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A New Framework for Measuring Global-Flow-of-Funds : Financial Stability in China[#]

Nan ZHANG[*]

Summary

In this paper we aim to build a statistical monitoring system for measuring global-flow-of-funds using concepts and theoretical frameworks of global-flow-of-funds. Firstly, we inspect the influence of global-flow-of-funds and the continual growth of macro economy on the stability of financial systems, and build a statistical monitoring system for global-flow-of-funds while referring to the Financial Soundness indicator (FSIs) frameworks of International Monetary Funds. Secondly, we dynamically link real economics with financial economics, and combine domestic flow of funds with international capital flows, to build a composite index (CI) that reflects the risks involved in external flow of funds. Thirdly, we create a Chinese finance stress index that corresponds well with the current status of Chinese external flow of funds. Fourthly, we expand the empirical analysis based on above statistical methods, and bring up future issues for discussions.

Key Words

Statistical framework, Financial Soundness Indicator, Composite Index, Finance Stress Index

1. Introduction

Treasury International Capital provided by the U.S. Department of the Treasury brought Chinese flow of funds to the world's attention by indicating that as of March, 2011 China holds almost 1.15 trillion U.S. dollars worth of U.S. Treasury bonds. At the end of 2006, the Chinese foreign exchange reserves reached 1.07 trillion U.S. dollars, the largest in the world. Then by March 2011, the Chinese foreign exchange reserves rapidly increased to 3.04 trillion U.S. dollars. As U.S. dollar depreciation continues, the risks accompanying the massive Chinese foreign exchange reserves hang like the Sword of Damocles. Reality asks that we objectively observe the direction of Chinese external flow of funds, assess the risks in possessing massive foreign exchange reserves for the development of the Chinese economy, and contemplate ways to deal with the China-U.S. mirror-image in the scope of international flow of funds.

There are different explanations for the causes of imbalance that exists in the China-U.S. economy, but they all share one common viewpoint. That is, governments should strengthen their supervision on international flow of funds to prevent future financial crises. China joined the International Monetary Fund (IMF) in December 1996, and by agreeing to the IMF's Article VIII－General Obligation of

* Faculty of Economic Sciences, Hiroshima Shudo University

Members, has realized the liberation of its current accounts. However, the Chinese government has not fully opened its capital financial market, and liberation is limited to only part of the capital accounts. As the Chinese economy becomes more influential in the world's economy, China's external flow of funds become increasingly integrated into global-flow-of-funds. Therefore, an inevitable task for the Chinese economy is to supervise and operate its capital accounts to internationalize the Chinese finance. A statistical monitoring system to establish financial stability is imperative to accomplish this task. Based on the suggestions from IMF, People's Bank of China published the *China Financial Stability Report* in 2005 for the first time, and which continues to today. Meanwhile, IMF has published Financial Soundness Indicator (FSIs) in 2006 and also the *Global Financial Stability Report* to reflect on world financial stability. In addition, IMF has strengthened their research on the Early Warning System (EWS) for future financial crises.

FSIs take advantage of three basic computational frameworks: SNA system, international accounting standards, and Basel Committee on Banking Supervision, to build 12 core indices and 27 encouraged indices to reflect financial stability. However due to differing analytical goals, there are two shortcomings in FSIs for it to reflect financial structural problems and to assess financial risks. First, since FSIs focus on the sum of sectors, it cannot provide statistical bases for the argument that economic structural changes affect financial stability. Secondly, FSIs focus on financial stability, but lacks feedbacks on financial risks caused by real economics as well as factors from overseas.

The aim of this paper is to build a statistical monitoring system for global-flow-of-funds using concepts and theoretical frameworks of global-flow-of-funds. First, inspect the influence of global-flow-of-funds and the continual growth of macro economy on the stability of financial systems, and analyze FSIs frameworks as well as Treasury International Capital. Secondly, build a statistical monitoring system for global-flow-of-funds from a theoretical framework of international flow of funds. Thirdly, dynamically link real economics with financial economics, and combine domestic flow of funds with international capital flows. Then build 1) a composite index (CI) that reflects the risks involved in external flow of funds and 2) a Chinese finance stress index to focus on the current status of Chinese external flow of funds. Fourthly, based on the above statistical methods, expand the empirical analysis, and brings up future discussions.

2. About *the Financial Stability Statistics Guide*

One of the lessons learned from the 1997 Asian financial crisis is the lack of statistical information for monitoring financial risks. Aiming to build a global financial stability statistics reporting system, the Statistics Department at IMF organized a conference of statisticians in related fields in 1999, which was the start of FSIs. In 2000, the Statistics Department at IMF conducted statistical surveys on financial stability among participating countries. Based on the surveys, IMF Executive Board introduced the FSIs statistical system in 2001. In the following years 2002 to 2004, IMF drafted *the Guide*, which is a guidebook for establishing and promoting the FSIs system. After careful consideration and soliciting views on its draft, IMF published *the Guide* on its website in July 2004 and as an official document in March 2006. Starting

July 2009, FSIs data have been sent to 62 engaging countries through IMF's database for use. IMF encourages its participating members to establish FSIs, to allow comparison of FSIs data among themselves and to strengthen its supervision on individual countries and the international financial system.

