China's Financial Market Risk: Macroeconomic Response and Crisis Warning

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Abstract

Financial stress index (FSI), as a financial risk measure, can timely reflect the risk of China's financial market with early warning function and forecasting ability. First of all, referring to the IMF index system, this paper constructs the pressure indicators of China's financial market, and then establishes the impulse response function of VAR (2,2) model with the main macroeconomic variables to analyze the impact of the FSI index on China's macroeconomic. The research conclusion shows that the financial stress index constructed in this paper has a lasting negative impact on China's major macroeconomic variables. At the same time, FSI can objectively and timely reflect the crisis warning of financial risk, and can also well correspond to the real economic and financial events that have happened already.

Keywords: financial market risk, financial stress index, macroeconomic response

1. Introduction

From 2007 to 2009, the global financial crisis not only brought serious economic losses to Europe and the United States, but also caused the intensification of China's financial risk. After financial crisis, Chinese economic development supporting by rapid economic growth in the past has changed significantly. The potential economic growth rate tends to go down and the economy enters "New Normal" period. Faced with a new and more complex economic and financial environment, in order to enhance the ability to identify and prevent financial risk crisis, Chinese government, financial institutions and scholars have been exploring new rules in the financial markets, paying particular attention to the issue of national financial security.

Financial security has been become China's important national strategy. At the 2016 Central Economic Work Conference, efforts were made to prevent and control asset bubbles to ensure that there was no systematic financial risk. Then special attention was given to financial risk management in the Central Government's Work Report also. In April 2017, the Central Political Bureau proposed to take the initiative to adapt to the New Normal economic situation, adhere to the concept of new development and attach great importance to the prevention and control of financial risk. In July 2017, the National Financial Work Conference proposed that the prevention of systematic financial risk should be the eternal theme of financial work, and China would take the initiative to prevent and defuse systematic financial risk in a more important position and scientifically prevent. Therefore, to build a financial risk prevention system, effectively monitor the financial market risk, accurately predict and effectively prevent systematic incidents, is a very important research topic in today's financial security in China.

Based on the previous researches, the innovations of this paper are as follows: First, unlike the previous literature, this paper, based on the framework of financial stress index for emerging market countries released by IMF (2009), combines published financial stress indices and the actual situation of China, we build a risk measure index FSI that is in line with the actual situation of China's financial market, and then we verify that FSI can reflect the real-time risk conditions in China's financial market and correspond to historical events one by one. Second, we use VAR(2,2) model to consider China's financial market risk long-term impact on its macro economy and economic policy uncertainty ,which the other scholars haven't done before. Third, the rolling β coefficient in the banking sector is a very important measure of systematic financial risk, but it has been neglected in the existing literature on China's financial stress index. This paper calculates this indicator and finds

that it can not be ignored in the measurement of financial stress.

This paper is organized as follows. Section 2 summarizes the relevant financial stress index literature. Section 3 shows our China Financial Stress Index (FSI) theory to measure the risk of China's financial market. Section 4 presents the empirical results of FSI and establish impulse response function of VAR (2,2) model with major macroeconomic variables to analyzes the impact of FSI index on China's macro-economy. Section 5 concludes the paper and give policy suggestion.

2. Literature Review

Accurately determine the hidden dangers is the premise of ensuring financial security, we must accurately measure and effectively monitor the financial risk. The main measures of financial risk measurement are diverse. At the micro level, the mainstream indicators include the systematic expected loss value and the systematic risk indicator (named SES and SRISK, Acharya & Robert Engle, 2012), and the delta of the conditional value at risk (Δ CoVar, Adrian & Brunnermeier, 2008). They can measure the marginal contribution of financial institutions to overall financial risk. In addition, there is the Joint Crisis Probability Approach (Segoviano & Goodhart, 2009) which measures systematic risk across banks and portrays the interdependence of interbank risks. At the macro level, the mainstream methods are the composite index method and the early warning method (Frankel & Rose, 1996; Kaminsky, Lizondo, & Reinhart, 1998), which measures financial risk based on balance sheets and market data. This article needs to build a method that can fully reflect the China overall financial market risk and reflect its dynamic financial risk value. Therefore, this paper chooses the composite index method from the macro systematic risk level. The composite index approach is widely used and is especially important for developing countries that lack financial data. This method is feasible，continuity and flexibility. First, the method chooses various indicators related to financial market risk and then weights the indicators according to different weighting.

