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Empirical analysis for the impact of RMB real effective exchange rate on foreign direct investment in China

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ABSTRACT

In this paper, from the perspective of RMB exchange rate reform, the impact is studied of RMB real effective exchange rate on FDI (Foreign Direct Investment) in China from January 1997 to December 2013. In the long run, there is an equilibrium relationship between RMB real effective exchange rate and FDI. The impact of RMB real effective exchange rate on FDI was not affected until the promulgation of the reform policy from July 2005. That is, only after the reform, RMB exchange rate had a significant Granger causality on FDI and the appreciation of RMB can promote FDI inflow.

Key words: Exchange rate reform; RMB real effective exchange rate; FDI

INTRODUCTION

China began to attract FDI from the beginning of 1970s. With the further development of reform and opening, the FDI actually utilized has been increasing continually and risen from 9.2 billion US dollars in 1983 to 1.176 trillion US dollars in 2013 (National Bureau of Statistics in China). To say the least, FDI has played an important role in promoting economic growth in China. On one hand, FDI allows for a more efficient allocation of resources for the investing firm in the home country; on the other hand, the host country can benefit from knowledge transfers and spillovers as well as inciting competition and increased productivity [1]. As FDI is in the category of international capital, exchanging is indispensable between different currencies in the process of international capital flows [2]. In recent years, with the expanding of global FDI scale and an increasing number of countries implementing the floating exchange rate policy, the impact of exchange rate on FDI has attracted more and more attention from researchers and policymakers. Although a lot of work has been done in the area of exchange rate movements and FDI, there is still no consensus either in theory or empirical studies.

Most researchers believe that the currency appreciation in the host country is not conducive to the flow of FDI and the depreciation can promote FDI inflow. In the theories of Kohlhagen (1977) and Cushman (1988), the depreciation of host-country currency can reduce the production cost and transnational merger and acquisition cost, and thus stimulate FDI. On the assumption of imperfect capital markets, Froot and Stein (1991) develop a model and show that the depreciation of host-country currency, by systematically lowering the relative wealth of domestic agents, can lead to the increase of FDI acquisition. A similar theoretical result comes from Blonigen (1997) who plausibly shows how the real currency depreciation in the receiving country increases FDI acquisition to this country. Empirical evidence in a number of studies has revealed the correctness of the above-mentioned theories [3-9].

By contrast, Campa (1993) derives, under Dixit's (1989) real options framework, a negative effect of real host-country currency depreciation on FDI [10]. He believes that the multinational corporation's overseas investment decision depends on its future earnings expectation. The stronger the currency of a country is, the higher the future earnings expectation is, and thus more FDI can be attracted. A number of empirical evidence has confirmed the prediction [11-13]. Unlike other people, Hymer (1960) insists in his theory based on the perfect capital markets that the impact of exchange rate on FDI is not significant [14]. Empirical finding from Trevino et al. (2002) shows that the domestic production scale, the degree of marketization and the consumer price index (CPI) are the important factors of FDI; whereas the exchange rate is not [15]. Similar results can be found in Dewenter (1995) and Pan (2003) [16-17]. However, none of studies including Benassy-Quere et al. (2001) and Chen et al.(2006) are able to identify a statistically significant effect of host-country currency valuation on FDI [18-19].

There are two possible reasons for the results in the studies above. First, the impact of exchange rates on FDI is different for different industries, which is verified by Froot and Stein (1991) in empirical evidence. So the analysis based on aggregate data is probably to result in aggregation bias. Second, the macro and micro economic environments in many countries change over time, and they more or less influence the effect of exchange rate on FDI. For instance, Jeanneret (2005) points out that the multinational corporation can, with the development of world's financial derivative instruments, completely allocate the assets reasonably all over the world to avoid the risk of exchange rate change [20].

In this paper, we conducted empirical statistical analyses on the impact of RMB real effective exchange rate on FDI in China. As we all know, RMB exchange rate has been adjusting since the reform and opening. In 1981, China started to implement a dual exchange rate policy. The next managed floating exchange rate policy based on market supply and demand was established in 1994. In 1997, the RMB exchange rate was, in order to cope with the Asian financial crisis, pegged to the US dollar. Since July 2005, China has implemented the managed floating exchange rate policy which is not only based on market supply and demand but also referenced to a basket of currencies. Then we can not help asking, with the continuous adjustment of the exchange rate, whether the impact of exchange rate on FDI was affected by the reform of exchange rate policy ? If so, when exactly did it occur?

