Chapter 5

Results and the Interpretation

Results and the Interpretation

I) Testing of the efficiency of the foreign exchange market

The equation (1) in chapter 4 was tested the efficiency of the foreign exchange market by using the ordinary least square method. The regression equation can be expressed as the following :

$$\ln S_t = a + b\ln F_{t-1} + u_t \quad \text{----------} (1)$$

The empirical result of testing the model from July 2, 1997 to February 18, 1998 is shown in equation (2)

$$\ln S_t = 3.290023 + 0.141676\ln F_{t-1} \quad \text{----------} (2)$$
$$(3.390897) \quad (0.581033)$$

$$\text{Adjust } R^2 = 0.902212$$
$$\text{F-statistic} = 167.0719$$

The other statistics are shown in table 3

Table3: Regression results of the efficiency of the foreign exchange market equation

LS // Dependent Variable is LNS1
Date: 05/18/98 Time: 15:23
Sample(adjusted): 2 38
Included observations: 37 after adjusting endpoints
Convergence achieved after 5 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.290023	0.970252	3.390897	0.0018
LNF1	0.141676	0.243834	0.581033	0.5651
AR(1)	0.928187	0.063159	14.66426	0.0000

R-squared	0.907645	Mean dependent var	3.778050
Adjusted R-squared	0.902212	S.D. dependent var	0.139494
S.E. of regression	0.043621	Akaike info criterion	-6.186820
Sum squared resid	0.064695	Schwarz criterion	-6.056205
Log likelihood	64.95544	F-statistic	167.0719
Durbin-Watson stat	1.857082	Prob(F-statistic)	0.000000

Inverted AR Roots	.93

Esrimation Method: Ordinary Least Squares

According to t-statistic which are greater than 1.671, the coefficients of the logarithm of the lagged forward rate is significantly indifferent from zero at 5 percent level of significance but the computed F-statistic is 167.0719 which is higher than the critical F-statistic with 1 and 54 degrees of freedom. So the null hypothesis that all coefficients are jointly zero can be strongly rejected.

From the coefficient of the logarithm of lagged forward rate, if the 1-month forward rate in previous period increase 1 Baht, the current spot exchange rate may increase 0.141676 Baht. It can be explained that the 1-month forward rate in previous period is less influenced in the current spot exchange rate. From this result, it can be concluded that the foreign

exchange rate. From this result, it can be concluded that the foreign exchange market is inefficient under the risk neutrality and rational expectation, then, the forward rate is not an unbiased forecast of the future spot rate. This may be because of a failure of rational expectation or because there exists a sizeable time varying risk premium.

II) Testing of the determination of the exchange rate in the short-run : The News Model

The equation used in our estimation is equation (9). In this equation, the expected interest rate differential can be computed first by using the ordinary least squares (OLS) method.

The model used in the analysis is as the following :

$$\ln S_t = a + b\ln F_{t-1} + \alpha\left\{\left[(\imath - \imath^*)\right]_t - E_{t-1}\left[(\imath - \imath^*)_t\right]\right\} + u_t \qquad \text{------ (9)}$$

From this equation , the expected interest rate differential is computed from a regression of the interest rate differential on a constant , on a lagged values of the differential , and the logarithm of the lagged forward exchange rates[1].

Model 1) : According to, 1-month interest rate differential and 1-month forward rates are computed which can express as :

[1] See also chapter 4

By using ordinary least squares method, the estimated equation, with t-statistics in parentheses, is, as the following :

$$E_{t-1}(i - i^*)_t = -0.003286 - 0.287516(i - i^*)_{t-1} + 0.252470F_{t-1} \quad -- (11)$$
$$(-0.001921) \quad (-2.028616) \quad (0.555391)$$

$$\text{Adjust } R^2 = 0.459641$$
$$\text{F-statistic} = 11.20746$$

The other statistics are shown in table 4

Table4: Regression results of the expected interest rate differential equation(1)

LS // Dependent Variable is LAG1DI1
Date: 05/15/98 Time: 05:58
Sample(adjusted): 2 38
Included observations: 37 after adjusting endpoints
Convergence achieved after 9 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003286	1.710869	-0.001921	0.9985
LAG2DI1	-0.287516	0.141730	-2.028616	0.0506
LNF1	0.252470	0.454581	0.555391	0.5824
AR(1)	0.620566	0.132304	4.690452	0.0000

R-squared	0.504671	Mean dependent var	0.740246
Adjusted R-squared	0.459641	S.D. dependent var	0.265295
S.E. of regression	0.195016	Akaike info criterion	-3.167539
Sum squared resid	1.255035	Schwarz criterion	-2.993385
Log likelihood	10.09874	F-statistic	11.20746
Durbin-Watson stat	1.667582	Prob(F-statistic)	0.000032

Inverted AR Roots .62

Esrimation Method: Ordinary Least Squares

According to t-statistic which are greater than 1.697, the coefficient of the lagged value of interest differential is statistically differ from zero at 5 percent level of significance. The coefficient of the forward rate is not statistically significant, therefore, we will drop this variable from the model.