This paper uses the Financial Stress Index (FSI) to measure the systematic dynamic risk of financial market. It was first proposed by economists Illing and Liu (2003), which is a comprehensive index to estimate the macroeconomic financial pressure, through indicators of the four major financial markets (banking, stock market, bond market and foreign exchange market) measure risk and uncertainty. The IMF World Outlook Report (2008) using Cardarelli, Elekdagand, and Lall (2009), in which seven indicators were selected to measure the financial market risk by measuring the financial stress index of 17 developed countries to capture the corresponding stressful events. Empirical It is found that the financial stress index has a predictive effect on the real economy. Balakrishnan, Danninger, Elekdag, and Tytell (2011) selected five indicators to construct the stress index (EM-FSI) for 25 emerging market countries and used a two-stage model to verify the financial pressures linkage and spillover effects between in emerging market countries and developed countries. This method has been affirmed and adopted by IMF. Hakkio and Keeton (2009) chose 11 indicators to construct the Kansas City Stress Index (KCFSI), and selected more characteristic variables to measure the financial stress in U.S. cities. Subsequently, a large number of foreign literatures widely used the IMF (2008) measurement of financial stress indicators (short for AE-FSI) for developed countries and Balakrishnan (2011) measurement of financial stress indicators (short for EM-FSI) in emerging market countries.

In recent years, Chinese scholars have carried out research on financial stress analysis, most of them are the analysis of single financial market risk and stress testing, and the literature on the overall financial market stress measurement is relatively scarce. Juan Lai and Linjiang Lv (2010) selected four indicators of the four major markets of banks, foreign exchange, bonds and stocks to make preliminary estimates of the financial market pressures and were widely cite by scholars. However, in my opinion, the indicators chosen for the article and the widely used indicator system is quite different. Financial stress index were constructed by Xiaosing Liu and Lei Fang (2012), Shoudong Chen and Yan Wang (2011) and Guihuan Zheng (2014) by selecting from 7 to 10 indicators. In addition to the four major financial markets, they added the changes in insurance claims to measure financial stress in the insurance market. Dilong Xu and Shuanglian Chen (2015) based on the CRITIC weighting Law to build the financial stress index, add the real estate market to the new financial stress index. The literature places more emphasis on the impact of other markets on the risk of China's financial system rather than on financial markets itself, such as adding the real estate market and the insurance market.

However, we consider that the establishment of a financial risk measurement system is more important than in addition to supplement other market risk measures. Different from the traditional credit index, non-performing loan ratio, non-performing loan ratio, the ratio of corporate credit to GDP, etc., most of the traditional literature choose to synthesize the financial systematic risk index. In this paper, we consider these indicators are all indicators of the lag of the economic cycle. But our FSI can represent forward-looking investors' anticipation of

the future economic situation. Such a market-oriented index has the expected effect on the future financial market risk.

3. China's Financial Stress Index Theory

In general, financial stress is thought to interrupt the normal functioning of the financial markets. Specifically, any financial stress events are different, but we believe that every financial stress event can be identified by some important market indicators. The common signal of financial stress is an increase in the fundamental value of financial assets such as volatility in stock prices and interest rates. These changes in uncertainty often turn into the volatility of financial asset prices. To some extent, the increase in the uncertainty of asset prices in financial markets reflects the surge of uncertainty and financial risks in some sectors or in the economy as a whole.

