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## **Test of a V-Shaped Relationship between the Expected Real Effective Exchange Rate and Real Output: The Case of France**

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### **Abstract**

Applying a simultaneous equation model incorporating the monetary policy reaction function and the interactive dummy variable technique, this paper finds that real GDP and the expected real effective exchange rate exhibit a V-shaped relationship, suggesting that expected real depreciation raises real output during early years whereas expected real appreciation increases real output in recent years. Hence, recent real appreciation of the euro would work in favor of France. Other findings are that a higher government debt ratio, a higher real stock price, a higher real EU interest rate, and a lower expected inflation rate would increase real output for France.

**Keywords:** MPRF, UIP, Expected real depreciation or appreciation, Government debt, World interest rate, Expected inflation

**JEL Classification:** F41, F31

### **Introduction**

Recent real appreciation of the euro has led to renewed interest in its impact on real output in the EU member countries including France. Real appreciation of the euro would reduce exports, increase imports, and cause net exports and aggregate expenditures to decline. On the other hand, real appreciation of the euro would reduce import prices, lower inflation, may cause the central bank to

reduce the real interest rate, and stimulate consumption and investment expenditures. Hence, whether real appreciation or real depreciation of the euro would reduce or increase real output for France needs to be examined.

This paper attempts to study the roles of the expected real effective exchange rate and other major macroeconomic variables in determining output fluctuations for France. First, the paper incorporates the monetary policy reaction function in the formulation of the model as the central bank determines its short-term interest rate based on an inflation targeting of less than 2%. Second, the paper tests whether the expected real effective exchange rate and real output may exhibit different relationships during different sub-sample periods. The dummy variable technique is employed to test if the intercept and/or the slope coefficient of the expected real effective exchange rate may have changed. Third, comparative static analysis is applied in order to determine the possible response of equilibrium real GDP to a change in one of the exogenous variables.

There are several major studies examining the impact of currency depreciation or devaluation on output. Krugman and Taylor (1978) state that one of the conditions for currency devaluation to have a contractionary impact is if exports are initially less than imports. Edwards (1986), Upadhyaya (1999), Bahmani-Oskooee, Chomsisengphet, and Kandil (2002) and Christopoulos (2004) find that currency devaluation or depreciation could have a contractionary, an expansionary, or no effect depending upon the countries or time periods in empirical work. Chou and Chao (2001) and Bahmani-Oskooee and Kutan (2008) indicate that depreciation or devaluation is ineffective or has little impact in the long run.

Studies reporting depreciation or devaluation is expansionary include Gylfason and Schmid (1983) except for the U.K. and Brazil, Gylfason and Risager (1984) for developed countries. On the other hand, studies showing that depreciation or devaluation is contractionary include Gylfason and Risager (1984) for LDCs, Rogers and Wang (1995), Moreno (1999), Kamin and Rogers (2000), Chou and Chao (2001) in the short run, and Bahmani-Oskooee and Miteza (2006) for 24 non-OECD countries.

These previous studies have made significant contributions to the understanding of the subject. These findings suggest that the impact of real depreciation could be expansionary, contractionary or neutral and depends on the country, time period, the formulation of a model, and the methodology employed in empirical work. To the author's best knowledge, few of the previous studies have focused

on the hypothesis that the impact of the real exchange rate on real output may be nonlinear and vary over time.

### The Model

Suppose that aggregate expenditures are a function of real output, the domestic real interest rate, government spending, government tax revenues, the real financial stock price, and the real effective exchange rate, that the real interest rate is determined by the inflation rate, real output, the real effective exchange rate, and the world real interest rate, that the real effective exchange rate is affected by the domestic real interest rate, the world real interest rate, and the expected real effective exchange rate, and that the inflation rate is determined by the expected inflation rate, the output gap, and the real effective exchange rate. Applying and extending Taylor (1993, 1995), Romer (2000, 2006) and Svensson (2000), we can express the open-economy IS function, the monetary policy reaction function, uncovered interest parity, and the augmented aggregate supply function as:

$$Y = W(Y, R, G, T, A, \varepsilon) \quad (1)$$

$$R = X(\pi, Y, \varepsilon, R') \quad (2)$$

$$\varepsilon = Z(R, R', \varepsilon^e) \quad (3)$$

$$\pi = \pi^e + \alpha_1(Y - Y^*) - \alpha_2\varepsilon \quad (4)$$

where,

- Y = real GDP in France,
- R = the domestic real interest rate,
- G = government spending,
- T = government tax revenues,
- A = the real financial stock price,
- $\varepsilon$  = the real effective exchange rate (REER),  
(An increase means real appreciation of the currency.)
- $\pi$  = the inflation rate,
- $R'$  = the world real interest rate,
- $\varepsilon^e$  = the expected real effective exchange rate,
- $\pi^e$  = the expected inflation rate,
- $Y^*$  = potential output for France, and
- $\alpha_1, \alpha_2$  = parameters

Solving for four endogenous variables  $Y$ ,  $R$ ,  $\varepsilon$ , and  $\pi$  simultaneously, we can express equilibrium real GDP as:

$$\bar{Y} = \bar{Y}(\varepsilon^e, G, T, A, R', \pi^e; \alpha_1, \alpha_2, Y^*). \quad (5)$$

The Jacobian for the endogenous variables is given by:

$$\begin{aligned} |J| = & (1 - W_Y) - Z_R W_\varepsilon X_Y - W_R X_Y - Z_R X_\varepsilon (1 - W_Y) \\ & - X_\pi [-\alpha_2 Z_R (1 - W_Y) + \alpha_1 W_R + \alpha_1 Z_R W_\varepsilon] > 0. \end{aligned} \quad (6)$$

We expect that the sign of  $(\partial \bar{Y} / \partial G - \partial \bar{Y} / \partial T)$  or  $\partial \bar{Y} / \partial A$  is positive. The effect of an increase in the expected real effective exchange rate on equilibrium real GDP is uncertain because the negative impact of decreased net exports may be less or greater than the positive impacts of a lower inflation rate and a lower real interest rate due to monetary easing:

$$\partial \bar{Y} / \partial \varepsilon^e = Z_{\varepsilon^e} (W_\varepsilon + W_R X_\varepsilon - \alpha_2 W_R X_\pi) / |J| > or < 0. \quad (7)$$

The effect of a higher world real interest rate on equilibrium real GDP is uncertain as the first term in the parenthesis in (8) is positive whereas the remaining terms in the parenthesis in (8) are negative:

$$\begin{aligned} \partial \bar{Y} / \partial R' = & (Z_{R'} W_\varepsilon + Z_{R'} W_R X_\varepsilon + Z_{R'} W_\varepsilon X_{R'} \\ & + W_R X_{R'} - \alpha_2 Z_{R'} W_R X_\pi) / |J| > or < 0. \end{aligned} \quad (8)$$

A higher expected inflation rate would cause equilibrium real GDP to decline partly because the central bank would raise the real interest rate to contain inflation and partly because a higher real interest rate would cause real appreciation and reduce net exports:

$$\partial \bar{Y} / \partial \pi^e = (Z_R W_\varepsilon X_\pi + W_R X_\pi) / |J| < 0. \quad (9)$$

### Empirical Results

The data were collected from the *International Financial Statistics* (IFS), which is published by the International Monetary Fund. Real GDP is measured in billion euros. The lagged real effective exchange rate is used to represent the expected real effective exchange rate. Due to lack of complete data for budget deficits, the ratio of government debt to GDP is selected to represent fiscal

policy. The share price index is divided by the harmonized consumer price index to derive the real stock price index. The world real interest rate is represented by the refinancing interest rate of the European Central Bank (ECB) minus the inflation rate in the EU. The inflation rate is the percent change in the harmonized consumer price index in France. The expected inflation rate is represented by the lagged inflation rate. Except for the dummy variable and the expected inflation rate with zero or negative values, all other variables are measured in the log scale. After calculating the percent change and taking lags, the sample ranges from 1999.Q3-2008.Q3.

