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A PROPOSAL FOR AN EXHANGE RATE ADJUSTMENT IN THE PRESENCE OF INTERVENTION ACTIVITIES

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Abstract

This paper proposes a technique which adjusts exchange rate series after taking into consideration that monetary authorities intervene in the foreign exchange market whenever it seems appropriate. The results demonstrate that the majority of intervention actions are succesful, while they improve the forecasting capability of exchange rate movements. (JEL Classification: F31)

1. Introduction

This study suggests a methodology which adjusts exchange rates within the framework of target zones developed by Williamson (1983 and 1989). It has been suggested (Vinod, 1992) that wherever intervention activities occur in the market concerned (i.e., foreign exchange) it is really hard for economic researchers to identify whether these activities have been succesful or not, particularly, in case that the intervention actions tend —explicitly as in the European Monetary System or implicitly as in the U.S. (Apergis, 1992)— to restrict price movements.

It has been aknowledged that the monetary authorities in many countries intervene in the foreign exchange market to affect exchange rate movements either directly, via purchases and sales that involve domestic currency holdings and foreign reserve holdings, or indirectly, as an alternative for monetary policy

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(BIS, 1988). In other words, the monetary authorities have a specific target-price for the exchange rate and they are willing to allow only a (+ / -) x% deviation from this target value. Thus, whenever the spot exchange rate lies beyond these allowed deviations, the monetary authorities intervene to restore that perverse situation. Whether this action is succesful or not cannot be identified by the published value of the spot exchange rate. Therefore, it has to be adjusted in such a way that the fact of the target zone for the exchange rate has to be taken explicity into consideration.

In the light of the statistical framework proposed by Razzak (1991) —who developed a statistical method that estimates target zones for exchange rates— this study demonstrates that published exchange rate data are different from those generated by a particular technique which considers the target zone framework. The empirical method is applied for four currencies, namely, the U.S. dollar, the Deutsche Mark, the French Franc, and the British Pound.

The paper is organized as follows. Section 2 describes the methodology, while section 3 presents the empirical results. Finally, section 4 provides some concluding remarks.

2. The method

The method works within the Exponentially Weighted Moving Average (EWMA) framework (Razzak, 1991) where,

$$w_t = \lambda \overline{Y}_t + (1 - \lambda) w_{t-1} \qquad (1)$$

with

w_t = EWMA for the exchange rate series at time t

w_{t-1} = EWMA for the exchange rate series at time t-1

$\overline{Y}_t$ = the sample mean for the exchange rate

λ = a smoothing constant with $0 < \lambda < 1$

λ is estimated with equation (1) and OLS. The OLS estimation and data on effective exchange rates obtained from the IMF International Statistics gave $\lambda = 0.051$ for the U.S. dollar, $\lambda = 0.045$ for the British Pound, $\lambda = 0.007$ for the French Franc, and $\lambda = 0.011$ for the Deutsche Mark. Once lamdas were estimated, equation (1) generated the EWMA series which will be used in the empirical analysis section.

Razzak (1991) estimated the target zone band with

$$LL = \mu - \delta \sigma \sqrt{(\lambda / ((2-\lambda(n))} \quad (2)$$

as the lower limit (LL) of the band and,

$$UL = \mu + \delta \sigma \sqrt{(\lambda / ((2-\lambda) n))} \quad (3)$$

as the upper limit (UL) of the band,

with

δ = a choice parameter
μ = the mean of the EWMA exchange rate series
σ = the standard deviation of the EWMA series
n = the number of observations

The peculiarity with the choice parameter δ is that as long as it increases the width of the band follows. For the empirical purposes of this study δ was chosen in such a way that the width of the band of the adjusted series —with a technique mentioned in section 3— should be large enough to make the band hypothesis consistent. Therefore, δ was selected to be 5 for the case of the U.S., 3 for the case of Germany, 4 for the case of France, and 7 for the case of the U.K. Once the choice parameter was selected, we turned into the empirical analysis which estimates the band zone for all four currencies and assesses whether by taking into consideration intervention activities in the foreign exchange market these activities turn to be succesful.