Therefore, the FSI index constructed in this paper is forward-looking, real-time high-frequency data in the market. It covers the financial markets such as stock market, bond market, foreign exchange market and banking institutions, and can measure the changes in the financial market risk in China from the market level. At the same time, it is also very suitable for analyzing countries with many financial markets and financial institutions to measure financial risks and reflect them in time.

FSI is designed for zero, positive and negative values. Zero value means that the financial system is under average stress and the financial system is not under pressure. Positive values mean that the financial stress is above average. At this moment, the higher the FSI, the greater the pressure on the financial system and the greater the financial risk. The negative value means the financial pressure is lower than average level, the lower FSI at this time, the better the financial system, the less financial risk.

Scientific measurement of financial market risk, the choice of indicators of the system is very important. The core of the index system in this paper is the IMF Emerging Market stress Index System. We have made some specific calculations on the absence of important data on China financial markets, such as the rolling beta coefficient in the banking sector. For some selected indicators of the original data, we also make reference to the IMF's developed countries' stress index system and the financial stress index system released by other major banks, such as the St Louis Federal Financial Stress Index, with corresponding adjustments and additions. The carefully chosen indicators for this paper are the rolling beta coefficient in the banking sector, the banking Ted spread, the term spread, the stock return, the volatility in the time-varying stock index, the sovereign bond spread, the devalued variables in currencies, and foreign exchange reserves 8 Indicators, as described below.

3.1 Banking Stress Indicators

The traditional banking financial stress index mainly consists of beta coefficient, and the index system of this article is supplemented accordingly, as follows.

(1) Banking sector rolling β coefficient. It is estimated by the asset pricing model. Select the bank's monthly rate of return and market monthly return using a 12-month rolling window to measure the beta factor. If $\beta> 1$ indicates that the banking industry is more volatile than the market risk, the financial stress on the banking industry is stronger. To better capture the systemic risk in the banking industry, we set 1 as the threshold and $\beta-1> 0$ as the banking stress. For $\beta-1 <0$, the stress will be zero.

(2) Banking Ted spread. The 3-month interbank offered rate minus the risk-free rate reflects the bank's liquidity position. The increase in the bank's Ted spread shows that banks are facing inadequate capital flows, lack of liquidity and aggravating banking risks.

(3) Negative term spread. The term spread is the slope factor for treasury yields, which is generally determined by the difference between long-term government bond yields (10 years) and short-term government bond yields (3 months). As banks typically convert short-term deposits into long-term loans, the bigger the spread is, the easier to earn profit for banks. Conversely, negative term spread measures the extent to which bank earnings are compromised, and the greater the value, the greater the stress on banks.

3.2 Stock Market Stress Indicators

(1) Negative stock return

The stock return is selected the monthly returns of the Shanghai Composite Index. It has a negative correlation with the stock market stress index. The smaller the stock market returns, the greater the risk of the stock market, the higher the financial stress, and vice versa.

(2) Time-varying stock index return volatility H_t

This indicator is the authors through the stock index yield GARCH (1,1) model to measure the dynamic volatility.

The greater H_t, the greater risk of investing in stocks and the greater the financial stress on the stock market and vice versa.

(3) Sovereign bond spread (SDS)

It refers to the difference between the yield on China's 10-year bond and the yield on the United States 10-year bond. The larger the SDS, the higher the cost of capital in China than in the United States, the greater the financial stress on the securities market , and vice versa.

