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Exchange Rate and its Forecasting: Market-Based Forecasting and Forecasting with the Use of Currency Betas (β_S)

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ABSTRACT: This paper is using the market-based and the currency beta (β) theories of exchange rate forecasting. It is testing empirically these theories by using data, spot and forward rates, from seven different countries with respect the U.S., as our domestic country. The countries are: U.S. with Euro-zone, Mexico, Canada, U.K., Switzerland, Japan, and Australia. The results show that both methods, the market-based forecasting and the currency betas are giving very good forecasting for these seven exchange rates by minimizing the standard error of the regression (SER) and the root mean squared error (RMSE). Of course, uncertainty exits always in the forecasting of any economic variables, due to unanticipated public policies (monetary, fiscal, and trade) and other "innovations" in our financial markets and new philosophies in our way of living.

KEYWORDS: Demand for Money and Exchange Rate, Foreign Exchange, Forecasting and Simulation, Information and Market Efficiency, International Financial Markets

I. INTRODUCTION

There are many theories of exchange rate determination and forecasting and economists have looked at some of the macroeconomic variables (fundamentals) that influence and are influenced by the exchange rate. Also, the efficiency of the foreign exchange market has been discussed and tested empirically and extensively. Then, we can envision a "true" model of the two economies (domestic and foreign) that include all of these exchange rate markets, variables, incorporate full information, and expectations and in the context of economic optimization and random events generates the time path of foreign exchange rate between two currencies. Now, forecasting can be thought of as the formal process of generating expectations by using economic theory, mathematics, statistics, and econometric analysis. When expectations for future financial markets and economic variables are derived, we have an implicit forecast of the variable in question, the exchange rate.

Here, past spot and forward rates are used to forecast the future spot exchange rates. Also, the currency beta (β) considered to determine the sensitivity of an exchange rate with respect to a market index for foreign currencies. The rational expectations theory says that people form expectations of future values of the exchange rate, other variables and the markets in the same way that the "true" model of the economy generates these variables. Forecasting is very common and necessary in our times, but difficult, due to complexity of our world and its unanticipated effect on the markets. People take forecasting into consideration, when they make economic decisions. These decisions then, influence the direction, in which the economy will move. Cash flows of all international transactions are affected by the expected value of the exchange rates; therefore, the forecasting of the exchange rate movements is very important for businesses, investors, academic economists, and policy makers.

Multinational corporations (MNCs) need forecasts of exchange rates for their *hedging decision*. Firms face the decision of whether to hedge future payables and receivables, which are in foreign currencies. *Short-term financial and investment decisions* require exchange rate forecasting to determine the ideal currency for borrowing money and to allocate the one that maximize the return of an investment. *Capital budgeting decisions* need forecasting of exchange rate to determine the timing for this investment in physical capital and the expected cash flows and make an accurate decision for these foreign investments. Also, *long-term financial decisions* require forecasting of the currencies to decide from where to borrow money (which will reduce the cost if the currency is depreciated) and if it is better to issue a bond denominated in foreign currency. Furthermore, *earnings assessments* want to forecast the foreign currency, in which the earnings are coming and decide if earnings are going to be remitted back to the parent company or to be invested abroad.

II. MARKET-BASED FORECASTING

A very simple way to develop future forecasting for the exchange rate is for someone to follow the market indicators, the spot rate (s_t) and the forward rate (f_t). This type of forecasting is called the Market-Based Forecasting. The spot prices in our markets are following the futures prices.

II.1. The Current Spot Rate as a Forecasting Indicator

The current spot exchange rate (s_t) can be used to forecast the spot rate next period (s_{t+1}^e). Rational market participants observe the trend of a currency (exchange rate) based on market expectations. This market is also an efficient market, where full information exists. Then,

$$s_{t+1}^e = E_t\, s_{t+1} = s_t + v_t \,|\, I_t \qquad (1)$$

where, s_t = the ln of spot exchange rate (S_t), a lower case letter is the natural logarithm of the capital one, I_t = the set of information available at time t and v_t = an observation trend of the value of the currency and a weaker definition of rationality allows for a zero observation trend error. Thus,

$$E(s_{t+1} - s_{t+1}^e \,|\, I_t) = 0 \qquad (2)$$

If the market expects the euro ($€\downarrow$) to depreciate against the dollar ($\$\uparrow$) in the near future, speculators will buy dollars with euros today in anticipation of its appreciation. This excess demand for dollars will immediately increase the dollar value and cause the euro to fall because of its excess supply. Thus, the current value of the euro reflects the expectations of the euro's value in the near future. Spot rates can be used as a very good estimate of the spot rates at a future time in an efficient foreign exchange market.

$$€^e\downarrow \,\&\, \$^e\uparrow \Rightarrow EX\ D_{\$} \,\&\, EX\ S_{€} \Rightarrow \$\uparrow \,\&\, €\downarrow$$

We can run the following regressions:

$$s_t = \delta_0 + \delta_1 t + \varepsilon_t \qquad (3)$$

From eq. (3), we get the estimated trend of the spot rate: $v_t = t_{t+1}^e$ (i.e., LEUSF = forecasted trend of the spot rate). Now, we run the regression by utilizing the forecasted trend of eq. (3), as follows,

$$s_t = \alpha_0 + \alpha_1 s_{t-1} + \alpha_2 v_t + \varepsilon_t \qquad (4)$$

Where, s_t = the ln of the spot exchange rate, t = time (1, 2, 3, …), v_t = the forecasted trend from eq. (3), and ε_t = the error term.

II.2. The Forward Exchange Rate as a Forecasting Indicator

Forward rates are quoted for a specific date in the future ($F_1, F_3, F_6, F_{12}, etc.$). A one-month (F_1) forward rate provides a forecast for the spot rate in one month (S_{t+1}^e); then, it is a forecasting indicator of the spot rate next period. In general,

$$F_j = E(S_{t+j} \,|\, I_t) \qquad (5)$$

Where, F_j = the j-month forward rate quoted now and S_{t+j} = the spot rate j months from today.

The forward rate, as a reflector of the market expectations, is a very good market-based forecast because market participants (speculators and businesses) follow it to the expected level regarding the future spot rate. Let's say that the one-month forward rate[1] is quoted as, $F_1 = 1.05672$ \$/€ and the spot rate is $S_t = 1.05137$\$/€. The market expects the U.S. dollar to depreciate and the euro to appreciate. Then, market participants will start selling dollars and buying euros. This excess supply of dollars will depreciate the dollar, which will start going down (the spot rate will rise) until its exchange rate reaches 1.05672 \$/€. Thus, the participants' actions caused the dollar to depreciate and through their reaction proved that the forward rate is a very good predictor of the future spot rate and must be consider for their forecasting. Actually, we forced the spot rate to reach the quoted forward rate. Unfortunately, there is no escape from the market expectations. Everyone trust and follows the market; then, if someone decides to go against the market, he will lose (because he did not follow the market and instead of selling dollars, he was selling euros). Actually, we are "captive" of the forward and futures market for all the assets (financial, real, commodities, currencies, etc.).

$$F_1\uparrow \Rightarrow S_{t+1}^e\uparrow \Rightarrow \$^e\downarrow \Rightarrow selling\ \$ \Rightarrow EX\ S\ (\$) \Rightarrow \$\downarrow \Rightarrow S_{t+1}\uparrow$$

[1] See, https://www.barchart.com/forex/quotes/%5EEURUSD/forward-rates . Also, https://www.fxstreet.com/rates-charts/rates . Further, https://tradingeconomics.com/euro-area/currency . In addition, see, https://www.fxempire.com/currencies/eur-usd/forward-rates

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The forward rate is actually an unbiased predictor of the future spot rate, eq. (5). To test this unbiased forward rate hypothesis, we can run the following regression:

$$s_t = \gamma_0 + \gamma_1 f_{t-1} + \varepsilon_t \quad (6)$$

If $\hat{\gamma}_0 \cong 0$ and $\hat{\gamma}_1 \cong 1$; then, $s_t = f_{t-1}$ and $f_t = s_{t+1}$.

