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Dynamic interactions between real exchange rate and international fund flows in China

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As the progress of capital account liberalization in China, the volume and volatility of international fund flows has increased significantly since 2000. Therefore, it is of vital importance to investigate their influence on domestic financial market. Based on a novel database, EPFR Global, we get the monthly fund flows in China from January 2005 to June 2013. Vector autoregression (VAR) models are employed to investigate the dynamic relationships between real exchange rate and international fund flows.The following conclusions can be drawn: (i) large amount of international fund investments tend to result in RMB appreciation; (ii) the appreciation of real effective exchange rate leads to the decrease of fund flows in the first month and attracts more fund investments afterwards; (iii) the interaction between equity flows and exchange rate is more significant than bond flows.

Key words: International fund flows, exchange rates, vector autoregression (VAR) model, equity flows, bond flows.

INTRODUCTION

In most countries, the capital inflows are often associated with the real exchange rate appreciation and increased exchange rate volatility (Calvo et al., 1993). The role of international capital flows in the exchange rate dynamics gets a broad-based interest due to their significant increase during the past few decades. Their relationship also affects the stability of the financial system as well as broader economic developments and conditions (Gyntelberg et al., 2014).

As an increasingly important part of international capital flows, international fund flows also affect the fluctuations of exchange rates directly. A large amount of literature has examined the role of foreign exchange order flows, which are at least partially determined by investors' portfolio rebalance behavior, on the dynamics of exchange rates (Evans and Lyons, 1999; Hau et al., 2002; Hau and Rey, 2006; Killeen et al., 2006). Therefore, it suggests a significant linkage between international fund flows and exchange rates. The portfolio balance approach developed by Hau and Rey (2006) explains the mechanism. On one hand, as international investors change their portfolios, the demand forforeign currencies changes as well, which will lead to the fluctuations of exchange rates. Specifically in China, as fund investments in China increase, the demand for Renminbi (RMB) in exchange market also increases. It

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will lead to the appreciation of RMB. In the context of managed flexible exchange rate regime, if the amplitude of RMB appreciation exceeds the expectation of central bank, it will sell RMB in foreign exchange market through open market operations to eliminate its appreciation pressure. Consequently, the money supply increases and so does the domestic inflation rate, and therefore leads to real exchange rate appreciation. On the other hand, the dynamics of exchange rate also affect fund investments. With incomplete hedgeing of foreign exchange risks[1], foreign investors tend to diversify their portfolios both denominated in domestic currency and in various foreign currencies. Therefore, the return of exchange rate will affect international investors' asset allocation. Meanwhile, the exchange rate appreciation is usually associated with the expectation of further appreciation, and investment returns tend to increase due to the higher currency returns. Thus, the appreciation of RMB tends to attract more fund investments in China. During this process, exchange rates, portfolio investments and domestic equity returns are jointly and endogenously determined.

Vector autoregression (VAR) models can illustrate these dynamic interactions properly. VAR models were constructed in this research. This research aims to answer the following questions: (i) what are the dynamic interactions between exchange rate and international fund flows in China? and (ii) is there any difference between international equity flows and bond flows? In the context of managed flexible exchange rate regime, the fluctuation amplitude of nominal exchange rate is limited. Therefore, real effective exchange rate is used in our research. Based on a novel database, EPFR Global, the monthly fund flows in China was gotten from January 2005 to June 2013. To observe their dynamic interactions and compare the differences, we employ VAR models for equity flows and bond flows separately. It is concluded that large amount of international fund investments tends to increase the demand of RMB, and therefore leads to RMB appreciation. Meanwhile, the appreciation of RMB attracts more international fund investments afterwards. Besides, the interaction between equity flows and exchange rate is more significant than bond flows, because the amount of equity flows is much larger than bond flows.

LITERATURE REVIEW

Three strands of literature are closely related to our research question, (i) the role of international capital flows in the exchange rate dynamics, (ii) the influence of the volatility and uncertainty of exchange rate movements, and (iii) literature on international fund flows.