3.3 Foreign Exchange Market Stress Indicators

The foreign exchange market pressure index, abbreviated as EMPI, is composed of the devaluation variables of currency and the changes of foreign exchange reserves. The greater the devaluation of the currency, the greater the pressure on the foreign exchange market. The more foreign exchange reserves increase, the less pressure on the foreign exchange market will be. Therefore, the financial stress index of the foreign exchange market in t is defined as follows:

$$FSI_{FX,t} = \frac{(\Delta e_t - \mu_{\Delta e})}{\sigma_{\Delta e}} - \frac{(\Delta RES_t - \mu_{\Delta RES})}{\sigma_{\Delta RES}} \tag{1}$$

Among them, $\Delta\varepsilon_t$ is the exchange rate change on the t-month, ΔRES_t refers to the t-month total national reserves minus the change in the amount of gold reserves, $\mu_{\Delta e}$ and $\mu_{\Delta RES}$ are the mean of respective sequences. $\sigma_{\Delta e}$ and $\sigma_{\Delta RES}$ are the standard deviations of the respective sequences.

The weight of FSI construction in this paper is based on the IMF construction method ---- equal weighted method. This method assumes that the variables follow a normal distribution by subtracting the mean and dividing by the standard deviation, and then taking the normalized variables by the same weight and then summed(the subject variables below represent the normalization of the corresponding variables). This article refers to the IMF take the weight as 1, the financial total stress index and the three major financial market sub-stress index formulas are as follows:

$$FSI_{Total} = FSI_{Bank} + FSI_{Security} + FSI_{FX} \tag{2}$$

$$FSI_{Bank} = \beta_{std} + BankTed_{std} + TermSpreads_{std} \tag{3}$$

$$FSI_{Security} = Ret_{std} + ht_{std} + SDS_{std} \tag{4}$$

$$FSI_{FX} = \frac{(\Delta e_t - \mu_{\Delta e})}{\sigma_{\Delta e}} - \frac{(\Delta RES_t - \mu_{\Delta RES})}{\sigma_{\Delta RES}} \tag{5}$$

According to the identification of the stress period of China's financial market, this paper uses a statistically more scientific method of identification, that is, when the financial stress index minus the average of the historical period of the series , then divided by twice the standard deviation. The smaller the value indicates that the lower probability of occurrence of financial crisis. If the value is greater than zero, it indicates that this period is in a dangerous financial crisis period. In this paper, the recognition index FSI^* of the stress period is below:

$$FSI^* = \frac{FSI - \mu_{FSI}}{2\sigma_{FSI}} - 1 \tag{6}$$

4. China's FSI Empirical Results

4.1 China's FSI Indicators Data Sources and Pretreatment

Constructing FSI selecting monthly data can reflect the financial market stress in time. This article selects monthly data from January 2007 to December 2016. The main data sources for this article are: Datastream, Resset, Wind and CSMAR. In addition, the rolling β coefficient and the time-varying stock index volatility (h_t) in the banking sector are respectively estimated by the authors' establishment of the CAPM model and the GARCH (1,1) model.

4.2 The Response of China's FSI on Macroeconomic and Crisis Warning

4.2.1 China's Financial Market Risk of Macroeconomic Response

In July 2007, the financial market in the United States was affected by the default of subprime loans. The subprime mortgage crisis broke out in an all-round way. The storm spread rapidly and infect to the whole world, causing the global financial crisis for nearly three years. After the crisis, the global financial market has entered a recovery period, and financial market risk in China has also shown some new characteristics. This paper builds the financial market stress index and sub-market stress index. In terms of FSI constructed by this paper, overall, China's financial market risk has been relatively stable, most of which fluctuate in the [-5,5] region and show a periodical character. The value of FSI is divided into negative stress fluctuation period, zero stress duration and positive stress fluctuation period, a total of three phases: negative stress fluctuation period - January 2007 ~

October 2007 and January 2009 ~ December 2010; zero stress duration - January 2011 ~ June 2014; positive stress fluctuation period - November 2007 ~ December 2008 and July 2014 ~ December 2016.

