

The forward exchange rate as a predictor of the spot rate: The case of the B.L.E.U. Some further results

I. INTRODUCTION

In a recent article in this Review¹ Mr. Verwilt contributed to the testing of the efficiency hypothesis in the foreign exchange market. His conclusion was that the forward exchange rate is a poor predictor of the subsequent spot rate and that the efficiency hypothesis should be rejected. This conclusion holds for both the official and the free markets.

In this article the results of Verwilt are critically examined, and the basic conclusion is rejected. We conclude that the efficiency hypothesis, at least in its «weak form», cannot be rejected using the available statistical evidence.

II. EFFICIENCY TESTS

For the sake of clarity the efficiency tests used by Verwilt are briefly summarized. Essentially these empirical tests are tests of two theoretical propositions. A first proposition is that the forward exchange rate is an unbiased estimator of the subsequent spot rate.

Formally we have, using Verwilt's notation

$$FR_t^{t+n} = E_t(SR^{t+n}) \quad (1)$$

1. H. Verwilt, The forward exchange rate as a predictor of the spot rate: The case of the B.L.E.U., *Tijdschrift voor Economie en Management*, nr. 4, 1976.

where

FR_t^{t+n} = the forward exchange rate in period t , relating to period $t+n$;

$E_t(SR^{t+n})$ = the market's expectation in period t concerning the spot rate in period $t+n$.

The second proposition states that in an efficient market all available information is used to predict the future spot rate. This implies that there are no systematic deviations between the expected and the observed exchange rates; or put differently, the forecasting error is a random variable.

Formally we have

$$SR_{t+n} - E_t(SR^{t+n}) = u_{t,n} \quad (2)$$

where $u_{t,n}$ is a random number.

Combining (1) and (2) allows to derive an equation which can be tested empirically, i.e.

$$SR_{t+n} - FR_t^{t+n} = u_{t,n} \quad (3)$$

The testable proposition, therefore, states that the difference between the forward rate in period t and the subsequent spot rate is a random number. This random number represents information which is not yet available in period t .

III. EMPIRICAL TESTS

In his empirical investigation of equation (3) Verwilt regresses SR_{t+n} on FR_t^{t+n} to determine the forecasting ability of the forward rate.

This empirical investigation leads him to reject the efficiency hypothesis primarily because of high serial correlation in the error term. The high serial correlation, however, is introduced artificially when Verwilt selects and uses a series of weekly observations of three-month forward rates.

The observed three-month forward rate in week $t+1$ will not be inde-

pendent from the observed three-month forward rate in week t , because both observations of the forward rate relate to future periods which are strongly overlapping.

Formally, it can be shown that when the forward rate observed in week t with maturity n weeks ahead is used, an autoregressive pattern of the residuals of order $n-1$ will be introduced. Thus $u_{t,n}$ in equation (3) can be written as

$$u_{t,n} = \sum_{i=1}^{n-1} \gamma_i u_{t-i,n} + e_t$$

where the γ 's are decreasing as the lag increases. Since Verwilt uses weekly observations of three-month forward rates ($n=13$) the error terms in equation (3) follow an autoregressive pattern of the 12th order.

The substantial serial correlation which is found by Verwilt when regressing equation (3) should, therefore, not be surprising. In addition, the Cochrane-Orcutt procedure used by the author is insufficient to eliminate serial correlation as this procedure eliminates only serial correlation of the first order².

To avoid these problems of spurious serial correlation we selected monthly series of non-overlapping periods, during the sample period 1970 (January) to 1976 (September). Our procedure consisted in constructing three series of non overlapping monthly observations. Thus the first series consists of the three-month forward rate observed in January, April, July and October; the second series has the observed three-month rate in February, May, August and November; the third series has the observed three-month rate in March, June, September and December. The same procedure was applied to the spot rates in order to have the relevant spot rate for each forward rate.

Equation (3) was then estimated by OLS for the following currencies: DM, pound sterling, guilder and dollar. Only the official market was analyzed using buyer's rates. The results are given in table 1. In table 1 we have also added the results on the one-month forward rate. Since we use monthly observations, problems of overlapping do not occur in this case.

