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Time series analysis of the RMB/HKD exchange rate and foreign direct investment from Hong Kong, China

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ABSTRACT

In this paper, a co-integration model was estimated to analyze the dynamic relationship of RMB/HKD exchange rate and FDI (Foreign Direct Investment) from Hong Kong, China, from 1997 to 2013. Our results show 1) in the long run, there is an equilibrium relationship between RMB/HKD exchange rate and FDI from Hong Kong, China, and 2) the appreciation of RMB can promote FDI inflow. Additionally, a unit root analysis of the model was conducted and Granger causality tested based on the empirical data.

KEYWORDS

RMB/HKD exchange rate; Foreign direct investment; Co-integration model; Unit root analysis; Granger causality test.

INTRODUCTION

China actively implemented the policy of attracting foreign direct investment (FDI) from the beginning of 1970s. FDI since then has started to flow into China. 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 relationship between exchange rate and 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[3-7].

By contrast, Campa (1993) derives, under Dixit's (1989) real options framework, a negative effect of real host-country currency depreciation on FDI[8]. 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[9,10]. 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[11]. 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[12]. Similar results can be found in Dewenter (1995) and Pan (2003)[13,14]. However, none of studies including Chen et al.(2006) are able to identify a statistically significant effect of host-country currency valuation on FDI[15].

Two possible reasons could explain 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[16].

Reviewing the history of the development of RMB exchange rate we know that, 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 not only based on market supply and demand but also referenced to a basket of currencies. At the meantime, FDI actually utilized from Hong Kong accounts more than 60% of the total

FDI China attracted (China Economic Information Network statistics database). So we can not help asking, what the relationship between the RMB/HKD exchange rate (the exchange rate for RMB to HK dollars) and FDI from Hong Kong is ?

In this paper, we conducted empirical statistical analyses on the relationship between RMB/HKD exchange rate and FDI from Hong Kong,China. To examine the relationship between the two time series we estimated statistical models based on Engel and Granger's co-integration model (Engel and Granger 1987). Additionally, Granger causality of the two time series was also examined.

EXPERIMENTAL SECTION

Data for the FDI actually utilized from Hong Kong and RMB/HKD exchange rate were yearly observations from 1997 to 2013. RMB/HKD exchange rate is an index whose rise means RMB depreciation and fall means appreciation. The data were both obtained from China Economic Information Network statistics database.

Data were log-transformed before modeling to stabilize the variability. The plots of FDI from Hong Kong time series in original scale and in log-scale are shown in Figure 1. The time series for RMB/HKD exchange rate are shown in Figure 2.

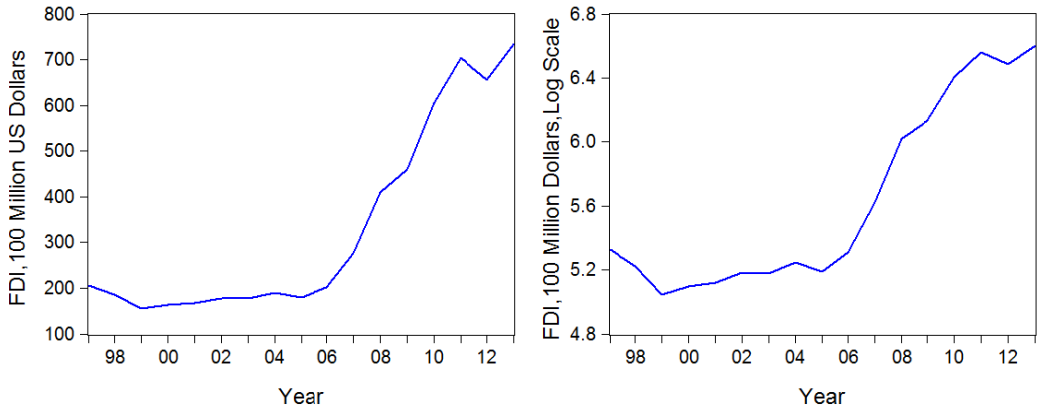

Figure 1 : Plots of FDI from Hong Kong (100 Million US Dollars) in the original scale and in the log scale

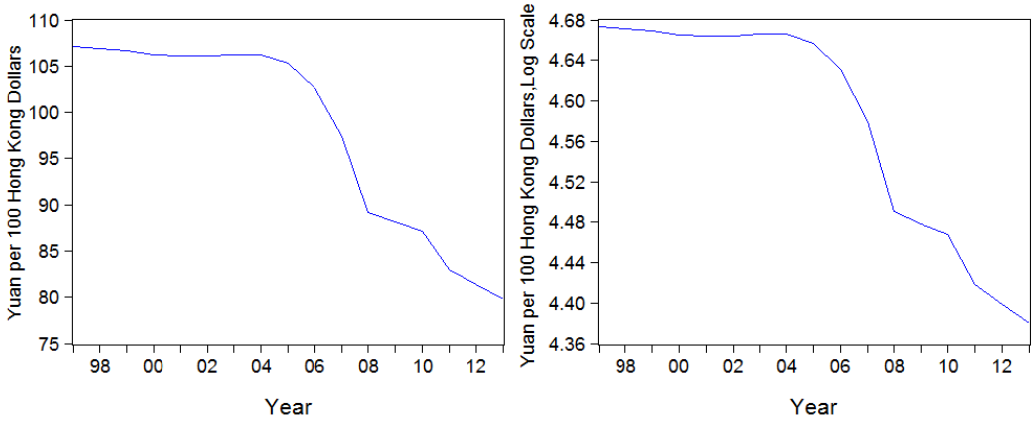

Figure 2 : Plots of RMB/HKD exchange rate in the original scale and in the log scale

EMPIRICAL METHODS

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:

$$\Delta X_t = \delta X_{t-1} + \sum_{i=1}^{m} \beta_i X_{t-i} + \varepsilon_t \quad (1)$$

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

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

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.

