Project question for Empirical Finance

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Section 1 (to be completed by the student)

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Introduction

This essay focus on whether forward rates is an unbiased predictors of future spot exchange rates and do forward rates contain time varying risk premium. The essay is organized as follows. In the next section investigate whether the forward rate is an unbiased predictors of future spot exchange rate. In Section 2, descriptive data and unit root test are stated. In the third section, the co-integration between forward and future spot rates and unbiasedness hypothesis are tested. Section 4 tests forward premium that contains time varying risk premium and forward rate with information about the future rates. Section 5 computes the risk premium using Luintel and Paudyal (1998) method. Sec. 6 concludes the essay.

1. Tests of Forward Market Efficiency

Estimating following equation and testing the hypothesis of forward rate whether it is an unbiased predictor of future spot rate.

$$lnS_{t+1} = \kappa + \lambda lnF_t + \varepsilon_{t+1},$$

Where 'ln ' represent for logarithm, κ and λ are estimated parameters and ε is an error term. Under the rational expectations assumption, the null hypothesis is that F_t is an unbiased predictor, κ should equal to zero and λ is positive and equal to unit. The alternative hypothesis is κ different from zero and λ is different from unit. Edwards (1983) argued that forward rates to be unbiased predictors of future spot rates.

2. Descriptive data and unit root test

Now I turn to test the relationship between spot and forward exchange rates of pound sterling against four currencies: Australian dollar, Chinese Yuan, Indian Rupees, and US Dollar. The future spot rates are matched with the respective forward rates. Each sample consists of 4450 observations between 3 January, 2000 and 20 January, 2017, except for forward rates of Chinese Yuan, which only consists of 3900 available observations between 11 February, 2002 and 20 January, 2017. The descriptive statistics and unit root tests of the data are documented in Table 1.

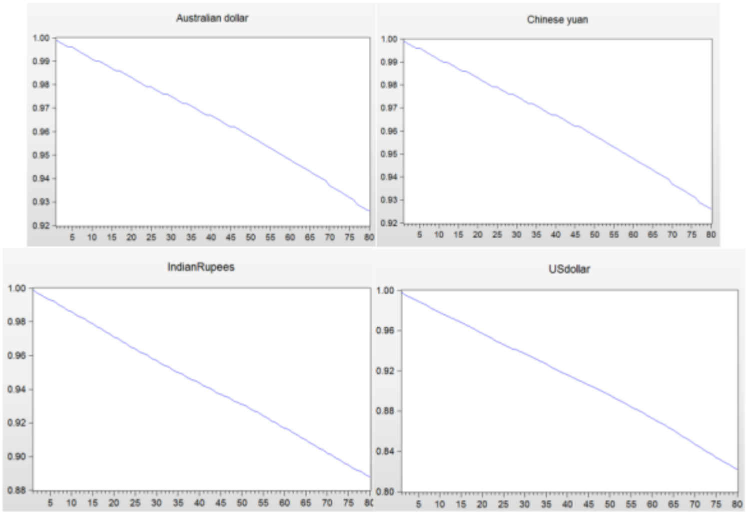
Table 1: Descriptive statistics of percentage change and stationarity of nominal exchange rates

Currency	Spot rates				Forward rates			
	Mean	S.D.	ADF 1st diff.	ADF level	Mean	S.D.	ADF 1st diff.	ADF level
AUD	0.746804	0.203849	-67.1827	-2.22	0.748309	0.202912	-67.1864	-2.23
CHY	2.463819	0.179505	-64.9718	-1.61	2.457355	0.187746	-61.3978	-2.79
INR	4.390517	0.121022	-66.4000	-2.29	4.393843	0.122105	-66.2699	-2.29
USA	0.485612	0.109800	-64.0639	-1.21	0.485612	0.109800	-64.0663	-1.21

