The influence factors of short-term international capital flows in China —Based on state space model

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Abstract. Based on international short-term capital as the object, this paper analyzed the main factors which affect capital flows before and after the financial crisis, from the study, we found that: long-standing spreads and the RMB appreciation expectations are the main factors that lead to short-term capital inflows to our country in recent years. Although, the effect of expected factors is more obvious, the role of spreads at home and abroad is also strengthened， at the same time, the influencing factors of short-term capital flows present obvious nonlinear relationship with short-term capital flows, so the traditional estimation method has shortcoming.

Introduction

Since October 2008，The United States has continuously implemented four rounds of quantitative easing monetary policy，which is undoubtedly in order to further support the economic recovery and the Labor market, making the global low-interest environment and abundant liquidity last for a longer time，but the impact of this monetary policy is far from that. Bin Jiancheng, Zhan Huaxiu found that the surplus of the quantitative easing which the United States use to deal with the financial crisis is very obvious [1]. The super-currency flowing into domestic real economy and capital market is not too much，some of which was stranded in the US banking system in form of excess reserves, while others went to the international market. Because of the short-term capital's profit-driven, the super-currency will inevitably flow to the region with higher yields，and emerging markets are definitely the best choices. China, one of the fastest growing emerging market countries, undoubtedly will attract a large amount of capital in the short term. In recent years, the international short-term capital inflows to China with the trends of large scale and fast-flow, which has a dramatic impact on the macroeconomic development in our country, the cause of such a result relates to the long-standing spreads between China and the United States and the factors such as the expectations of RMB appreciation.

A large amount of short-term capital inflowing to China's economy，although in favor of promoting the economic development of China，puts pressure on inflation and asset price boom, the characteristics of short-term capital determine its frequent flow between different countries, which will undoubtedly make our country's economy fluctuates widely, macroeconomic regulation will become more difficult because of uncertainty factors such as psychological expectations. Therefore, it is necessary to study the effect of short-term capital flows on China's macro economy, which is of great practical significance to resist and guard against economic downward pressure caused by a large number of outflows in time as well as the macroeconomic policy formulation.

Literature Review

In terms of short-term capital flows' impact on China's exchange rate, Wang Lei theoretically analyzed how the interest rates and exchange rates influenced the international short-term capital inflows to China, and established the econometric model to determine the extent of the influence, He

suggested that the fluctuation of exchange rate and the linkage effect between interest rate and exchange rate expectations are important factors affecting international short-term capital flows[2]. In the field of short-term capital flows' effect on asset price in our country, Zhu Mengnan and Liu Lin discussed the relationship among the short-term international capital flows, exchange rate and asset price with theoretical analysis, and then they made an empirical analysis on the relationship among short-term capital flows, exchange rate, shares and house price, since the exchange rate reform in 2005 with the VAR model. They found that short-term capital inflows could lead to appreciation of RMB exchange rate as well as the increase of stock prices and house prices, coming up with some advice such as improving the domestic financial system and considering the independence of domestic monetary policy [3].

In the area of studying the scale and influencing factors of short-term capital flows, Chen Jinmei and Xu Zhenling measured the scale of the short-term international capital flows in our country, and respectively analyzed the influence that the explicit and implicit international short-term capital flows put on China's economic development and financial stability，with a variety of methods such as co-integration model, granger causality test, impulse response and variance decomposition [4]. Wang Shihua and He Fan who studied the scale of the short-term capital flows in China and the main factors influencing the capital's inflows and outflows, found that long-standing spreads and the RMB appreciation expectations are the main factors affecting China's short-term capital flows, but the effect of RMB appreciation expectations is more important [5].

Throughout the argument above, we can find: most of papers adopt the linear model based on ordinary least squares to analyze short-term capital flows, but in recent years short-term capital flows present obvious non-linear features， as a result of which, the traditional estimation method inevitably will appear the bias. Therefore, this paper uses the nonlinear regression model based on Kalman filter to analyze the short-term capital flows.