Thus, $s^e_{t+1} = \hat{\gamma}_0 + \hat{\gamma}_1 f_t \quad (7)$

Further, long-term exchange rate forecasting can be derived from long-term forward rates. Forward rates are available for periods up to five (5) years, but the bid/ask spreads are wider, due to limited trading volume. These long-term forward exchange rates are determined based on interest rate parity (IRP) between the two countries.[2]

III. FORECASTING WITH THE USE OF CURRENCY BETAS (β_s)

This type of forecasting is based on similar argument as the market beta of a financial asset. Currency betas (β_s) measure the responsiveness of a particular currency to a market index of foreign currencies. To estimate currency betas (β_s), we use the following equation:

$$\dot{s}_t = \alpha + \beta \dot{e}_{XRI_t} + \varepsilon_t \quad (8)$$

where, $\dot{s}_t$ = the percentage change of the spot exchange rate, as a percentage per annum [$\%\Delta S_t = \frac{S_t - S_{t-1}}{S_{t-1}} \frac{12}{n} 100 = (s_t - s_{t-1}) \frac{12}{n} 100$], $\dot{e}_{XRI_t}$ = the percentage change of a market index for foreign currencies, as a percentage per annum, α = the vertical intercept, β = the sensitivity (responsiveness) between the currency and the currency index (slope of the line), and ε_t = the error term.

By using a least squares regression, we can determine (estimate) the $\hat{\alpha}$ and the $\hat{\beta}$ of the specific currency (exchange rate) with respect to the market index of foreign currencies, as it is presented in section V.

IV. FORECASTING EVALUATION

Forecasts are made with errors because the economy is dynamic and unpredictable (manipulated), our information is restrained (misinformation)[3] and many news are "fake" because there is no free press (it is controlled by the "elites" = dark powers) or free speech (the deception of politically correct), and a lot of propaganda;[4] so our models are only approximations of reality, and our actual knowledge is limited. Suppose the true model is given by,

$$s_t = \chi_t \beta + \varepsilon_t \quad (9)$$

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[2] Interest Rate parity (IRP): $i_t - i_t^* = \frac{F_{t+n} - S_t}{S_t} \frac{12}{n} 100 = (f_{t+n} - s_t) \frac{12}{n} 100$, where n = the number of months of the forward rate. See, Kallianiotis (2019c).

[3] The public media are completely controlled, thus most of the News are very subjective lies (pure propaganda), which have wrong effects on individuals' decisions, perceptions, and confidence. (*Sic*). Biden has established a Disinformation Governance Board by the Department of Homeland Security, the "Ministry of Truth", with Nina Jankowicz to head the board. See, https://www.newsweek.com/nina-jankowicz-resignation-disinformation-governance-board-1707888 . But, Biden's 'disinformation board' is PAUSED after just three weeks and its head Nina Jankowicz resigned after sparking outrage for pushing debunked Russian collusion claims and calling Hunter Biden's laptop a 'Trump campaign tool' . See, https://www.dailymail.co.uk/news/article-10829859/Bidens-disinformation-board-PAUSED-just-three-weeks-following-outrage.html. See also, "We are grateful to the Washington Post, the New York Times, Time Magazine and other great publications whose directors have attended our meetings and respected their promises of discretion for almost forty years. It would have been impossible for us to develop our plan for the world if we had been subjected to the lights of publicity during those years. But, the world is more sophisticated and prepared to march towards a world government. The supranational sovereignty of an intellectual elite and world bankers is surely preferable to the national auto-determination practiced in past centuries." David Rockefeller, Speaking at the June, 1991 Bilderberger meeting in Baden, Germany (a meeting also attended by then-Governor Bill Clinton and by Dan Quayle). https://rense.com//general17/quote.htm .

[4] This is going on lately, the last three years, with the suspicious COVIN-19 virus and currently, with the war in Ukraine that the West provoked since 2014.

where, β is a vector of unknown parameters, and ε_t is an independent and identically distributed with mean zero random disturbance [$E(\varepsilon_t) = 0$].

The true model generating s_t is not known, but we obtain estimates $\hat{\beta}$ of the unknown parameters β. Then, setting the error term equal to its mean value (zero), the forecasts of s_t are obtained as follows:

$$\hat{s}_t = \chi_t \hat{\beta} \tag{10}$$

The forecast error (e_t) is the difference between the actual and the forecasted value,

$$e_t = s_t - \chi_t \hat{\beta} \tag{11}$$

Assuming that the model is correctly specified, there are two sources of forecast errors: (1) residual or innovation uncertainty and (2) coefficient uncertainty.

(1) Residual or Innovation Uncertainty

This first source of errors arises because the innovations ε_t in the equation are unknown for the forecast period and are replaced with their expectations. While the residuals are zero in expected value, the individual values are non-zero; the larger the variation in the individual errors, the greater the overall error in the forecasts. The standard measure of this variation is the "Standard Error of the Regression" (SER) in the equation output. Residual uncertainty is usually the largest source of forecast errors. Our criterion, here, will be minimization of the SER because the smaller the SER in our output, the better the forecast of this model. This is the reason that we report the SER in our empirical results and we can compare with it the forecasting accuracy of the different exchange rates (min SER).

(2) Coefficient Uncertainty

The second source of forecast error is coefficient uncertainty. The estimated coefficients $\hat{\beta}$ of the equation deviate from the true coefficients β in a random fashion. The standard error of the estimated coefficient, given with the output from the regression, is a measure of the precision, with which the estimated coefficients measure the true coefficients. The effect of coefficient uncertainty depends on the exogenous variables. Since the estimated coefficients are multiplied by the exogenous variables χ_t in the computation of forecasts, the more exogenous variables deviate from their mean values, the greater is the forecast uncertainty.

When we construct a forecast of the $s^e_{t+1} = LEUSF$ by using different estimated equations, the computer output will give to us different forecast evaluation options (root mean squared error, mean absolute error, mean absolute percentage error, Theil inequality coefficient, etc.). The output will give to us the actual (s_t) and the forecasted value ($\hat{s}_t$) of the variable, with an F at the end (i.e., $LEUS$ and $LEUSF$). The reported forecast error statistic that we can look is the Root Mean Squared Error (RMSE) and it is computed as follows:

$$RMSE = \sqrt{\sum_{t=T+1}^{T+n} (\hat{s}_t - s_t)^2 / n} \tag{12}$$

This statistic (RMSE) depends on the scale of the dependent variable and it is used as a relative measure to compare forecasts for the same series across different models; the smaller the error, the better the forecasting ability of that model according to the RMSE criterion. Statistical programs offer dynamic and static forecasting. The *dynamic forecasting* is a multi-step forecast of $\hat{s}_{t+n}$. The *static forecasting* performs a series of one-step ahead forecast of the dependent variable $\hat{s}_{t+1}$. Both methods will always yield identical results in the first period of a multi-period forecast.[5] Here, we use static forecasting to measure the *RMSE* and the best forecasting is the one that minimizes the *RMSE*.

Finally, there are currency forecasting services and many MNCs use forecasting services regularly. Forecasting is essential, but it is theoretically impossible; of course, it is better to have a view about the future instead ignoring it. A variety of opinions is generally useful when attempting to predict the future. Most forecasting services also provide added discipline to the forecasting process often missing within smaller corporate finance units. For example, the need to focus on the likely movement of an exchange rate within a specific time interval is typically stressed within a forecasting unit while not within a business unit's planning horizon. A treasurer might also use a forecasting service because "it exists". If the

[5] See, Kallianiotis (2013) for Unit Root (Stationarity) Test and for Cointegration Test, too.

treasurer does not use it, and guesses wrong on an exchange rate, the treasurer could be criticized for not using available "expert advice".