As to the first topic, a large amount of studies have appeared since 1990s. For example, based on monthly data of ten Latin American countries[2] covering the period January 1988 to December 1991, Calvo et al. (1993) conclude that international capital flows (proxy by official reserves) and exchange rate demonstrated a sizable degree of co-movement and the degree of co-movement in exchange rate increased during capital inflow episodes. Granger causality test shows that reserve accumulation precedes the real exchange rate appreciation. Hau and Rey (2006) develop a two-country framework to analyze the joint equilibrium dynamics of equity returns, exchange rate returns and investors' portfolio choices. As the markets are incomplete to hedge all the FX risk, foreign investors tend to diversify their portfolios of stocks, bond, and other financial assets denominated in domestic currency and various foreign currencies. Therefore, as they change their portfolios, international capital flows occur. In the meantime, foreign investors will buy or sell domestic currencies, which leads to exchange rate appreciation or depreciation. Afterwards, Gyntelberg et al. (2014) give some empirical support for this framework. Employing a daily frequency dataset for Thailand during 2005 to 2006, they investigate the interaction between exchange rate fluctuations and returns on risky financial assets. The results indicate that net purchases of Thai equities by nonresident investors will lead to an appreciation of Thai baht, and higher returns of Thai equities are accompanied by a depreciation of Thai baht.

Since the generalized floating of exchange rates in 1973, amounts of researchers have focused on the impacts of its volatility and uncertainty (Chowdhury, 1993). Some of them argue that the exchange rate volatility tends to enhance costs for risk averse market participants, decrease their profits, and therefore hamper the trade flows (Akhtar and Hilton, 1984; Coes, 1981; Cushman, 1983, Thursby and Thursby, 1987). Other empirical studies indicate that trade tend to benefits from exchange rate risks (Franke, 1991; Giovannini, 1988; Sercu and Vanhulle, 1992). In the context of an Error-Correction Model and based on the quarterly data for G7[3] countries from 1973 to 1990, Chowdhury (1993) conclude that exchange rate volatility has a significant negative impact on the volume of exports.

As to the research on international fund flows, three topics have been examined: (i) the behavior of international fund investments (Gelos, 2012; Hsieh et al., 2011; Jinjarak et al., 2011; Patro, 2006), (ii) the role of these investments in the transmission of financial shocks between countries (Gelos, 2012), and (iii) the drivers of international portfolio flows (Fratzscher, 2012; Puy,

[1] (Levich *et al.,* 1999) calculated that only 8% of the total foreign equity investment had their foreign exchange risk hedged. (Hau and Rey, 2006) also point out that evidence from U.S. global mutual funds indicate that foreign exchange risk in international equity portfolios is mostly un-hedged. (Gyntelberg *et al.,* 2014) also support evidence of imperfect hedging in Thailand stock market.

[2] Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay and Venezuela.

[3] Canada, France, Germany, Italy, Japan, the United Kingdom and the United States

2016). However, the interaction between exchange rates and international fund flows has never been investigated. As the dynamic of exchange rates is one of the most important parts in domestic financial market, it is increasingly important to explore the influence of fund flows on exchange rates.

DATA AND METHOD

Data

The EPFR Global Database is used to describe the international fund flows. Fund flows are international investments in domestic financial markets by institutional investors, including mutual funds, exchange traded funds (ETFs), closed-end funds and hedge funds. EPFR Global covers more than 33,735 equity funds and 21,716 bond funds, which are registered in most major markets and allocate their assets globally. Since 2000, the assets under management by international funds have increased dramatically and the total amount came to more than 16 trillion in 2013. The database collects the purchase and redemption information of each fund as well as their asset allocation, and then calculates the total amount of fund flows flowing into or out of each country.

A couple of other studies are based on this database as well (Borensztein and Gelos, 2003; Fratzscher, 2012; Jotikasthira et al., 2012; Kaminsky et al., 2001; Raddatz and Schmukler, 2012) and Jotikasthira et al. (2012) show in detail the close match between EPFR Global fund flows and portfolio flows stemming from balance of payments (BOP) data. As China set up its exchange rate regime reform in 2005, the time span of our study is from January 2005 to June 2013.

