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Test of an Inverted J-Shape Hypothesis between the Expected Real Exchange Rate and Real Output: The Case of Ireland

Yu Hsing[1]

Abstract

Applying an open-economy macroeconomic model, incorporating the monetary policy reaction function and uncovering interest parity, this paper finds that the expected real exchange rate and real output exhibit an inverted J-shape relationship, suggesting that expected real depreciation increases real output during 1999.Q2-2001.Q3 whereas expected real appreciation raises output during 2001.Q4-2009.Q1. Other findings show that a higher real financial stock price, a higher world real interest rate, or a lower expected inflation rate would increase real output. Fiscal prudence may be needed as the coefficient of the government borrowing/GDP ratio is insignificant at the 10% level.

Keywords: Expected Real Depreciation or Appreciation, Monetary Policy Reaction Function, Fiscal Policy, Financial Stock Price, Uncovered Interest Parity

JEL classification: E52, F31, F41, O52

1. Introduction

Known as the Celtic Tiger for more than a decade, Ireland had enjoyed rapid economic growth, budget surpluses, low inflation, low unemployment, and other positive developments. However, since 2008 Ireland's economy has been hit hard by the global financial crisis and world economic recession. According to the International Monetary Fund (2009), Ireland was faced with high dependence on construction, overvaluation of housing prices, over expansion of the banking sector, global competitive disadvantages, falling international market shares, high unit labor costs, declining share of FDI, risks associated with falling inflation, vulnerability in the financial sector, low interest margins, lack of growth in deposits, concentration of loan portfolios in residential mortgages, commercial properties, and real estate developments, and other challenges. According to the forecast for Ireland in 2009 made by the Economist (2009), its real GDP would suffer a decline of 7.7%, the government would have a budget deficit of 12.9% of GDP, and the current account balance would have a deficit of 3.1%. The short-term interest rate would drop to 1.4% from 4.6% in 2008. Due to a weak demand, the inflation rate would decline 3.6%.

This paper attempts to examine the roles of the expected real exchange rate and other related macroeconomic variables affecting output fluctuations. First, it incorporates

1. Professor of Economics, Department of Business Administration & Finance, College of Business, Southeastern Louisiana University, Hammond, Louisiana 70403, USA. email: yhsing@selu.edu

the monetary policy reaction function in the formulation of the model. It is appropriate as the central bank of Ireland determines its short-term interest rate based on an inflation targeting of less than 2%. Second, the paper examines whether expected real depreciation or appreciation and real output may exhibit different relationships over time. The dummy variable technique will be employed to test if the intercept and/or the slope of the expected real exchange rate may have changed. Third, comparative static analysis will be 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 whether exports are initially less than imports. Edwards (1986), Upadhyaya (1999), Bahmani-Oskooee, Chomsisengphet, 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 expansionary include those of Gylfason and Schmid (1983) except for the U.K. and Brazail, Gylfason and Risager (1984) for developed countries, and Bahmani-Oskooee and Rhee (1997). 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 countries, time periods, specifications of a model, and methodologies 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 exhibit an inverted J-shape relationship during different time periods.

2. The Model

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

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

$$R = Z(\pi, Y, \varepsilon, R') \tag{2}$$
$$\varepsilon = E(R, R', \varepsilon^e) \tag{3}$$
$$\pi = \pi^e + \delta_1(Y - Y^*) + \delta_2 \varepsilon \tag{4}$$

where

Y	= real GDP in Ireland,
R	= the domestic real interest rate,
G	= government spending,
T	= government tax revenues,
W	= the real financial stock price,
ε	= the real exchange rate measured as the euro per U.S. dollar times the relative prices in the U.S. and the EU (An increase means real depreciation of the euro),
π	= the inflation rate,
R'	= the world real interest rate,
ε^e	= the expected real exchange rate,
π^e	= the expected inflation rate,
Y^*	= potential output for Ireland, and
δ_1, δ_2	= parameters.

Solving for four endogenous variables Y, R, ε, and π simultaneously, we can express equilibrium real GDP as:

$$\overline{Y} = \overline{Y}(\varepsilon^e, G, T, W, R', \pi^e; \delta_1, \delta_2, Y^*). \tag{5}$$

The Jacobian for the endogenous variables is given by:

$$\begin{aligned} |J| &= (1 - X_Y) - E_R X_\varepsilon Z_Y - X_R Z_Y - E_R Z_\varepsilon (1 - X_Y) \\ &\quad - Z_\pi [\delta_2 E_R (1 - X_Y) + \delta_1 X_R + \delta_1 E_R X_\varepsilon] > 0. \end{aligned} \tag{6}$$