V. EMPIRICAL RESULTS

The data are monthly and are coming from *Economagic.com*, *Eurostat*, and *Bloomberg*. They are for the Euro-zone (€), for Mexico (MP), for Canada (C$), for U.K. (£), for Switzerland (SF), for Japan (¥), and lastly, for Australia (A$); the data are from 1973:03 to 2021:08. The variables are the spot exchange rate (S_t) quoted in American terms ($/FC), the forward exchange rate (F_t), a U.S. foreign exchange rate index ($USXRI_t$),[6] and an asterisk (*) on a variable represents the foreign country

Table 1 gives the estimation of the trend of the exchange rate, eq. (3), for seven different exchange rates ($/FC). The basic evaluation of these forecasting equations is the criterion of minimization of the standard error of the regression (min SER). The second criterion is the minimization of the root mean squared error (min RMSE). The dollar is depreciated with respect the euro, Canadian dollar, Swiss franc, Japanese yen, and Australian dollar. The dollar is appreciated toward the Mexican peso and the U.K. pound. All trends are statistically significant at 1% level. The smallest SER and RMSE are for the ln of Mexico spot exchange rate, *ms* ($/MP). Graph 1 gives this forecasted trend.

Table 1. Estimation of Exchange Rate Trend, Eq. (3)

$$s_t = \delta_0 + \delta_1 t + \varepsilon_t$$

	eus	*ms*	*cs*	*uks*	*sws*	*js*	*as*
C	0.105***	-2.138***	-0.288***	0.568***	-0.425***	-4.713***	-0.417***
	(0.016)	(0.011)	(0.017)	(0.013)	(0.012)	(0.015)	(0.021)
t	0.001***	-0.003***	0.001***	-0.001***	0.002***	0.001***	0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.082	0.894	0.093	0.311	0.760	0.048	0.175
SER	0.132	0.088	0.139	0.108	0.101	0.122	0.172
F	24.051	2,308.395	27.843	121.812	862.920	13.510	57.230
$D-W$	0.033	0.097	0.022	0.038	0.052	0.033	0.028
N	272	276	272	272	275	272	272
$RMSE$	0.131693	0.087931	0.138344	0.108063	0.100309	0.121760	0.171251

Note: *eus* = ln of EU spot ($/€), *ms* = ln of Mexico spot ($/MP), *cs* = ln of Canada spot ($/C$), *uks* = ln of U.K. spot ($/£), *sws* = ln of Swiss spot ($/SF), *js* = ln of Japan spot ($/¥), *as* = ln of Australia spot ($/A$), s_t = ln of spot exchange rate, t = time, R^2 = R-squared, SER = S.E. of regression, $D-W$ = Durbin-Watson statistic, *F* = F statistic, N = number of observations, $RMSE$ = Root Mean Squared Error, *** significant at the 1% level, ** significant at the 5% level, and * significant at the 10% level.
Source: *Economagic.com*, *Bloomberg*, and *Eurostat.*

From eq. (3), we get the estimated trend of the spot rate: $v_t = t^e_{t+1}$ (forecasted trend of the spot rate, *LEUSF*). Now, we run the regression of eq. (4) by utilizing the forecasted trend of eq. (3), as it is shown in Table 2, where, s_t = the ln of the spot exchange rate, t = time (1, 2, 3, …), v_t = the forecasted trend from eq. (3), and ε_t = the error term. The lag spot rate (s_{t-1}) is statistically significant at 1% level for all the exchange rates. The forecasted trend (v_t) is significant with *ms* (at 1% level) and with *sws* (at 10% level). The best forecasting is with *uks* because it minimizes SER and RMSE, which is shown in Graph 2.

Table 3 shows the forecasting of the future spot rate by using the forward rate. The forward markets determine all the future spot prices, exchange rates, interest rates, etc. "The market knows best". But, this happens because we, with our actions prove that the market knows best. The lag value of the forward exchange rate is significant at 1% level on the current spot rates for the four countries, here, eq. (6). The best forecasting is with ukf_{t-1} ($/£), which forecast the *uks*; it has the smallest SER and

[6] The $USXRI_t$ is the Trade Weighted U.S. Dollar Index: Major Currencies Index in ($\frac{FC}{\$}$), March 1973=100, NSA. Source: *Economagic.com*.

RMSE, Graph 3 gives this forecasting. Table 4 gives the correlation (ρ) and causality between the spot and forward rates. The correlation coefficient is positive and closed to (+1). The highest is for $\rho_{cs,cf} = +0.994$ and the causality between f_{t-1} and s_t and it follows by $\rho_{cs,cf} = +0.970$ between f_{t-3} and s_t; both are significant at 1% level with a very high F-statistic. Thus, the forward rate determines the future spot rate.

Table 2. **The Spot Rate and the Trend as Forecasting Indicators, Eq. (4)**

$$s_t = \alpha_0 + \alpha_1 s_{t-1} + \alpha_2 v_t + \varepsilon_t$$

	eus	*ms*	*cs*	*uks*	*sws*	*js*	*as*
C	0.001	0.008	-0.007	-0.003	0.001	-0.142	-0.004
	(0.007)	(0.017)	(0.006)	(0.008)	(0.002)	(0.232)	(0.006)
s_{t-1}	0.984***	0.946***	0.988***	0.981***	0.974***	0.984***	0.987***
	(0.011)	(0.018)	(0.009)	(0.012)	(0.014)	(0.011)	(0.010)
v_t	0.011	0.057***	-0.023	0.024	0.026*	-0.014	-0.004
	(0.039)	(0.019)	(0.030)	(0.021)	(0.016)	(0.051)	(0.024)
R^2	0.970	0.990	0.980	0.974	0.988	0.968	0.977
SER	0.024	0.027	0.021	0.021	0.023	0.022	0.029
F	4,265.779	13,509.04	6,655.379	5,085.136	10,959.74	4116.486	5,761.315
$D-W$	1.602	1.483	1.651	1.497	1.690	1.505	1.351
N	271	276	272	272	275	272	272
$RMSE$	0.023798	0.025901	0.021140	0.020555	0.022207	0.022577	0.028608

Note: See, Tables 1. s_t= ln of spot exchange rate, v_t= the forecasted trend of the spot exchange rate from eq. (3).
Source: See Table 1.

Further, the results of forecasting the spot rate by using currency betas (β_s), eq. (8), are given in Tables 5a, 5b, and 5c. Table 5a gives the β_s of these seven exchange rates by regressing the ln of spot rate ($\frac{€}{\$}$) with the ln of the exchange rate index ($\frac{FC}{\$}$). The β_s are statistically significant, except for the *as*. The problem, here, is the low D-W, which shows serial correlation of the error term, $E(\varepsilon_t, \varepsilon_{t-1}) \neq 0$. The best estimation is with *eus*; it has the smallest SER and RMSE, Graph 4a. In addition, Graph 5a gives the beta (β) for *LCS*. Then, the serial correlation of the error term is corrected with an AR(1) process. The new estimations are presented in Table 5b. The β_s are statistically significant at 1% level for all seven exchange rates. The minimum SER and RMSE are for *cs* and are represented in Graph 5b. The beta (β) of the *LEUS* after the correction is shown in Graph 4b. Now, by using the growth of the spot rates ($\dot{s}_t$) and the growth of the index ($\dot{e}_{USXRI}$) we estimate the β_s. All β_s are statistically significant at 1% level and the criteria are best for Canada's spot ($\dot{s}_{CS}$) with the smaller SER and RMSE, Table 5c; and graphically, it is depicted in Graph 5c.

