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Authors

Sengupta, Jati K.
Sfeir, Raymond

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**Past trend versus future expectation:
test of exchange rate volatility**

JATI K. SENGUPTA and RAYMOND SFEIR[‡]

University of California, Santa Barbara, CA, USA
and

[‡]*School of Business, Chapman University, Orange, CA, USA*

Which of the two forces, past trends or future expectations plays a more dominant role in exchange market volatility? This hypothesis is econometrically tested here for four advanced industrial countries, France, UK, Japan and Germany over the period 1985 to 1995.

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I. INTRODUCTION

The foreign exchange market is by far the largest financial market in the world, with a daily turnover exceeding \$1000 billion in 1995. The role of central banks and hence the government is not a passive one in these markets. They continue to intervene in this global market to maintain an 'orderly market' through trading. This trading generally involves the US dollar, due to the depth and importance of the dollar currency market. Exchange rate volatility has acquired a special importance in this global framework of trade due to two main reasons. One is that national governments have increasingly felt the impact of this volatility on their own monetary policies and secondly, the investors today are increasingly participating in globally diversified portfolios following the asset market approach.

Our object here is to model the adjustment process in the foreign exchange market through a representative government's policy aspiration, where an orderly market is considered to be the desired goal or the target. This framework allows us to develop a dynamic model to test which of the two forces, past history or future expectations plays a more dominant role in the evolution of the real exchange rate process for the four industrial countries: France (FR), Japan (JP), United Kingdom (UK) and Germany (GR) over three sample periods with monthly data as follows: Sample I (February 1985 through January 1988), Sample II (February 1988 through January 1991) and Sample III (February 1991 through August 1995).

II. A DYNAMIC FORWARD-LOOKING MODEL

We assume a quadratic adjustment cost function for the government as a policymaker, which minimizes expected adjustment costs with respect to a control variable x_t , i.e.,

$$\begin{aligned} & \text{Min } E_t C(x) \\ \text{where } C(x) = & \sum_{t=0}^{\infty} (\frac{1}{2}) \rho^t \left[a_1 (y_t - y_t^0)^2 + a_2 (y_t - y_{t-1})^2 \right] \end{aligned} \quad (1)$$

where $y_t = g(x_t)$ is a linear policy intervention function, e.g., $g(x_t) = k_0 + kx_t$, $E_t(\cdot)$ is expectation as of time t , ρ is the exogenous discount rate, y_t is the real exchange rate in log units with y_t^0 as the desired or target rate. On minimizing the loss function (1) with respect to the control variable x_t we obtain the necessary condition

$$y_t = (a_1/a_0) E_t y_t^0 + (a_2/a_0) y_{t-1} + (a_2\rho/a_0) E_t y_{t+1} \quad (2)$$

where $a_0 = a_1/a_2(1 + \rho)$ and $E_t(\cdot)$ denotes the conditional expectation taken with respect to information available up to time t . Note that we have two unobserved variables here, e.g., $E_t y_t^0$ and $E_t y_{t+1}$. The first has two interpretations. One is due to Hall and Henry (1988) who consider this to be the expected rate to prevail in the competitive market were there no government intervention. A second interpretation is that it is the expected value of the target or the goal. The second unobserved variable $E_t y_{t+1}$ denotes the conditional expectation of the future exchange rate y_{t+1} . The rational expectations hypothesis assumes that $E_t y_{t+1} = y_{t+1}$, where y_{t+1} is observed at time point $(t+1)$.

Three types of estimation methods are applicable for the dynamic system (2). The first, due to Hall and Henry (1988) considers a deterministic version by dropping out the expectation operator E_t , e.g., replacing $E_t y_{t+1}$ by the observed series y_{t+1} and assuming a specification for y_t^0 as

$$y_t^0 = \alpha_1 \Delta i_t + \alpha_2 \Delta i_{t-1} + \alpha_3 y_{t-1} \quad (3)$$

where $\Delta i_t = RI_t - RIUS_t$ is the real interest rate differential between the domestic economy and the US economy. One combining (2) and (3) one obtains the final specification

$$\ln RX_t = \beta_0 + \beta_1 \ln RX_{t-1} + \beta_2 \ln RX_{t+1} + \beta_3 \Delta i_{t-1} + \beta_4 \Delta i_t + u_t. \quad (4)$$

Clearly if $\beta_3 = 0$, $\beta_1 = 1$ and $\beta_4 > 0$ then this equation reduces simply to the open arbitrage equation. But if $-\beta_3 = \beta_1 > 0$ then it suggests an asset stock model in which assets adjust fully to a change in interest rate within the time period.