As China employs managed flexible exchange rate regime, the fluctuation amplitude of nominal RMB exchange rate is limited. Therefore, real effective exchange rate is used in our research. Real effective exchange rate (REER) is the weighted average of a country's currency relative to a basket of currencies, which is defined as follows:

$$REER_i = \sum_{j=1} \frac{P_i R_i}{P_j R_j} * w_{i,j}$$

where $REER_i$ indicate the real effective exchange rate of country i; $w_{i,j}$ is the weight according the trade relationship between country i country j; R_i, R_j are nominal exchange rates in US dollars in country i and country j, respectively; P_i, P_j are price indexes in country i and country j, respectively. The RMB real effective exchange rate employed in this research derived from IMF, and higher value of REER indicates the appreciation of RMB.

VAR Model

In order to investigate the interaction of fund flows and exchange rates, a multivariable vector autoregressive (VAR) model is used in this paper. By allowing both the instantaneous and lagged effects of variables, the VAR system illustrates multi-period interaction of endogenous variables. Both endogenous and exogenous variables are included in our VAR model were included (Guo and Huang, 2010). The model can be written as:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{bmatrix} = A_1 \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \\ y_{3t-1} \end{bmatrix} + A_2 \begin{bmatrix} y_{1t-2} \\ y_{2t-2} \\ y_{3t-2} \end{bmatrix} + \ldots + BX_t + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \end{bmatrix} \quad t = 1, 2, \ldots, T$$

As exchange rate, fund investments and asset returns are jointly and endogenously determined; three endogenous variables in VAR models are included; y_{1t} indicates the international fund flows at time t; y_{2t} indicates the real effective exchange rate at time t;. y_{3t} is the asset price index at time t; X_t is a vector of exogenous variables, including 3-month NDF exchange rate, interest rate difference, and CBOD Volatility index (VIX). NDF exchange rate is included as the proxy of exchange rate expectation, and we assume that higher appreciation expectation tends to attract more fund investments. Fund investments also increase with higher interest rate differential and lower CBOD Volatility index. In this study, fund flows are scaled by assets under management of each receiving country (c.f. Fratzscher, 2012; Puy, 2016). The definition of variables is shown in Table 1, and the summary statistics for variables are shown in Table 2.

EMPIRICAL RESULTS

VAR model for equity flows

Unit root test

Before the identification of long-term relations of endogenous variables, we have to ensure that they are all time-stationary variables. Therefore, Augmented Dickey-Fuller test is conducted and Table 3 describes the results. It was found that all the endogenous variables in level are I (1) process and the differenced variables are confirmed to be stationary. Hence, our VAR model consists of the difference of endogenous variables.

VAR model for equity flows

According to the rule of FPE and AIC criteria[4], the optimal lag length in the VAR system is two months. A VAR (2) system is constructed. Table 4, the real effective exchange rates and the equity flows interact with each other. Large amount of international equity investments tend to enhance the demand of RMB, and therefore lead to RMB appreciation. Meanwhile, the appreciation of RMB, which increases the investment income denominated by foreign currencies and implies the further expectation of RMB appreciation, attracts more international equity investments. As to the exogenous variables, NDF and interest rate differential exert little impact both on real effective exchange rates and on the equity flows.

However, the VIX index is significant in the three equations. It is positively related with real effective exchange rates and negatively related with international equity flows.With the higher volatility in US market, investors tend to flight and US dollars are under the pressure of depreciation. Meanwhile, international equity

[4] FPE stands for final prediction error, and AIC stands for Akaike information criterion. The significance of each test is at 5% level.

Table 1. Definition of VAR variables.

Variables	Description	Data source
Endogenous variable		
International fund flows	International equity/bond flows scaled by assets under management	EPFR Global
REER	Real effective exchange rate	IMF
Asset price index	Shanghai stock exchange (SEE) composite index OR SSE government bond index	CEIC
Exogenous variable		
NDF	3-Month NDF exchange rate	Bloomberg
Interest rate differential	Difference between 3-month Shanghai interbank offered rate and the 3-month United States Treasury Bills	CEIC
VIX	CBOD volatility index, implied volatility of S&P 500 index options over the next 30 day period	Thomson Reuters

Table 2. Summary statistics of VAR variables.