This paper establishes bivariate VAR (2,2) models between FSI and other macroeconomic variables, and analyzes the corresponding impulse response function. Think about how the uncertainties in China's macroeconomic and economic policies will change as the FSI increases by one unit positive shock? The macroeconomic variables selected in this paper are: GDP growth rate, CPI, interest rate, investment, national housing climate index, macroeconomic prosperity index and economic policy uncertainty index (Note 1). The empirical results show that for every unit positive shock of the FSI, it will have a lasting negative impact on GDP growth rate, CPI, interest rate, investment, national housing climate index and macroeconomic prosperity index. And most macroeconomic indicators won't be reduced immediately by the innovation of the FSI, they tend to be subject to a significant negative response after 1 or 2 months. Therefore, we believe that FSI established in this paper can predict the future change of China's macro-economy.
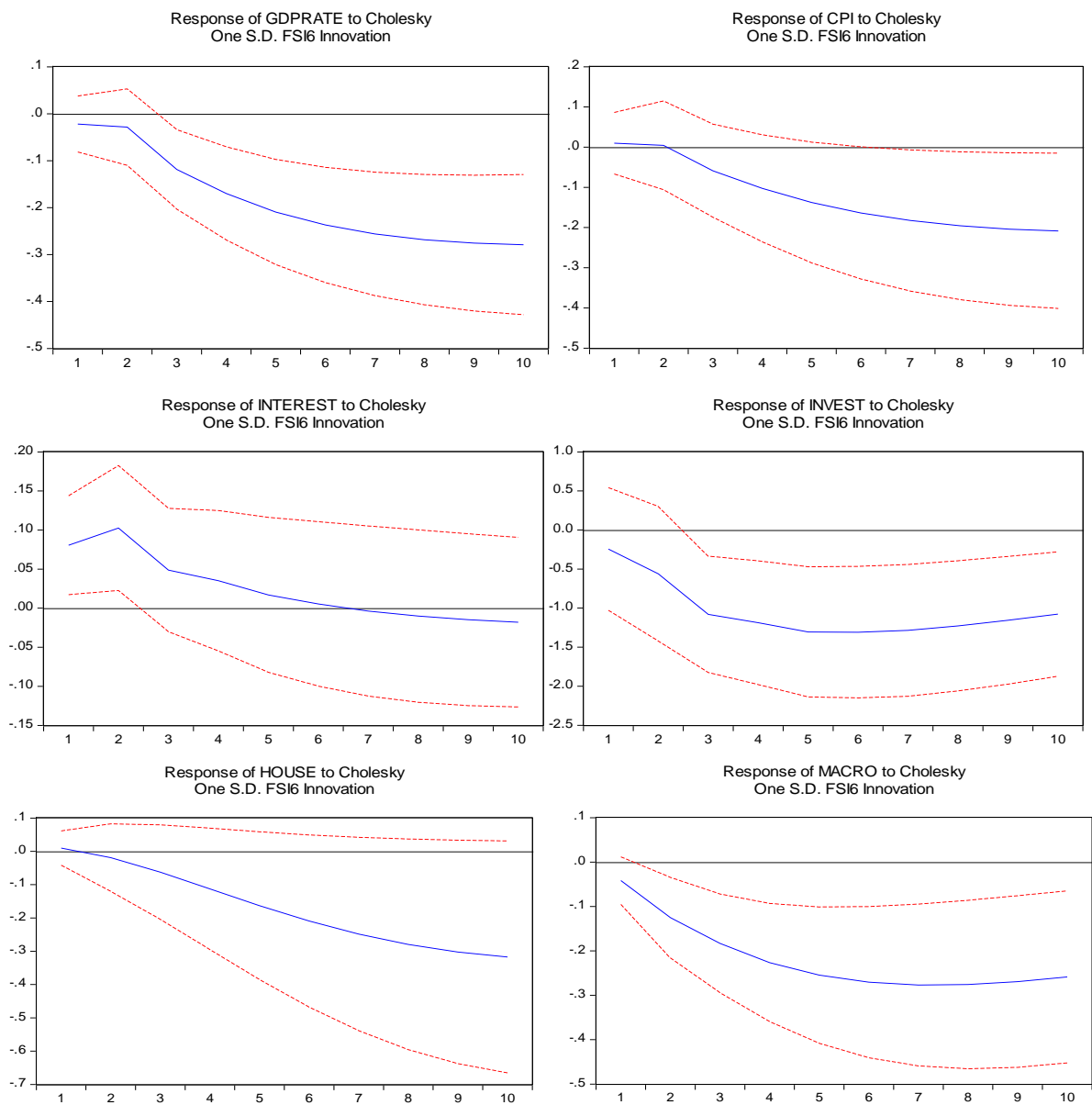