The relationship between the expected real effective exchange rate and real GDP is presented in Graph 1. It seems that the relationship is nonlinear and exhibits a V-shape. In other words, they have a negative relationship during 1999.Q3-2000.Q4 and a positive relationship during 2001.Q1-2008.Q3. The threshold real GDP in 2001.Q1 was 367.07 billion euros. Therefore, a dummy variable DUM is generated with a value of 0 during 1999.Q3-2000.Q4 and 1 otherwise. An interactive dummy variable  $DUM \times LOG(\varepsilon^e)$  is also generated to test whether the slope coefficient of the expected real effective exchange rate may have changed.

Based on the ADF test, variables have unit roots in the level form and are stationary in the first-difference form. According to the unrestricted cointegration rank test in Table 1, there are 5 cointegrating relationships. The vector-error correction model is not applied due to a relatively small sample size in the study. Estimated parameters, standard errors, t-statistics, and other related results are presented in Table 2. Because a reduced form equation is estimated, endogeneity would not be an issue. The Newey-West method is applied in order to correct for autocorrelation and heteroskedasticity simultaneously when their forms are unknown. As shown, 96.4% of the behavior of real GDP can be explained by the seven right-hand side variables. All the coefficients are significant at the 1%, 5% or 10% level. Real GDP is positively associated with the interactive dummy variable  $DUM \times LOG(\varepsilon^e)$ , the ratio of government debt to GDP, the real stock price, and the real refinancing rate set by the European Central Bank and negatively influenced by the dummy variable, the expected real effective exchange rate, and the expected inflation rate. The coefficient of the expected real effective exchange rate is estimated to be -0.515 during 1999.Q3-2000.Q4 and 0.660 ( $= -0.515 + 1.175$ ) during 2001.Q1-2008.Q3.

Several different versions are tested. When the intercept and interactive dummy variables are not included in the estimated regression, the adjusted  $R^2$  is

estimated to be 0.841, and the coefficient of the expected real effective exchange rate is negative but insignificant at the 10% level. This result may be misleading as possible different intercepts and/or slopes are not tested. If the ratio of government consumption spending to GDP replaces the government debt ratio, its coefficient is positive but insignificant at the 10% level. When the European Central Bank's real refinancing rate is replaced by the U.S. real federal funds rate, its coefficient is positive and significant at the 10% level. However, the use of the real federal funds rate causes the coefficients of the government debt ratio, the real stock price, and the expected inflation rate to be insignificant at the 10% level. If the expected inflation rate is represented by lagged inflation rate of the non-harmonized CPI, its coefficient is negative but insignificant at the 10% level. To save space, these results are not printed here and will be made available upon request.

There are several comments. The V-shaped relationship between the expected real effective exchange rate and real GDP suggests that the recent trend of real appreciation of the euro against the U.S. dollar would work in favor of France due to its positive impact on real output. Expansionary fiscal policy may be considered to stimulate the economic slowdown. As the stock market is reversing its downward trend, the wealth effect and the balance-sheet effect (Kuttner and Mosser, 2002) of a higher stock price would increase household consumption and business investments. It would be desirable for the central bank to maintain transparency and independence in order to reduce inflationary expectations.

### **Summary and Conclusions**

This paper has examined the impacts of expected real depreciation or appreciation and other changing macroeconomic conditions on output fluctuations in France. The model is formulated based on a simultaneous equation model incorporating the open-economy IS function, the monetary policy reaction function, uncovered interest parity, and an augmented aggregate supply function. Equilibrium real GDP is postulated to be a function of the dummy variable, the expected real effective exchange rate, the interactive dummy variable with the expected real effective exchange rate, the ratio of government debt to GDP, the real stock price, the EU real refinancing rate, and the expected inflation rate. A generalized least squares method is employed in empirical work to yield consistent estimates for the covariance and standard errors.

There is evidence of a V-shaped relationship between the expected real effective exchange rate and real output, suggesting that expected real depreciation would increase real output up to 2000.Q4 whereas expected real appreciation would raise real output after 2000.Q4. Besides, a higher ratio of government debt ratio, a higher real stock price, a higher EU refinancing rate, or a lower expected inflation rate would help raise real output.