Variable	Obs	Mean	Std. Dev.	Min.	Max.
International equity flows	102	0.581	1.853	-4.191	6.321
International bond flows	102	1.311	2.578	-10.262	8.737
REER	102	97.454	9.655	82.480	117.140
Stock index	102	2529.077	1003.512	1060.740	5954.770
Bond index	102	120.198	10.697	97.270	138.650
NDF	102	7.015	0.641	6.176	8.218
Interest rate differential	81	2.468	2.249	-2.302	6.362
VIX	102	20.905	8.904	11.100	46.350

Table 3. Results of augmented Dickey-Fuller test: equity flows.

Null hypothesis	Lag length (Based on SIC)	Number of obs.	Test Statistic Z(t)	MacKinnon approximate p-value for Z(t)
D (equity flows) has a unit root	7	95	-6.925	0.000
D (REER) has a unit root	0	102	-7.520	0.000
D (stock index) has a unit root	1	101	-5.284	0.000

investments in China, mainly from developed countries, tend to decrease with the higher market volatility.

Generalized impulse response functions for equity flows

In order to trace the time paths of the interactions between exchange rate and equity flows, we apply the generalized impulse response, which does not depend on the VAR ordering. In each case, the shock to each equation is equal to one standard deviation of the equation residual, and we trace the impulse responses of all the variables for 10 months. The upper and lower standard error bonds (±2 standard errors) of the impulses are also presented. As shown in Figure 1, the real effective exchange rates perform a large degree of persistence. The impulse response of real effective exchange rates to a positive shock of equity flows is significantly positive 3 months later, and this influence tends to disappear 5 months after the shock. This indicates that international equity flows tend to provoke the pressure of RMB appreciation in three to four months. However, the impulse response of equity flows to real effective exchange rates is negative in the first month and significantly positive in the second month as well as afterwards. This effect also disappears in five

Table 4. Result of VAR Model: equity flows.

Variable	D (REER)	D (equity flow)	D (stock index)
D (REER(-1))	0.369*** (3.32)	-0.132 (-0.91)	-10.149 (-0.41)
D (REER(-2))	-0.093 (-0.87)	0.269** (1.95)	6.840 (0.29)
D (equity flow (-1))	0.044 (0.44)	-0.223** (-1.72)	13.621 (0.61)
D (equity flow (-2))	0.158** (1.76)	-0.153* (-1.30)	-36.072** (-1.79)
D (stock index (-1))	-0.001* (-1.34)	-0.002*** (-2.85)	-0.132 (-1.12)
D (stock index (-2))	0.000 (0.52)	0.000 (0.56)	0.333*** (2.61)
Constant	0.204 (0.85)	0.253 (0.81)	161.778*** (3.02)
D (NDF)	1.402 (0.46)	2.544 (0.64)	2066.318*** (3.01)
Interest rate differential	0.038 (0.55)	-0.109 (-1.19)	-47.585*** (-3.02)
D (VIX)	0.094*** (3.10)	-0.076** (1.91)	-17.816*** (2.63)
Adj. R-squared	0.23	0.22	0.26
N	81	81	81

t statistics in parentheses and *p < 0.10, **p < 0.05, ***p < 0.01. First difference of the variable is used in the regression, including REER, international equity flow, stock index, NDF and VIX.