Compared with other studies, there are the following innovations in this paper. **First**, although many scholars at home and abroad studied the impact of exchange rate on FDI, so far no studies examining the change of the impact can be seen from the perspective of exchange rate reform. That is to say, with the introduction of the related policy, the exchange rate behaves differently and the impact followed on FDI may be different. Because RMB exchange rate has become more elastic since July 2005, we chose the reform policy as our research object. **Second**, with the promulgation of the reform policy, the impact may be affected before or after the reform. Accordingly, Chow breakpoint test was, which verifies the change of the impact, used to identify when exactly it occurred. **Last but not the least**, it more or less exists autocorrelation when establishing the model of time series, so we performed Box-Jenkins' ARMA(p,q) model to eliminate the autocorrelation in the co-integration model.

EXPERIMENTAL SECTION

Time series used here are monthly observations of FDI actually utilized in China and RMB real effective exchange rate(REER) from January 1997 to December 2013. RMB real effective exchange rate is an index, whose rise means currency appreciation and fall means currency depreciation [13]. We collected the data of RMB real effective exchange rate from the website of Bank for International Settlements www.bis.org/. The data of FDI actually utilized was obtained from China Economic Information Network statistics database.

Due to climate, custom or other economical factors, the monthly economic statistical series contains seasonal changes. It is hard to clearly understand the actual changes in the data, so the seasonal adjustment should be conducted before the empirical analysis. The X-12 seasonal adjustment method was employed.

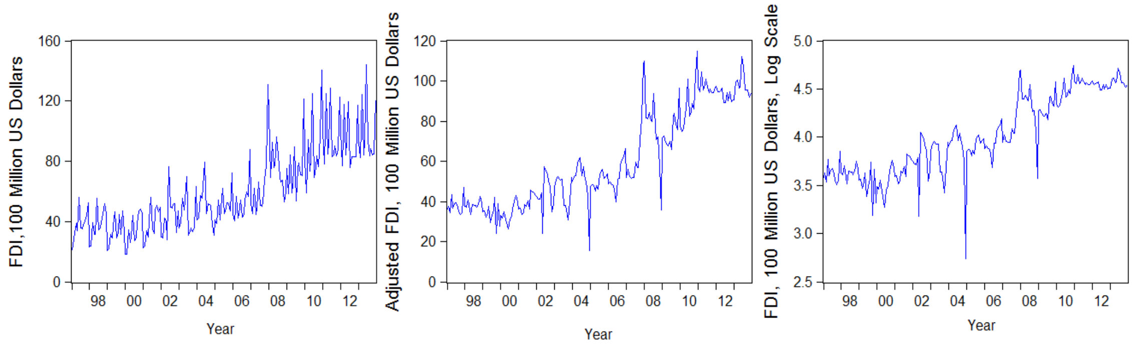


Fig. 1 Plots of FDI (100 Million US Dollars) in the Original Scale, in the Adjusted Scale and in the Log Scale