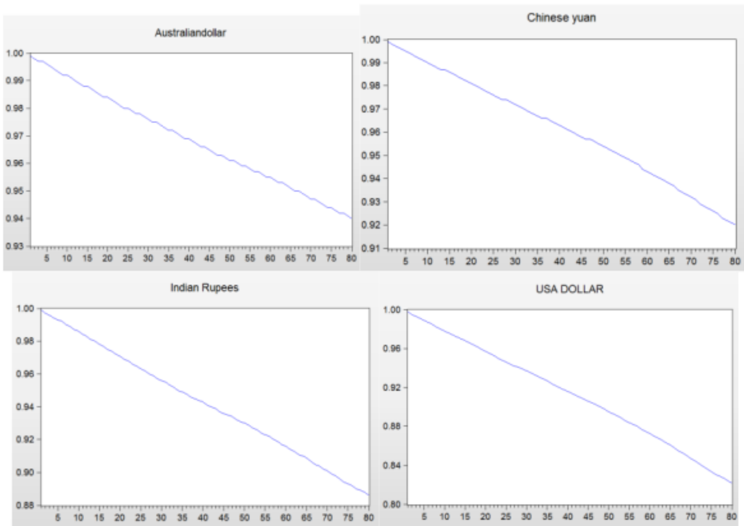
ADF critical value at 5.0% significant level: 3.41

Variable are expressed in natural logarithms.

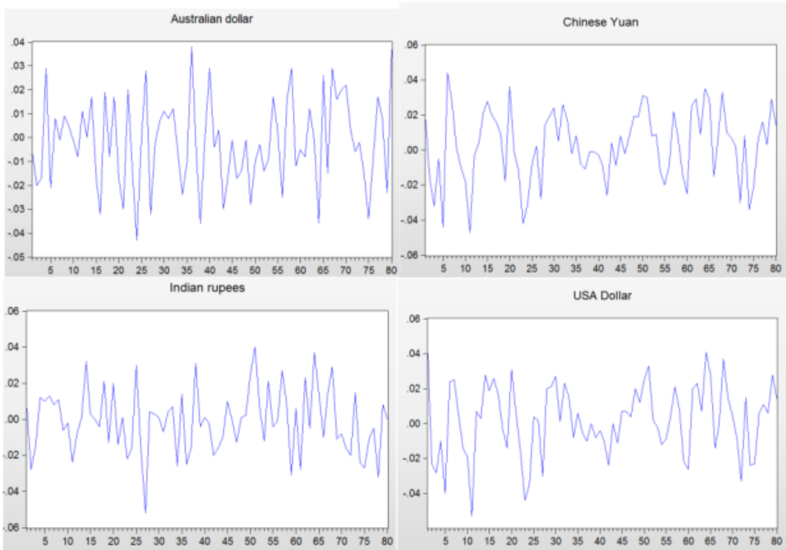
Figure 1: Autocorrelation functions in the Logarithm of forward rates



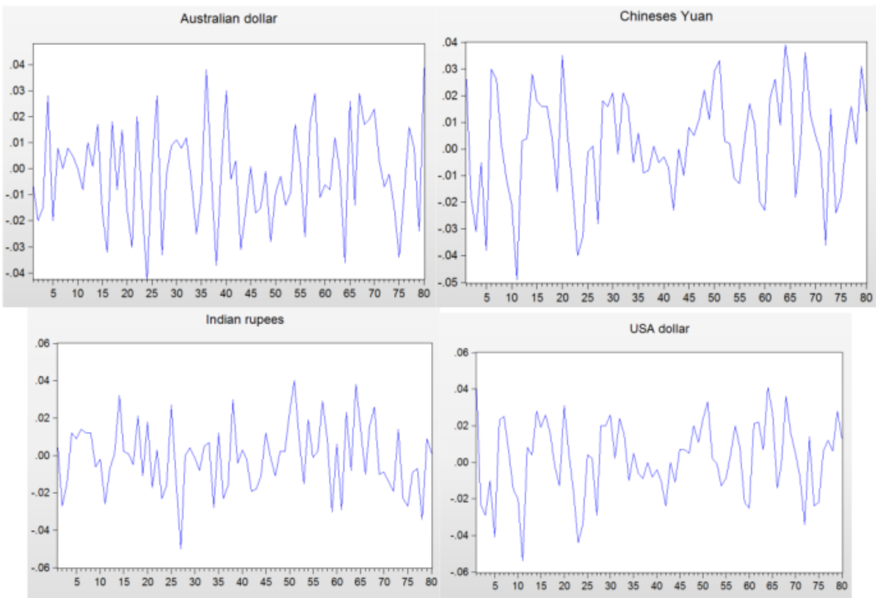
Autocorrelation Function in the Logarithm of Spot Rates



Autocorrelation functions of changes in the log level of forward rates



Autocorrelation functions of changes in the log level of spot rates



From table 1, Augment Dickey-Fuller (ADF) tests on log levels and their first difference exhibit that both spot rates and forward rates are first difference stationary. In Fig.1, I plot the first 80 autocorrelation coefficients of the log levels and logarithmic changes of F_t and S_{t+1} for all currency. Clearly, F_t and S_{t+1} are stationary in first difference and non-stationary in level, which consistent with previous results of ADF test.

