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Abstract
In this paper we analyze empirically the efficiency hypothesis after the revaluation on July 21, 2005, using daily non-deliverable forward (NDF) renminbi rates in the Hong Kong market. The efficiency hypothesis for the renminbi NDF market is rejected. Therefore, the NDF rate is not an unbiased predictor of the future spot rate.

Key words: renminbi; non-deliverable forward (NDF); foreign exchange market efficiency hypothesis

JEL classification: F31, F37

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1. Introduction

The Chinese govenment revalued the renminbi (RMB) per dollar by about 2 percentage points, to 8.11 from 8.2765 at 7 p.m. on July 21, 2005. It announced that the exchange rate regime would change trom the de facto dollar peg to a managed float in reference to the currency basket. However, the exchange rates have not appreciated very much. In this paper, we analyze empirically the efficiency hypothesis after the revaluation, using daily non-deliverable forward (NDF) renminbi rates in the Hong Kong market. If the efficiency hypothesis holds, the NDF rate is an unbiased predictor of the future spot rate. Could the NDF market forecast the valuation on July 21, 2005? The 1 month NDF rate was 8.2397, the 3 month rate was 8.1829, the 6 month rate was 8.0464, and the 12 month rate was 8.1731. Therefore, the 1, 3, and 12 month rates were underestimated while the 6 month rate was overestimated. It seems that the valuation was not anticipated accurately.

In the ilterature, the efficiency hypothesis in foreign exchange markets has been tested. For example, see Hai etc. (1997). However, the renminbi NDF has never been treated.

In Section 2, we show the empirical results. In Section 3, we give remark and the conclusion.

2. Empirical Results

Figure 1 shows the RMB spot rates and NDF (1, 3, 6, and 12 calendar months) rates. NDF rates are shifted to the right to compare with the corresponding future spot rates. We use NDF rates on contract date and the spot rates on valuation date, shown below.

・NDF rate (F) on contract date

↓ two business days later (if holiday, next available business day)

・initial date of reckoning

↓

・spot rate (S) on valuation date

↓ two business days prior to settlement

・settlement date

Daily data by CEIC Data Company Ltd. are used in this paper. But the estimation periods start from each date corresponding to 1, 3 and 6 month NDFs terms contracted on July 21, 2005 because the NDFs suddenly appreciated, as Figure 1 shows. In the case of the 12 month NDF, the estimation period of spot rates starts from July 21, 2005, corresponding to the 12 month NDF on July 21, 2004. The end of the data is May 10, 2006.

We start from unit root tests. If both spot and NDF variables have unit roots, we test Engle-Granger cointegration and then dynamic OLS (DOLS). Finally we test the efficiency hypothesis.

(1) Unit root test

(1 month NDF case)

As shown in Table 1, Augmented Dickey-Fuller (ADF) statistic of logarithm of spot rate, s, is 0.469 and ADF t statistic of logarithm of NDF rate, f, is -0.097. Moreover, ADF t statistics of the difference (Δ) of s and f are -12.085 and -40.764, respectively. Therefore both s and f have unit roots, i.e. I(1) at 1% significance level. We also checked PP and KPSS unit root tests and got robust results

(3 month NDF case)

The ADF t statistic of s is 0.234 and ADF t statistic of f is -0.006. The ADF t statistics of the difference of s and f are -6.718 and -26.641, respectively. Therefore both s and f have unit roots, i.e. I(1)

(6 month NDF case)

The ADF t statistic of s is -0.952 and ADF t statistic of f is -6.354. f does not have unit root. The ADF t statistics of the difference of s is -9.142. Therefore s has a unit root. In such a case we will not test cointegration.

(12 month NDF case)

The ADF t statistic of s is 0.568 and ADF t statistic of f is -1.718. The ADF t statistics of the difference of s and f are -8.531 and -15.188, respectively. Therefore both s and f have unit roots.

(2) Engle-Granger cointegration test

$s(t) = \alpha + \beta f(t\text{-}k) + u(t)$

where k=1, 3, 6 and 12 calendar months corresponding to the NDF contract.

(1 month NDF case)

As shown in Table 2, τ (ADF), ADF t statistic of residual derived from OLS regression following Engle-Granger cointegration test is -4.4. The residual of OLS regression is stationary, I(0). A cointegration relationship exists.

(3 month NDF case)

The ADF t statistic of residual derived from OLS regression following Engle-Granger cointegration test is -6.42. The residual of OLS regression is stationary, I(0). A cointegration relationship exists.