Model 2) : The model used in this analysis is as the following :

$$E_{t-1}(i - i^*)_t = a + b(i - i^*)_{t-1} + u_t \qquad \text{——— (12)}$$

By using ordinary least squares method, the estimated equation, with t-statistics in parentheses, is, as the following :

$$E_{t-1}(i - i^*)_t = -0.945129 - 0.289540(i - i^*)_{t-1} \qquad \text{——— (13)}$$
$$(-7.679317) \quad (-2.065639)$$

Adjust R^2 = 0.470620

F-statistic = 17.00206

The other statistics are shown in table 5

Table5: Regression results of the expected interest rate differential equation(2)

LS // Dependent Variable is LAG1DI1
Date: 05/15/98 Time: 07:49
Sample(adjusted): 2 38
Included observations: 37 after adjusting endpoints
Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.945129	0.123075	7.679317	0.0000
LAG2DI1	-0.289540	0.140170	-2.065639	0.0466
AR(1)	0.622287	0.128264	4.851619	0.0000

R-squared	0.500030	Mean dependent var	0.740246
Adjusted R-squared	0.470620	S.D. dependent var	0.265295
S.E. of regression	0.193025	Akaike info criterion	-3.212268
Sum squared resid	1.266793	Schwarz criterion	-3.081653
Log likelihood	9.926227	F-statistic	17.00206
Durbin-Watson stat	1.686250	Prob(F-statistic)	0.000008

Inverted AR Roots .62

Esrimation Method: Ordinary Least Squares

The coefficient of all explanatory variables statistically differ from zero at 5 percent levels of significance.

The expected interest differentials can be computed directly from equation (13) . Then, minus the actual interest differential by corresponding computed expected interest differential to obtain news.

Model 3) : The future spot exchange rate is determined by two factors : expected future exchange rate reflecting on the forward exchange rate and unexpected new information which is called news. The regression format is as below :

$$\ln S_t = a + b\ln F_{t-1} + \alpha\left\{\left[(\imath - \imath^*)\right]_t - E_{t-1}\left[(\imath - \imath^*)_t\right]\right\} + u_t \quad \text{----(9)}$$

By the method of ordinary least squares, the regression result including t-statistic is shown as the following equation :

$$\ln S_t = 1.577131 + 0.590350 \ln F_{t-1} + 0.023393 news$$
$$(4.756240) \quad (6.644752) \quad (0.669526)$$

$$\text{Adjust } R^2 = 0.539365$$

$$\text{F-statistic} = 22.07652$$

The other statistics are shown in table 6

Table6: Regression results of the spot exchange rate equation (3)

LS // Dependent Variable is LNS1
Date: 05/15/98 Time: 11:47
Sample(adjusted): 2 38
Included observations: 37 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.577131	0.331592	4.756240	0.0000
LNF1	0.590350	0.088845	6.644752	0.0000
NEWS	0.023393	0.034939	0.669526	0.5077

R-squared	0.564956	Mean dependent var	3.778050
Adjusted R-squared	0.539365	S.D. dependent var	0.139494
S.E. of regression	0.094675	Akaike info criterion	-4.637015
Sum squared resid	0.304751	Schwarz criterion	-4.506400
Log likelihood	36.28405	F-statistic	22.07652
Durbin-Watson stat	0.24063	Prob(F-statistic)	0.000001

Esrimation Method: Ordinary Least Squares

$\ln F_{t-1}$ is highly correlated with $\ln S_{t-1}$, Durbin-Watson statistic may not be appropriate. Durbin's h-statistic is also not valid in this case[2]. Durbin proposed an alternative method to test autocorrelation by estimating the equation.

Model 4) : After correcting this problem, the result of this model is shown in this equation.

$$\ln S_t = 3.613727 + 0.063391 \ln F_{t-1} + 0.023520 news$$
$$(3.668158) \quad (0.256617) \quad (1.023555)$$

Adjust R^2 = 0.9000917

F-statistic = 107.0796

The other statistics are shown in table 7.

[2] Damodar N. Gujarati, Basic econometric, p. 327.