3. The empirical analysis

Before estimating the band zones for the currencies concerned, tests for stationary, proposed by Dickey and Fuller (1981), showed that all four EWMA series have a unit root in their levels. The results are reported in Table 1 and suggest that first differences must be used to eraise the problem of non-stationarity; thus, the computation of the band zones was done with respect to the first differenced data which later they transformed back into their levels for the main presentation of the results. With respect now to the differentiated data, the band zones, along with the means and standard deviations of the EWMA series, are defined as follows:

U.S.	Germany	France	U.K.
LL = 0.157	LL = 0.840	LL = -0.633	LL = -0.498
UL = 0.202	UL = 1.113	UL = -0.531	UL = -0.237
μ = 0.180	μ = 0.976	μ = -0.582	μ = -0.367
σ = 0.404	σ = 5.330	σ = 2.520	σ = 2.510

However, some exchange rate observations are below the lower limit (LL), while others are above the upper limit (UL) (figures 1, 3, 5 and 7). Once the monetary authorities observe those values out of the limits of the band zone they will intervene in the foreign exchange market in order to bring them within the band limits. Therefore, it seems interesting enough to examine whether this reaction would be succesful or not.

3.1. The U.S. dollar case

It is first assumed that the effective exchange rate dollar series could be described by a normal distribution with the above mean and standard deviation. The probability that a certain observation would be lying below or above the limits concerned is 0.48, while the probability that an observation would be lying within the limits is 0.04. Then, by multiplying each exchange rate observation by its corresponding probability, a new U.S. dollar exchange rate time series —the adjusted series— is generated. The behavior of the new series within the band zone framework is presented in Figure 2. From the comparison of Figures 1 and 2 it is easily implied that the new adjusted series exhibits that the majority of exchange rate observations are within the band limits as well as that intervention activities tend —at least, in cases that the presence of these intervention actions seems appropriate— to be continuous and succesful.

3.2. The Deutsche Mark case

It is assumed that the mark series could be described by a normal distribution with the above mean and standard deviation. The probability that an unadjusted exchange rate observation would be lying above the upper limit or below the lower limit is equal to 0.40. Finally, the probability that an observation would be lying within the limits is just 0.02. By repeating the process of adjustment, new (adjusted) observations are generated whose behavior is observed in Figure 4. Once again, the behavior of the adjusted series indicates more succesful intervention actions, at least, at points where these intervention activities were needed.

3.3. The French Franc case

Assuming that the franc series is well described by a normal distribution with a mean and a standard deviation mentioned above, the probability that an observation would be lying above the upper limit of the band is 0.67, the probability that an observation would be lying below the lower limit is 0.32, and, finally, the probability that an observation would actually be lying within the band limits is 0.01. The new exchange rate series is shown in Figure 6. Again, the behavior of the adjusted series exhibits that the majority —excluding the earlier years of the time period concerned— of intervention activities —where appropriate— turn to be succesful.

3.4. The British Pound case

Finally, it is assumed that the pound series is well depicted by a normal distribution with a mean and a standard deviation provided above. The probability that an observation would be above the upper limit of the band is 0.59, while the probability that an observation would be lying below the lower limit is 0.36. Finally, the probability that a series observation would be lying within the band limits is 0.05. A new pound series is generated and its behavior is presented in Figure 8. Once again, the same conclusions are held; with the exception of an observation in the beginning, intervention actions — where appropriate— have turned to be succesful.

3.5. Forecasting performance of the unadjusted and the adjusted series

In this section a statistical assessment is attempted in order to compare the unadjusted and the adjusted series in terms of their forecasting performance. A likely better performance of the adjusted series would indicate that intervention activities in the foreign exchange markets tends to reveal more information about exchange rate movements and seem to eraise any "fussy" expectations originated from a framework in which exchange rates are determined solely by market forces. Therefore, identification ARIMA diagnostics for all series over the period 1975:1-1990:4 reported the results presented in Table 2. Note, the identification was based on the test statistic proposed by Box and Pierce (1970) and modified by Ljung and Box (1978) and given by the formula

$$Q = n(n+2)\sum_{k=1}^{m} (n-k)^{-1} r_k^2 \qquad (4)$$

with r_k to be the residual autocorrelations, η the number of observations used to fit the mobel, and m is usually taken to be 15 or 20. Q is approximated by a chi-squared distribution with (m-p-q) degrees of freedom, with ρ to be the number of autoregressive terms and q the number of moving average terms. Then, the models were out-of-sample forecasted for the period 1991:1-1993:4 and, via, the U-Theil statistic and the Root Mean Square Error (RMSE) statistic, their forecasting performance was assessed. The results appear in Table 3. They suggest that adjusted series exhibit a better forecasting performance which implies that the monetary authorities via itervention activities in the foreign exchange market seem to reflect more information about exchange rate movements.