3. Co-integrating tests

Since both F_t and S_{t+1} are first order integrated, I cannot estimate using traditional OLS since regress on non-stationary data suffer from a non-standard distribution. First, to analysis of long-run co-integrating relationship using Dynamic OLS (DOLS) method. The advantages of DOLS method is allowed me test significance of parameter and conduct Hypothesis tests using Wald statistic. After estimating regression and generate the error correction term (ECT). Use the ADF test for the stationarity of ECT. If ECT is stationary, there is a robust co-integrated relationship between corresponding F_t and S_{t+1}. The results suggest that F_t and S_{t+1} are co-integrated in 5.0% significance level expect for USA, which reject null of unit root in 10.0% significance level.

Table 2: Co-integration test between F_t and S_{t+1}

Cointegrating vector	ADF	Probability
AU\$$\boldsymbol{S_{t+1}}$ =-0.005+1.005AU\$$\boldsymbol{F_t}$	-3.216	0.0335
CHY$\boldsymbol{S_{t+1}}$ = -0.035+1.015CHY$\boldsymbol{F_t}$	-7.044	0.0000
INR$\boldsymbol{S_{t+1}}$ = 0.038+ 0.991INR$\boldsymbol{F_t}$	-3.749	0.0035
USA$\boldsymbol{S_{t+1}}$ = -0.001+1.003USA$\boldsymbol{F_t}$	-2.578	0.0977

Tests based on DOLS procedure. The critical value at the 5% significance level is -2.86.

Now I can use Wald statistic method test the significance of κ and λ. From result, Table 3 show that the results of the Wald tests of the unbiasedness hypothesis. The second column of Table 3 Wald test statistics under the null of zero intercept. At the 5.0% significance level the null rejected in all case. The third column contains the Wald test statistics under the null of a unit slope coefficient. This null is s rejected in all case. Moreover, the third column contains the joint test of both of null ,results suggest the unbiasedness hypothesis is rejected in all cases at the 5% level. Therefore, it could be conduct that a robust co-integrating relation exists between F_t and S_{t+1}. Nevertheless, in figure 2, I plot the ECT term. Obviously, the statistic around zero, which reinforces the result of the ADF tests. The results strongly opposed to the unbiasedness of the forward rate.

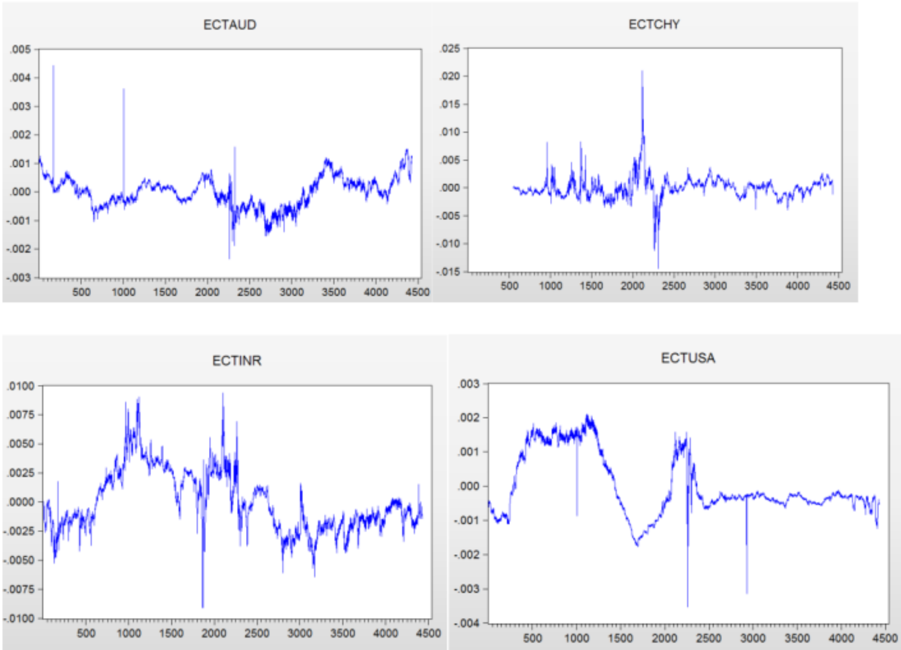
Table 3: Wald tests of unbiasedness of F_t in predicting S_{t+1}