Table7: Regression results of the spot exchange rate equation

LS // Dependent Variable is LNS1
Date: 05/18/98 Time: 11:48
Sample(adjusted): 3 38
Included observations: 36 after adjusting endpoints
Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.613727	0.985161	3.668158	0.0009
LNF1	0.063391	0.247027	0.256617	0.7991
NEWS	0.023520	0.022979	1.023555	0.3137
AR(1)	0.914351	0.059644	15.33017	0.0000

R-squared	0.909410	Mean dependent var	3.783454
Adjusted R-squared	0.900917	S.D. dependent var	0.137489
S.E. of regression	0.043278	Akaike info criterion	-6.175779
Sum squared resid	0.059936	Schwarz criterion	-5.999832
Log likelihood	64.08223	F-statistic	107.0796
Durbin-Watson stat	1.897202	Prob(F-statistic)	0.000000

Inverted AR Roots .91

Estimation Method: Ordinary Least Squares

The coefficient of both lnF_{t-1} and news are positive. The sign of the coefficient of news, in fact, may be either positive or negative, depending on the sources of news. The coefficient of them are significantly indifferent from zero at 5 percent level of significance. The overall test shows that F-statistic with 2 and 35 degrees of freedom is much greater than critical value so null hypothesis that all coefficients are jointly zero can be strongly rejected. In this regression , the computed F-statistic is 107.0796 which is highly significant so we can reject the null hypothesis.

The comparison with Frenkel's Model

We want to compare the result of our analysis with Frenkel's analysis of Dollar/Pound, Dollar/DM, and Dollar/Franc.

Frenkel found a statistically significant α in a model of Dollar/Pound but in other two model (Dollar/DM and Dollar/Franc) α were not significantly different from zero. The result of his study is shown in this table below.

$\ln S_t$	Constant	$\ln F_{t-1}$	News	R^2
Dollar/Pound	0.031	0.959	0.432	0.96
	(1.824)	(39.958)	(2.387)	
Dollar/DM	-0.022	0.972	0.413	0.93
	(-0.846)	(31.355)	(1.190)	
Dollar/Franc	-2.46	0.837	0.245	0.80
	(-31.448)	(16.412)	(1.467)	

Source:Frenkel (1981)

It can be concluded from Frenkel's analysis that the current exchange rates already reflect expectations concerning the future course of events implies that the unanticipated changes in exchange rate are primarily due to innovations or news. From this results, the current changes in exchange rates are response to new information, therefore, the evidence indicates the importance of innovations in the interest differential.

The result of our analysis.

$\ln S_t$	Constant	$\ln F_{t-1}$	News	R^2
Baht/US dollar	3.614	0.063	0.024	0.91
	(3.668)	(0.251)	(1.024)	

From our analysis, the coefficient of both lagged forward rate which are based on past information and news are significantly indifferent from zero at 5 percent level of significance. This indicates that both of these variables do not have any effect to changes in the current spot exchange rate in this period.

III) Testing of the determination of exchange rate in the long-run.

The equation (10) from chapter 4 was estimated by using cointegration method which tests the long run relationship between the current spot exchange rate and the price level in the logarithm forms. The price level are used to be the spot exchange rate which are computed from the $\ln(P/P^*)$ according to the purchasing power parities.

The regression equation can be expressed as the following :

$$\Delta_t = \ln S_t - \ln (P/P^*)_t \qquad \text{---------} (10)$$

where Δ_t is the deviation from purchasing power parity during month t

P . is the consumer price indices of Thailand

P^* is the consumer price indices of US

$\ln S_t$ is the logarithm of the current spot exchange rate (Baht / US dollar)

Firstly, we test in stationarity in both the spot exchange rate and the price level. Secondly, we perform the unit root test on the residual of equation (11) to find the cointegration of the two variables. The result indicates that there is no long run relation between the spot exchange rate and the price level. Thirdly, we search for the deviation pattern of analysis.