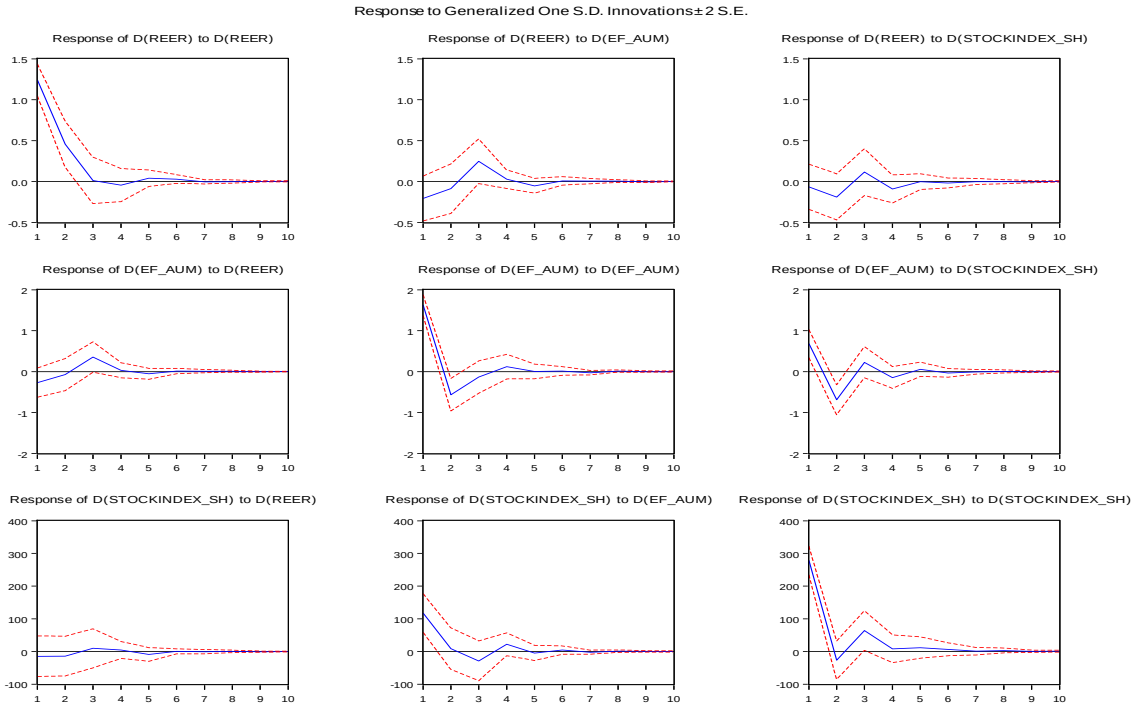

Figure 1. Response to generalized one S.D. Innovations and ±2 standard errors: equity flows.

months.

VAR model for bond flows

Unit Root Test

Before a VAR model for bond flows is constructed, the time-stationary feature of endogenous variables is also checked. Table 5 presents the result of Augmented Dickey-Fuller test. Endogenous variables, including bond flows, real efficient exchange rate and bond index, are I (1) process in level and the differenced variables are stationary.

Therefore, our VAR model is based on the difference of endogenous variables.

Table 5. Results of augmented Dickey-Fuller test for unit root: bond flows.

Null hypothesis	Lag length (Based on SIC)	Number of obs.	Test Statistic Z(t)	MacKinnon approximate p-value for Z(t)
D (bond flow) has a unit root	0	102	-12.931	0.000
D (REER) has a unit root	0	102	-7.520	0.000
D (bond index) has a unit root	0	102	-8.141	0.000

Table 6. Result of VAR Model: bond flows.

Variable	D (REER)	D (bond flow)	D (bond index)
D (REER(-1))	0.226** (2.15)	-0.101 (-0.64)	0.160*** (4.53)
D (bond flows (-1))	-0.138** (-1.76)	-0.202** (-1.71)	0.085*** (3.21)
D (bond index (-1))	0.270 (0.97)	1.045*** (2.47)	0.289*** (3.08)
Constant	0.138 (0.60)	-0.071 (-0.20)	0.101* (1.30)
D (NDF)	1.583 (0.533)	-3.139 (-0.70)	1.966** (1.96)
Interest rate differential	0.036 (0.56)	-0.148* (-1.51)	0.043** (1.99)
D (VIX)	0.103*** (3.51)	-0.160*** (-3.61)	0.016** (1.66)
Adjusted R-squared	0.24	0.20	0.39
N	81	81	81

t statistics in parentheses and *p < 0.10, **p < 0.05, ***p < 0.01. First difference of the variable is used in the regression, including REER, bond flows, bond index, NDF and VIX.