Cointegrating vector:	κ= 0	λ= 1	κ= 0 ∩ λ= 1
AU\$$S_{t+1}$ =-0.005+1.005AU\$$F_t$	2795.004	1447.953	5264.862

CHYS_{t+1} = -0.035+1.015CHYF_t	722.7604	776.8208	919.7573
INRS_{t+1} = 0.038+ 0.991INRF_t	74.53925	88.34279	850.1797
USAS_{t+1} = -0.001+1.003USAF_t	15.77607	55.75184	289.7074

All Wald test statistics are χ^2 distributed with degree of freedom 1. Figures within parenthesis are x 1 statistics computed under the null of zero coefficient.

Figure 2: Plot the ECT term for all currency.



My findings are consistent with Luintel and Paudyal (1998) and Evans and Lewis (1995). Luintel and Paudyal find a robust co-integrating relationship exists between F_t and S_{t+1} of the pound Sterling vis-`a-vis five major currencies. For unbiasedness of the forward rate, except for C$, the unbiasedness hypothesis is rejected in all other cases at the 5% level.

4. Do forward rates contain time varying risk premium

It has been argued that lack of one for one co-integrated relationship between spot and future rates is because F_t contains time varying risk premium. Hansen and Hodrick (1983), Hodrick and Srivastava (1984), and Korajczyk (1983) findings support for existence of time varying premiums in forward rates. Fama (1984) tests a model for joint measurement of variation in the premium and conduct that the biasedness of the forward rate is caused by a time varying risk premium. Estimating the following equation proposed by Fama (1984) to examine existence:

$$\text{Ln } F_t - \ln S_{t+1} = \alpha_1 + \beta_1(lnF_t - lnS_t) + \varepsilon_{1,t+1}$$

$$\text{Ln } S_{t+1} - lnS_t = \alpha_2 + \beta_2(lnF_t - lnS_t) + \varepsilon_{2,t+1}$$

Where β_1 is significantly different from zero means that premium component of $(F_t - S_t)$ contains a variation and β_2 significantly different from zero means the information about the future rates have been contained in the forward rate. Suggestion by Fama (1984) that measure variation of the premium in forward rate is depend on standard deviation of β_2 different from one. Estimate these two models in all currency and results are show in Table 4.

Table 4: Test of the existence of risk premium in the forward exchange rate: estimation of Fama

Currency	α_1	β_1	α_2	β_2	S(α)	S(β)	R_1b^2	R_2b^2	P(β_1)	P(β_2)
AUD	0.001	1.458	-0.001	-0.458	0.0008	0.4574	0.00	0.00	0.0014	0.3163
CHY	0.002	1.328	-0.002	-0.328	0.0005	0.1302	0.03	0.00	0.0000	0.0119
INR	-0.002	1.265	0.002	-0.265	0.0007	0.1567	0.01	0.00	0.0000	0.0906
USA	0.002	2.171	-0.002	-1.171	0.0005	0.4343	0.01	0.00	0.0000	0.0070

P ($\boldsymbol{\beta_1}$) and P($\boldsymbol{\beta_2}$) are probability of respective coefficients. Below 0.05 means reject null hypothesis in 5.0% significant level.

S (.) indicates the standard error of respective coefficients. Since they are very close only one set of coefficient standard errors is reported
R_1b^2 and R_2b^2 are R-bar squares associated with Eqs. (2). and (3). In the text, respectively.