Table 11 : Augmented Dickey-Fuller Unit Root Test on exchange rate in logarithm form

ADF Test Statistic	-4.006519	1% Critical Value*	-3.5850
		5% Critical Value	-2.9286
		10% Critical Value	-2.6021

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(F1LNEM,2)
Date: 04/30/98 Time: 11.47
Sample(adjusted): 1994:04 1997:11
Included observations: 44 after adjusting endpoints

Variable	Coefficient	Std. Error	T-statistic	Prob.
D(F1LNEM(-1))	-0.799337	0.199509	-4.006519	0.0003
D(F1LNEM(-1),2)	0.033630	0.168011	0.200162	0.8423
C	0.008573	0.006974	1.229345	0.2260

R-squared	0.387896	Mean dependent var	0.000307
Adjuated R-squared	0.358038	S.D. dependent var	0.055736
S.E. of regression	0.044657	Akaike info criterion	-6.151725
Sum squared resid	0.081766	Schwarz criterion	-6.030076
Log likelihood	75.90466	F-statistic	12.99106
Durbin-Watson stat	1.972696	Prob(F-statistic)	0.000043

From table 11, it shows that the spot rate in logarithm form is stationary in first difference because the computed value in absolute term is 4.006519 which is less than the 1%, 5%, and 10% ADF critical values are -3.5850, -2.9286, and -2.6021, respectively.

Table 12 : Augmented Dickey-Fuller Unit Root Test on price level in logarithm form

ADF Test Statistic	-3.372970	1% Critical Value*	-3.5850
		5% Critical Value	-2.9286
		10% Critical Value	-2.6021

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(F1LNPPP,2)
Date: 04/30/98 Time: 12.02
Sample(adjusted): 1994:04 1997:11
Included observations: 44 after adjusting endpoints

Variable	Coefficient	Std. Error	T-statistic	Prob.
D(F1LNPPP(-1))	-0.701579	0.208000	-3.372970	0.0016
D(F1LNPPP(-1),2)	-0.236185	0.154185	-1.531825	0.1332
C	0.002187	0.001153	1.896339	0.0650

R-squared	0.490026	Mean dependent var	0.000141
Adjuated R-squared	0.465149	S.D. dependent var	0.009148
S.E. of regression	0.006690	Akaike info criterion	-9.948530
Sum squared resid	0.001835	Schwarz criterion	-9.826881
Log likelihood	159.4344	F-statistic	19.69811
Durbin-Watson stat	2.025312	Prob(F-statistic)	0.000001

Table 12 demonstrates that price level (lnP/P*) is stationary in first difference. According to the computed absolute value is 3.37290 which is less

than the 1%, 5%,and 10% ADF critical values are -3.5850, -2.9286, and -2.6021, respectively.

Then, we test the long run relationship between the spot exchange rate and the price level in the logarithm forms.

$$\ln S_t = a + b\ln(P/P^*)_t + u_t \qquad \text{----------} (11)$$

By using the ordinary least squares method, the estimated equation, with t-statistic in parentheses, is :

$$\ln S_t = 48.50414 + 1.549212\ln(P/P^*)_t$$

$$\text{Adjust } R^2 = 1.867725$$

$$\text{F-statistic} = 148.5996$$

Table13: Regression results of the spot exchange rate equation

LS // Dependent Variable is LNEM
Date: 05/15/98 Time: 06:21
Sample(adjusted): 1994:02 1997:11
Included observations: 46 after adjusting endpoints
Convergence achieved after 100 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	48.50414	29189.79	0.001662	0.9987
LNPPP	1.549212	1.027201	1.508187	0.1388
AR(1)	0.999874	0.085590	11.68220	0.0000

R-squared	0.873603	Mean dependent var	3.265930
Adjusted R-squared	0.867725	S.D. dependent var	0.120073
S.E. of regression	0.043670	Akaike info criterion	-6.199194
Sum squared resid	0.082004	Schwarz criterion	-6.079935
Log likelihood	80.31029	F-statistic	148.5996
Durbin-Watson stat	1.741503	Prob(F-statistic)	0.000000

Inverted AR Roots 1.00

Esrimation Method: Ordinary Least Squares

The residual are estimated in this regression by Engle-Granger test .

Table 14 : Augment Dickey-Fuller Unit Root Test on Residual

ADF Test Statistic	-2.258511	1% Critical Value*	-3.5889
		5% Critical Value	-2.9303
		10% Critical Value	-2.6030

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
LS // Dependent Variable is D(RESIDUAL)
Date: 05/15/98 Time: 12.05
Sample(adjusted): 1994:05 1997:11
Included observations: 43 after adjusting endpoints

Variable	Coefficient	Std. Error	T-statistic	Prob.
RESIDUAL(-1)	-0.570073	0.252411	-2.258511	0.0296
D(RESIDUAL(-1)	-0.294168	0.216628	-1.357941	0.1823
D(RESIDUAL(-2)	-0.355478	0.161246	-2.204570	0.0335
C	0.001647	0.006548	0.251509	0.8027