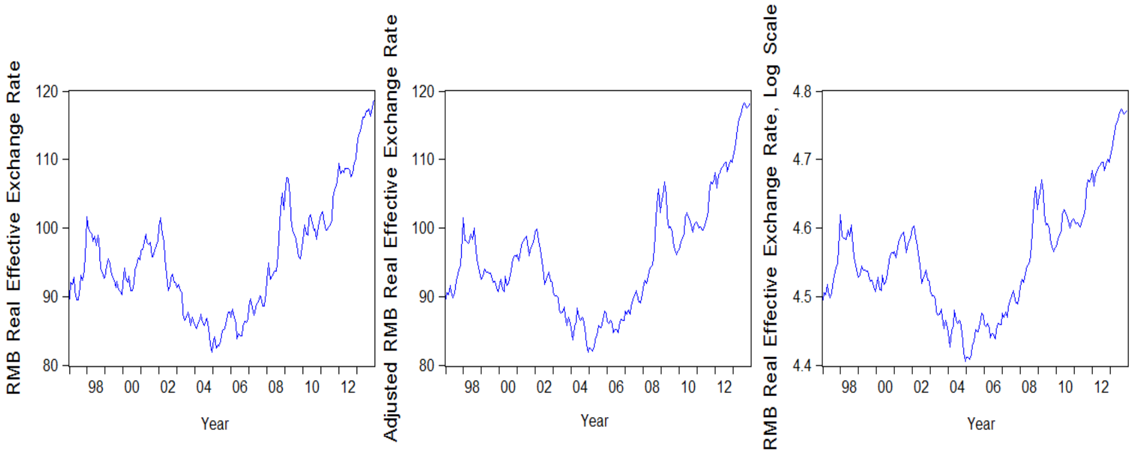


Fig.2 Plots of RMB Real Effective Exchange Rate in the Original Scale, in the Adjusted Scale and in the Log Scale

Data were log-transformed before modeling to stabilize the variability. The plots of FDI time series in original scale, in adjusted scale and in log-scale are shown in Figure 1. The time series for RMB real effective exchange rate are shown in Figure 2.

3. Empirical Methods

3.1 Chow Breakpoint Test

Chow Breakpoint Test is used to examine the stability of the model structure. Suppose two subsamples are expressed by n_1 and n_2 , and $T = n_1 + n_2$. The multiple regression model is established as: $y_t = \theta_0 + \theta_1 x_{t1} + \cdots + \theta_k x_{tk} + \mu_t$. Then the model can be estimated with n_1 and n_2 observations, respectively. The null hypothesis H_0 is: the regression coefficients are correspondingly equal. The test statistic is defined as

$$F = \frac{[SSE_T - (SSE_1 + SSE_2)]/(k+1)}{(SSE_1 + SSE_2)/(T-2k-2)} \tag{1}$$

Where k is the number of independent variables; T being the number of all observations; SSE_T, SSE_1 and SSE_2 being the three sum squared residual of regression model with T, n_1 and n_2 observations, respectively. Under the confidence probability α , if $F \geq F_\alpha(k+1, T-2k-2)$, then the null hypothesis H_0 should be rejected. That is to say, the regression coefficients are not correspondingly equal and there is a structural change in the model.

3.2 Augmented Dickey-Fuller test

In order to avoid spurious regression and get the valid statistical inference, the test of time series' stability is essential. Augmented Dickey-Fuller test is the main tool for this objective and thus can be used to determine the unit root order. It can be completed through the following three models:

$$\Delta X_t = \delta X_{t-1} + \sum_{i=1}^{m} \beta_i X_{t-i} + \varepsilon_t \tag{2}$$

$$\Delta X_t = \alpha + \delta X_{t-1} + \sum_{i=1}^{m} \beta_i X_{t-i} + \varepsilon_t \tag{3}$$

$$\Delta X_t = \alpha + \beta t + \delta X_{t-1} + \sum_{i=1}^{m} \beta_i X_{t-i} + \varepsilon_t \tag{4}$$

Where X_t is the time series being tested; Δ being the first-difference operator; t being the time trend; m being the optimal lag length which is determined by Akaike Information Criteria (AIC); ε_t being the white noise disturbance term. The null hypothesis of ADF unit-root test $|\beta| = 1$ is tested against the alternative hypothesis $|\beta| < 1$. If the null hypothesis is rejected, then the time series X_t is stationary.

3.3 Co-integration Test

Engle and Granger (1987) note that even though economic time series might be described as a random walk process it is possible that the linear combinations of the series would converge to equilibrium over time [21]. They proposed co-integration models for multivariate and non-stationary time series commonly observed in econometric studies. Using our two time series, a simple co-integration model in log scale is defined as

$$L(FDI_t) = \beta_0 + \beta_1 L(REER_t) + \varepsilon_t \tag{5}$$

In expression (5), FDI_t is the foreign direct investment in China and $REER_t$ is RMB real effective exchange rate. In above model, these two time series can be non-stationary, but the linear relationship (co-integration) would make the innovations, ε_t, independent and identically distributed. We can perform the ADF test on ε_t to validate the model.

