other words, we think Shanghai A stock market suffers the issue of irrational prosperity and leads to the appearance of financial bubbles.

The results of bounds testing means restricted error correction model (ECM) can be established to check for the short-run coefficients. We conduct our analysis following the steps below: First, we lagged the residuals from equation (11) by one period. Then, add the lagged residual to equation (12) as the error correction term to construct the restricted error correction model. The specification of the ARDL (3, 0, 6, 8, 2) restricted ECM is set up as follow:

$$\Delta IP_t = \alpha + \sum \beta_i \Delta IP_{t-i} + \sum \gamma_j \Delta SHA_{t-j} + \sum \delta_k \Delta SHB_{t-k} + \sum \theta_l SZA_{t-l} + \sum \eta_m SZB_{t-m} + \varphi ECT_{t-1} + \epsilon \quad (13)$$

where ECT stands for the error correction term. Before checking the estimation results, we have to examine whether the model passes the serial correlation test and model stability test. Table 6 below shows the results of serial correlation test of our ARDL restricted ECM.

INSERT TABLE 6 HERE

It can be seen that both test statistics cannot reject the null hypothesis of 10 lags case in ARDL (3, 0, 6, 8, 2) restricted ECM model, which prove that there is no serial correlation in the residual of our model.

Next, Cusum test is used to check the model stability and the result is demonstrated in the figure 2.

INSERT FIGURE 2 HERE

We can see the result of Cusum test suggests the model is stable at 5% significance level or greater. Since the ARDL (3, 0, 6, 8, 2) restricted ECM model passes both serially correlation test and model stability test, we can use this model to conduct short-run relationship analysis among the variables of interest. The estimation results of the restricted error correction model are shown in the following table.

INSERT TABLE 7 HERE

As can be seen from the table, no short-run coefficient between financial sector and real sector has been found significant. As a result, we conclude that there is no short-run association between the stock market and Chinese economy. The last item in table 6 indicates speed of adjustment, as the value is negative and statistically significant, we conclude that the model will converge to a long run equilibrium at the speed of 18.71 percent.

5.4 Toda Yamamoto (1995) Version of Causality Testing

The most widely known approach to examine the causal relationship between two variables is the Granger causality test proposed by Granger in 1969. The test is easy to carry out and has been employed to answer the question of causality in variety of circumstances. However, it also suffers from several limitations.

First, bivariate Granger causality test does not consider the effect of other variables and may suffers from possible specification bias. Second, time series data are usually non-stationary which can lead to spurious regression. Gujarati (2006) also argued that F test is not valid when variables are integrated because the test statistic does not obey a standard distribution under this circumstance. Although researchers can still check significance of individual coefficients using t-statistic, they may not able to jointly test Granger causality via F-statistic.

Consequently, in this paper, we employ Toda Yamamoto (1995) version of causality testing which can overcome the problems mentioned above to examine the direction of causality between China's real sector and financial sector. In fact, this procedure had been proved to be superior to conventional Granger causality test as it does not require to pre-test for cointegration and therefore can prevent pre-test bias and the approach can be applied to series with any arbitrary level of integration. Moreover, Todo Yamamoto test can fit a standard autoregressive model in levels of variables rather than the in first differences as proposed in Granger causality test. This minimizes the risk of possibility of identifying order of integration of variables wrong.

To undertake Toda Yamamoto version of Granger causality test, we use a bivariate VAR, which includes all of our variables of interest in the following model specification.

$$X_t = \varpi + \sum_{i=1}^{m} \theta_i X_{t-i} + \sum_{i=m+1}^{dmax} \theta_i X_{t-i} + \sum_{i=1}^{m} \delta_i Y_{t-i} + \sum_{i=m+1}^{dmax} \delta_i Y_{t-i} + v_{1t} \quad (14)$$

$$Y_t = \psi + \sum_{i=1}^{m} \phi_i Y_{t-i} + \sum_{i=m+1}^{dmax} \phi_i Y_{t-i} + \sum_{i=1}^{m} \beta_i X_{t-i} + \sum_{i=m+1}^{dmax} \beta_i X_{t-i} + v_{2t} \quad (15)$$