Figure 1. The response of China's macroeconomic variables to FSI innovation

Note. This figure shows the impulse response function obtained by establishing the bivariate VAR (2,2) models with FSI and GDP growth rate, CPI, interest rate, investment, national housing climate index, macro economy sentiment index and economic policy uncertainty index respectively. They describe the response of the positive innovation of the endogenous variable FSI on other macroeconomic variables, respectively.

4.2.2 China's Financial Market Crisis Warning

The financial stress index can measure real-time financial market risk and measure the absolute value of the financial market risk at a particular moment. However, the index can't directly judge whether the financial market risk is in a dangerous period or not and lacks a definite warning function. The financial market risk warning is based on the financial stress index to measure the relative risk value (FSI*), which is compared with the warning value (zero value) to determine the current level of financial market risk. When FSI* > 0, it indicates that the financial market risk touches the warning line, and the financial market is judged to be in a dangerous warning period at this moment. The higher the stress identification index value, the higher the risk of the financial market. On the contrary, when FSI* < 0, the financial market risk is stable, the lower the value, the lower the risk of the financial market. Judging from financial stress identification index that have been constructed, the financial market risk in China hadn't touched the warning line during most of the period and the financial risk were stable. Financial market risk hit the warning line statistics are as follows:

Table 2. China's financial market crisis warning   unit: times

	Overall financial market	Bank institutions	Security market	Foreign exchange market
Global financial crisis	1	0	4	1
New Normal period	3	3	1	5
Others	0	3	0	0
Total	4	6	5	6

Note. This table is derived from the financial stress identification index (FSI*). Among them, the period of the global financial crisis refers to January 2007 to December 2009; the New Normal period refers to May 2014 to December 2016; the others refer to January 2010 to April 2014.
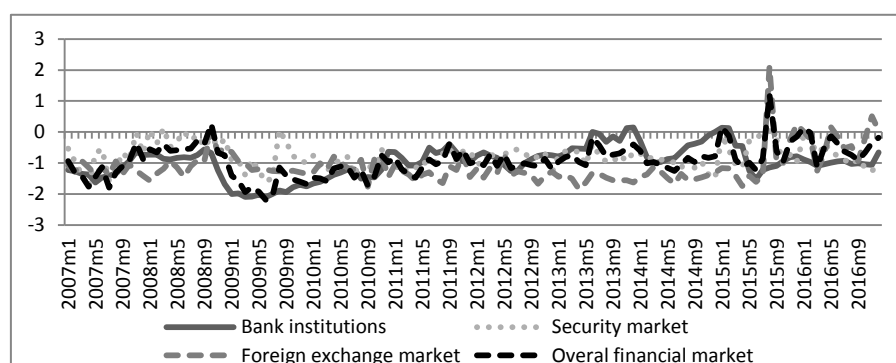

Figure 2. Financial stress identification index of Post-World Financial Crisis

Note. This table consists of the financial stress index minus the historical average of the series divided by two times the standard deviation. The smaller the value is, the probability of financial market crisis is smaller. If the value is greater than zero, then said the financial markets during this period is in danger of financial risk period.