3.4 Granger-causality Test
The co-integration test tells us whether a long-run equilibrium exists between A and B, but we have no idea about the direction between the two variables. The Granger-causality test can be used to solve this problem. The Granger causality model is as below:

$$Y_t = \phi_1 + \sum_{i=1}^{k} \alpha_i Y_{t-i} + \sum_{i=1}^{k} \beta_i X_{t-i} + \mu_{1t} \tag{6}$$

$$X_t = \phi_2 + \sum_{i=1}^{k} \lambda_i X_{t-i} + \sum_{i=1}^{k} \delta_i Y_{t-i} + \mu_{2t} \tag{7}$$

Where α_i, δ_i are the regression coefficients for lag length of Y_t; β_j, λ_j being regression coefficients of lag length of X_t; μ_{1t}, μ_{2t} being the white noises. In judging whether X is the Granger cause for Y, the null hypothesis and also the restricted condition is: $\beta_i = 0, i = 1,2...k$. The test statistic is:

$$F = \frac{(SSE_1 - SSE_2)/k}{SSE_2/(T-2k-1)} \tag{8}$$

Where SSE_1, SSE_2 are the sum squared residual of regression equation by Original Least Square (OLS) method under restricted and unrestricted condition, respectively; T being the number of observations of time series Y_t; k being the number of regression coefficients β_i. Under the confidence probability α, if $F > F_\alpha$, then the null hypothesis should be rejected. That is, X is the Granger cause for Y.

In addition to the above mentioned methods, in our analysis, to estimate the parameters β_0 and β_1 in model (5), ordinary least squares (OLS) method was used. Furthermore, we performed Box-Jenkins'ARMA(p,q) model to eliminate the autocorrelation in model (5) [22] . Our statistical analyses were carried out using Eviews 8.0.

RESULTS

The plots of FDI and RMB real effective exchange rate indicate that the measurements were all from non-stationary processes in the original scale, in the adjusted scale and in the log scale. It is also evident that trends of these time series were more stable in the log-scale (Figures.1-2).

The results from ADF test tell us that both of log transformed FDI and RMB real effective exchange rate exist unit root at a significance level 0.05. However, the ADF tests were significant in the first difference, indicating that the differences of these two time series were stationary (Table.1).

Table.1 Results from Augmented Dickey-Fuller test

Variable	ADF Test	AEG (5%)	(C,T,N)
LFDI	-2.17	-2.88	(C,0,1)
$\Delta LFDI$	-14.17**	-1.94	(0,0,1)
LREER	-0.17	-2.88	(C,0,1)
$\Delta LREER$	-11.05**	-1.94	(0,0,0)

Note: ** denotes that statistical significance at 5% level. C represents the intercept,T represents the time trend and N represents the optimal lag length.

In Table.2(a), the Granger causality of log transformed RMB real effective exchange rate on FDI was not statistically significant. It might have resulted from the non-stationarity of these two time series. When the tests were conducted on the differences of these two time series, we were able to observe statistically significant results at a significance level 0.1.

Table.2 Results from Granger Causality Test

(a)

Null Hypothesis:	F-Statistic	P-value
LREER does not Granger Cause LFDI	0.9258	0.4878
LFDI does not Granger Cause LREER	1.5882	0.1414
$\Delta LREER$ does not Granger Cause $\Delta LFDI$	1.9477	0.0646*
$\Delta LFDI$ does not Granger Cause $\Delta LREER$	1.6696	0.1190

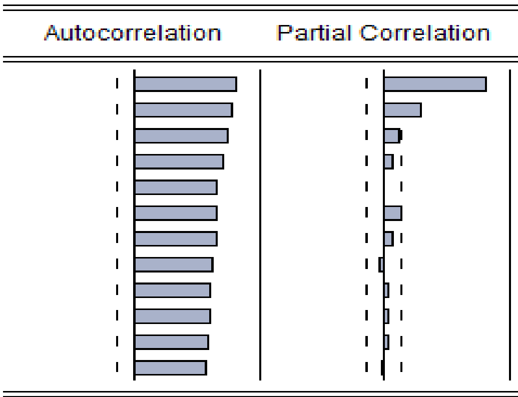
*Note: * denotes that statistical significance at 10% level.*

(b)

Time Interval	Null Hypothesis:	F-Statistic
Jan,1997-Jun,2005	LREER does not Granger Cause LFDI	1.0086
	LFDI does not Granger Cause LREER	0.8659
Jul,2005-Dec,2013	LREER does not Granger Cause LFDI	5.4001***
	LFDI does not Granger Cause LREER	1.3703