where X and Y are all combinations of pairs constructed by the variables of interest and they must be different series, that is, excluding cases such as both X and Y are IP. The item ϖ, θ, δ, ϕ, β are parameters of the model, dmax stands for the maximum order of integration in the model, $v_{1t}\sim N(0, \sum_{v_1})$ and $v_{2t}\sim N(0, \sum_{v_2})$ are residuals, where $\sum_{v_1}$ and $\sum_{v_2}$ represent covariance matrices of v_{1t} and v_{2t} respectively. And the null hypothesis of the test can be expressed as there is no causality running from X to Y, that is, H_0: $\delta_i = 0$, $\forall$ i = 1, 2,…, m.

There are two steps in total to implement the test: First is to select the maximum order of integration (dmax) for all variables of interest. In this study, we apply Augmented Dickey-Fuller (ADF) test with the null hypothesis that series is not stationary and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test with the null that variable is stationary to determine the order of integration. The reason why we use two tests with totally opposite null hypothesis is joint testing of both nulls can strengthen about the stationarity decisions of a time series, which has been known as confirmatory analysis. The results of unit root tests are provided in the following table.

INSERT TABLE 8 HERE

As can be seen from table 8, in some cases ADF and KPSS tests give different conflicting results. For all variables, the ADF test statistic cannot reject the null hypothesis at the level, but reject the null once variables are first differenced, which implies all the series are integrated of order one. By contrast, KPSS only ascertains IP is I(1) but considers the remaining variables are stationary at level. A confirmatory analysis tallying the results of both the tables suggests that only IP is confirmed to be of order of integration one, while the order of integration is inconclusive for all the other variables. Therefore, for conducting causality test, VAR models will only add one extra lags, that is, dmax = 1.

Second step is to determine the lag length (m). Based on the results of sequential modified LR test statistic (LR), final prediction error (FPE), Akaike Information Criterion (AIC), Schwartz Information Criterion (SC) and Hannan-Quinn Information Criterion (HQ), three of them suggest the optimal number of lags should be eight. Because this number is greater than the maximum order of integration, it has enough restrictions and can be selected as the optimal lags to conduct Toda Yamamoto test. We first check the short-run causality pattern between the stock markets and the real economy in China to see which hypothesis can be satisfied: demand-driven, supply-leading or neither of them and results are shown in the following table.

INSERT TABLE 9 HERE

It can be seen from table 9 that supply-leading hypothesis cannot be confirmed in China, while an interesting finding is that demand-driven hypothesis only works between B share markets and the economy in China. Almost no literature gives explanation to this, and we deem one of the possible reasons is the transaction cost for stock market. Usually a certain percentage of transaction fees need to be charged in order to maintain operating stock market. In other words, only people who are able to afford the entry cost are allowed to invest in stock market. In fact, majority B share investors come from Hong Kong and GDP per capita for Hong Kong is larger than Chinese mainland for many years. Therefore, with the economic growth, there will be more new B share investors who can afford the entry cost rather than investors for A share market, which further stimulates performance of B share markets.

In addition, we also capture causality direction within Chinese stock market, which also known as the substitution effect and the results are described in the table below.

INSERT TABLE 10 HERE

From table 10, it can be seen that the existence of bidirectional causality has been discovered within China's A share market and also B share market. Furthermore, it seems that Shanghai B share market plays a vital role in Chinese financial sector because it can influence the performance of the whole A share markets in China.

6.0 Conclusion

This paper is an initial attempt to investigate both long-run and short-run equilibrium relationship between the stock market and the real economy in one of the largest yet still growing economies: China by considering the issue of structural breaks and employing more powerful methodologies that previous studies did not use. Based on our analysis, it can be concluded that exploring the reason of a country's economic growth is a complicated and comprehensive problem. It is hard to stimulate economic development in a large economy by relaying only on simple factors such as stock market.