Table 3. **The Forward Rate as a Forecasting Indicator, Eq. (6)**

$$s_t = \gamma_0 + \gamma_1 f_{t-1} + \varepsilon_t$$

	eus	*ms*	*cs*	*uks*	*sws*	*js*	*as*
C	0.003	-	0.001	0.012**	-	-0.101***	-
	(0.006)		(0.002)	(0.005)		(0.033)	
f_{t-1}	0.976***	-	0.997***	0.972***	-	0.978***	-
	(0.021)		(0.007)	(0.010)		(0.007)	
R^2	0.938		0.989	0.968		0.984	
SER	0.023		0.017	0.016		0.019	

F	2,093.480	21,240.56	9,445.428	19,289.64
$D-W$	1.631	2.089	1.758	1.839
N	141	243	315	325
$RMSE$	0.023177	0.016782	0.016256	0.019065

Note: See, Tables 1. *eus* = s_t = ln of spot exchange rate, f_{t-1} = the ln of forward exchange rate (lag value).
Source: See Table 1.

Table 4. Correlation (ρ) and Causality ($\overset{F}{\Rightarrow}$) between the Spot and the Forward Rate

$\rho_{s_t, f_{t-1}}$ and $\rho_{s_t, f_{t-3}}$

$f_{t-1} \overset{F}{\Rightarrow} s_t$ and $f_{t-3} \overset{F}{\Rightarrow} s_t$

eus	ρ=+0.969	$f_{t-1} \overset{F=20.955***}{\Longrightarrow} s_t$
euf	ρ = +0.863	$f_{t-3} \overset{F=20.955***}{\Longrightarrow} s_t$
cs	ρ=+0.994	$f_{t-1} \overset{F=58.603***}{\Longrightarrow} s_t$
cf	ρ=+0.970	$f_{t-3} \overset{F=58.603***}{\Longrightarrow} s_t$
uks	ρ=+0.984	$f_{t-1} \overset{F=117.218***}{\Longrightarrow} s_t$
ukf	ρ=+0.884	$f_{t-3} \overset{F=117.218***}{\Longrightarrow} s_t$
js	ρ=+0.992	$f_{t-1} \overset{F=114.341***}{\Longrightarrow} s_t$
jf	ρ=+0.941	$f_{t-3} \overset{F=114.341***}{\Longrightarrow} s_t$

Note: See, Tables 1. s_t = ln of spot exchange rate, ρ_{s_t, f_t} = correlation coefficient, between s_t and f_t, F = F statistic, and $\overset{F}{\Rightarrow}$ = the direction of causality.
Source: See Table 1.

Table 5a. Estimation of Currency Betas (β_s), Eq. (8)

$$s_t = \alpha + \beta\, e_{USXRI_t} + \varepsilon_t$$

	eus	*ms*	*cs*	*uks*	*sws*	*js*	*as*
C	-3.633***	-0.078	-1.130***	-0.957***	-7.385***	-3.943***	0.082
	(0.161)	(0.717)	(0.166)	(0.233)	(0.388)	(0.392)	(0.319)
e_{USXRI}	0.773***	0.564***	0.292***	0.096*	1.716***	1.964***	0.020
	(0.036)	(0.160)	(0.037)	(0.051)	(0.085)	(0.086)	(0.070)
R^2	0.631	0.036	0.095	0.006	0.398	0.460	0.001
SER	0.084	0.401	0.127	0.179	0.300	0.301	0.245
F	461.971	12.461	63.868	3.512	403.088	517.070	0.084
$D-W$	0.051	0.008	0.013	0.016	0.006	0.009	0.011
N	272	340	608	608	611	608	608
$RMSE$	0.083469	0.399346	0.127026	0.178538	0.299416	0.300637	0.244619

Note: See, Tables 1. s_t= ln of spot exchange rate, e_{USXRI} = ln of the trade weighted U.S. dollar index.
Source: See Table 1.

Table 5b. Estimation of Currency Betas (β_s), Eq. (8) with $AR(1)$ Correction

$s_t = \alpha + \beta e_{USXRI_t} + \varepsilon_t$

	eus	*ms*	*cs*	*uks*	*sws*	*js*	*as*
C	-3.370***	1.647***	-1.306***	-3.887***	-4.874***	0.671*	-2.670***
	(0.258)	(0.456)	(0.159)	(0.208)	(0.586)	(0.399)	(0.282)
e_{USXRI}	0.705***	0.248***	0.338***	0.762***	1.009***	0.845***	0.651***
	(0.054)	(0.095)	(0.032)	(0.042)	(0.045)	(0.046)	(0.050)
$AR(1)$	0.985***	0.983***	0.991***	0.990***	0.996***	0.996***	0.994***
	(0.014)	(0.005)	(0.005)	(0.004)	(0.003)	(0.002)	(0.004)
R^2	0.981	0.993	0.988	0.989	0.997	0.997	0.992
SER	0.019	0.035	0.014	0.019	0.020	0.021	0.023
F	7,023.519	22,280.70	25,872.52	27,390.80	110,035.7	118,544.7	35,487.78
$D-W$	1.896	1.617	1.764	1.461	1.657	1.477	1.478
N	271	339	607	607	610	607	607
$RMSE$	0.018838	0.034691	0.014335	0.018652	0.020136	0.020564	0.022465

Note: See, Tables 1. s_t= ln of spot exchange rate, e_{USXRI_t} = ln of the trade weighted U.S. dollar index, $AR(1)$ = autoregressive (1) process for correction of serial correlation of the error term.
Source: See Table 1.

Table 5c. Estimation of Currency Betas (β_s), Eq. (8), with Growth Variables

$\dot{s}_t = \alpha + \beta \dot{e}_{USXRI_t} + \varepsilon_t$

	eus	*ms*	*cs*	*uks*	*sws*	*js*	*as*
C	-0.001	0.005***	0.001	0.001	-0.003***	-0.002**	0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\dot{e}_{USXRI_t}$	0.711***	0.224***	0.337***	0.761***	1.015***	0.849***	0.650***
	(0.055)	(0.096)	(0.032)	(0.042)	(0.045)	(0.046)	(0.050)
R^2	0.387	0.016	0.155	0.355	0.457	0.362	0.218
SER	0.019	0.035	0.014	0.019	0.020	0.021	0.023
F	170.124	5.411	110.875	333.088	512.376	342.988	168.617
$D-W$	1.919	1.579	1.768	1.459	1.659	1.476	1.479
N	271	339	607	607	610	607	607
$RMSE$	0.018882	0.035372	0.014386	0.018762	0.020169	0.020614	0.022517

Note: See, Tables 1. $\dot{s}_t$ = the growth of the spot exchange rate, $\dot{e}_{USXRI_t}$ = the growth of the trade weighted U.S. dollar index.

Source: See Table 1.

VI. POLICY IMPLICATIONS OF MARKET EFFICIENCY, FULL INFORMATION, AND FORECASTING The efficient-market hypothesis (EMH) is a hypothesis in Finance, which states that asset prices (exchange rate) reflect all available information. A direct implication is that it is impossible to "beat the market" consistently on a risk-adjusted basis since market prices (exchange rates, mostly

forward rates) should only react to new information. Thus, forecasting is difficult and it is made with errors because the economy is dynamic, manipulated, controlled, interdependent with other major global economies, so it is unpredictable; our information is restrained and many news are controlled (dictated) "fake" because there is no free press or free speech,[7] and a lot of propaganda, especially lately with the socialist and liberal governments in power in most of the countries. Consequently, our models are only approximations of reality (the official data), and our actual (true) knowledge is limited. Insiders have more information (illegal), but they are in control (above the law) and no one can impose on these people (businessmen or politicians)[8] any penalty. For the general public, this (the 21st century) is the century of misinformation.