*Note: *** denotes that statistical significance at 1% level.*

To assess the goodness of fit of the co-integration model (5), we performed the Augmented Dickey-Fuller test on the residual for co-integration model of the log transformed time series. The test statistic was -2.87. We rejected the null hypothesis of unit root for the residual at a significance level 0.01. That is to say, there is an equilibrium relationship between RMB real effective exchange rate and FDI in the long run. However, the adjusted $R^2 = 0.305$ and DW value was 0.3, indicating that it exists serious autocorrelation in the innovations ε_t. In order to eliminate the autocorrelation, we employed ARMA(p, q) model to ε_t. Figure 3 tells us that ε_t was the second order autocorrelation. That is, $\varepsilon_t = \alpha_0 + \alpha_1\varepsilon_{t-1} + \alpha_2\varepsilon_{t-2} + v_t$ (v_t is independent and identically distributed). As a result of this adjustment, the adjusted $R^2 = 0.825$ and the autocorrelation was eliminated (DW value was 2.0). Accordingly, the model was improved.



Sample: 1997M01 2013M12
Included observations: 204

Lag	AC	PAC	Q-Stat	Prob
1	0.849	0.849	149.08	0.000
2	0.806	0.307	284.26	0.000
3	0.765	0.120	406.60	0.000
4	0.731	0.068	518.93	0.000
5	0.691	0.003	619.66	0.000
6	0.691	0.148	721.09	0.000
7	0.678	0.073	819.16	0.000
8	0.649	-0.026	909.55	0.000
9	0.638	0.038	997.18	0.000
10	0.626	0.034	1082.0	0.000
11	0.613	0.036	1163.7	0.000
12	0.593	-0.010	1240.6	0.000

Fig. 3 Correlogram of Residuals

From Figure 4 we can see that F statistic is greater than the critical value at a significance level 0.01, indicating that the impact of RMB real effective exchange rate on FDI was not affected until the promulgation of the reform policy from July 2005. The result from Table.2(b) illustrates that only after the reform, the exchange rate had a significant Granger causality on FDI. Before the reform, the estimate of β_1 was not statistically different from zero (p < 0.05) in the improved model. After that, it was significant at a significance level 0.01 and $\beta_1 = 1.65$, indicating that FDI would increase by 1.65 log units for one log unit increase in RMB real effective exchange rate.

Chow Breakpoint Test: 2005M07
Null Hypothesis: No breaks at specified breakpoints

Equation Sample: 1997M03 2013M12

F-statistic	5.907385	Prob. F(4,194)	0.0002
Log likelihood ratio	23.21709	Prob. Chi-Square(4)	0.0001
Wald Statistic	63.29231	Prob. Chi-Square(4)	0.0000

Fig.4 Results from Chow Breakpoint Test

CONCLUSION

In this paper, we first applied a co-integration model to establish the linear relationship of RMB real effective exchange rate and FDI in China, and then employed ARMA(p, q) model to eliminate the autocorrelation in the co-integration model. Finally, Chow breakpoint test was used to examine whether the reform of RMB exchange rate policy from July 2005 affects the impact of RMB real effective exchange rate on FDI and when exactly it occurred. Our results indicated that there is an equilibrium relationship between RMB real effective exchange rate and FDI in the long run. The impact of RMB real effective exchange rate on FDI was not affected until the promulgation of the reform. Only after the reform, the impact was significant and FDI was positively associated with RMB real effective exchange rate. That is to say, the appreciation of RMB can promote FDI inflow, which is consistent with the theory of Campa(1993). One possible reason why the impact was not significant before the reform is that the exchange rate in Chinese financial market was “fixed”, with strong intervention from Chinese central government. In other word, before the reform, RMB exchange rate was under the regulation of government, so as FDI, flowing to the industries and regions in terms of government direction. Since the reform, the exchange rate has become more elastic, and then the impact on FDI has become different.

This study may be underpowered due to the significance level 0.1 in assessing the Granger causality of RMB real effective exchange rate on FDI. It is not surprising to reject the null hypothesis since it would be better and more powerful if the test was used to the time series after the reform(the Granger causality was significant at a significance level 0.01, Table. 2(b)) .

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