We incorporate endogenous breaks in the unit root tests and find all series are stationary. It seems that GFC has a significant influence on both China's real economy and the stock markets. The performance of B share market was also affected by the September 11 terrorist attack on World Trade Center, which is reasonable because of the restrictions of B share markets that only Hong Kong, Macau, Taiwan and international investors are allowed to enter the market. In order to capture both long-run cointegration and short-run dynamics, we apply ARDL model rather than the ordinary Johansen cointegration analysis. We found that only Shanghai A share market shares a long-run stochastic trend with the real economy and it has 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 whole economy, which is not enough to make a measurable impact on the overall economic development of the country. In terms of the negative relationship between the stock market and the economy, the possible explanation could be the stock market is a tool for Chinese government to achieve its specific goal rather than the real reflection of the economic growth and the potential existence of irrational prosperity on the A share markets which can bring financial bubbles. For the short-run relationship, there is no evidence to support this kind of association between China's financial sector and the real sector. Furthermore, Toda Yamamoto approach is employed to test the finance growth nexus empirically. The demand-driven hypothesis holds the view that any economic growth will influence financial market which represents causality from growth in the real output of the economy to the growth of stock markets. China's B share markets and the real economy thereby supporting the existence of demand-driven hypothesis, and we deem the main reason behind it is the transaction costs of the stock markets. Last but not least, substitution effect among different stock markets is also investigated and we find a bi-directional causal link within China's A share markets and B share markets respectively. Moreover, Shanghai B share market should get attention by policy makers in the future as it can influence the performance of China's overall A share markets.

References

Atje, R. & Jovanovich, B. (1993), Stock Markets and Development, *European Economic Review,* 37(2-3),632-40.

Arestis, P., Demetriades, P &Luintel, K. (2001), Financial Development and Economic Growth: The Role of Stock Markets, *Journal of Money, Credit & Banking*, 33, 16-41.

Andreou, E., Ghysels, E., (2002) Detecting multiple breaks in financial market volatility dynamics, *Journal of Applied Econometrics*, 17(5), 579-600.

Bekaert, G., Garcia, M. & Harvey, C, R. (1995), The Role of Capital Markets in Economic Growth, *Catalyst Monagraph Series,* Catalyst Institute, Chicago, IL.

Beakaert, G & Harvey, C, R. (1997a), Emerging Market Volatility, *Journal of Financial Economics,* 43(1), 29-78.

Beakaert, G & Harvey, C, R. (1997b),Capital Market Integration, Stock Markets and World Development, *Working Paper*, Stanford University and Duke University.

Bai, J. &Perron, P. (1998), Estimating and Testing Linear Models with Multiple Structural Changes, *Econometrica,* 66(1), 47-78.

Cuche, N, A. & Hess, M, K. (1999), A Monthly Series of Swiss GDP: Business Cycle Indicator and Research Tool, *Working Paper,* University of Lausanne and University of Bern

Comincioli'95, B. (1996), The Stock Market as a Leading Indicator: An Application of Granger Causality, *ThE Park Place Economist,* Vol 4, available at: http://digitalcommons.iwu.edu/parkplace/vol4/iss1/13/

Demirgüç-Kunt , A. & Levine, R. (1996), Stock Market Development and Financial Intermediaries: Stylized Facts, *The World Bank Economic Review,* 10(2), 291-321.

Engel, R, F. & Granger, C, J. (1987), Cointegration and Error Correction: Representation, Estimation and Testing, *Econometrica,* 55(2), 251-276.

Fink, G, Haiss, P &Hristoforova, S. (2006). Credit, Bonds, Stocks and Growth in Seven Large Economies.*EI Working Papers / Europainstitut*, 70, Europainstitut, WU Vienna University of Economics and Business, Vienna.

Friedman, M., Schwartz, A.J. (1963), .*A Monetary History of the United States.Princeton University Press*, Princeton.

Granger, C, W. (1969), Investigatiing Causal Relations by Econometrics Models and Cross-spectral Methods, *Econometrica*, 37(3), 424-438.

Gujarati, D.N (2006),*Essential of Econometrics*, 3rd Edition, McGraw Hill

Hasan, I., Wachtel, P., & Zhou, M. (2009). Institutional development, financial deepening and economic growth: Evidence from China. *Journal of Banking & Finance*, 33(1), 157-170.

Johansen, S. (1991), Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica*, 59(6), 1551–1580.

Johansen, S. (1995), *Likelihood-based Inference in Cointegrated Vector Auto-regressive Models*, Oxford University Press, Inc., New York.