The goals in establishing FSIs are the final assessment and supervision of the strength and vulnerability of financial systems. Borrowing from the basic computational frameworks of SNA system, International Accounting Standard (IAS), and Banking Supervision Guide (Basel Committee on Banking Supervision), FSIs share commonality with the above three in sector classification, but at the same time differ significantly in three ways due to different analytical goals. One is that their treatment of sector information is different from the interest of commercial accounting and banking supervision approached in individual entities, but the FSIs framework, like the SNA system, focuses on aggregated sector information. Second is the difference in statistical range of focus. SNA system focuses on the entire macro economy, it embrace symmetric recording of flows and positions within and across sectors, but commercial accounting and supervisory approaches do not (because of the focus on the individual entity). The FSIs framework favors a symmetric recording of flows and positions within the sector, to avoid distortions in the sector data, but not necessarily among sectors, because the type of data required differs by sector. Third is the difference in observational targets. SNA targets include all economic activities, whereas the FSIs framework, adopt "summation" and "merger" to avoid the double counting of capital and activity, which resembles frameworks in commercial accounting and banking supervision[1)].

Table 1 contains 12 core and 27 encouraged sets in FSI. Core sets are applicable to all countries, and encouraged sets can be adopted according to each country's needs. Core sets cover capital adequacy, asset quality, earnings and profitability, liquidity and sensitivity to market risk. Encouraged sets cover deposit takers, other financial corporations, nonfinancial corporation sector, and four sectors in households, as well as market liquidity and real estate markets which are very influential to financial stability. Further, as rapid development in information technology and new financial products takes place, international capital flow is seeing intensive change in magnitude and speed. As a result, monitoring the financial system pressure and volatility of international capital circulation becomes more important, serving a vital role as a regulator in capital management in FSIs.

FSIs cover several aspects in financial stability. In a financial system, capital strength is an important factor for every organization, especially as a "buffer" for any unexpected losses. In monitoring financial stability, we should also consider other asset structure, quality, and exposure to financial risks. Income and expenditure information are also crucial. If an entity cannot produce enough income, it is never financially secure and stable. For non-financial corporations, the focal point is their ability to pay their liabilities and to finance debt. In short, financial stability index aims to monitor changes in savings (exposure to risks) and flow, because they are able to reflect changes in vulnerability in financial sectors and to help assess financial sectors' ability to handle stress and risks.

Table 1 Financial Soundness Indicators: The Core and Encouraged Sets

Core Set

Deposit takers	
Capital adequacy	Regulatory capital to risk-weighted assets
	Regulatory Tier 1 capital to risk-weighted assets
	Nonperforming loans net of provisions to capital
Asset quality	Nonperforming loans to total gross loans
	Sectoral distribution of loans to total loans
Earnings and profitability	Return on assets
	Return on equity
	Interest margin to gross income
	Noninterest expenses to gross income
Liquidity	Liquid assets to total assets (liquid asset ratio)
	Liquid assets to short-term liabilities
Sensitivity to market risk	Net open position in foreign exchange to capital

Encouraged Set

Deposit takers	Capital to assets
	Large exposures to capital
	Geographical distribution of loans to total loans
	Gross asset position in financial derivatives to capital
	Gross liability position in financial derivatives to capital
	Trading income to total income
	Personnel expenses to noninterest expenses
	Spread between reference lending and deposit rates
	Spread between highest and lowest interbank rate
	Customer deposits to total (non-interbank) loans
	Foreign-currency-denominated loans to total loans
	Foreign-currency-denominated liabilities to total liabilities
	Net open position in equities to capital
Other financial corporations	Assets to total financial system assets
	Assets to gross domestic product (GDP)
Nonfinancial corporations sector	Total debt to equity
	Return on equity
	Earnings to interest and principal expenses
	Net foreign exchange exposure to equity
	Number of applications for protection from creditors
Households	Household debt to GDP
	Household debt service and principal payments to income
Market liquidity	Average bid-ask spread in the securities market
	Average daily turnover ratio in the securities market
Real estate markets	Real estate prices
	Residential real estate loans to total loans
	Commercial real estate loans to total loans

Source: IMF, Financial Soundness Indicators Compilation Guide, March 2006

3. New frameworks for global-flow-of-funds statistics (GFFS)

GFF relate to domestic flows and international capital flows. The analysis of GFF shows the characteristics and the structure in the flows of fund, includes the flows of all domestic funds with investment-savings, links flow of funds with current balance, and connects international capital flows.

3.1 The Mechanism of Global - Flow - of-Funds

The financial markets indicate the debts and credits of funds as a whole in addition to the total process of financial liquidity. Investigated more carefully, items of financial markets include inflows of domestic funds, overseas funds by domestic savings, and credit loans of banks on the side of fund-sources (funds inflow). On the other hand, the financial markets split into supply of funds to the domestic economy and overseas sector as fund-uses (funds outflow).