The Central Bank (the Fed), which is a private bank,[9] plays a major role in our markets by controlling the money supply[10] through the federal funds rate and affects the exchange rate,[11] too. The monetary policy is very stranger (anti-social) since 2008 with its zero federal funds rate has caused serious economic problems. Lately, the fiscal[12] (with a war against fuel and against Russia) and trade (by lifting tariffs for imports from China) policies have become worse than the suspicious monetary one. New monetary policy instruments: Interest on Reserves, IOR **(** $i_{IOR} > 0$ **)** (since October 1, 2008),[13] abandonment of Required Reserves, $R_R = 0$ ($r_R = 0.00\%$) (since March 26, 2020), Overnight Reverse Repurchase Agreement Facility ($i_{ONRRP} > 0$) (Since September 17, 2014),[14] and many others.[15] The target federal funds rate is between 0.75%-1.00% (since May 5, 2022),[16] which is very low and the effective federal funds rate is ($i_{FF}^{e} = 0.83\%$) (5/17/2022).

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[7] "There is no such thing, at this date of the world's history, in America, as an independent press. You know it and I know it. There is not one of you who dares to write your honest opinions, and if you did, you know beforehand that it would never appear in print. I am paid weekly for keeping my honest opinion out of the paper I am connected with. Others of you are paid similar salaries for similar things, and any of you who would be so foolish as to write honest opinions would be out on the streets looking for another job. If I allowed my honest opinions to appear in one issue of my paper, before twenty-four hours my occupation would be gone. The business of the journalists is to destroy the truth, to lie outright, to pervert, to vilify, to fawn at the feet of mammon, and to sell his country and his race for his daily bread. You know it and I know it, and what folly is this toasting an independent press? We are the tools and vassals of rich men behind the scenes. We are the jumping jacks, they pull the strings and we dance. Our talents, our possibilities and our lives are all the property of other men. We are intellectual prostitutes." by John Swinton, as "the former Chief of Staff at the *New York Times*", before the New York Press Club in 1953.

[8]See, Says Nancy Pelosi "made millions in coronavirus insider trading.".
https://www.politifact.com/factchecks/2020/jun/30/facebook-posts/no-evidence-nancy-pelosi-made-millions-insider-cor/

[9] "I am a most unhappy man. I have unwittingly ruined my country. A great industrial nation is controlled by its system of credit. Our system of credit is concentrated. The growth of the nation, therefore, and all our activities are in the hands of a few men. We have come to be one of the worst ruled, one of the most completely controlled and dominated Governments in the civilized world no longer a Government by free opinion, no longer a Government by conviction and the vote of the majority, but a Government by the opinion and duress of a small group of dominant men." (President Woodrow Wilson). See also, Financial and Banking Cover-ups Key Information and Facts Reveal Major Cover-up.
https://www.wanttoknow.info/financialbankingcoverup?gclid=EAIaIQobChMInoXAoKXk9wIV_8mUCR1yrQisEAAYASAAEgIolvD_BwE

[10] See, Buiter (2014),
https://www.academia.edu/8944668/Central_Banks_Powerful_Political_and_Unaccountable?email_work_card=view-paper . The Fed can "create money" from zero, as its governor, Jerome Powell, said at a recent interview. (*Fox News*, 5/26/2022).

[11] Kallianiotis (2022a).

[12] See, Kallianiotis and Petsas (2022).

[13] Now, the interest rate on reserves is: $i_{IOR} = 0.90\%$ (since 5/5/2022).

[14] Currently, the interest rate on ONRRP is: $i_{ONRRP} = 0.80\%$ (since 5/5/2022).

[15] The Fed introduced new lending programs during the global financial crisis in 2007-2008. Thus, the Federal Reserve has a variety of policy tools that it was using in the past or it is still using them, now, in order to implement monetary policy and support the economy during the financial crisis and the latest coronavirus economic, healthcare, the war in Ukraine, and social crisis. These instruments are the followings: (I) Open Market Operations, (II) Discount Window and Discount Rate, (III) Reserve Requirements, (IV) Interest on Required Reserve Balances and Excess Balances, (V) Overnight Reverse Repurchase Agreement Facility, (VI) Term Deposit Facility, (VII) Commercial Paper Funding Facility, (VIII) Primary Dealer Credit Facility, (IX) Money Market Mutual Fund Liquidity Facility , (X) Primary Market Corporate Credit Facility, (XI) Secondary Market Corporate Credit Facility, (XII) Term Asset-Backed Securities Loan Facility, (XIII) Paycheck Protection Program Liquidity Facility, (XIV) Municipal Liquidity Facility, (XV) Main Street Lending Program, (XVI) Central Bank Liquidity Swaps, (XVII) Temporary Foreign and International Monetary Authorities (FIMA) Repo Facility, (XVIII) Expired Policy Tools, and (XIX) Margin Requirements. See, Kallianiotis (2021d).

[16] In March 2022, by using Taylor's rule, the target federal funds rate must be: $i_{FF} = 12.95\%$.

Exchange Rate and its Forecasting: Market-Based Forecasting and Forecasting with the Use of Currency Betas (β_s)

Public policies must prevent financial and economic crises. The global financial crisis in 2008 created serious and long term problems to the U.S. and worse ones to the Euro-zone countries. The Fed and the ECB tried to improve the economies, but since 2016 there was no improvement[17] (like, growth, low unemployment, low inflation, stability in the foreign exchange market and balanced trade, stability in the financial markets, interest rate stability, and balanced budget). The Fed with zero federal funds rates[18] and enormous money supply[19] caused a bubble in the financial market[20] and a double digit inflation rate (17%).[21] Then, in 2020 came the suspicious COVID-19 with lockdowns, vaccine mandates, and enormous restrictions and controls to human beings. Further, instead of finding a peace agreement between Ukraine and Russia, we finance Ukraine with billions of dollars to buy weapons, which contributes to our budget deficit and increases the probability of WWIII.[22] The government tried to stimulate the destructive economy with an expansionary fiscal policy and created huge budget deficits[23] and national debt.[24] To finance these deficits, the government continues to issue government securities and this excess supply reduces their prices and increases their return (interest rate). The Fed was buying these securities to reduce the interest rate by supplying non-borrowing reserves, which was increasing the monetary base and the money supply. The effect of these policies was a huge bubble in the financial market and an enormous inflation. The bail out cost to tax payers with the interest on reserves (IOR)[25] and the bail in cost to depositors with almost zero deposit rates for 14 years[26] are trillions of dollars per annum to citizens, which shows that the public policies are anti-social and unethical.

During the Annual Meeting in Davos (2022) of the World Economic Forum, they proved impudently again that they do not care about us (the people), they were laughing for our problems, they said that will track our pollution and our carbon fumes, they want to destroy the sovereignty of the nations, and to impose the one world government.[27] What kind of deception is this?

$$\bar{i}_{FF_t} = \pi_t + r_t^* + \alpha_\pi(\pi_t - \pi_t^*) - \alpha_u(u_t - u_t^N)$$

where, $\bar{i}_{FF_t}$ = the target short-term nominal interest rate (the federal funds rate), π_t = the rate of inflation as measured by the GDP deflator, π_t^* = the desired rate of inflation, r_t^* = the assumed equilibrium real interest rate, u_t = the unemployment rate, and u_t^N = the natural level or full employment unemployment rate. In this equation, α_π should be positive and α_u should be negative (as a rough rule of thumb, Taylor's 1993 paper proposed setting $\alpha_\pi = 0.5$ and $\alpha_u = -0.5$).