Johansen, S. &Juselius, K. (1990), Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money, *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.

Korajczyk, R, A. (1996), A Measure of Stock Market Integration for Developed and Emerging Markets, *World Bank Economic Review*, World Bank Group, 10(2), 267-89.

Keynes, J, M. (1936), *The General Theory of Employment Interest and Money,* New York: Harcourt Brace.

Levine, R &Zervos, A. (1998), Stock Markets, Banks, and Economic Growth, *American Economic Review*, 88(3), 537-58.

Li, W (2002), *Small and Medium Enterprises: The Source of China's Economic Miracle and their Finance Challenges,* available online at:http://sydney.edu.au/china_studies_centre/china_express/issue_3/features/small-and-medium-enterprises.shtml

Liang, Q., &Teng, J. (2006). Financial development and economic growth: Evidence from China. *China economic review*, 17(4), 395-411.

Lucas, R.E. (1988), On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3-42.

Lee, J. &Strazicich, M, C (2003), Minimum Lagrange Multiplier Unit Root Test with TwoStructural Breaks, *The Review of Economics and Statistics,* 85(4), 1082-1089.

Ling, S., Li, W.K., (1998) Limiting distributions of maximum likelihood estimators for unstable autoregressive moving-average time series with general autoregressive heteroskedastic errors, *Annals of Statistics*, 26(1), 84–125.

Laurenceson, J. & Chiai, J. (2003), *Financial Reform and Economic Development in China*. Cheltenham, UK, Edward Elgar.

McKinnon, R.I., (1973). *Money and Capital in Economic Development*. Brookings Institution, Washington, DC

Nelson, C, R. &Plosserin, C, I. (1982), Trends and Random Walks in Macroeconomic Time Series, *Journal of Monetary Economics*, 10(2), 139-162.

Narayan, P,K, Liu, R &Westerlund, J. (2016), A GARCH model for Testing Market Efficiency, Journal of International Markets, Financial Institutions and Money, in press

Olweny, T, O. &Kimani, D (2011), Stock Market Performance and Economic Growth Empirical Evidence from Kenya using Causality Test Approach, *Advances in Management & Applied Economics,* 1(3), 153-196.

Paramati, S, R & Gupta, R (2011), An Empirical Analysis of Stock Market Performance and Economic Growth: Evidence from India, *International Research Journal of Finance and Economics*, 73, 133-149.

Perron, P. (1989), The Great Crash, the Oil Price Shock and the Unit Root Hypothesiss, *Econometrica,* 57(6), 1361-1401.

Prakash, B, A. (2012), *The Indian Economy since 1991: Economic Reforms and Performance,* 2nd edition, Dorling Kindersley.

Pesaran, M, H. & Shin, Y. (1998), An Autoregressive Distributed-lag Modelling Approach to Cointegration Analysis,*Econometric Society Monographs*, 31, 371-413.

Pesaran, M, H, Shin, Y & Smith, R. (2001), Bounds Testing Approaches to the Analysis of Level Relationship, *Journal of Applied Econometrics*, 16(3), 289-326.

Schumpeter, J.A., (1911),*The Theory of Economic Development*. Harvard Univ. Press, Cambridge, MA

Shaw, E.S., (1973),*Financial Deepening in Economic Development*. Oxford Univ. Press, London

Shanghai Stock Exchange, (2010), *China Capital Market Overview*, available online at:http://english.sse.com.cn/investors/IntroductiontoSSE/C-MarketOverview/

Shanghai Stock Exchange, (2015), *Turnover*, available online at: http://english.sse.com.cn/information/statistics/historical/turnover/

Shenzhen Stock Exchange, (2015), *Fact Book*, available online at: http://www.szse.cn/main/en/MarketStatistics/FactBook/

Schmidt, P & Phillips, P, B, (1992), LM tests for a Unit Root in the Presence of Deterministic Trends, *Oxford Bulletin of Economics and Statistics*, 54(3), 257-287.

Toda, H. & Yamamoto, T. (1995), Statistical Inference in Vector Autoregressions with Possibility Integrated Process, *Journal of Econometrics*, 66(1-2), 225-250.