In summary, from the historical data of the financial market stress index and the identification index, the time points and corresponding financial events that may cause the risk of the financial market in China to surge significantly or reach the warning line are as follows: (1) From mid-2007 to early-2009, the global financial crisis. The turmoil in the international financial market and bear the brunt of China's securities market; (2) From June to December 2013, the China's banking institutions suffered from the "cash shortage" crisis; (3) From 2015 to 2016, China's economic development turned into the New Normal period. The banking sectors experienced soaring non-performing loan ratio; the foreign exchange market experienced "8.11" exchange reform and the RMB experienced gradual and sustained devaluation; the stock market soared and plummeted, stock price volatility soared.

5. Conclusions and Policy Recommendations

Since the global financial crisis in 2008, major changes have taken place in the domestic and foreign environments facing China's economic development. At the international level, at the stage of new economic development, the world economy shows notable features: slow growth of aggregate demand and profound readjustment of the economic structure. The global economic pattern has undergone profound adjustments and the external demand has shrunk normally. From China perspective, reviewing the three decades of rapid growth

in China and relying on the strong external demand brought about by the vast world market are important elements in creating China's economic miracle. But now, the external environment that supports China's rapid economic growth no longer exists. In fact, from 2010 to 2016, China's economic growth has been falling for seven consecutive years and the economy has entered New Normal. Under the new financial environment, China's economic growth in the next 10 years will enter the shift period and shift from a high speed to a mid-to-high-speed stage. This is an inevitable trend China during the new historical stage of development. The fact of the transition of financial market risk can't be neglected. This paper shows that:

At present, China's overall financial market risk is accumulating, and China's financial market risk hit the warning line many times, especially in "New Normal" period. From the analysis of this paper, we can see that the risk of China's financial market will have a long-term negative impact on the macro-economy.

Based on the conclusion of this paper, we put forward policy suggestions from the two perspectives of establishing the early warning mechanism of financial market risk and improving the macro-prudential framework of financial regulation:

First, establish an early warning index for financial market and dynamically monitor financial market risks. China's entry into the New Normal is a major strategic decision based on the international external environment, the long cycle of the world economy and the characteristics of the stage of development of China. Judging from the accumulation and resolution of financial risk, along with the economic growth reduction in China, all kinds of hidden risks have gradually become explicit. Fully understanding the characteristics and causes of the financial market risk under the New Normal can help us to clarify the thinking of risk prevention and control, and to tie in the bottom line of preventing systemic risks. This paper argues that the risk of China's financial market can be dynamically and timely reflected by the financial stress index (FSI). Some developed countries such as this early warning indicator already have a mature system and are released in time. It is very necessary for China's financial market to start a relatively late stage and yet to reach a mature stage. It is necessary to gradually improve the measurement and early warning mechanism for financial market risk. We should learn from experience in mature market economies.

Second, deepen the reform of financial supervision and improve the macro-prudential supervision mechanism for financial market risk. With the rapid development, financial market, as an important platform for financial risk management, needs to be focused and regulated. However, the current financial supervision system focuses more on the risk of individual financial institutions, lacks the macro-prudential regulatory concept of taking financial market as a whole, ignores the interdependencies among financial markets, cross-market risk spillover, and the impact of macroeconomic conditions on the financial market impact and other major factors that may trigger a sudden increase in financial risk. In times of changing financial market risk, a single regulatory system will underestimate the risk of financial market and neglect the root causes of the financial turmoil in the market at the present stage, which may eventually lead to further amplification and proliferation of individual and local risks and eventually evolve into a global and systematic problem. In the post-crisis era, we should re-examine the old financial regulatory system, establish new regulatory concepts, strengthen macro-prudential supervision in financial market, effectively monitor the dynamic changes in China's financial risk, accurately predict and effectively prevent systemic incidents .

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Note

Note 1. China economic policy uncertainty index: to measure economic policy uncertainty for China, economists construct a scaled frequency count of articles about policy-related economic uncertainty in the South China Morning Post (SCMP), Hong Kong's leading English-language newspaper. We download data from website http://www.policyuncertainty.com/