R-squared	0.500051	Mean dependent var	0.000197
Adjuated R-squared	0.461593	S.D. dependent var	0.058305
S.E. of regression	0.042782	Akaike info criterion	-6.214853
Sum squared resid	0.071383	Schwarz criterion	-6.051020
Log likelihood	76.60498	F-statistic	13.00264
Durbin-Watson stat	1.876368	Prob(F-statistic)	0.000005

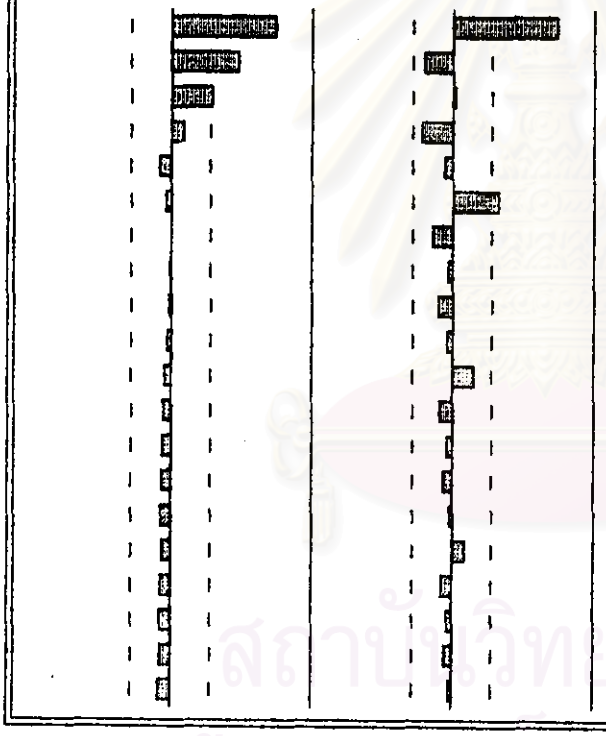
From this result, the Engle-Granger 1%, 5%, and 10% critical values are -3.5889, -2.9303, and -2.6030, respectively. Since in absolute terms the estimated value of 2.258511 is still below any of these critical values, the conclusion would be that the residual is non-stationary. All the above, there is no long run relation between the spot exchange rate and the price level.

Then, the pattern of deviations from purchasing power parities for consumer price indices are examined by using the autocorrelation functions and the partial autocorrelation functions.

Table15:The autocorrelation functions and the partial autocorrelation functions

Correlogram of DT

Date: 05/22/98 Time: 04:51
Sample: 1994:01 1997:11
Included observations: 47



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.763	0.763	29.126	0.000
		2	0.493	-0.211	41.586	0.000
		3	0.303	0.021	46.400	0.000
		4	0.093	-0.227	46.866	0.000
		5	-0.079	-0.057	47.207	0.000
		6	-0.033	0.339	47.270	0.000
		7	0.004	-0.139	47.270	0.000
		8	-0.008	-0.028	47.274	0.000
		9	-0.014	-0.100	47.285	0.000
		10	-0.025	-0.033	47.324	0.000
		11	-0.045	0.164	47.454	0.000
		12	-0.054	-0.093	47.647	0.000
		13	-0.058	-0.034	47.872	0.000
		14	-0.064	-0.059	48.160	0.000
		15	-0.068	-0.023	48.494	0.000
		16	-0.065	0.094	48.812	0.000
		17	-0.069	-0.081	49.174	0.000
		18	-0.074	-0.034	49.611	0.000
		19	-0.081	-0.050	50.144	0.000
		20	-0.086	-0.021	50.780	0.000

For this data, the Q-statistic based on 20 lags is about 29.126 exceeds the critical Q value from the chi-square table at 5 precent level of significance. It can reject the null hypothesis.

Based on correlogram, this conclusion is that the deviations from purchasing power parities is not stationary. In this case the autocorrelation function tails off at what seems to be an exponential rate, and the partial autocorrelation function shows a spike. This pattern seems to indicate that the deviations from purchasing power parities follow a first-order autoregressive process[28].

In view of this possibility it can be concluded that the deviations from purchasing power parities seem to follow a first-order autoregressive process. It implies that the deviation from purchasing power parities for consumer price indices from the last period can be used to determine the deviation from purchasing power parities for consumer price indices in this period.

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[28] Table 16 : Theoritical patterns of ACF and PACF

Typeof model	Typical pattern of ACF	Typical pattern of PACF
AR(p)	Decays exponentially or with damped sine wave pattern or both	Significant spikes through lags p
MA(q)	Significant spikes through lags p	Declines exponentially
ARMA(p,q)	Exponential decay	Exponential decay

Source: Damonar N. Gujarati, Basic econometric.