VAR model for bond flows

According to the LR, FPE, AIC, SC, and HQ criteria[5], a VAR (1) model is constructed for bond flows. Table 6 shows that the interaction between international bond flows and real effective exchange rate is also significant. In the real effective exchange rate equation, bond flows, which are different from equity flows, tend to be negatively related with real effective exchange rates, which indicate that large amount of bond flows lead to RMB depreciation in short term. The VIX index has significantly positive effect on real effective exchange rates, which means the increase of volatility in US market tends to be associated with the comparative appreciation of RMB. In the bond flow equation, the change of real effective exchange rates exerts little influence on the dynamics of bond flows, and the increase of bond index in China tend to attract more international bond investment significantly. The increase of VIX index tends to reduce the international bond investments in China, which is similar to equity flows. In the bond index equation, large amount of international bond investments in China will enhance the bond index. The interest rate differential and exchange rate expectation also exert positive influence on the bond index.

[5] LR indicates sequential modified LR test; FPE stands for final prediction error; AIC stands for Akaike information criterion; SC stands for Schwarz information criterion; and HQ stands for Hannan-Quinn information criterion. The significance of each test is at 5% level.

Generalized impulse response functions for bond flows

The time paths of interaction between exchange rates and bond flows were also present as shown in Figure 2. Generalized impulse response is used and Figure 2 also presents the upper and lower standard error bonds (±2 standard errors) of the impulses. The response of real effective exchange rate to a positive shock of bond flows is negative in the first two month and becomes slightly positive in the third month. The impulse response of bond flows to the change of real effective exchange rate is also negative in the first two month and the effect disappears after four months.

Differences between equity flows and bond flows

In order to capture the dynamic interactions between international fund investments and exchange rate in China and compare the differences between equity flows and bond flows, we construct VAR models for equity flows and bond flows separately. According to the lag structure test, we carry out a VAR (2) model for equity flows with three endogenous variables, which are international equity flows flowing into China, real effective exchange rate and Shanghai Stock Exchange composite index. For bond flows, a VAR (1) model is constructed with international bond flows into China, real effective exchange rate and Shanghai Stock Exchange bond index