2. Note also that the *D.W.* statistics do not test for serial correlation of a higher order than one. Therefore, the *D.W.* statistics reported by Verwilt in the Cochrane-Orcutt estimations do not reveal the existence of the higher order autocorrelation.

TABLE 1

*Regression of SR_{t+n} on FR_t^{t+n} using non overlapping monthly observations.
Sample period 1970-1976*

	Intercept	Coefficient of FR_n^{t+n}	R^2	D.W.	S
Series I					
dollar	0.89 (1.01)	0.98 (0.02)	0.96	1.66	1.06
sterling	-1.13 (1.66)	1.01 (0.02)	0.98	2.39	2.41
guilder	0.98 (0.46)	0.93 (0.03)	0.91	1.52	0.12
D.M.	1.31 (0.47)	0.92 (0.03)	0.91	2.15	0.20
Series II					
dollar	4.41 (3.58)	0.98 (0.08)	0.92	2.11	2.18
sterling	-1.17 (4.55)	1.00 (0.04)	0.95	2.16	3.63
guilder	2.86 (1.28)	0.80 (0.09)	0.76	1.43	0.20
D.M.	2.90 (1.22)	0.83 (0.08)	0.80	1.87	0.31
Series III					
dollar	2.81 (2.86)	0.92 (0.07)	0.89	1.77	1.68
sterling	-2.59 (4.35)	1.01 (0.04)	0.96	2.69	3.44
guilder	2.36 (1.06)	0.83 (0.07)	0.84	1.42	0.15
D.M.	3.01 (1.42)	0.79 (0.10)	0.73	1.82	0.35
Series IV (one-month forward rate)					
dollar	3.97 (3.43)	0.90 (0.08)	0.84	1.72	2.04
sterling	-3.51 (4.31)	1.02 (0.04)	0.96	2.00	3.56
guilder	2.97 (1.38)	0.79 (0.10)	0.73	1.37	0.21
D.M.	2.51 (1.18)	0.83 (0.08)	0.81	1.81	0.31

Figures in parenthesis are standard errors; S = the standard error of the regression. Note that these standard errors are not directly comparable with each other as the scale of the dependent variables are different.

The results of table 1 do not contradict the proposition that the forward rate is a good predictor of the future spot rate. The D.W. statistic does not reveal the existence of serial correlation of the error term and the coefficients of the forward rate are not significantly different from one.

Table 1 shows also the difference between a good (efficient) and a perfect predictor. Although we see no inefficiencies, which means that the market did not make errors that could have been avoided using the time series of past rates, we see that the market was consistently wrong in some instances, i.e. the constant term was statistically different from zero in the case of the guilder and the DM. This only proves that continuously new facts arose which pushed the rate in the same direction. The timing of the facts, however, was not predictable since there is no serial correlation.

TABLE 2
Theil's inequality coefficient and its decomposition
(Comparison of observed and predicted future spot rate, equation (3))

	U	U^M	U^S	U^C
Series I				
dollar	0.012	0.017	0.000	0.89
sterling	0.012	0.023	0.015	0.96
guilder	0.004	0.000	0.008	0.99
D.M.	0.007	0.004	0.012	0.98
Series II				
dollar	0.026	0.030	0.003	0.97
sterling	0.018	0.096	0.015	0.89
guilder	0.007	0.003	0.033	0.96
D.M.	0.011	0.006	0.027	0.97
Series III				
dollar	0.020	0.050	0.003	0.95
sterling	0.017	0.109	0.026	0.87
guilder	0.006	0.001	0.050	0.95
D.M.	0.013	0.001	0.019	0.98
Series IV (one-month forward rate)				
dollar	0.024	0.037	0.002	0.96
sterling	0.018	0.102	0.041	0.86
guilder	0.008	0.001	0.022	0.98
D.M.	0.011	0.012	0.033	0.95

Additional information on the forecasting performance of the forward rate is provided by Theil's inequality coefficient and its decomposition. These are presented in table 2. Theil's inequality coefficient, U , is in all cases very close to zero. In addition, its decomposition shows that most of the forecasting error is due to unequal correlation (U^C), and very little is due to unequal central tendency (U^M) or unequal variation (U^S). This suggests that the forecasting error is mostly due to «unsystematic» errors.