Figure 1 is a figure showing the mechanism of global-flow-of-funds among three countries: A, B and C; an international financial market; and an international organization. The economy of three countries consists of the balance of savings-investment which reflects real economy activity, and the financial market which indicates the financial circulation of funds. As a balance between domestic economy and overseas sector in each country, real economy (savings-investment balance) serves as a current balance, and the fund loan balance in the financial market serves as the capital balance from an international viewpoint. The current transaction and capital transaction of each country are connected internationally, and a part of capital transaction links to an international financial market, IMF, the World Bank, etc., that are formed by fund-rings in the global-flow-of-funds.

On Figure 1, the excess savings corresponding to current balance surplus occur in the country of capital supplier (in country A), causing financial assets to see net increase in financial sector. Financial market receives inflow of the funds from domestic and overseas sector, and supplies funds to the two sectors simultaneously. In the fund loan balance of country A financial market, the net inflow of funds corresponds to excess savings balance in the domes-

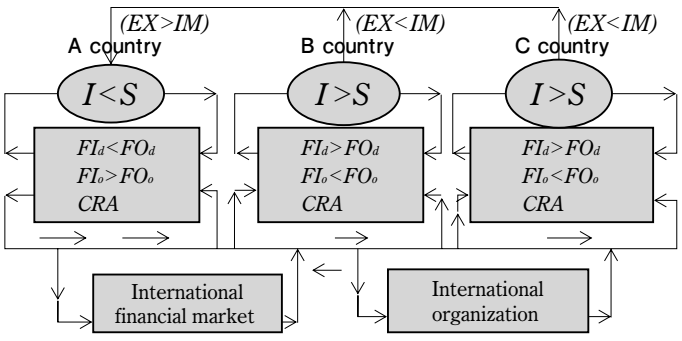

Figure 1 the Mechanism of Global-Flow-of-Funds

Notes : FI_d : domestic inflow of funds, FI_o : overseas inflow of funds
FO_d : domestic outflow of funds, FO_o : overseas outflow of funds
CRA : Changes in Reserve Assets

tic sector, and the net outflow of funds (including the change in foreign exchange reserves) corresponds to the current account surplus in the overseas sector. That is, the net increase of the financial assets which offsets the excess of domestic savings is balanced with the net inflow of funds from the domestic sector in the financial market. And the external claimable assets formed corresponding to the current balance surplus becomes the net outflow of the funds from financial market as supply of overseas lending.

On the other hand, in a capital importer such as country B or C, the current balance deficit is linked with the domestic excess of investment (savings deficit) and the net increase of the financial liability in the financial sector. In the financial market, there is an excess of credit with the domestic excess of investment, and current account deficit is financed by the net inflow of funds (capital balance surplus) from overseas. Therefore, on the funds account balance with the sectors of the domestic-and-overseas in the financial market of country B and C, it becomes a net outflow of funds with the domestic sector, and the net inflow of funds with the overseas sector. The net inflow of funds from the overseas sector becomes a source of funds for the domestic sector that attempts to keep a balance of credit. Moreover, the net outflow of funds into the domestic sector in the financial market will serve as over-borrowing for the domestic sector, also known as the net increase of financial liability.

In this way, an international capital movement from a surplus country of current balance to a deficit country arises. The flow of capital goes directly between two nations: from a surplus country to a deficit country, or, also arises in many countries via the international financial market, IMF, the World Bank, etc. indirectly. These international funds will be managed by an agency of an intergovernmental public base or part of the World Bank, although most of them arise by factors such as the pursuit of interest differential or capital gain and risk aversion through a market mechanism. Anyway, international capital movement will be financed with the balance on current account from the standpoint of Balance of Payment in each country, and will perform the function of international financial intermediation from an excess-savings country to a deficit-savings (excess-investment) country from a global standpoint. Moreover, when a capital supplier country is a key-currency country (like the U.S.), this country has achieved the function which supplies international liquidity. Thoroughly observing the flow of funds, the mobility (international liquidity and domestic money supply) is an integrated system in global-flow-of-funds which connect major power economies, because the flow of funds between countries are connected with domestic flow of funds as an integrated whole in each of the relevant countries.

3.2 New Framework for Global-Flow-of-Funds Statistics

When the flow of funds in financial markets is tied up with the balance of payments, the overseas sector will have fund outflow excess (net capital outflows) if the current account is in surplus. Conversely, the domestic sector will have fund inflow excess. Therefore, when the real economic side of the domestic and overseas economy is analyzed under an open economic system, the balance of savings-investment of the domestic economy corresponds to the current account balance. According to the dynamic process of external flow of funds and the defini-

tional equation of a system of national account, the accounting identity becomes as follows,

$$Y = C + I + G + EX - IM$$

Equilibrium condition is obtained through arranging the above formula.

$$S - I = EM - IM$$

The right side of equilibrium condition is the current account, and the left side of equilibrium condition is the balance of savings-investment, or net financial investment. Hence, equilibrium condition equations are reached as follows.

$$S - I = EX - IM = NFI$$

However, domestic net funds outflow correspond with the capital account balance when we examine the financial relationship between domestic and overseas. Therefore, relationships among the domestic savings-investment balance, the financial surplus or deficit, the current account, and the overseas net fund outflow will be expressed in the following structural formulae.