Empirical Analysis

Because of the capital profit chasing, when there is an obvious profit opportunity in China compared with foreign countries，the capital will be bound to flow into our country. Referring to the theoretical model made by Wang Shihua and He Fan (2007), in this paper, the determinant of short-term international capital flows (K) is expressed as follows：

$$K=f(ER，ME) \tag{1}$$

We can assume that there are only two main factors influencing the short-term capital flows in our country, namely the expected excess returns (ER) and the macro economic situation (ME). Also deviation from the interest parity is used to indicate the excess returns, the above equation can become:

$$K=f(R-(FR+(EE-E)/E),ME)=f(R-(FR+EA),ME)=f(RD-EA,ME) \tag{2}$$

Where R means the representative yields, FR is foreign representative yields, EE represents spot rates, EA indicates the rate of the RMB appreciation expectation, and RD denotes representative spreads at home and abroad.

According to the formula above, we can analyze how the spreads and RMB appreciation expectations influence the short-term international capital with econometric model.

Construction and test of the model

Basic econometric equation model is set as follows:

$$K=C+\alpha RD+\beta EA+e_t \tag{3}$$

The studied samples range from 2006M1 to 2012M12, just covering the initial, mid-term and later stage of the financial crisis, data frequency is set in monthly, The specific index selection and data declaration are as follows：

a. K represents the amount of short-term international capital flows. In the long term, there is a heated debate among the scholars about how to better measure the amount of short-term international capital flows. This paper adopts customs data, and substitutes non-trade and FDI capital flows for short-term international capital flows，"plus" meaning capital inflows, while "minus" standing for capital outflows. The advantage of this method lies in considering that part of the short-term capital flows into our country in form of current account transactions.

b. RD denotes spreads between China and the United States，which is represented by the difference between the weighted average inter-bank overnight rate and the closing price of dollar overnight interest rates.

c. EA stands for the expectations of RMB depreciation and appreciation. Referring to the method of Shi Qiaorong (2010), this paper also measured the expectations of RMB depreciation and appreciation from the point of exchange rate, using NDF exchange rate instead of expected exchange rate. So the expectations of RMB depreciation and appreciation can be shown as the ratio of the spot exchange rate of RMB /USD to NDF exchange rate.

The time-series data we use in this paper can cause "spurious regression" for its non-stationarity, so we should test the stationarity of variables before setting up the model with time-series data. From the results, we can see the original sequence of variables is not stable at 1% level，but after the first order difference, they become stationary, thus co-integration test can be carried out on the variable K, RD and EA.

Classical regression model is built on the basis of the stationary data, only when there is stable long-term relationship among the non-stationary variables, namely co-integration, can the variables be analyzed in classical regression model. Co-integration test can be classified to two kinds according to test objects: One is the Johansen and Juselius Test; the other is the Engle and Granger two-step Test based on residual error. This paper adopts the Johansen and Juselius Test.

Table 1 Johansen and Juselius Test

Null hypothesis	Eigenvalue	Trace statistic	The critical value at 5% significancelevel	P value
None*	0.343752	45.23240	29.79707	0.0004
At most 1	0.115015	11.95630	15.49471	0.1590
At most 2	0.028740	2.303728	3.841466	0.1291

Note：* denotes rejecting null hypothesis at 5% significance level

From the results of co-integration test in table 1, we can see the conclusion of trace test: rejecting null hypothesis of no co-integration relations at 5% significance level. Therefore, there is a long-term stable equilibrium relationship among the variables in the sample interval. So this paper uses the ordinary least squares to estimate the original series, the specific results are as follows:

$$K = -10.18 + 3.35RD + 0.70EA \quad (4)$$

From the estimated results above, the coefficients before RD and EA have passed the test of significance. The regression coefficient before EA(the expectations of RMB appreciation) is 0.7,while that before RD(spreads between China and the United States) is about 3.35, but the adjusted R-Square is small, so we will try to find out the possible breakpoint using the CHOW test, and the results are shown in table 2. Through the analysis, we can find that CHOW test significantly declined the null hypothesis of no breakpoint in December 2008.