Financial market plays a major role in market oriented economies and its optimal growth has a positive effect on investors' and consumers' confidence. The opposite happens, if growth is artificially enormous (abnormal bubbles). We are also using, here, Kallianiotis (2019b) rule, which uses an extra term, the growth of the financial market (g_{DJIA_t}) and gives the target federal funds: i_{FF} = 16.76%; but it is 1% now, which it is very low. Of course, you reach this $\bar{\imath}_{FF}$ gradually starting in 2010 or 2012. In 1981, the federal funds rate was 19.10%.

$$\bar{i}_{FF_t} = \pi_t + r_t^* + \alpha_\pi(\pi_t - \pi_t^*) - \alpha_u(u_t - u_t^N) + \alpha_{DJIA}(g_{DJIA_t} - g_{DJIA_t}^*)$$

where, g_{DJIA_t} = the actual growth of the DJIA index, $g_{DJIA_t}^*$ = the optimal (the bubble prevention) growth of the DJIA ($g_{DJIA}^* = i_{RF} + HRP = 0.96\% + 8.7\% = 9.66\%$), and $\alpha_\pi = 0.25$, $\alpha_u = -0.50$, $\alpha_{DJIA} = 0.25$

See, Dow Jones - DJIA - 100 Year Historical Chart. Macrotrends https://www.macrotrends.net/1319/dow-jones-100-year-historical-chart

[17] See, *U.S. GDP Growth Rate 1961-2022*. https://www.macrotrends.net/countries/USA/united-states/gdp-growth-rate
[18] See, Federal Funds Target Range - Upper Limit (DFEDTARU). https://fred.stlouisfed.org/series/DFEDTARU
[19] See, M2 (WM2NS). https://fred.stlouisfed.org/series/WM2NS . M2= $21.7 trillion.
[20] See, Dow Jones - DJIA - 100 Year Historical Chart. https://www.macrotrends.net/1319/dow-jones-100-year-historical-chart . $g_{DJIA} = 31.42\%\ p.a.$
[21] See, Alternate Inflation Charts. http://www.shadowstats.com/alternate_data/inflation-charts
[22] U.S. has given hundreds of millions of dollars of military aid to Ukraine and lately, another $40 billion aid. (*Fox News*, 5/19/2022). This is actually a war of the U.S. against Russia.
[23] See, Federal Deficit Trends Over Time. https://datalab.usaspending.gov/americas-finance-guide/deficit/trends/ . $BD = \$3\ trillion$ for 2021.
[24] See, Federal Debt Trends Over Time. https://datalab.usaspending.gov/americas-finance-guide/debt/trends/ and https://www.usdebtclock.org/ . $ND = \$30.494\ trillion$
[25] The bail out cost is now: bank reserves $3,615.4 billion x 0.90% (i_{IOR}) = $32.539 billion per annum.
[26] The bail in cost is: bank deposits $18,072.4048 billion x (-8.45%) real deposit rate = $1,527.118 billion per annum.
[27] See, *Fox News*, 5/25/2022. See also, "Russia's invasion of Ukraine may have marked the start of "a third world war," and Russian President Vladimir Putin must be defeated "as soon as possible" if the world wants to preserve civilization. That was the stark message that Hungarian-born billionaire and philanthropist George Soros delivered on Tuesday to attendees at the 2022 World Economic Forum in Davos, Switzerland. "Even when the fighting stops, as it eventually must, the situation will never revert" to

What the leaders of our "democratic" governments are doing? Why people are voting for them (the followers)? Who is in control of this fallen world? How can we have an accurate forecasting? Then, what can be forecasted for the future of our economy, of our country, and of the world?

VII. CONCLUSION

The paper is using a market-based forecasting and a forecasting with the currency beta (β_s) and utilizes them for exchange rate forecasting. We start with the current spot exchange rate as a forecasting indicator and we continue with the forward rate as another forecasting indicator. The theoretical equations are supported by the empirical results of seven different exchange rates. The past spot exchange rate is forecasting the future spot rate. The same holds for the forward exchange rate, which forecast the future spot. There is no doubt that the forward exchange rate determines the future spot rate; the unbiased forward rate hypothesis. In our economy, all prices are determined in the futures market and the spot prices follow these future prices. "We just follow the markets, the experts and the elites."[28] (*Sic*).

Thus, the currency beta is used extensively, as it happened with the betas in our financial markets, for forecasting the exchange rates. The currency market used, here, is the trade weighted U.S. dollar index. The seven betas are estimated and they give a very good forecasting for these exchange rates. Of course, in our dynamic and globalized markets, it is difficult to forecast any variable correctly. The monetary policy, the fiscal policy, and the trade policy in both countries are all affecting the exchange rate because it is a relative price (i.e., $/€ or $/£, etc.). We need some ethical and moral public policies, which will maximize social welfare and the wellbeing of the citizens and not to maximize (with artificial bubbles) the market values of some financial variables that are not related with the real variables and the true values.

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where it was before, warned the 91-year-old Soros. "Other issues that concern all of humanity -- fighting pandemics and climate change, avoiding nuclear war, maintaining global institutions -- have had to take a back seat to that struggle. That's why I say civilization may not survive." https://us.cnn.com/2022/05/24/economy/george-soros-davos-world-economic-forum/index.html. In addition, the Treasury Secretary, Janet Yellen, said, "banning abortion would be very damaging to the economy", (*Fox News*, 5/27/2022). These people and the administration are atheist, against families, barbaric and sick people. They are controlled "forerunners" by the dark powers.

[28] "Lastly, we (especially Greeks) must be aware that we are undergoing changes in our financial, economic, geopolitical, cultural, political, technological, spiritual, and risk contexts and we must be sensitive and act with attention to these inhumane changes. Christian Orthodox Russia is not an enemy of the west the controlled heretic and atheist west is actually an enemy for Russia and the rest of the world. Atheist and Muslim Asia may be proven to be a future "enemy" for the entire west, the EU and the U.S. With the new President in the U.S., Donald Trump, there is some hope for Europe and the entire world because he has some values different than the corrupted establishment of professional ignorant politicians. We cannot be opportunists and we cannot be danger-speakers, but realists, altruists, humanists, and truthful. "From the start, the construction of Europe was an extravagant political idea designed to imprison the nations of Europe into an 'ever closer' union of states." The best choice will be to reassess the need to move forward with the union or to hold back. Holding back might preserve whatever remains of each nation's sovereignty and culture. We do not need any type of integrations or common currency and of course we do not want to have a supra-nationality, as a minority of people (and they are non-Europeans) believes, but it has louder voice, powerful control, and global influence than the majority. In recent years, citizens of Greece, Europe, and of the U.S. have shown their disappointment in and apprehensions for whom to vote. They try to elect the least evil in their questionable, immoral, and deceptive "democracies". The elected representatives are unable to act in favor of their countries' interest. Their corruptive practices have become a national way of life. In EU there are different Europeanized domestic parties that all have the same beliefs and objectives, to ignore their countries; and they have created a class of citizens through favoritism and job offering to them that these voters support and fight for these parties. Territorial changes and political upheavals, as well as a public sense of lost identity and a public loss of faith in the government and all their leaders have become citizens' everyday problems. Euro-communism is doing relatively better in EU (and in Greece these atheists anti-Greece traitors are in government for three years terrorizing businesses, universities, and individuals) than in Russia, now. All these can have a profound negative effect on individual member-nations and on the current interdependence between the EU and its members. But, the current problem is to recover from the financial crisis and its recession, and to send illegal immigrants and foreign anarchists back to their countries of origin, which seems as a very long process. Of course, Greeks have a big obligation towards their history and ancestors, who have created their civilization, the Hellenic-Orthodox one, which is unique on earth for those who have cultivated their intellect and are able to do objective comparisons. Greeks have no right to be like the rest of the Europeans because they have the obligation to be perfect. God gave to them the ancient moral philosophers and the revelation in their language. These obligations are enormous and their destiny is to reach perfection and enlighten the rest of Europe and the world." John N. Kallianiotis, *The European Union and its Debt Crises: The Deception of the Greeks*, Hauppauge, N.Y.: Nova Science Publishers, August 2018, ISBN: 978-1-53614-067-5. https://novapublishers.com/shop/the-european-union-and-its-debt-crises-the-deception-of-the-greeks/