Savings-Investment and Current Account Balance

$$S - I = \Delta FA - \Delta FL = EX - IM \quad (1)$$

Overseas Income and Expenditures Balance

$$EX - IM = (FO - FI) + CRA \quad (2)$$

Regard $r_{t-1}FI_{t-1}$ as interest payment of external debt, and put $CRA = FRA_t - FRA_{t-1}$, (2) changes to (3)

$$(EX_t - IM_t) + (FI_t - FO_t) + (r_{t-1}FI_{t-1}) + (FRA_t - FRA_{t-1}) = 0 \quad (3)$$

GFF crisis can be shown as follows when FRA minimum received was set to FRA'

$$(EX_t - IM_t) + (FI_t - FO_t) + (r_{t-1}FI_{t-1}) + FRA_{t-1} < FRA' \quad (4)$$

Where S : gross savings,
I : gross investments,
ΔFA : change in financial assets,
ΔFL : change in financial liabilities,
EX : exports, IM : imports,
FO : fund outflow, FI : fund inflow,
FRA : foreign reserves asset

Formula (1) shows the relationship among the savings-investment and domestic fund flows and current account. When $S > I$, $\Delta FA > \Delta FL$ is capital surplus, $CA > 0$, and mean current account is a surplus $(EM > IM)$. On the other hand, when $S < I$ and $\Delta FA < \Delta FL$, there exists financial deficit in the flow of funds with $CA < 0$, and mean current account is deficit $(EM < IM)$. It is clear that global flow of funds and international flow of goods behave like the head and tail of a coin formula (2).

When current account is in surplus, capital account can be in deficit ($FO > FI$, net outflow of funds). Or an increase in foreign reserves can cause a country's external claim to increase. Otherwise, when domestic investment is larger than domestic savings, current account is in deficit, and external debt can only increase through inflow of funds ($FO < FI$, capital balance is in surplus), or decreasing foreign reserves as a compensation for the current account deficit. By changing formula (2), we see constitutes of foreign reserves which show that the simultaneous existence of current balance and capital balance surplus will increase foreign reserves. In other words, when current balance is in surplus, net outflows should also be in surplus, or foreign reserves will increase. As a result, foreign reserves increase rapidly, which leads to a systematic problem in external flow of funds. Based on formula (2), main factors that affect the change in foreign reserves are current balance and capital balance. Since the change in current balance is due to the balance of savings-investment, change in foreign reserves actually depends on the change in the structure of flow of funds.

Formula 4 shows several possibilities for cri-

sis to take place in international flow of funds. One is when current account deficit is too large ($IM > EM$) for pre-foreign exchange reserves to handle. Second comes from changes in stock market returns, market interest rates, and foreign exchange rates, which cause short-term capital outflow to be dramatically larger than international capital inflow. In this case, a shortage in foreign exchange reserve for handling domestic capital needs may trigger a currency crisis. Third is crisis in external debt payments due to current account deficit and capital account deficit. The fourth case is when exchange rates rapidly fluctuate, causing currency to go through significant appreciation or depreciation and eventually leading to systematic crises in current account, capital account, external debt payments, and so on.

In order to test financial stress and make early warnings for systematic financial crisis through GFF, we need a new statistical framework that corresponds to the operational structure of GFF, which becomes the foundation of a statistical monitoring system. This statistical framework must reflect dynamic changes in economic entities and financial statistics, and also link domestic flow of funds with international capital movement. Four aspects of external flow of funds should be monitored: 1) indicate any influence on current accounts from changes in economic structure which causes savings-investment imbalances, 2) indicate risks in international capital flow caused by surplus or deficit of domestic funds, 3) indicate shocks to international capital flow caused by imbalance in current accounts, and by international large-scale capital inflows or outflows, 4) indicate causes of changes in foreign exchange reserves and pressure of financial stability from rapid changes in foreign exchange reserves.

3.3 Selection of Indexes for Monitoring System for GFF

In building the computational rules for a statistical monitoring system for international flow of funds, four basic computational frameworks can be referred: SNA system index, Basel Committee on Banking Supervision, IMF financial stability statistical system, and Treasury International Capital provided by the U.S. Department of the Treasury. According to the dynamic structure of international flow of funds (see formula 1-4), we designed a statistical monitoring system for GFF (see table 2).

Out of the four observational stages in international flow of funds, we first picked factors that affect savings-investment balance (S-I): disposable income, final consumption, net savings ratio, CPI, market interest rates, GDP and government expenditure. As factors that affect domestic fund surplus or shortage ($\Delta FA - \Delta FL$), we picked sectoral financial surplus or deficit to GDP, net outflow of funds to GDP, spread between highest and lowest interbank rate, regulatory capital to risk-weighted assets, liquidity asset to total assets, liquid asset to short-term liabilities, non-performing loans to total gross loans, residential real estate loans to total loans, real estate prices. As factors that affect external trade flows (EX − IM), real effective exchange rate, consumption expenditure of U.S., total GDP of main areas, import price index, Chinese GDP, trade balance to GDP. As factors that affect external flow of funds (FO − FI), we picked economic growth rate, spread between overseas and domestic interests, interest rates of central bank, foreign − currency-denominated loans to total loans, government bonds yields of the US, holding US government bonds to total