Table 2 The state space model statistics

Statistics		P value	
F-statistic	7.195668	Prob. F(3,78)	0.0003
Log likelihood ratio	20.52312	Prob. Chi-Square(3)	0.0001
Wald Statistic	21.587	Prob. Chi-Square(3)	0.0001

Visibly, the slopes of factors influencing the short-term capital flows significantly change after the financial crisis. Therefore, only using the linear ordinary least squares estimation is not fit for the model. So this paper adopts the state space model to analyze the factors affecting China's short-term capital inflows. The construction of the state space model is as follows:

$$K_t = \text{c} + \alpha_t EA_t + \beta_t RD_t + \mu_t$$
$$\alpha_t = \varphi_1 \alpha_{t-1} + \eta_{1t},$$
$$\beta_t = \varphi_2 \beta_{t-1} + \eta_{2t},$$

State space model describe the dynamic change, consisting of signal equation and measurement equation. Parameter α_t , β_t serve as state variables, which reflect the sensitivity of short-term capital flows to the expectations of RMB appreciation and spreads between China and the United States, namely the multiplier of each variable. The estimates of time-varying parameters α_t , β_t can be obtained by Kalman filter.

Parameter estimation and analysis results

The estimated results of the model are shown in table 3, which describes that P values of parameters in the entire model are less than 0.01, indicating that the coefficients in model pass the significance test. Compared with the results obtained by ordinary least squares regression model, we can find that the multipliers of spreads between China and the United States and the expectations of RMB appreciation to short-term capital flows are positive in the ultimate state, but in terms of the values, the impact of expectation on short-term capital flow is more evident. This result presents markedly different from that of the ordinary linear least squares estimation.

Table 3 Results of parameter estimation in state space model

Nullhypothesis	Final steady-state value	Z-statistic	Pvalue
α_t	70.34129	7.036934	0.0000
β_t	3.346424	2.860904	0.0042
Log likelihoodvalue	AICvalue	SICvalue	Hannan-Quinnvalue
-398.8304	9.543581	9.601458	9.566847

Put the above data into the measurement equation and state equation，we can get the following results of parameter estimation in state space model by using Kalman filter algorithm.

$$K_t = \text{-}10.18 + \alpha_t EA_t + \beta_t RD_t + \mu_t$$

a. Figure 1 shows the time-varying trajectory of how the expectations of RMB depreciation and appreciation influence short-term capital flows. From the graph, we can see that, before 2008, the expectation shad an obvious effect on short-term capital flows, always in a state of fluctuation, while the effect remained to increase after 2008. Obviously, the expectations of RMB appreciation attracted constant short-term capital flows to our country after financial crisis. As shown by the values, the multiplier of the RMB appreciation expectation to short-term capital flows ranges from 0.895 to 179.433, which denotes that for every one unit increase in the expectations of RMB appreciation, there will be 0.859 ~ 179.433 units increase in the short-term capital flows to our country. Between

2006 and 2007, the multiplier of RMB appreciation expectation to short-term capital flows is in the stage of volatility, and the maximum and the minimum of multipliers are still in that period, before which, financial crisis happened, the global economy was in boom, the expectations of RMB appreciation fluctuated obviously, and so did the short-term capital flows, which reflected the high liquidity and profit-driven of short-term capital. In the second half of 2007,the impact that the RMB appreciation expectation puts on short-term capital fell from 104.4 to 11.7 because of financial crisis. With our country taking the lead in the recovery from the financial crisis, the expectations of RMB appreciation gradually increased, which caused short-term capital inflows to slowly and constantly increase after 2008.

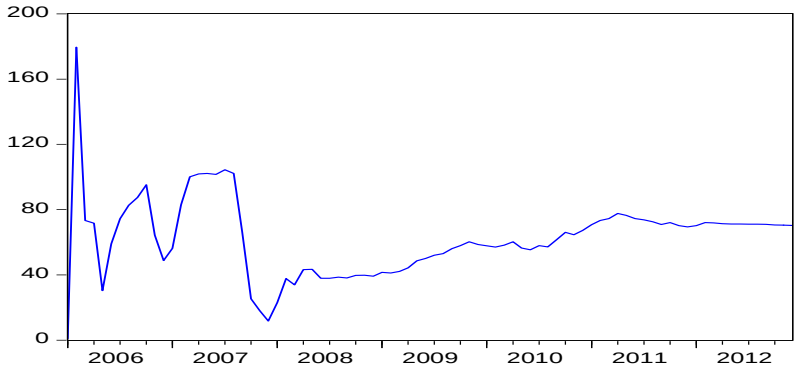

Fig.1 the time-varying trajectory of expectations of RMB influence on short-term capital flows