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[17]. 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

$$L(FDI_t) = \beta_0 + \beta_1 L(ER_t) + \varepsilon_t \quad (4)$$

In expression (4), FDI_t is the FDI actually utilized from Hong Kong and ER_t is the RMB/HKD 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.

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:

$$Y_t = \phi_1 + \sum_{i=1}^{k} \alpha_i Y_{t-i} + \sum_{i=1}^{k} \beta_i X_{t-i} + \mu_{1t} \quad (5)$$

$$X_t = \phi_2 + \sum_{i=1}^{k} \lambda_i X_{t-i} + \sum_{i=1}^{k} \delta_i Y_{t-i} + \mu_{2t} \quad (6)$$

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:

$$F = \frac{(SSE_1 - SSE_2)/k}{SSE_2/(T - 2k - 1)} \quad (7)$$

Where SSE_1, SSE_2 are the sum squared residual of regression equation 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, ordinary least squares (OLS) method was used to estimate the parameters β_0 and β_1 in model (4). Our statistical analyses were carried out using Eviews 8.0.

RESULTS

The plots of FDI from Hong Kong and RMB/HKD exchange rate indicate that the measurements were all from non-stationary processes in the original scale and in the log scale. It is also evident that trends of these two 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 from Hong Kong and RMB/HKD exchange rate exist unit root at a significance level 0.1. 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 (10%)	(C,T,N)
LFDI	0.81	-2.67	(C,0,0)
$\Delta LFDI$	-1.90*	-1.61	(0,0,0)
LER	1.19	-2.67	(C,0,0)
ΔLER	-1.71*	-1.61	(0,0,0)

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

In TABLE 2, the Granger causality of log transformed RMB /HKD exchange rate on FDI from Hong Kong 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 them, we were able to observe statistically significant results at a significance level 0.05.

TABLE 2 : Results from granger causality test

Null Hypothesis:	F-Statistic	P-value
LER does not Granger Cause LFDI	2.3723	0.1435
LFDI does not Granger Cause LER	0.8900	0.4408
ΔLER does not Granger Cause $\Delta LFDI$	7.2931	0.0131**
$\Delta LFDI$ does not Granger Cause ΔLER	0.4017	0.6806

Note : **denotes that statistical significance at 5% level.

Null Hypothesis: RESIDUAL has a unit root
Exogenous: None
Lag Length: 1 (Automatic based on SIC, MAXLAG=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.537938	0.0002
Test critical values:	1% level	-2.728252	
	5% level	-1.966270	
	10% level	-1.605026	

Figure 3 : Results from augmented dickey-fuller test on residual

To assess the goodness of fit of the co-integration model (4), we performed the Augmented Dickey-Fuller test on the residual for co-integration model of the log transformed time series. The test statistic was -4.54. The null hypothesis of unit root for the residual was rejected at a significance level 0.01(see Figure 3). That is to say, there is an equilibrium relationship between RMB/HKD exchange rate and FDI from Hong Kong in the long run.

From Figure 4 we know that, the estimate of β_1 was statistically different from zero at a significance level 0.01 in the co-integration model and the coefficient was -5.20, indicating that FDI from Hong Kong would increase by 5.20 log units for one log unit decrease in RMB/HKD exchange rate.

Sample: 1997 2013
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	38.65384	0.986731	39.17362	0.0000
LER	-5.200312	0.215434	-24.13877	0.0000

R-squared	0.974903	Mean dependent var	14.84201
Adjusted R-squared	0.973230	S.D. dependent var	0.588015
S.E. of regression	0.096209	Akaike info criterion	-1.734466
Sum squared resid	0.138841	Schwarz criterion	-1.636441
Log likelihood	16.74296	Hannan-Quinn criter.	-1.724722
F-statistic	582.6804	Durbin-Watson stat	1.207163
Prob(F-statistic)	0.000000		

Figure 4 : Results from the co-integration model

CONCLUSION

In this paper, we applied a co-integration model to establish the linear relationship of RMB/HKD exchange rate and FDI from Hong Kong, China. The co-integration model was statistically significant. Our results indicated that FDI from Hong Kong was negatively associated with RMB/HKD exchange rate. That is to say, the appreciation of RMB can promote FDI inflow, which is consistent with the theory of Campa(1993).

This study may be underpowered due to the relatively small number of observations. It is not surprising to reject the null hypothesis of unit root of the residual from model since it would be better and more powerful if a longer time series was used for the Augment Dickey-Fuller test.

In assessing the Granger causality of RMB/HKD exchange rate on FDI, our results showed that the Granger causality of RMB/HKD exchange rate was statistically significant, and it had a negative

effect on FDI. However, the Granger causality of FDI on RMB/HKD exchange rate was not statistically significant.

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