Table 2 Global-Flow-of-Funds Statistics

$S-I=\Delta FA-\Delta FL=EX-IM$

GFFS	Source		Source
Net savings ratio	SNA	GDP	SNA
Disposable income	FOF	Government Expenditure	FOF
CPI	CBQSB	Final consumption	FOF
Spread between lending and deposit rates	FSIs	Spread between highest and lowest interbank rate	FSIs
Net outflow of funds to GDP	IFS	Liquid asset to total assets	FSIs
Sectoral financial surplus or deficit to GDP	FOF	Liquid asset to short-term liabilites	FSIs
Regulatory capital to risk-weighted assets	FSIs	Residential real estate loans to total loans	FSIs
Nonperforming loans to tatal gross loans	FSIs	Real estate prices	FSIs
Trade balance to GDP	BOP	Consumption Expenditure of the US	BEA
Real effective exchange rate	IFS	Total GDP of main areas	IFS
Yuan Change rate	BOP	Import Price Index	GAC

$CA=(FO-FI)+CRA$

GFFS	Source		Source
Economic growth rate,	SNA	Return on equity	FSIs
Spread between overseas and domestic interests	FSIs	Changes in reserve assets	BOP
Interest rates of central bank	CBQSB	Profit from investment	BOP
Foreign-currency-denominated loans to total loans	FSIs	Net foreign exchange exposure to equity	FSIs
Government bonds yields of the US	FRB	FDI	BOP
Holding US government bonds to total FRA	FSIs	Large exposures to capital	FSIs
Federal funds rate of the US	TIC	Net open position in foreign exchange to capital	FSIs

FRA, return on equity, change in reserve assets, profit from investment, net foreign exchange exposure to equity, FDI, large exposure to capital, net open position in foreign exchange to capital.

We can use the statistics observation system of GFF to measure long-term structural problem. There are 11 endogenous variables and 16 exogenous variables in the model of GFF (Zhang, 2008). This model takes the change in the formation of expectation and risk, it with a lag structure or immanent relevant factors of many economic variables, and explains the state of the funds flow in the continuous adjustment process to the balance from imbalance, and in a medium-to-long period of time. It also belongs to a kind of dynamic model. A system of simultaneous equations is a model of financial market equilibrium, consisting of the follows. However, this model can't reflect the short-term wave motion or financial stable situation of external flow of funds, and can't observe the shock to the financial pressure by rapid change of overseas financial markets, either. Moreover, the model doesn't have a function which emits the early alarm relative to generating of financial crisis when we want to know that how the profit factor and the risk factor affect international capital flows, and how the change of the pattern of funds flow affect domestic economy growth. Therefore, it needs to create the index system which shows the short-term trend of GFF, and financial stress index as a continuous research.

4. Create a Trend Index for GFF

Because external flow of funds fluctuate fluently due to international flow of funds, interests, stock prices, foreign exchanges, so the

GFF model doesn't reflect necessarily a country's short-term equilibrium in flow of funds, but is able to make predictions to the future progress and to simulate effects of financial policies from dynamically observing the mid- or long-term change trend. Besides, in designing the model, we have to pay attention to domestic factors, changes in international market, and also benefits and risks involved in foreign capital flows. Due to these concerns, in building GFF model we aim to observe the causal relationship of each economic variable and structural problem in the system of external flow of funds.

However this model cannot reflect recent capital flow and financial stability, statistically speculate for potential financial crisis, nor can it statistically describe the financial stress caused by a dramatic change in a financial market. That being said, we attempt to build a GFF trend composite index (CI) system and a financial stress index.

4.1 Purpose and the Basis of Selection

Figure 2 indicates that Flow of Funds and GDP share a similar trend, which is our actual basis for building GFF trend index. GFF trend index refers to Diffusion Index. Under a statistical monitoring system (see Table 2) that reflects the changes of GFF, we select n kinds of time series indicators excluding seasonal variations, irregular variations and trend changes. We call the adjusted time series index as DI (Diffusion Index) and it is defined by n+/n, when moving in the extended direction compared with the first half and setting the number of series to n+. Expressed as percentages, DI basically uses monthly data. The main focus is timeliness, sustainability, and corresponding equivalence with GFF changes. The concept of corresponding equivalence considers whether or not an index can reveal the amount along with the direction flow of funds and can reflect the dynamics of domestic and the international financial markets. More importantly, corresponding equivalence requires that the change of index over time exhibits the change of fund flows amount, direction and the financial market volatility. Based on different movements in time by different indices, we can classify GFF index as Leading Index, Coincident Index, and Lagging Index.

Based on above definition on the diffusion index, we can observe changes in those indices.