4. Concluding remarks

This study has suggested a (simple) method which adjusts exchange rate series in order to examine whether intervention activities in the foreign exchnage market —where appropriate— tend to be succesful or not. The results tend to support this argument while out-of-sample forecasting seems to support that these intervention actions tend to reveal more information about ecchange rate movements.

Of course, the empirical methodology has been implemented under a univariate analysis. However, additional economic variables, e.g., interest rates or the trade balance surplus (or deficit), could be appropriate to be included in the analysis. Further research, therefore, is needed to prove the robustness of the empirical results reached in this study.

Table 1
Stationarity tests

Variable (X)	Estimated t_t on levels	Estimated T_t on fisrt differences
EUS	-2.03(4)	-4.09(4)*
EUS1	-1.75(4)	-4.25(4)*
EGER	-2.33(5)	-4.83(5)*
EGER1	-2.42(3)	-4.96(3)*
EFR	-1.36(3)	-4.08(4)*
EFR1	-1.58(4)	-4.97(3)*
EUK	-2.09(3)	-4.69(3)*
EUK1	-2.01(5)	-5.53(4)*

Notes:

1. The test in the second column is based on the regression:

$$\Delta X = a_0 + \alpha_1 T + a_2 X_{-1} + \sum_{i=1}^{m} b_1 \Delta X_{-1} + u$$

while, the test in the third column is based on the regression:

$$\Delta^2 X = a_0 + a_1 T + a_2 \Delta X_{-1} + \sum_{i=1}^{m} b_1 \Delta^2 X_{-1} + u$$

where, T = is a time trend variable, Δ = denotes first differences, m = the number of observations, and u = a random term.

2. the number in parentheses denote the correct number of lags of bs in the regressions of note 1.

3. t_t = the statistic proposed by Fuller (1976)

4. * | statistical significant at 1%, 5%, and 10% levels.

Table 2
ARIMA identification

Unadjusted dollar series	:	ARIMA (2, 1, 2)	Model I
Adjusted dollar series	:	ARIMA (0, 1, 3)	Model II
Unadjusted mark series	:	ARIMA (2, 1, 2)	Model III
Adjusted mark series	:	ARIMA (0, 1, 2)	Model IV
Unadjusted franc series	:	ARIMA (2, 1, 0)	Model V
Adjusted franc series	:	ARIMA (1, 1, 1)	Model VI
Unadjusted pound series	:	ARIMA (2, 1, 3)	Model VII
Adjusted pound series	:	ARIMA (1, 1, 0)	Model VIII

Table 3
Forecasting performance

	U-Theil	RMSE
Model I	0.0343	0.0636
Model II	0.0080	0.0005
Model III	0.0904	0.9890
Model IV	0.0233	0.7077
Model V	0.2612	0.6264
Model VI	0.0906	0.5417
Model VII	0.1216	0.7400
Model VIII	0.1191	0.7380

Notes:

The U-Theil and the RMSE statistics are given by

$$U = \sqrt{[1/n \sum_{i=1}^{n} (R_{t1} - F_{t1})^2]} \Big/ \sqrt{[1/n \sum_{i=1}^{n} (R_{t1})^2]}$$

$$\text{PM}\Sigma\text{E} = \sqrt{[1/n \sum_{i=1}^{n} (F_{t1} - R_{t1})^2]}$$

with R to be the actual observation and F the forecasted observation.