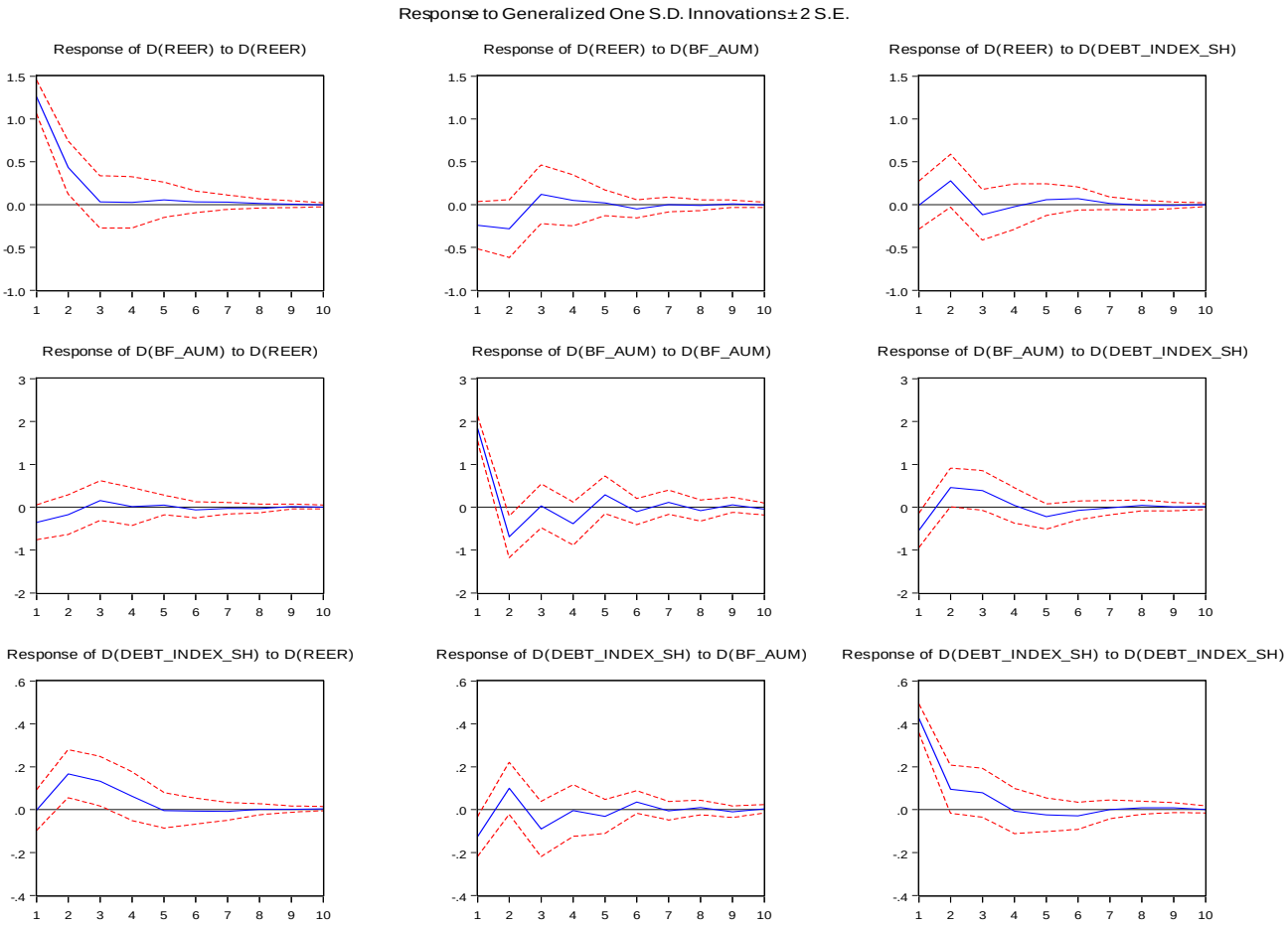

Figure 2. Response to Generalized One S.D. Innovations and ±2 standard errors: bond flows.

as endogenous variables. Same exogenous variables are included in both VAR models.

As to the interaction with exchange rate, equity flows and bond flows behave differently. The interaction between equity flows and exchange rate is more significant than bond flows. Specifically, in the VAR model, two-month lagged equity flows exert significantly positive effect on the exchange rate appreciation, while one-month bond flows exert negative effect. Besides, two-month lagged exchange rate has significantly positive influence on equity investments but has little influence on bond investments. This phenomenon may be due to that the amount of equity flows is much larger than that of bond flows in China, and thus illustrates more significant dynamics. In January 2013, the amount of equity flows in China is 7415.17 million US dollars while there is 737.38 million US dollars for bond flows. As to the generalized impulse response functions, there is no significant difference between the time paths of interaction of equity flows and bond flows, which shows the relationship between fund flows and exchange rate is robust. However, the response of exchange rate to the shock of equity flows is much larger.

Conclusions

In this paper, the time variation of the interaction between exchange rate and international fund flows in China is analyzed. Equity flows and bond flows are analyzed separately, and VAR models are employed. Our analysis leads to the following conclusions. Firstly, large amount of international fund investments tend to enhance the demand of RMB, and therefore result in RMB appreciation. This effect begins to work especially in three to five months. Secondly, the appreciation of real effective exchange rate leads to the decrease of fund flows in the first month and attracts more fund investments afterwards. This is because appreciation of RMB implies the further expectation of RMB appreciation and it attracts more fund investments in the third and later months. Thirdly, the VIX index is significantly positively related with real effective exchange rates and negatively related with international fund flows. As to the differences

between equity flows and bond flows, the interaction between equity flows and exchange rate is more significant than bond flows, which may because that the amount of equity flows is much larger than that of bond flows, and thus illustrates more significant dynamics.

Our findings provide new evidence on the interaction of fund flows and exchange rates, which is meaningful both for researchers and for policy-makers. During the liberalization of capital account in China, this study also provides the potential risk analysis of the opening of domestic security market.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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