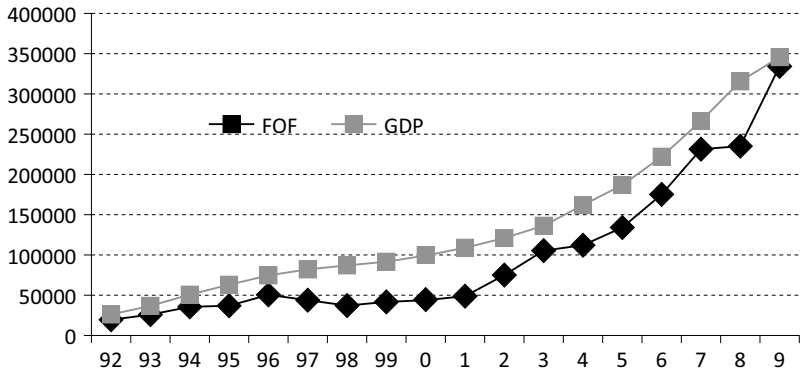

Figure 2 FOF and GDP with common trends of change in China (100 million)

Sources: The People's Bank of China Quarterly Statistical Bulletin.

Table 3 Composite Index for GFF

Leading Index
Return on equity
Real estate prices
Real exchange rate
CPI
Government Bonds Yields of the US
Spread between lending and deposit rates
Residential real estate loans to total loans
Spread between overseas and domestic interests
Spread between highest and lowest interbank rate
Coincident Index
Net savings ratio
Trade balance
Regulatory capital to risk-weighted assets
Net outflow of funds
Sectoral financial surplus or deficit
Changes in reserve assets
Lagging Index
Holding US government bonds
Net open position in foreign exchange to capital
Profit from investment
Disposable income
Final consumption

Among the coincident indices, when any index increases by 50%, we consider it as an expansion phase of flow of funds, or economic development. On the other hand, when the increase is less than 50%, we may see it as a shrinking phase of flow of funds, or economic depression. By the selection criterion of the above index, the system of the trend index in global flow of funds is shown in Table 3.

4.2 The method of the index creation

Set the value of any index at time = t as $y_i(t)$ ($i = 1, 2, \cdots, n$), and its rate of change is

$$r_i(t) = \{y_i(t) - y_i(t-d)\} / y_i(t) \quad (5)$$

During a period = d, we may set d = 1, comparing with a month before, or d = 3, 3 months before. To simplify our explanation, set d = 1. When DI at any one point can be written as

$$DI(t) = \frac{1}{2n}\sum_{i=1}^{n}\{\mathrm{sgn}(r_i(t)) + 1\} \quad (6)$$

Where sgn is a sign function, defined as

$$\mathrm{sgn}(x) = \begin{cases} -1 & (x < 0) \\ 0 & (x = 0) \\ 1 & (x > 0) \end{cases}$$

From formula (6) we see that DI is the average value in each index sgn(r). sgn is an increasing function, and DI changes in the same direction as r. Hence we know that DI can reflect changes in flow of funds, and also changes in different economies.

However, DI only reflects one type of change, increase or decrease in variable series, and does not show the magnitude. To compensate for this, we can use composite index, which is built by four stages as below.

① About an individual series $y_i(t)$, a symmetrical change rate $r_i(t)$ as follows

$$r_i(t) = \frac{y_i(t) - y_i(t-1)}{\{y_i(t) + y_i(t-1)\}/2} \quad (7)$$

But, when $y_i(t)$ is 0, negative, or a fraction, $r_i(t) = y_i(t) - y_i(t-1)$

② Calculate the average, standard deviation of $r_i(t)$

$$\overline{r_i}(t) = \frac{1}{T}\sum_{\tau=t'}^{t} r_i(t) \quad s_i(t) = \left[\frac{1}{T}\sum_{\tau=t'}^{t}\{r_i(t) - \overline{r_i}(t)\}^2\right]^{\frac{1}{2}}$$

Where T = 60 (five years), $t' = t - T + 1$ is the time before five years.

We get standardization.

$$z_i(t) = (r_i(t) - \overline{r_i}(t)) / s_i(t) \quad (8)$$

③ By each Leading Index, Coincident Index and Lagging Index, compound an individual index as follows and calculate an average (composition) change rate $v(t)$.

$$v(t) = \overline{r}(t) + \overline{s}(t) \cdot \overline{z}(t) \quad (9)$$

When considering it as the number of the indices which constitute **n**

$$\bar{r}(t)=\frac{1}{n}\sum_{i=1}^{n}\bar{r}_i(t),\ \bar{s}(t)=\frac{1}{n}\sum_{i=1}^{n}s_i(t),\ \bar{z}(t)=\frac{1}{n}\sum_{i=1}^{n}z_i(t)$$

④ CI(t) is set by standard time to 100, and an average change rate is calculated one by one

$$CI(t)=CI(t-1)\frac{2+v(t)}{2-v(t)} \quad (10)$$

The above formula can rewrite as follows.

$$v(t)=\frac{CI(t)-CI(t-1)}{\{CI(t)+CI(t-1)\}/2} \quad (11)$$

Changes in v(t) is the average change in r(t), or a change rate in Flow of Funds. Therefore, change rate of CI(t) is the same as v(t). When CI increases (decreases), flow of funds increases (decreases) and the economy is going up (or fall)

5. Financial Stress Test in GFF Analysis

After investigating changes in GFF and financial stability using CI, we further explore financial stress using Financial Stress Index (FSI) that is made by GFF statistical monitoring system. The aim of the stress test is to test stress using the system and assess any potential pressure on financial stability. Please refer to articles below: KLR Model (Kaminsky, Lizondo & Reinhart, 1996, 1999), FR Model (Frankel & Rose, 1996), STV Model (Sachs, Tornell & Velasco, 1996), DD Model (Demirgüç-Kunt, A. & E. Detragiache, 1998), HK Model (Hakkio and Keeton, 1999), LMY Model (Illing, M. and Y. Liu, 2003), RSSI Model (Ravi Balakrishnan, Stephan Danninger, Selim Elekdag, and Irina Tytell, 2009). Stress test and financial stress index have different functions. Stress testing, as a predictive tool, aims to assess the impact of unexpected shocks such as the 2008 Financial Crisis on the soundness of GFF. On the other hand, tests such as CI use indices that reflect current financial conditions. Stress testing and CI play different but complementary roles in surveillance.