Figure 1. Unadjusted U.S. dollar

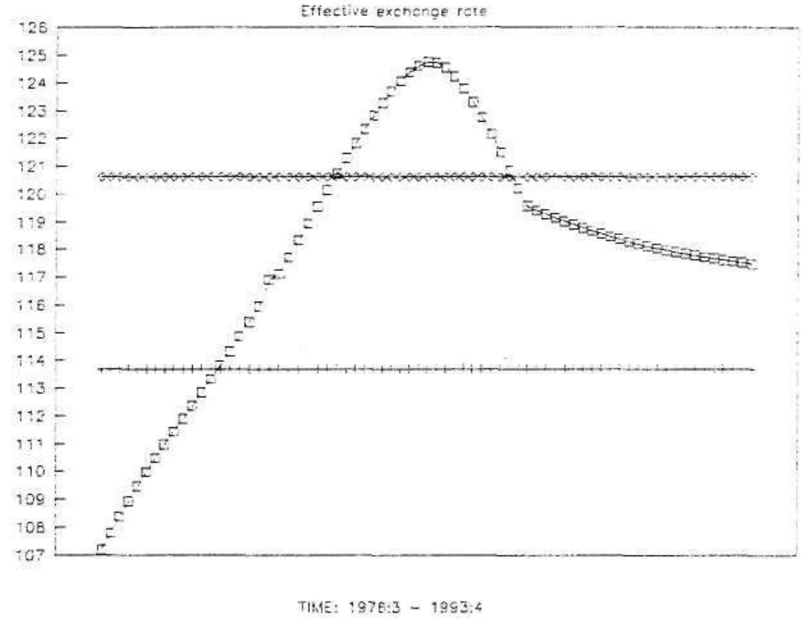


Figure 2. Adjusted U.S. dollar

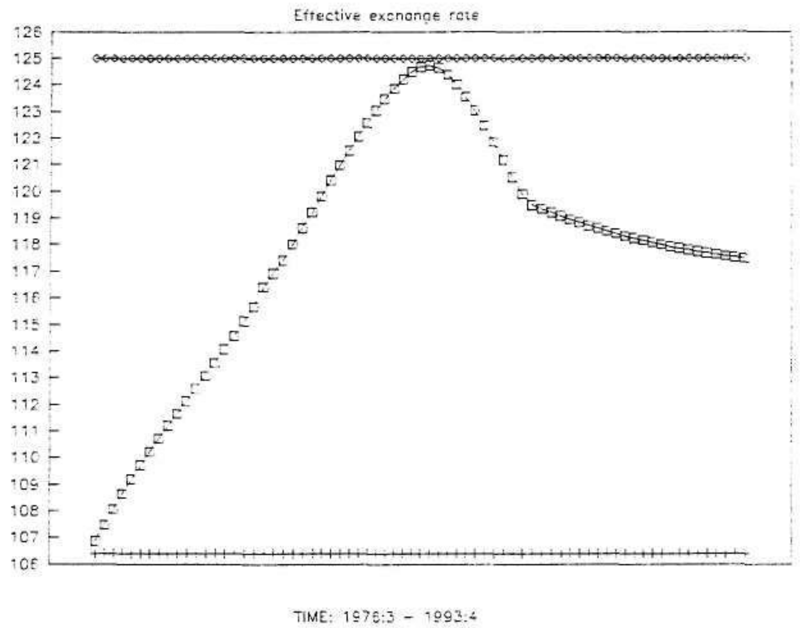


Figure 3. Unadjusted DM

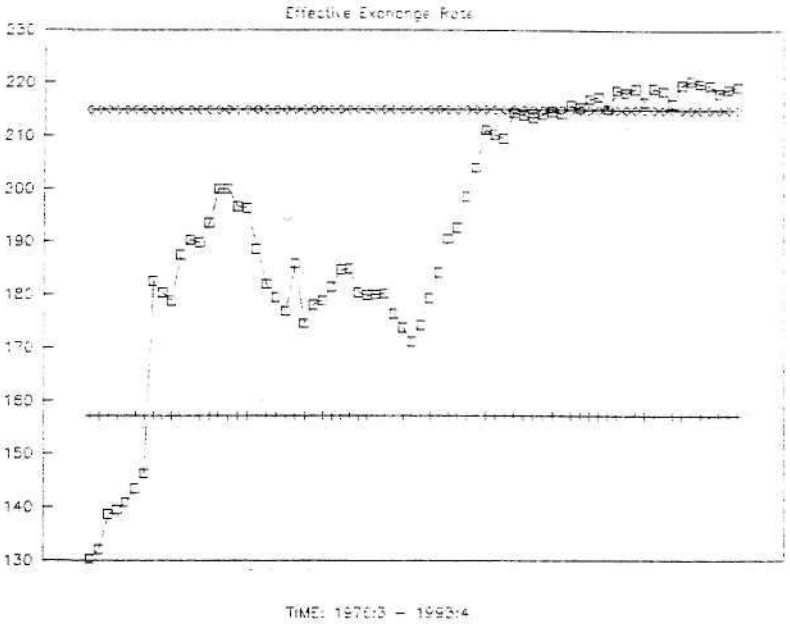