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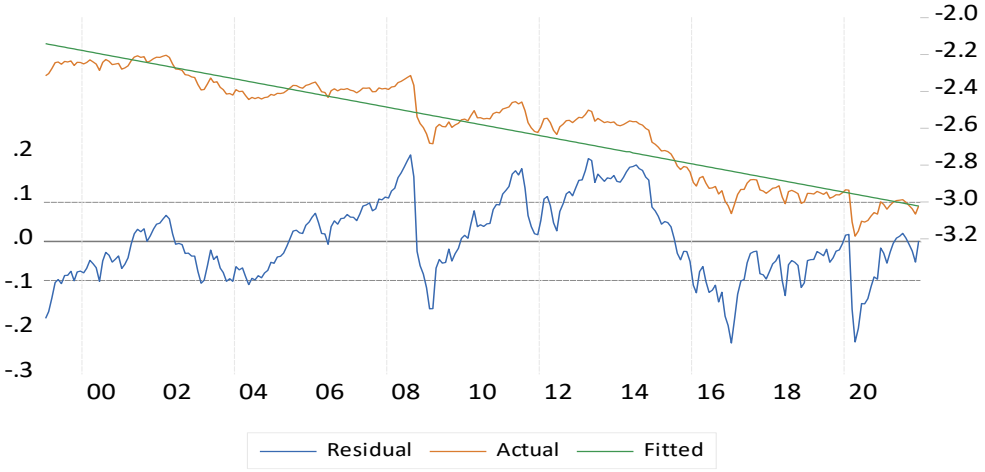
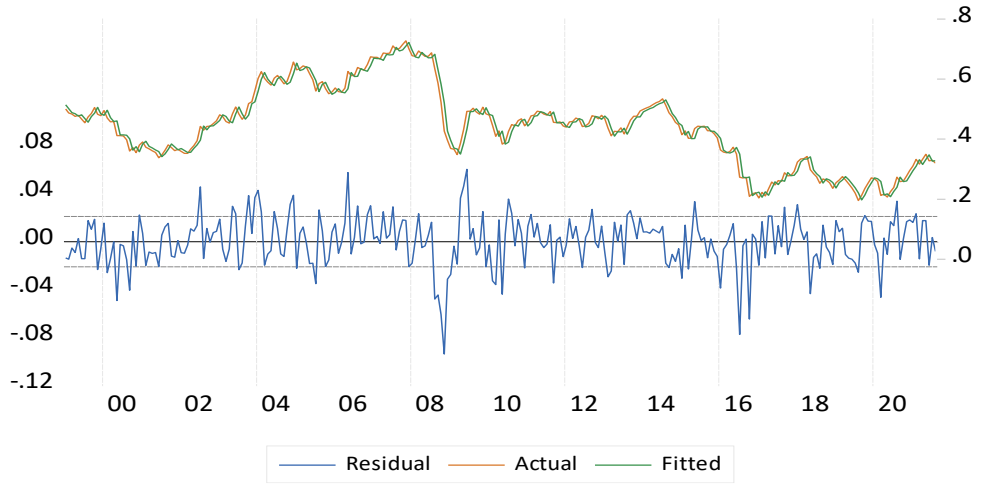
APPENDIX

Graphs with min RMSE



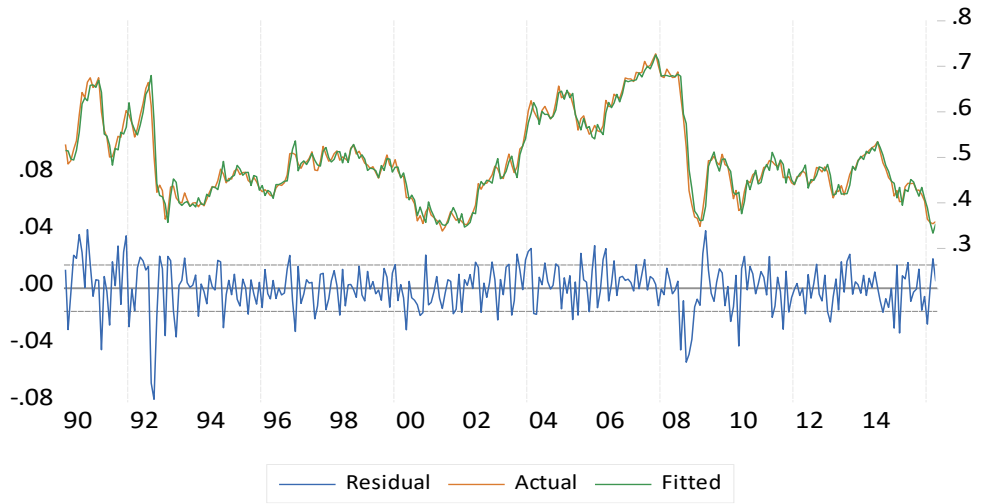
Graph 1. Forecasted Trend of the Spot Exchange Rate *ms* ($/MP), Eq. (3)

Note: Actual = *LMS* = ln of Mexican spot exchange rate ($\frac{\$}{MP}$) and Fitted = *LMSF* = forecasted ln of Mexican spot exchange rate by using the time trend, eq. (3), Table 1.



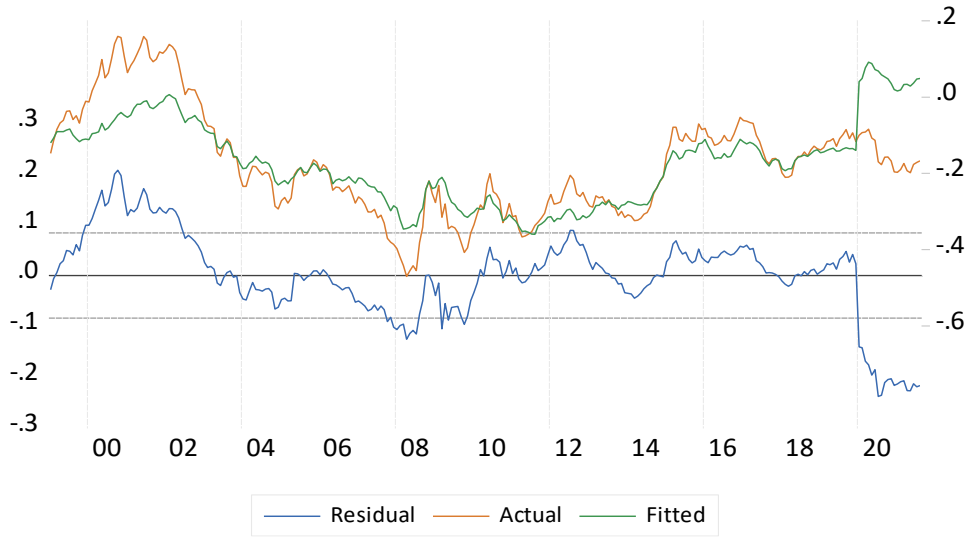
Graph 2. Forecasting the Exchange Rate with the Forecasting Trend for the *uks* ($/£), Eq. (4)

Note: Actual = *LUKS* = ln of U.K. spot exchange rate ($\frac{\$}{£}$) and Fitted = *LUKSF* = forecasted ln of UK spot exchange rate by using eq. (4), Table 2.



Graph 3. The Forward Rate as a Forecasting Indicator for the *uks* ($/£), Eq. (6)

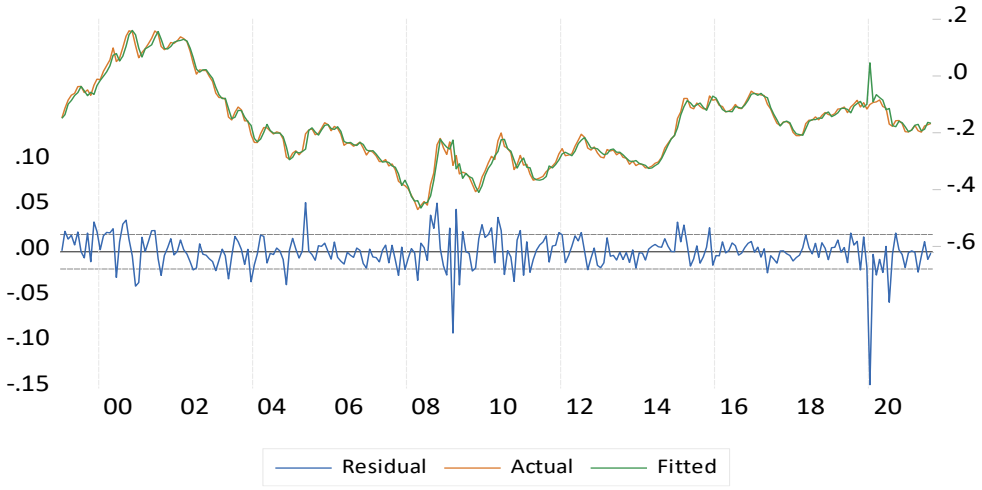
Note: Actual = *LUKS* = ln of UK spot exchange rate ($\frac{\$}{£}$) and Fitted = *LUKSF* = forecasted ln of UK spot exchange rate by using eq. (6), Table 3.