5.1 Establishing Chinese FSI

The FSI addresses the weakness inherent in models that use EWIs by improving the reference variable. In particular, the FSI is continuous, of high frequency (daily), and covers the equity markets, bond markets, foreign exchange markets, and the banking sector. Therefore, it is suitable for analyzing financial stability in highly developed countries with numerous systemically important financial markets and institutions. Financial stress is a continuous variable with a spectrum of values, where extreme values are called a crisis. Stress increases with expected financial loss with risk (a widening in the distribution of probable loss) or uncertainty (lower confidence about the shape of the distribution of probable loss). Stress is the product of a vulnerable structure and some exogenous shock. Financial fragility describes weaknesses in financial conditions and/or in the structure of the financial system. (Illing and Liu, 2003).

Based on the characteristics of Chinese flow of funds and the timeliness and sustainability of GFFS data, we selected the variables below to build the financial stress index.

Ⅰ Spread between overseas and domestic interests

Ⅱ Return on equity (Shanghai comprehensive index)

Ⅲ Holding US government bonds to total FRA

Ⅳ Net open position in foreign exchange to capital

Ⅴ Exchange Market Pressure Index (EMPI)

$$EMPI_t=\frac{er_{ij}-\mu_{er_{rj}}}{\sigma_{er_{ij}}}-\frac{CRAR_{ij}-\mu_{CRAR_{ij}}}{\sigma_{CRAR_{ij}}} \quad (12)$$

er : the change rate of exchange rate in monthly

CRAR : the change rate of reserve asset in monthly

Because we are unable to obtain the monthly data of net open position in foreign exchange to capital, we used 4 variables in Table 4 to build the Chinese FSI. Variable A stands for the stress factors on global flow of funds from spread between overseas and domestic interests. Variable B is for return on equity, using Shanghai composite index to reflect stress on capital market. Variable C is Chinese holding US government bonds to total FRA, used to test the risks involved in Chinese holding the US bonds. Variable D, exchange market pressure index, shows the stress on Chinese finance from Chinese exchange rate appreciation and increase in foreign exchange reserves. In formula (12), μ and σ indicate the average and standard deviation respectively of *er* and *CRAR* sequence. These four variables are taken from monthly data from January 2004 to March 2011, and we have calculated the average and standard deviation respectively for each 4 variables.

Standardizing variable A, B, C, D based on Table 4, we obtain standardized variables Z_{Ai}, Z_{Bi}, Z_{Ci}, Z_{Di}, with consistent units. Then we sum these standardized variables to obtain FSI with GFF in perspective.

$$FSI_t = Z_{Ai} + Z_{Bi} + Z_{Ci} + Z_{Di} \quad (13)$$

Figure 3 indicates changes in Chinese FSI

Table 4 Variable selection and the feature of China's FSI

Variable's code	Variables	Period of data	Mean	Standard Error
A	Spread between overseas and domestic interests	Jan. 2004-March 2011	3.5276	1.7275
B	Return on equity	Jan. 2004-March 2011	1.2327	9.4927
C	Holding US government bonds to total FRA	Jan. 2004-March 2011	37.0156	3.8583
D	Exchange Market Pressure Index (EMPI)	Jan. 2000-March 2011	0.0000	1.5723

Included observations: 96

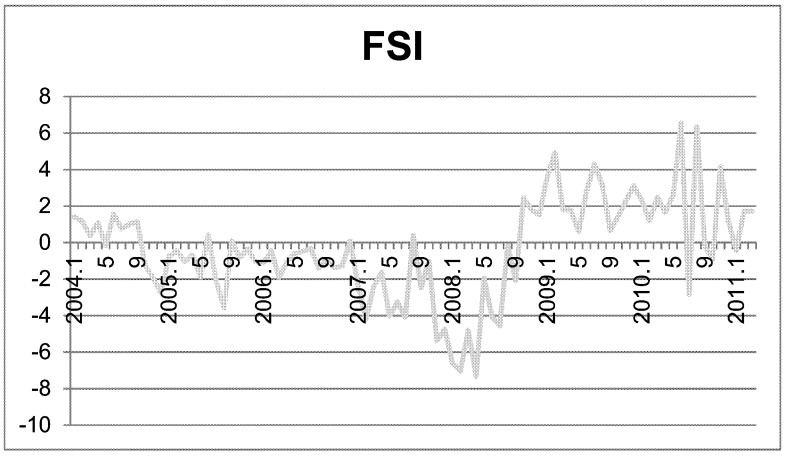

Figure 3 The changes of FSI

from January 2004 to March 2011. There are 50 months with FSI＞0, 46 months with FSI＜0. Of the entire observing period, FSI remained relative stable from January 2004 to June 2007. However since then till August 2010, FSI was in a volatile range, especially since August 2007 it slid from 0.33 to −5.5 in August 2008 due to B (return on equity), C (holding US government bond to total FRA), and D (exchange market pressure index). Then FSI rose to 4.47 in January 2009, and reached its maximum of 6.4 in June 2010. These changes reflect massive stress on Chinese finance from the US subprime mortgage crisis in the 2007 4th quarter which led to the financial crisis in May 2008.