Tables and Figures

Table 1: **Results for LM unit root test with two structural breaks**

	Break in Intercept			Break in Intercept and Trend		
Index	**Test Statistic**	**TB1**	**TB2**	**Test Statistic**	**TB1**	**TB2**
IP	-4.1031*	Jun-06	Jan-13	-10.9527*	Dec-05	Jan-12
SHA	-3.9797*	Jul-07	Jul-09	-5.4978	Nov-11	Nov-12
SHB	-4.1164*	Feb-02	Jul-09	-4.9936	Apr-01	Mar-07
SZA	-3.4625	Jan-08	Sep-12	-5.2512	Nov-06	Aug-12
SZB	-4.8391*	Feb-01	Dec-05	-5.5369	Apr-01	Feb-07

Critical Values for S_{t-1}									
Model AA (Break in Intercept Only)									
1%	5%	10%							
-4.54	-3.84	-3.50							
Model CC (Break in Intercept and Trend)									
λ_2	0.4			0.6			0.8		
λ_1	1%	5%	10%	1%	5%	10%	1%	5%	10%
0.2	-6.16	-5.59	-5.27	-6.41	-5.74	-5.32	-6.33	-5.71	-5.33
0.4	-	-	-	-6.45	-5.67	-5.31	-6.42	-5.65	-5.32
0.6	-	-	-	-	-	-	-6.32	-5.73	-5.32

Notes: IP, SHA, SHB, SZA, SZB denote Industrial Production, stock amounts of A share outstanding in Shanghai stock market, stock amounts of B share outstanding in Shanghai stock market, stock amounts of A share outstanding in Shenzhen stock market, stock amounts of B share outstanding in Shenzhen stock market respectively. TB1 and TB2 are dates of structural breaks,λ_j denotes the location of breaks. The LM unit root test for model AA is invariant to the location of breaks, however, this invariance does not hold for model CC, for which the null distribution of LM test depends on the relative location of the breaks, * denotes the significance level at 5%.

Table 2: Results for Narayan et al (2016) GARCH unit root test with two structural breaks in the intercept

Index	Test Statistic	TB1	TB2
IP	-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

Notes: The 5% critical value for the unit root test statistics 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 only. * Denotes rejection of null hypothesis of a unit root at 5% significance level.

Table 3: Breusch-Godfrey Serial Correlation LM Test Results

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

Table 4: ARDL Bounds Testing Results

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

Notes: Lower bound and upper bound listed in the table are 5% significance level critical value bounds

Table 5 ARDL Long Run Coefficients

Variable	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: * denotes rejection of the null at 5% percent significance level.

Table 6:Breusch-Godfrey Serial Correlation LM Test Results

Test Statistic		p-value
F-statistic	0.85	0.59
Observed R-squared	10.34	0.41

Table 7: ARDL Restricted Error Correction Model Estimation Results

Variable	Coefficient	Standard Error	t-statistic	Probability
C	-0.206187	0.238481	-0.864584	0.39
D(IP(-1))	-0.635997	0.113319	-5.612442	0.00
D(IP(-2))	-0.351983	0.114841	-3.064971	0.00
D(IP(-3))	-0.164460	0.093347	-1.761818	0.08
D(SHA)	-0.000013	0.000042	-0.301736	0.76
D(SHB)	-0.005082	0.007126	-0.713173	0.48
D(SHB(-1))	-0.005750	0.006815	-0.843705	0.40
D(SHB(-2))	-0.009303	0.006424	-1.448222	0.15
D(SHB(-3))	-0.005462	0.004711	-1.159341	0.25
D(SHB(-4))	-0.001815	0.004923	-0.368626	0.71
D(SHB(-5))	-0.001061	0.004279	-0.247985	0.80
D(SHB(-6))	-0.005413	0.004565	-1.185610	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	-2.102432	0.04

Table 8: Unit Root Results

	China	
	ADF	**KPSS**
Level		
IP	-2.13	0.37*
SHA	-2.58	0.09
SHB	-2.61	0.05
SZA	-2.06	0.10
SZB	-3.15	0.10
First Difference		
D(IP)	-11.14*	0.04
D(SHA)	-11.07*	0.04
D(SHB)	-12.61*	0.04
D(SZA)	-12.19*	0.04
D(SZB)	-11.56*	0.03

Notes: The ADF statistics were generated by a model with constant, trend, 12 lags.The KPSS test uses the automatic bandwidth selection technique of Newey-West using Bartlett kernelin computing the spectrum. * denotes reject the null at 5% significance level.