b. Figure 2 shows the time-varying trajectory of how the spreads between China and the United States influence short-term capital flows. In specific, before 2008, the spreads impacted evidently on short-term capital flows and fluctuated. Different from the results obtained in Figure 4, short-term capital not only inflowed but also out flowed to our country， especially obvious in late 2007. But the effect of spreads remained to increase after 2008. Visibly, the spreads played a vital role in the short-term capital inflows to our country after the financial crisis. As shown by the values, the multipliers of the spreads between China and the United States to short-term capital flows range from -7.11 to 15.37,which denotes that for every one unit increase in the spreads, there will be -7.11～15.37 units increase in the short-term capital flows to our country. So in some case, increased spreads will not lead to short-term capital inflows in China, especially during the financial crisis, but the common role of other factors such as expectation may have a combined effect on capital flows. From 2006 to 2007, the multiplier of the spreads to short-term capital flows is in the stage of volatility, and the maximum and the minimum of multipliers are still in that period, before which, financial crisis happened, the global economy was in boom, the spreads between China and the United States were in a relatively stable position, and short-term capital flows fluctuate, wildly at the beginning, in the position of relatively stable position. So the long-standing spreads between China and the United States only is one of the most important reasons for capital inflows to our country. In the second half of 2007, affected by financial crisis, the impact that spreads between China and the United States put on short-term capital fell from 5.78 to -3.36. With our country taking the lead in the recovery from the financial crisis, the United States adopted long-term low-interest policy, enlarging the spreads between China and the United States. As a result, the short-term capital inflows slowly and constantly increased after 2008.

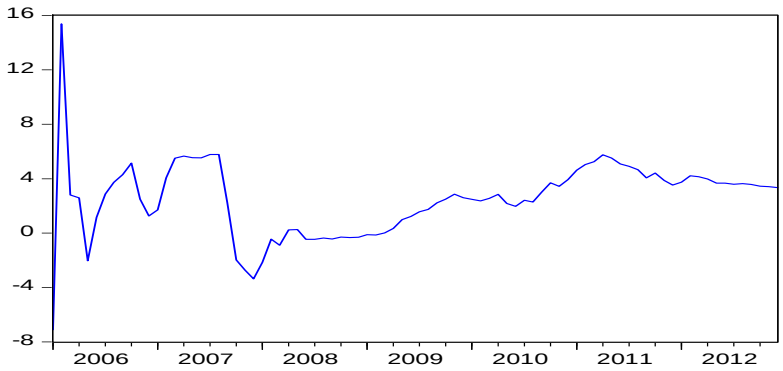

Fig.2 the time-varying trajectory of interest differential influence on short-term capital flows

c. The time-varying trajectory of the effects that RMB appreciation expectation and the spreads between China and the United States have on short-term capital flows. Seen from the trend in the graph, Figure 2 is consistent with Figure 3, but there exist a situation of short-term capital outflows in the factor of spreads, which denotes the spreads have a complex effect on short-term capital flows. In terms of the values, the multiplier of the RMB appreciation expectation finally stabilizes at about 70 which is greater than 4 that the multiplier of the spreads stabilizes, which suggests that the RMB appreciation expectation play a more important role in short-term capital flows.

Conclusion

In this paper, with the state space model based on Kalman filter to analyze the influencing factors of short-term capital flows in our country, we can get the following conclusions:

a. The RMB appreciation and devaluation expectation and the spreads between China and the United States are the important factors that affect China's short-term international capital flows. But RMB appreciation expectation plays a more important role in short-term capital flows, which the spreads less weakly impact on. In some period, the multiplier of the spreads is negative.

b. Before the financial crisis, the effects of the RMB appreciation expectation and the spreads on short-term capital flows present obvious fluctuations, the multiplier obviously decreases during financial crisis, and then gradually increase.

c. The traditional estimation method based on ordinary least squares has evident shortcomings in studying short-term capital flows. Especially in recent years, affected by financial crisis, there is an obvious nonlinear relationship between short-term capital flows and RMB appreciation expectation as well as the spreads, as a result of which, the traditional estimation method inevitably will result in the bias. So the nonlinear method is more suitable for analyzing the features of short-term capital flows in recent years.

According to the analysis above, at the present stage, controlling the spreads between China and the United States cannot well inhibit the short-term capital inflows, while weakening RMB appreciation can fundamentally curb the heavy inflows of capital. So we need to actively seek a long-term development strategy to manage internal and external imbalances.

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