From Wald test results suggest that β_1 for all currency rates in the sample are significantly different from zero and unity. According suggests appropriate specifications from FAMA (1984), the forward premium contains time varying risk premium. Also, from results of statistical significance β_2 for all currencies shows that the information about the future rates have been contained in the forward rate. However, for CHY and USA currency of β_2 is negative and significant but for AUD and INR currency of β_2 is not significant. INR is significant in 10% level. Same findings are also found by Luintel and Paudyal (1998) and Evans and Lewis (1995). My findings complementarity between two models proposed by

Fama. Since F_t is a biased predictor of S_{t+1}, I have proven this above. It is well known that the presence of time varying risk premium in forward rates that makesF_t a biased predictor of S_{t+1}.

5. Measuring the risk premium

I use method by Luintel and Paudyal (1998) to measure of risk premium. It could regard risk premium as $(lnF_t - lnS_{t+1})/\ lnF_t$ and forward premium as $(lnF_t - lnS_t)/\ lnS_t$. Test risk premium by using ADF method, results are reported in Table 5. Finally test random walk on risk premium by busing variance ratio tests, the results presented in Table 6.

Table 5 Unit root tests on risk premium

Currencies	AUD	CHY	INR	USA
ADF	-8.26	-8.07	-9.08	-9.48
Probability	0.0000	0.0000	0.0000	0.0000

The critical value of ADF tests at the 5.0% significance level is -2.86.

Figure 3: Plot the risk premium and the forward premium

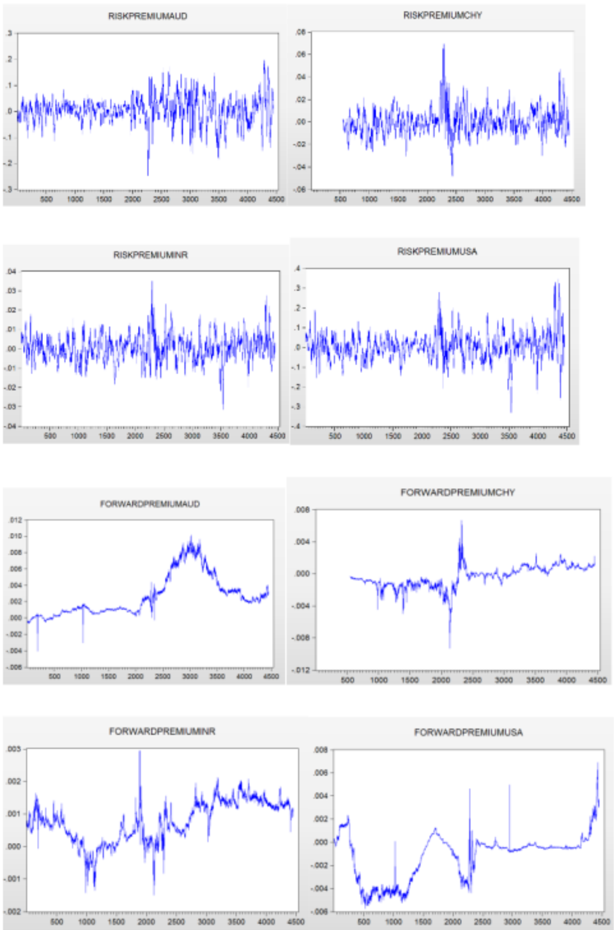


Table 6: Variance ratio test on risk premium

Currency	**AUD**	**CHY**	**INR**	**USD**
Value	1.09	1.98	1.19	1.04
Probability	0.728	0.178	0.653	0.756

The results suggest all risk premium are rejected null hypothesis of unit root, which means time varying risk premiums for all currency are stationary. Fig. 2 plot risk premium and the forward premium. Clearly, the degree of risk premium correlation decreased rapidly and number close to zero, which reinforce the results of ADF tests. Moreover, results of variance ratio tests suggest risk premium is random walk.

6. Conclusion

In this easy I mainly test forward market efficiency, then discuss the forward rates contain risk premium and to compute it by Luintel and Paudyal.

I find that the forward rate is a biased predictor of future spot rate which attributed contains a time varying risk premium. Same results is confirmed following Fama (1984). Measure Risk premium based on rational expectations and results suggest it is stationary, which support Evans and Lewis.

Reference:

Evans, M. and Lewis, K. 1995. Do Long-Term Swings in the Dollar Affect Estimates of the Risk Premia?. *Review of Financial Studies*, 8(3), pp.709-742.

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