Table 9: Toda Yamamoto Causality Test Results between Stock Markets and the Real Economy (Short-term Causality Patterns)

China	Test Statistic	p-value
Demand-driven Hypothesis		
IP to SHA	7.47	0.49
IP to SHB	17.01*	0.03
IP to SZA	15.08	0.06
IP to SZB	22.01*	0.00
Supply-leading Hypothesis		
SHA to IP	5.81	0.67
SHB to IP	4.61	0.80
SZA to IP	5.63	0.69
SZB to IP	2.54	0.96

Notes: * denotes rejection of the null hypothesis at 5% significance level

Table 10:Toda Yamamoto Causality Test Results between Stock Markets (Substitution Effect)

China	Test Statistic	p-value
SHA to SHB	47.82*	0.00
SHB to SHA	15.99*	0.04
SHA to SZA	50.21*	0.00
SZA to SHA	25.91*	0.00
SHA to SZB	12.28	0.14
SZB to SHA	12.47	0.13
SHB to SZA	24.27*	0.00
SZA to SHB	21.53*	0.01
SHB to SZB	22.10*	0.00
SZB to SHB	21.06*	0.01
SZA to SZB	9.53	0.30
SZB to SZA	9.31	0.32

Notes: * denotes rejection of the null hypothesis at 5% significance level

Figure 1: ARDL Unrestricted Error Correction Model Stability Cusum Test

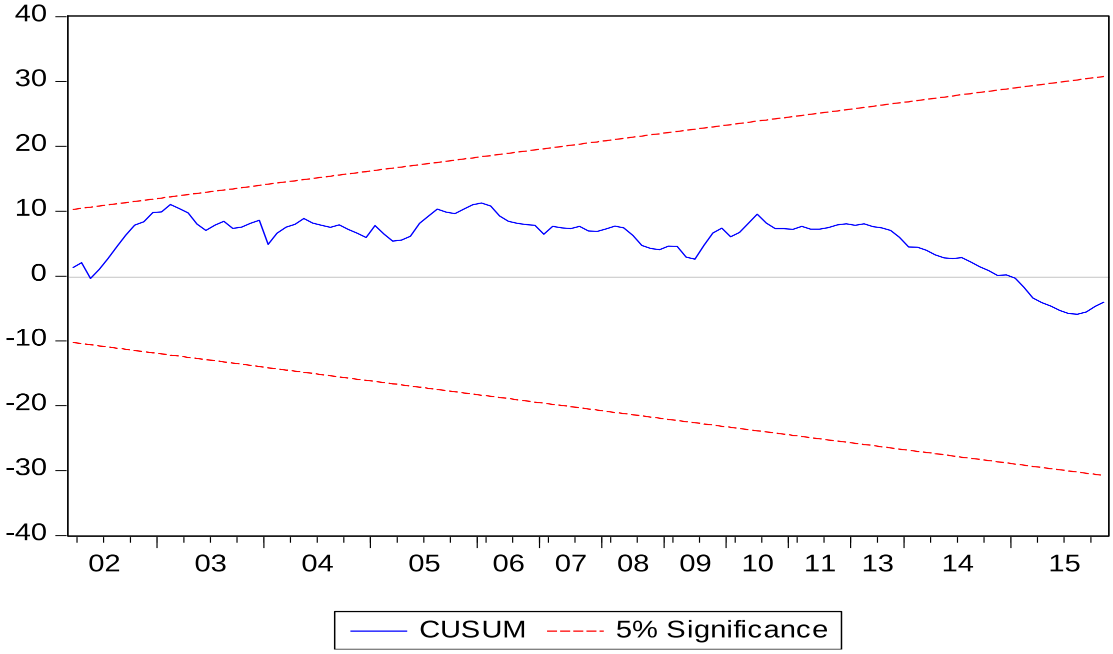

Figure 2ARDL Restricted ECM Stability Cusum Test