Figure 4. Adjusted DM

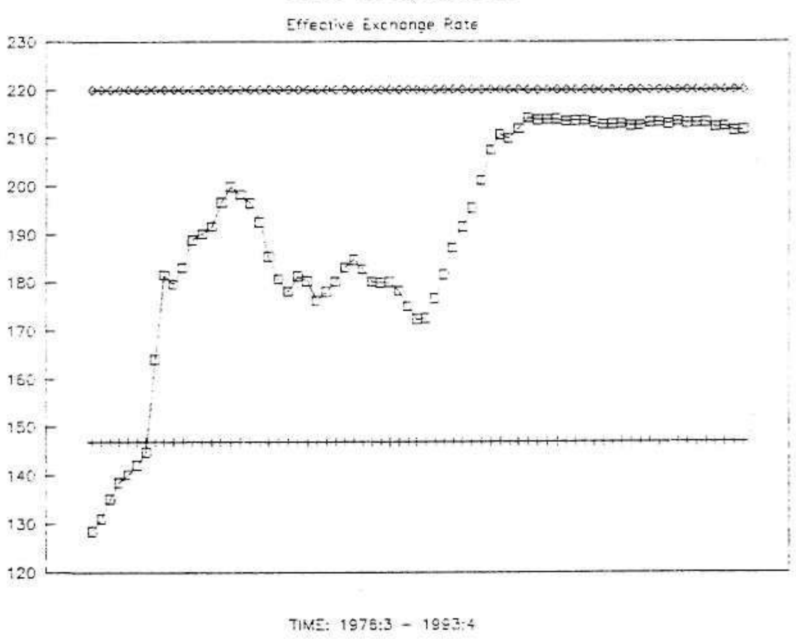


Figure 5. Unadjusted French Franc

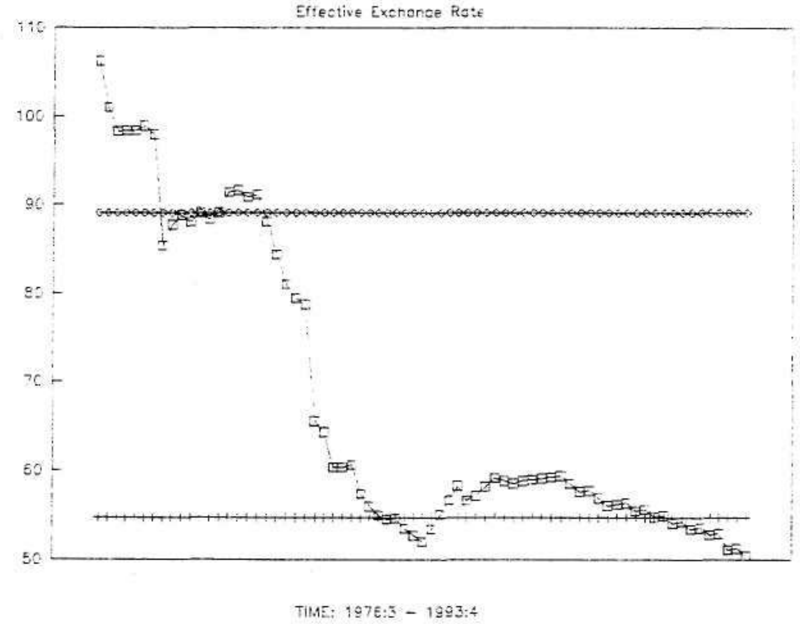


Figure 6. Adjusted French Franc

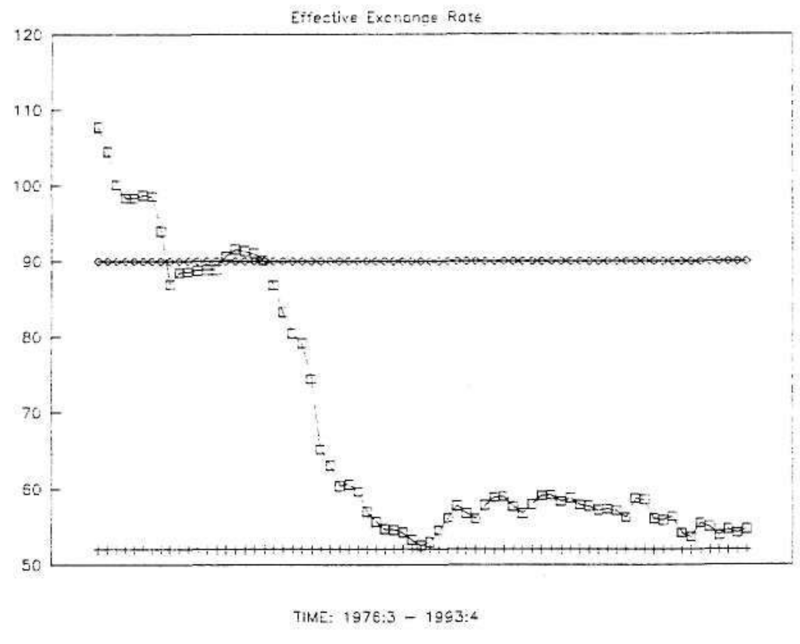