A second method due to Kennan (1979) considers the infinite horizon case (1) of the expected loss function and assumes the hypothesis of rational expectations, e.g., $E_t y_{t+1} = y_{t+1}$. He further assumes that the stochastic target variable y_t^0 is linearly related to a set of observed exogenous variables z_t . This finally yields an estimating equation in the form

$$\Delta y_t = \gamma_0 \Delta y_{t+1} + \gamma_1 (y_t - \alpha z_t) + v_t \quad (5)$$

where $\Delta y_t = y_t - y_{t-1}$ and the error component v_t is assumed to be stochastically independently distributed with a zero mean and finite variance. Since the z_t variables are exogenous this equation (5) can be consistently estimated by the method of instrumental variables. A third method, due to Gregory et al. (1993) employs an additional assumption about how the exogenous term z_t is generated, e.g., a first or higher order process and then derives an estimating equation. However their simulation studies have shown that Kennan's method is more robust.

In our empirical application we have basically applied Kennan's method, where we have used the relative interest rate differential as the exogenous variable. This means the we have dropped the term $\beta_4 \Delta i_t$ in the specification (4), since Δi_t is an endogenous variable and hence the least squares estimation of (4) suffers from the simultaneous equation bias. Furthermore we also considered additional explanatory variables as exogenous to see if it improves the prediction of real exchange rates.

III. EMPIRICAL DATA AND ESTIMATION RESULTS

The real exchange rate (RX) is calculated here as SP^*/P , where S is the nominal exchange rate expressed in the domestic currency per unit of the foreign currency, P and P* are the consumer price indices of the domestic and foreign country. The monthly data on the nominal exchange rate are obtained from IMF *International Financial Statistics*, while the consumer price indices are from DRI data bank. With US as the foreign country the following countries: France (FR), Japan (JP), United Kingdom (UK) and West Germany (GR) are used here with three sample periods: Sample I: February 1985 to January 1988, Sample II: February 1988 to January 1991 and Sample III: February 1991 to August 1995. These sample periods are selected from the pattern of the graphic plots.

Following the standard unit root models we calculated the estimated residuals e_t from the fitted equation:

$$RX_t = \alpha + \beta_1 RX_{t-1} + \beta_2 RX_{t-2} + \beta_3 RX_{t-3} + \varepsilon_t \quad (6)$$

and then used a six-month moving average estimate of conditional variance $\hat{\sigma}_t^2 = E_{t-1}(e_t^2)$.

The temporal dynamics of the real exchange rate series was first tested for random walk by running the regression equation (6) in the form $\Delta RX_t = (\beta_1 - 1) RX_{t-1} + \beta_2 \Delta RX_{t-2} + \Delta RX_{t-3}$ and testing if the estimated coefficient $(\hat{\beta}_1 - 1)$ is significantly different from zero. The ADF (augmented Dicky-Fuller) test statistic was used with a sample size $n=33$ and in each of the four cases FR, JP, UK and GR the test statistic showed that the four series are not stationary, i.e., the unit root exists thus implying a random walk. Hence the conditional variance estimates $\hat{\sigma}_t^2$ have a temporal variation over time. This aspect of volatility has been examined empirically by Sengupta and Sfeir (1996) elsewhere. Here our object is to test which of the two explanatory variables, the past represented by y_{t-1} or the future expectation represented by y_{t+1} is more dominant in influencing the time series behavior of the real exchange rate process $y_t = \ln RX_t$.

Tables 1-3 provide OLS estimates of the exchange rate equation (4) with the provision that the term Δi_t is dropped due to simultaneous equation bias. A number of conclusions emerge from these monthly estimates. First of all, the estimated model rejects the open arbitrage condition in two important ways for all the four countries. It finds a statistically significant role for the lagged exchange rate, implying that the exchange rate cannot jump sufficiently freely to satisfy the open arbitrage condition. Also, the results show a very insignificant role of the interest rate differential. This implies that asset shocks seem to reach an equilibrium much before the interest rate differential is removed. This inference is very similar to the conclusion reached by Hall and Henry (1988) in respect of their estimated NIESR (National Institute for Economic and Social Research) model for UK over the period 1973(3) - 1984(6) based on monthly data. Secondly, it is clear that of the two coefficients $\hat{\beta}_1$ and $\hat{\beta}_2$ it is more often the case that the first exceeds the second and both are highly significant in a statistical sense. This implies that the past trend is more important than the future expectation as an explanatory variable. For the most recent period (Sample III: Feb. 91-Aug. 95) though, the case $\hat{\beta}_2 > \hat{\beta}_1$ holds for both France and Germany, suggesting that the real exchange rates here are more driven by future expectations than past history. Finally, we checked to see if the null hypothesis $H_0: \beta_1 + \beta_2 = 1.0$ is rejected by the data. At the 5% level one must have a p value of less than 0.05 by the Wald test in order to reject the null hypothesis. For all the three samples and all the four