IV. FURTHER EMPIRICAL TESTS

In the previous section it was found that when problems of spurious autocorrelation in the error terms are taken care of the efficiency hypothesis cannot be rejected when applied to Belgian official foreign exchange data during 1970-76. To test whether the forward rate is a good predictor we have not only to demonstrate that there is no serial correlation in the error term but we have to ask also whether there are other variables which outperform the forward rate as predictors of the future spot rate. One obvious candidate is the present spot rate. If the present spot rate is found to be a better predictor of the future spot rate than the forward rate this could be used as evidence to reject the efficiency hypothesis. For in that case the forward rate would not incorporate readily available information. Formally the test consists in regressing the future spot rate on the present spot rate. Thus

$$SR_{t+n} = SR_t + \epsilon_t \quad (5)$$

Equation (4) can also be interpreted as a random walk: the future spot rate is equal to the present spot rate plus a random disturbance (ϵ_t).

The results of the estimation of equation (4) are presented in table 3. Comparison of these results with the results of table 1 leads to the conclusion that the present spot rate and the forward rate are equally good predictors of the future spot rate. In table 4, Theil's inequality coefficients are presented. The order to magnitude of the coefficients is similar to the ones obtained in table 2. The forecasting errors, therefore, are comparable whether one uses the present spot rate or the forward rate. Similarly, the forecasting errors seem to be equally stochastic in both cases.

TABLE 3

*Regression of SR_{t+n} on SR_t using non-overlapping monthly observations.
Sample period 1970-76*

	Intercept	Coefficient of SR_t	R^2	D.W.	S
Series I					
dollar	1.07 (0.98)	0.97 (0.02)	0.96	1.67	1.03
sterling	-1.72 (1.62)	1.01 (0.02)	0.98	2.47	2.34
guilder	0.49 (0.43)	0.97 (0.03)	0.93	1.99	0.11
D.M.	0.65 (0.48)	0.96 (0.03)	0.91	2.26	0.20
Series II					
dollar	4.72 (3.53)	0.88 (0.08)	0.83	2.08	2.16
sterling	-3.22 (4.62)	1.01 (0.05)	0.95	2.22	3.63
guiler	1.44 (1.28)	0.90 (0.09)	0.80	1.78	0.18
D.M.	1.51	0.90	0.80	2.06	0.31
Series III					
dollar	(1.32) 3.30 (2.77)	(0.09) 0.91 (0.06)	0.89	1.69	1.65
sterling	-4.12 (4.30)	1.02 (0.04)	0.96	2.64	3.36
guilder	0.88 (1.12)	0.94 (0.08)	0.85	1.86	0.15
D.M.	2.11 (1.53)	0.86 (0.11)	0.73	2.09	0.35
Series IV					
dollar	4.15 (3.37)	0.89 (0.08)	0.84	1.74	2.02
sterling	-5.89 (4.09)	1.04 (0.04)	0.96	2.24	3.31
guilder	1.43 (1.28)	0.90 (0.09)	0.80	1.67	0.18
D.M.	1.28 (1.19)	0.92 (0.08)	0.84	1.85	0.28

TABLE 4

*Theil's inequality coefficients and its decomposition.
(Comparison of observed and predicted future spot rate, equation (5))*