Figure 7. Unadjusted Pound

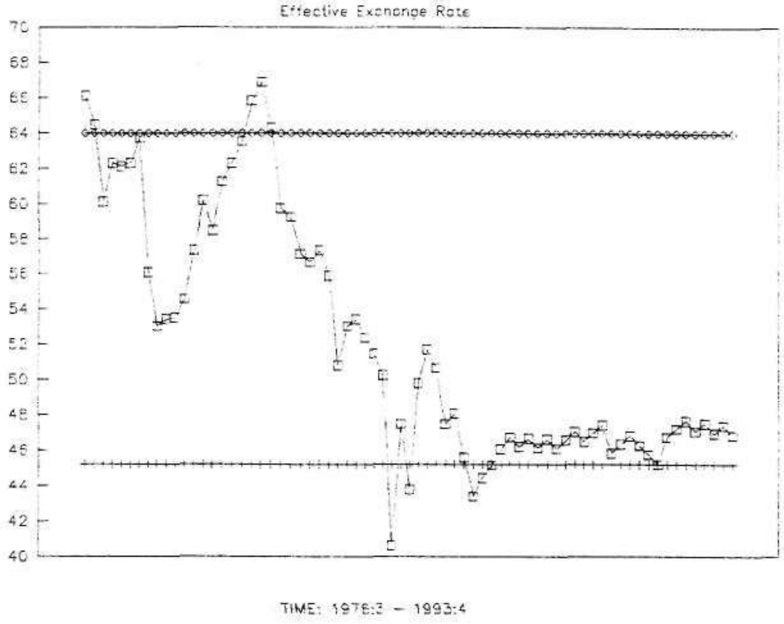
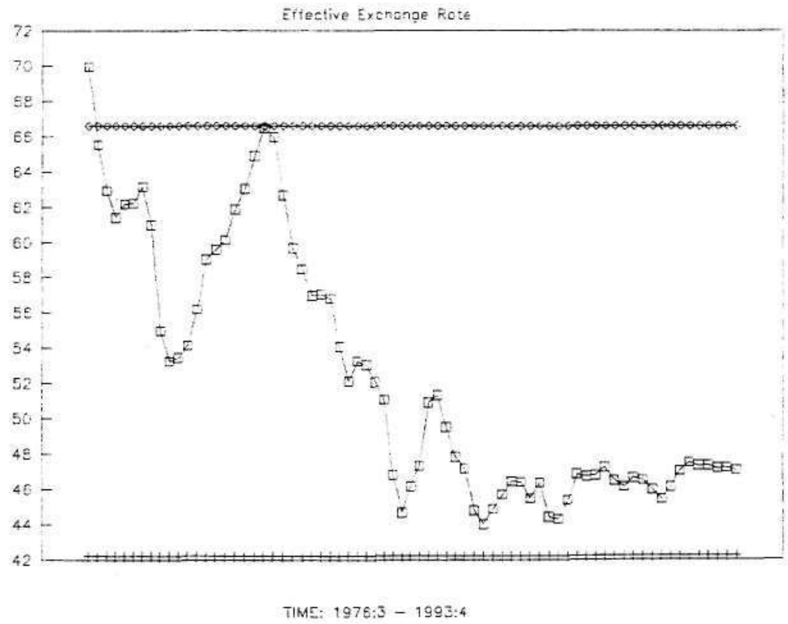


Figure 8. Adjusted Pound



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