(12 month NDF cae)

The ADF t statistic of residual derived from OLS regression following Engle-Granger cointegration test is -0.61. The residual of OLS regression is not stationary. A cointegration relationship does not exist.

(3) Efficiency Hypothesis

We test the null hypothesis, H(0) of efficiency hypothesis in 1 and 3 month NDF cases.

H(0) : α=0, β=1, and u is serially uncorrelated (or white noise)

If the null hypothesis is not rejected, efficiency hypothesis holds.

(1 month NDF case)

As shown in Table 2,

α = 0.286 , β =0.864,

(0.045) (0.022)

standard errors are in parentheses

If investors are risk neutral, the constant term (α) is zero. However, if they are risk averse, α can be positive which may not necessarily imply the rejection of the efficiency hypothesis. However, β is significantly different from 1.

And the residual, u is serially correlated according to Box-Pierce tests Q(6) with lag=6.

Next, we estimate Stock and Watson's dynamic OLS (DOLS) regression with six leads and lags.

$$s_{t+k} = \alpha + \beta f_{k,t} + \sum_{i=-6}^{6} \gamma_i \Delta f_{k,t+i} + u_{k,t}$$

As shown in Table 3, α = 0.267 , β =0.873

F statistic is 93.51 so that the joint hypothesis (α =0 and β =1) is rejected. And β =1 is also rejected.

(3 month NDF case)

α = 0.618 , β = 0.706,

(0.052) (0.025)

Q(6) is 143.96. Therefore the residual is serially correlated.

From DOLS, α = 0.513, β =0.756. F statistic is 537.17 so that the joint hypothesis is rejected. And β =1 is also rejected.

3. Conclusion

In this paper we analyze empirically the efficiency hypothesis after the revaluation on July 21, 2005, using daily non-deliverable forward (NDF) renminbi rates in the Hong Kong market. The efficiency hypothesis in the renminbi 1 and 3 month NDF market is rejected. The NDF rate is not an unbiased predictor of the future spot rate. This phenomenon is generally referred to as “forward premium (or bias) puzzle”.

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Figure 1 Chinese renminbi spot rate and non-deliverable forward (NDF) rates