countries the null hypothesis was not rejected. Also we added a new explanatory variable representing lagged trade balance ratio in log terms to the equation (4) but the regression coefficient in each case was not significantly different from zero.

Finally, Table 4 shows the predominance of the case where the coefficient of RX_{t-1} equals or exceeds one. For example this predominance of unit root is 100% for Japan, 67% for UK and France for all the sample, taken together. The results of augmented Dicky-Fuller tests reported by Sengupta and Sfeir (1996) elsewhere show that in all samples and all the four countries the real exchange rate time series processes follow a random walk. This has an important implication for policy interventions in the exchange rate market that has been pointed out by Fisher (1992) recently. The model may not have a saddle point in the very long run, since the unit root may prevent convergence to the steady state as required by the terminal condition.

IV. CONCLUSIONS

The real exchange rate process is more influenced by the past trend than the future expectation, although in recent time expectation played a more dominant role for France and Germany. A random walk model is empirically supported by the data for all four countries. This has the implication that the long run elasticities may not be stable, so that the policy interventions may not be compatible with a stable solution.

Table 1. Impact of past and future on the exchange rate movements
(Sample I: Feb. 1985 through Jan. 1988)

$$\ln RX_t = \beta_0 + \beta_1 \ln RX_{t-1} + \beta_2 \ln RX_{t+1} + \beta_3 (RI - RUIS)_{t-1} + u_t$$

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	\bar{R}^2	n
FR	-0.4473 (1.63)	0.8966 (4.04)	0.3601* (2.31)	0.0075 (0.93)	0.86	17
JP	-0.0274 (-0.24)	0.5237** (4.91)	0.4808** (4.91)	0.0032 (0.42)	0.98	34
UK	-0.0193 (0.73)	0.4565** (4.98)	0.5105** (4.89)	-0.0036 (0.54)	0.93	34
GR	-0.0002 (-0.01)	0.5391** (4.18)	0.4565** (3.37)	0.0043 (0.45)	0.97	34

Notes:

1. t statistics in parentheses
 * significant at the 5% level
 ** significant at the 1% level
2. $H_0: \beta_1 + \beta_2 = 1$
 Wald Test:
 France: $F = 2.61, p = 0.13$, fail to reject H_0
 Japan: $F = 0.03, p = 0.87$, fail to reject H_0
 United Kingdom: $F = 0.44, p = 0.51$, fail to reject H_0
 Germany: $F = 0.02, p = 0.89$, fail to reject H_0
3. $\ln RX = \log$ of RX
 RI = real interest in a country
 RIUS = real interest in the US

Table 2. Impact of past and future on the exchange rate movements
(Sample II: Feb. 1988 through Jan. 1991)

$$\ln RX_t = \beta_0 + \beta_1 \ln RX_{t-1} + \beta_2 \ln RX_{t+1} + \beta_3 (RI - RUIS)_{t-1} + u_t$$

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	\bar{R}^2	n
FR	0.0031 (0.03)	0.5166** (4.99)	0.4833** (5.04)	0.0002 (0.02)	0.91	34
JP	-0.1045 (-0.34)	0.5355** (5.78)	0.4848** (4.71)	0.0104 (1.05)	0.91	34
UK	-0.0294 (-0.45)	0.4567** (3.59)	0.4978** (5.31)	-0.0051 (-0.81)	0.88	34
GR	-0.0103 (-0.22)	0.5044** (4.86)	0.5110** (4.57)	0.0014 (0.15)	0.89	34

Notes:

1. t statistics in parentheses
 * significant at the 5% level
 ** significant at the 1% level
2. $H_0: \beta_1 + \beta_2 = 1$
 Wald Test:
 France: $F = 4.76E-06$, $p = 0.998$, fail to reject H_0
 Japan: $F = 0.11$, $p = 0.74$, fail to reject H_0
 United Kingdom: $F = 0.2$, $p = 0.65$, fail to reject H_0
 Germany: $F = 0.05$, $p = 0.83$, fail to reject H_0
3. $\ln RX = \log$ of RX
 RI = real interest in a country
 RIUS = real interest in the US