	U	U^M	U^S	U^C
Series I				
dollar	0.012	0.021	0.001	0.978
sterling	0.012	0.082	0.018	0.899
guilder	0.04	0.013	0.000	0.986
D.M.	0.07	0.015	0.000	0.985
Series II				
dollar	0.026	0.031	0.006	0.963
sterling	0.020	0.223	0.022	0.754
guilder	0.006	0.039	0.000	0.961
D.M.	0.011	0.061	0.000	0.939
Series III				
dollar	0.020	0.060	0.010	0.930
sterling	0.029	0.264	0.030	0.705
guilder	0.005	0.070	0.002	0.927
D.M.	0.012	0.043	0.000	0.957
Series IV				
dollar	0.024	0.050	0.005	0.945
sterling	0.019	0.306	0.054	0.640
guilder	0.006	0.042	0.000	0.958
D.M.	0.010	0.065	0.000	0.935

The previous results imply again that we cannot reject the efficiency hypothesis. The forward rate is found to be as good a predictor of the future spot rate as the present spot rate. This should not come as a surprise. When interest parity holds speculation in the spot and forward markets are essentially equivalent. This is not, as Verwilt concludes, a proof that the market is inefficient. It only shows that all the efforts made by the market to establish forward rates are not so rewarding. This can be ascribed to the high competition which leads to the inclusion of all available information as soon as possible. This, in turn, leads to a zero incremental value for any other piece of information.

A final test consists in relating the forecasting errors obtained when using the forward rate with the forecasting errors obtained with the present spot rate. This is done in table 5. It shows that the forecasting errors obtained using respectively the forward rate and the spot rate are heavily correlated. In addition, the Theil's inequality coefficients are

usually small (the exception is the guilder when U is approximately 0.3). The largest part of the unequal forecasting ability is due to unequal covariance (U^C) of the forecasting errors and can thus be interpreted as unsystematic. (The exception is the pound sterling where one observes that the difference in forecasting errors, although small, is related to unequal central tendency (U^M)). Broadly, the previous results suggest that forecasting errors made when using the forward rate are comparable to those made when using the present spot rate.

TABLE 5

Comparison of the forecasting errors obtained with forward and present spot rate

	R^2	S	U	U^M	U^S	U^C
Series I						
dollar	0.98	0.14	0.069	0.006	0.022	0.972
sterling	0.98	0.50	0.102	0.432	0.016	0.553
guilder	0.84	0.05	0.215	0.042	0.067	0.892
D.M.	0.94	0.05	0.126	0.060	0.016	0.924
Series II						
dollar	0.99	0.21	0.048	0.001	0.000	0.999
sterling	0.97	0.94	0.123	0.617	0.000	0.382
guilder	0.87	0.09	0.230	0.270	0.118	0.611
D.M.	0.93	0.10	0.160	0.269	0.030	0.701
Series III						
dollar	0.96	0.32	0.095	0.012	0.00	0.987
sterling	0.95	1.07	0.147	0.541	0.004	0.454
guilder	0.75	0.10	0.301	0.236	0.045	0.719
D.M.	0.93	0.12	0.164	0.290	0.025	0.686
Series IV						
dollar	0.97	0.33	0.088	0.036	0.001	0.963
sterling	0.91	1.41	0.188	0.488	0.02	0.491
guilder	0.71	0.12	0.304	0.061	0.126	0.813
D.M.	0.87	0.12	0.203	0.094	0.120	0.805

V. CONCLUSION

In this article it has been shown that the hypothesis that the official foreign exchange market of the B.L.E.U. is efficient cannot be rejected during the sample period 1970-76. The tests reported here are of the «weak form» type. These tests indicate that forecasting efficiency can-

not be increased by looking at the past behavior of the exchange rates. Any forecast based on the past behavior of exchange rates will produce a suboptimal forecasting method.

To avoid possible confusion, it should be stressed that acceptance of the weak efficiency hypothesis does not preclude the possibility that other and superior information than the past behavior of exchange rates is used by some market participants. It is possible that better forecasts of the future spot rate can be obtained using other variables, e.g. purchasing power parities, or money supplies. To analyse this issue the efficient market hypothesis should be tested in its «strong» form. This has not been done here.

Finally the tests of efficiency reported here do not preclude the existence of destabilizing speculation. It does preclude, however, destabilizing speculation produced by simple «bandwagon» effects.