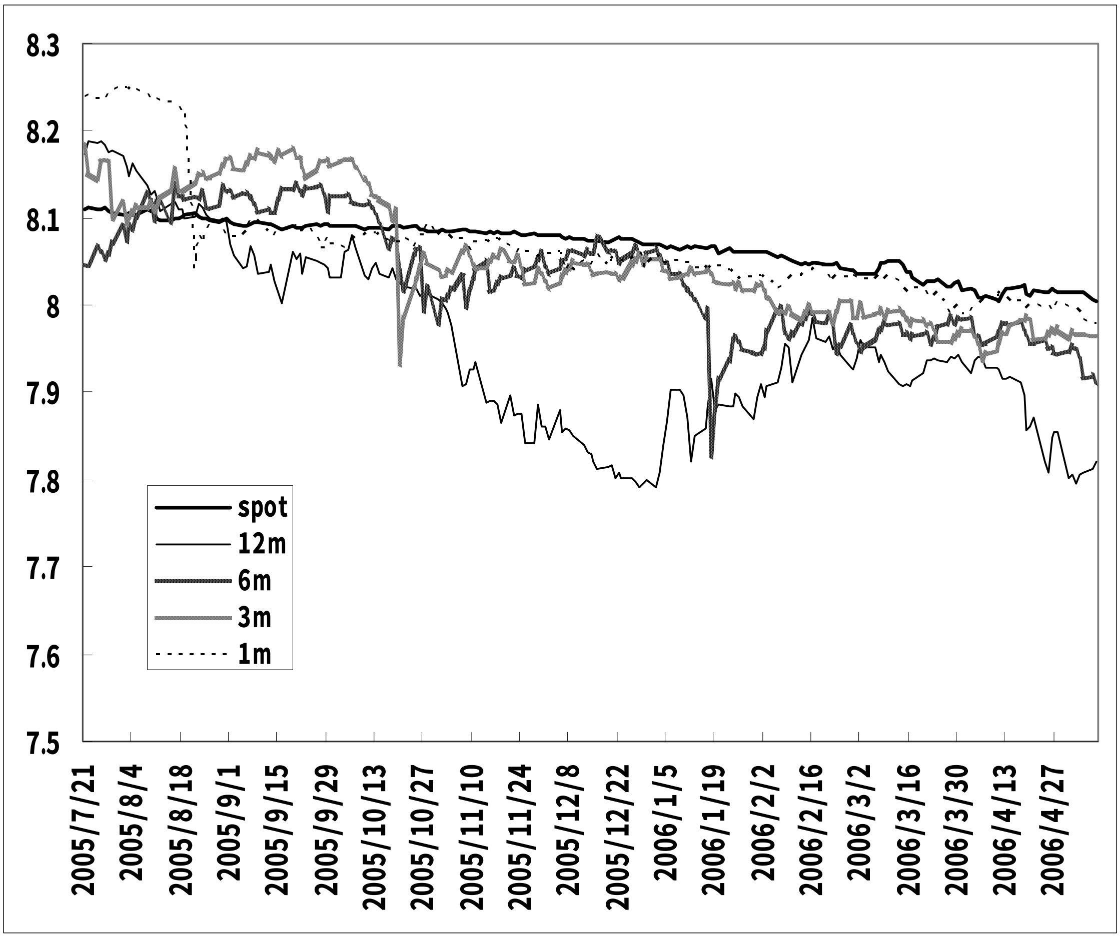

Table.1 Unit root tests

	lag		lag		lag		lag	
		$s_{1,t}$		$s_{3,t}$		$s_{6,t}$		$s_{12,t}$
ADF	0	0.469	5	0.234	0	-0.952	5	0.568
PP		0.497		0.065		-0.871		0.57
KPSS		2.606**		2.1**		1.159**		2.906**
		$\Delta s_{1,t}$		$\Delta s_{3,t}$		$\Delta s_{6,t}$		$\Delta s_{12,t}$
ADF	0	-12.085**	4	-6.718**	0	-9.142**	4	-8.531**
PP		-11.999**		-12.569**		-9.201**		-15.266**
KPSS		0.153		0.084		0.044		0.16
		$f_{1,t}$		$f_{3,t}$		$f_{6,t}$		$f_{12,t}$
ADF	1	-0.097	1	-0.006	0	-6.354**	0	-1.718
PP		-0.246		-2.527	6	-5.853**		-1.634
KPSS		2.63**		1.919**	6	0.22		1.93**
		$\Delta f_{1,t}$		$\Delta f_{3,t}$		$\Delta f_{6,t}$		$\Delta f_{12,t}$
ADF	0	-40.764**	0	-26.641**		-	0	-15.188**
PP		-47.336**		-24.263**		-		-15.503**
KPSS		0.292		0.344		-		0.174

Note. ADF is the augmented Dickey-Fuller test of a unit root against no unit root. All lag lengths are chosen based on SBIC. PP and KPSS indicate Phillips-Perron test and Kwiatkowski-Phillips-Schmidt-Shin (1992) test (Bandwidth=6). Tests for variables in levels and in first differences include a constant term. **: 1% siginificance level.

Table 2 Engle-Granger cointegration tests

$$s_{t+k} = \alpha + \beta f_{k,t} + u_{k,t}$$

	k=1	k=3	k=12
α	0.286	0.618	1.737
	(0.045)	(0.052)	(0.032)
β	0.864	0.706	0.169
	(0.022)	(0.025)	(0.016)
τ (ADF)	-4.4**	-6.42**	-0.61
τ (PP)	-4.47**	-6.51**	-0.55
Q(6)	320.09	143.96	-
p-value	[0]	[0]	-

Note. Newey-West HAC standard errors are in parentheses (lag truncation =6). τ (ADF) and τ (PP) are Studentized coefficients for the augmented Dickey-Fuller and the Phillips-Perron tests, respectively, that $\{u_{k,t}\}$ has a unit root. The 5% and 1% critical values are -3.37 and -4.00, respectively (Engle and Yoo, 1987). Q(6) is the Box-Pierce statistics with 6 lags for the residuals and the associate p-values are reported. **:1% siginificance level

Table 3. Cointegrating regressions (DOLS)

$$s_{t+k} = \alpha + \beta f_{k,t} + \sum_{i=-6}^{6} \gamma_i \Delta f_{k,t+i} + u_{k,t}$$

	k=1	k =3
α	0.267	0.513
	(0.085)	(0.080)
β	0.873	0.756
	(0.041)	(0.038)
t-value(α =0)	3.13**	6.42**
t-value(β =1)	9.66**	40.40**
F(α =0, β =1)	93.51**	537.17**

Note. Estimates of cointegrating regression coefficients using Stock and Watson's method with six leads and lags are reported. Newey-West HAC standard errors are in parentheses (lag truncation =6). **:1% significance level.

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