Graph 4a. Estimation of the Currency beta (β) of the *LEUS*, Eq. (8)

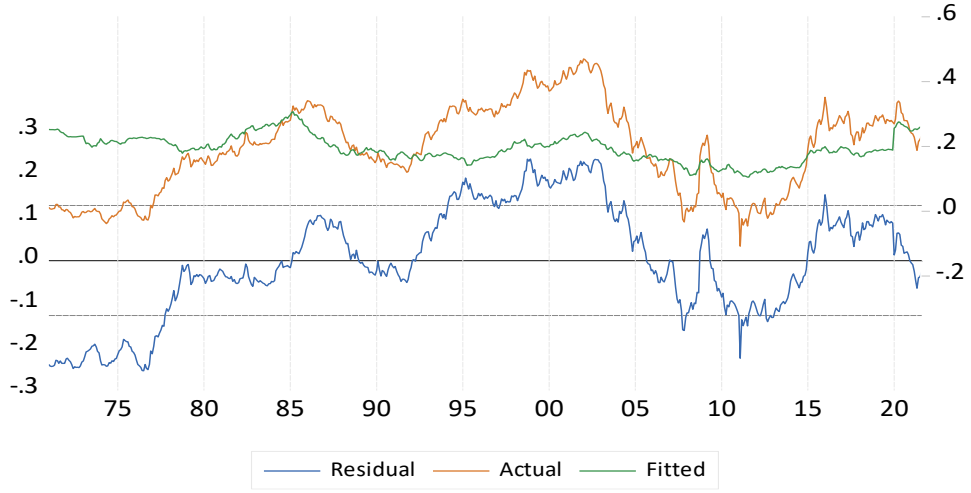
Note: Actual = *LEUS* = ln of European spot exchange rate (€/$) and Fitted = *LEUSF*= forecasted ln of European spot exchange rate by using the currency β, eq. (8), Table 5a.

Source: *Economagic.com*



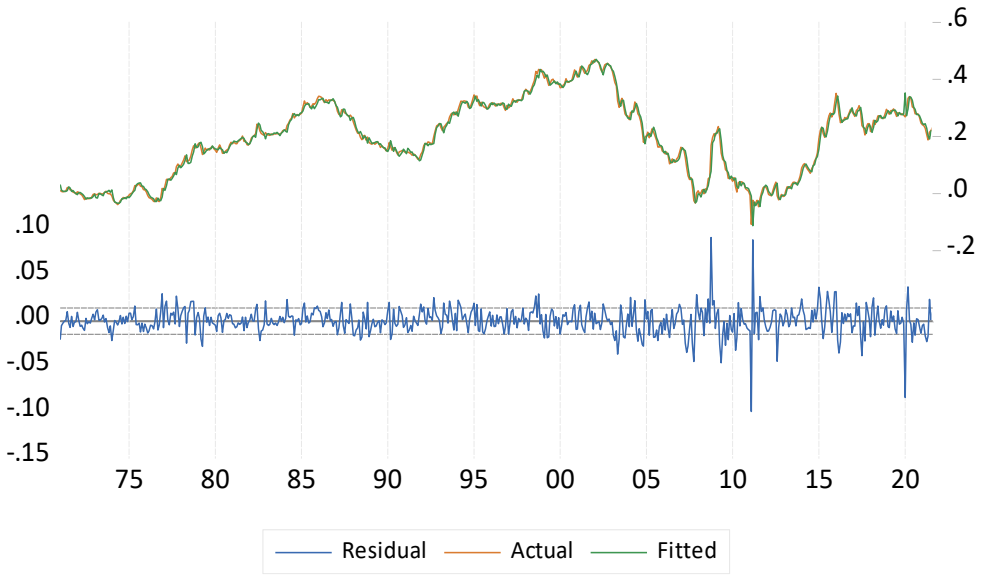
Graph 4b. Estimation of the Currency beta (β) of the *LEUS* with AR(1) Correction

Note: Actual = *LEUS* = ln of European spot exchange rate (€/$) and Fitted = *LEUSF*= forecasted ln of European spot exchange rate by using the currency β, eq. (8), Table 5b.

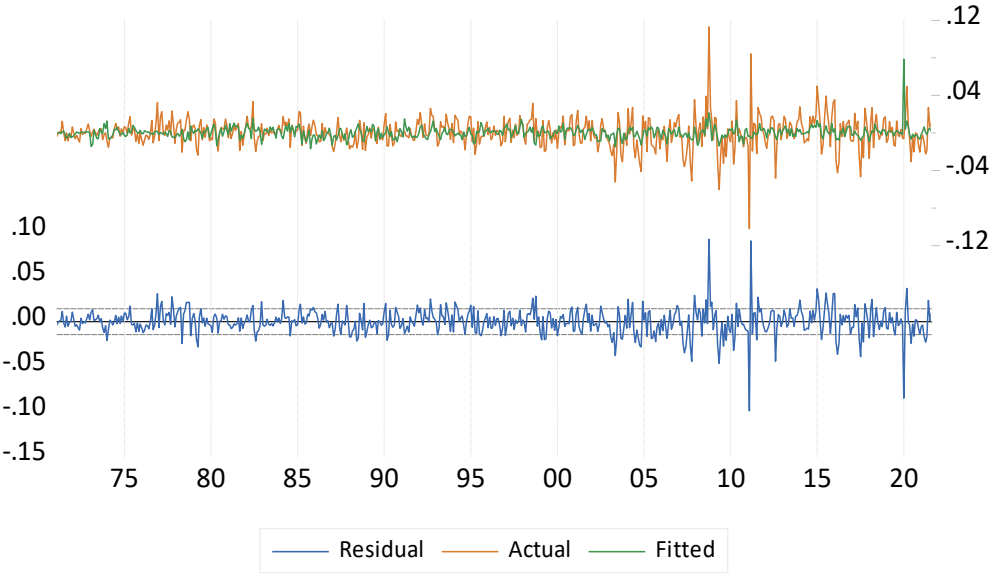


Graph 5a. Estimation of the Currency beta (β) of the *LCS,* Eq. (8)

Note: Actual = *LCS* = ln of Canadian spot exchange rate (C$/$) and Fitted = *LCSF*= forecasted ln of Canadian spot exchange rate by using the currency β, eq. (8), Table 5a.



Graph 5b. Estimation of the beta (β) of the *LCS* with AR(1) Correction, Eq. (8)
Note: Actual = *LCS* = ln of Canadian spot exchange rate (C$/$) and Fitted = *LCSF* = forecasted ln of Canadian spot exchange rate by using the currency β, eq. (8), Table 5b.



Graph 5c. Estimation of the Currency beta (β) of the *CS* with the Growth of the Variables
($\dot{s}_t$ and $\dot{e}_{USXRI}$), Eq. (8)
Note: Actual = $\dot{s}_t$ = growth of Canadian spot exchange rate (C$/$) and Fitted = forecasted growth of Canadian spot exchange rate by using the currency β, eq. (8), Table 5c.