5.2 Recognition of Financial Stress Period

From previous studies we know that there are 3 ways to recognizing stress period. 1) When FSI is at 1.5 times or twice the historical averages we should consider it as the stress period; 2) Looking at the longitudinal history, when FSI is above a critical value with index average (for example, 90%), government should pay attention to it as a stress period; 3) look at financial stress data during financial crises in other countries, and when one country's FSI is above those reference data caution should be used.

This paper uses the first method above in detecting stress period. In a normal distribution we have $P(|x-\mu| \le 2\sigma) = 0.9545$, meaning that it is statistically significant for FSI to reach a value twice of its historical value.

$$P(|FSI - \mu_{FSI}| > 2\sigma_{FSI}) = 0.05 \quad (14)$$

Hence we have $(FSI - \mu_{FSI}) > 2\sigma_{FSI}$, and

$$FSII_t = \frac{(FSI_t - \mu_{FSI})}{2\sigma_{FSI}} - 1 \quad (15)$$

Hence, $FSII_t$ is our index for recognizing financial stress period. In formula (15), when $FSII_t > 0$, we can consider this period as stress period and appropriate policies should be taken. When $-1 < FSII_t < 0$, financial stress is at a normal range, and when $FSII_t < -1$ financial stress is relatively low.

Figure 4 indicates changes in financial stress period recognition index from January 2004 to March 2011. From its trend we see that there is a systematic stress to Chinese financial stability from global flow of funds stress, domestic capi-

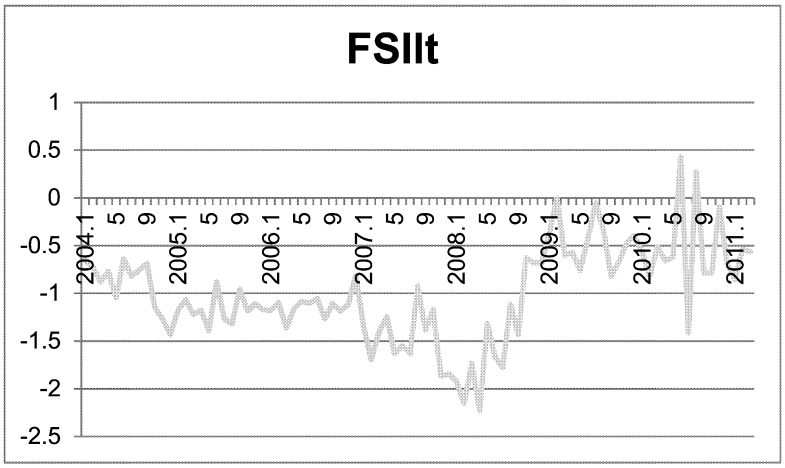

Figure 4 The changes of FSIIt

tal market stress, stress from holding US bonds, exchange rate appreciation, and increase in foreign exchange rates. From January 2004 to August 2008, the stress level was relatively low, but from August 2008 FSIIt was going up and has been greater than 0. In 2009 and afterwards, FSIIt continues going up and it has become a historical peak price in May to August, 2010. That is, financial stress has been increasing and governmental attention should be paid.

6. Concluding Remarks

This paper constructs a statistics observation system of GFF that is based on the mechanism of GFF, referencing FSIs that is released from IMF. It (GFFS) is promising for not only building the econometrics model for long-term analysis using this statistics observation system, but also made the trend index and financial stress index. We can test the strength of the shock to the financial system by the synthetic element of external flow of funds and using the trend index and financial stress index, and also can observe the situation of short-term financial stability.

By the viewpoint of global flow of funds, we concluded some points that financial stress in China is increasing after the U.S. financial-crisis in 2008, through observing the changes in financial stress index. It turns out that period of especially May, 2010 to September 2010 is the time which the Chinese policy authorities should look out for. However, two subjects still remain in this research.

One is a problem of the practice to DI and CI index. Although this paper examined the methodology of how to create DI and CI by the viewpoint of methodology, it hasn't done the actual trial calculation yet. In fact, this needs to make a database for making DI and CI becomes a necessity.

The other one is creating the measurement model which can estimate FSI. Due to restriction in word limit, this paper only conducted descriptive-statistics analysis on the situation of China financial pressure using FSI. However, based on FSI, it is necessary to build a model which can explain change of FSI and to make the effective early warning system in order to expand the function of FSI.

Notes

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1） IMF, Financial Soundness Indicators, 2006, p54.

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