There may be areas for future study. A quadratic function may be applied to determine the turning point of real GDP when the relationship between the expected real effective exchange rate and real GDP changes from being negative to being positive. If the data are available, the ratio of government deficit to GDP may be selected to represent fiscal policy. The model developed in this paper may be considered for other countries to determine whether it may apply. The expected real exchange rate and the expected inflation rate may be constructed by more sophisticated methodologies.

Graph 1. Scatter diagram between real GDP and the expected REER

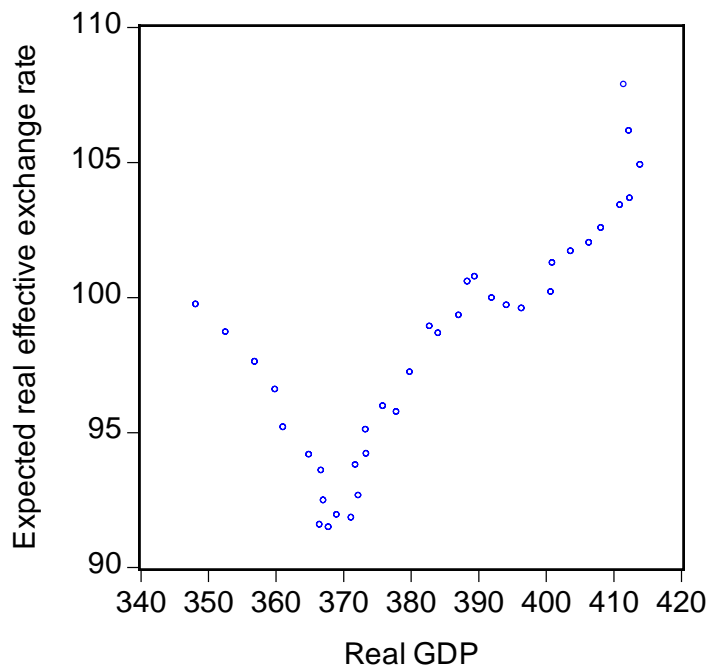


Table 1. Unrestricted cointegration rank test (maximum eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.992514	171.3164	52.36261	0.0000
At most 1 *	0.792287	55.00592	46.23142	0.0046
At most 2 *	0.729626	45.77819	40.07757	0.0103
At most 3 *	0.692936	41.32448	33.87687	0.0054
At most 4 *	0.590057	31.21078	27.58434	0.0163
At most 5	0.431471	19.76458	21.13162	0.0768
At most 6 *	0.375347	16.46957	14.26460	0.0220
At most 7 *	0.256112	10.35526	3.841466	0.0013

Notes:

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values



Table 2. Estimated regression of LOG(Y) for France

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.367149	0.499142	14.75964	0.0000
DUM	-5.304512	0.520391	-10.19333	0.0000
LOG( $\varepsilon^e$ )	-0.514685	0.100702	-5.110957	0.0000
DUM x LOG( $\varepsilon^e$ )	1.175333	0.113668	10.34002	0.0000
LOG(DY)	0.193376	0.092739	2.085166	0.0460
LOG(A)	0.034020	0.014072	2.417499	0.0221
LOG( $R'$ )	0.011954	0.005149	2.321805	0.0275
$\pi^e$	-0.005918	0.003202	-1.848295	0.0748
Adjusted R-squared	0.964187			
Akaike info. criterion	-6.312255			
Schwarz criterion	-5.963949			
F-statistic		139.4589		
Prob (F-statistic)	0.000000			
Sample period		1999.Q3 – 2008.Q3		
MAPE		2.469236		

Notes:

$Y$  is real GDP.

DUM is a dummy variable with a value of 0 during 1999.Q3-2000.Q4 and a value of 1 during 2001.Q1-2008.Q3.

$\varepsilon^e$  is the expected real effective exchange rate.

DY is the ratio of government debt to GDP.

$A$  is the real stock price.

$R'$  is the EU real refinancing rate.

$\pi^e$  is the expected inflation rate.

MAPE is the mean absolute percent error.

The Newey-West method is employed in empirical work.

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