Table 3. Impact of past and future on the exchange rate movements
(Sample III: Feb. 1991 through Aug. 1995)

$$\ln RX_t = \beta_0 + \beta_1 \ln RX_{t-1} + \beta_2 \ln RX_{t+1} + \beta_3 (RI - RUIS)_{t-1} + u_t$$

	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	\bar{R}^2	n
FR	-0.0075 (-0.06)	0.4395** (5.55)	0.5674** (7.47)	-0.0023 (-0.41)	0.84	53
JP	-0.1661 (-1.16)	0.5575** (9.93)	0.4758** (9.04)	-0.0048 (-0.84)	0.98	53
UK	-0.0157 (0.57)	0.4758** (8.07)	-.4924 (7.68)	0.0054 (0.87)	0.93	53
GR	-0.0232 (-0.79)	0.4627** (6.66)	0.5769** (8.62)	-0.0092 (-1.19)	0.92	53

Notes:

1. t statistics in parentheses
* significant at the 5% level
** significant at the 1% level
2. $H_0: \beta_1 + \beta_2 = 1$
Wald Test:
France: $F = 0.01$, $p = 0.92$, fail to reject H_0
Japan: $F = 1.37$, $p = 0.25$, fail to reject H_0
United Kingdom: $F = 0.48$, $p = 0.49$, fail to reject H_0
Germany: $F = 0.7$, $p = 0.41$, fail to reject H_0
3. $\ln RX = \log$ of RX
RI = real interest in a country
RIUS = real interest in the US

Table 4. Real exchange rate processes
(Dependent variable: RX_t)

Country and Sample	Intercept	RX_{t-1}	RX_{t-2}	\bar{R}^2	n	D_β	
FR	I	0.504*	0.906**	-	0.96	35	yes
		0.412	0.589**	0.326*	0.96	34	yes
	II	0.321	0.942**	-	0.82	35	no
		0.826	0.995**	-0.066	0.81	34	no
	III	0.997**	0.819**	-	0.67	54	yes
		0.870*	0.949**	-0.109	0.74	53	no
JP	I	6.328	0.947**	-	0.97	35	no
		6.490	0.796**	0.147	0.97	35	no
	II	17.84	0.889**	-	0.82	35	no
		20.92	0.941**	-0.069	0.81	34	no
	III	5.21	0.959**	-	0.93	54	no
		8.81	1.225**	-0.292*	0.94	53	no
UK	I	0.121**	0.798**	-	0.87	35	yes
		0.058	0.874**	0.024	0.88	34	no
	II	0.031	0.936**	-	0.79	35	no
		0.032	0.968**	-0.031	0.79	34	no
	III	0.063*	0.886**	-	0.83	54	yes
		0.054	1.149**	-0.249	0.85	53	no
GR	I	0.140	0.922**	-	0.96	35	yes
		0.111	0.583**	0.345*	0.96	34	yes
	II	0.159	0.919**	-	0.79	35	no
		0.200	0.986**	-0.087	0.78	34	no
	III	0.218	0.881**	-	0.76	54	no
		0.241*	1.048**	-0.181	0.81	53	no

Notes:

1. One and two asterisks denote significance at 5 and 1% levels of t-statistics respectively.
2. \bar{R}^2 is squared multiple correlation coefficient adjusted for degrees of freedom.
3. D_β denotes if the slope coefficient of RX_{t-1} is significantly less than one.

REFERENCES

- Fisher, P. 1992, *Expectations in Macroeconomic Models* (Dordrecht: North Holland).
- Gregory, A., Pagan, A. and Smith, G. (1993), Estimating linear quadratic models with integrated processes, in *Models, Methods and Applications in Econometrics*, ed. P.C.B. Phillips, Blackwell Publishers, Cambridge.
- Hall, S.G., and Henry, S.G.B., 1988, *Macroeconomic Modelling* (Amsterdam: North Holland).
- Kennan, J. (1979) The estimation of partial adjustment models with rational expectations, *Econometrica*, **47**, 1441-57.
- Sengupta, J.K., and Sfeir, R.E., 1996, Exchange rate instability: some empirical tests of temporal dynamics, to be published in *Applied Economics Letters*