We expect that the sign of $(\partial \overline{Y} / \partial G - \partial \overline{Y}) / \partial T$ or $\partial \overline{Y} / \partial W$ is positive. The effect of depreciation of the expected real exchange rate on equilibrium real GDP is unclear because the positive impact of increased net exports may be less or greater than the negative impacts of a higher inflation rate and a higher real interest rate due to monetary tightening:

$$\partial \overline{Y} / \partial \varepsilon^e = E_{\varepsilon^e} (X_\varepsilon + X_R Z_\varepsilon + \delta_2 X_R Z_\pi) / |J| > or < 0. \tag{7}$$

Spencer and Kulkarni (2010) and McKinlay and Kulkarni (2010) study the J-curve hypothesis for four Central American countries and five African countries and show that multiple or consistent devaluations of a currency would shift the J-curve rightward and continuously deteriorate the trade balance.

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

$$\partial \overline{Y} / \partial R' = (E_{R'} X_{\varepsilon} + E_{R'} X_R Z_{\varepsilon} + E_R X_{\varepsilon} Z_{R'} + X_R Z_{R'} + \delta_2 E_{R'} X_R Z_{\pi}) / |J| > or < 0. \quad (8)$$

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:

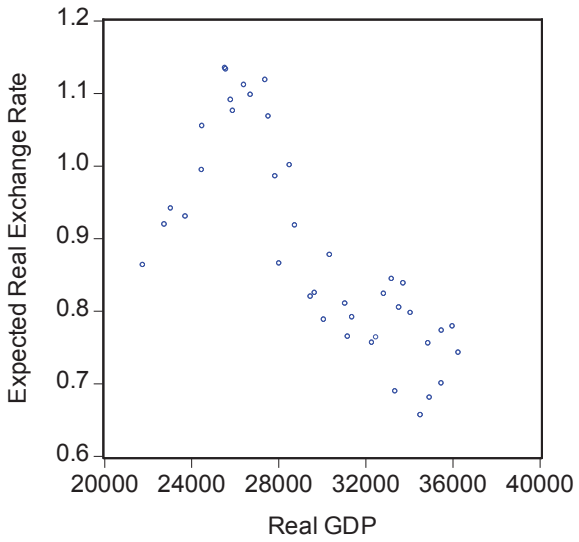
$$\partial \overline{Y} / \partial \pi^e = (E_R X_{\varepsilon} Z_{\pi} + X_R Z_{\pi}) / |J| < 0. \quad (9)$$

3. Empirical Results

The data were collected from the *International Financial Statistics* (IFS), which is published by the International Monetary Fund. Real GDP is an index number with 2005 as the basis year. The real exchange rate is represented by the units of the euro per U.S. dollar times the relative prices in the U.S. and the EU. Thus, an increase means real depreciation of the euro, and vice versa. The expected real exchange rate is represented by the lagged real exchange rate. The simple lagged value is selected in order to have as many observations as possible to capture the relationship between the expected real exchange rate and real output. Due to lack of complete data for budget deficits, the ratio of government borrowing to nominal GDP is selected to represent fiscal policy. Both government borrowing and nominal GDP are measured in billions. The share price index is divided by the consumer price index to derive the real stock price index. The world real interest rate is represented by the refinancing 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 Ireland. The expected inflation rate is the lagged inflation rate. Except for the dummy variable, the real refinancing interest rate, and the expected inflation rate with zero or negative values, all other variables are measured in the log scale. The sample ranges from 1999.Q2-2009.Q1 with a total of 40 observations. The quarterly data for the refinancing rate beyond 2009.Q1 were not available.

The relationship between the expected real exchange rate and real GDP is presented in Graph 1. It seems that the relationship is nonlinear and exhibits an inverted J-shape. In other words, they have a positive relationship during 1999.Q2-2001.Q3 and a negative relationship during 2001.Q4-2009.Q1. Therefore, a dummy variable is generated with a value of 0 during 1999.Q2-2001.Q3 and 1 otherwise. An interactive dummy variable is also generated to test whether the slope coefficient of the expected real exchange rate may have changed.

Graph 1: Scatter Diagram between the Expected Real Exchange Rate and Real GDP: 1999.Q2-2009.Q1



Estimated parameters, standard errors, t-statistics, and other related information are presented in Table 1. Because a reduced form equation is estimated, endogeneity would not pose a concern. The Newey-West method is applied in order to yield consistent estimates for the covariance and standard errors. As shown, 92.8% of the behavior of real GDP can be explained by the right-hand side variables with significant coefficients. Except for the coefficient of ratio of government borrowing to GDP, all other coefficients are significant at the 1% or 5% level. Real GDP is positively associated with the intercept dummy variable, the real exchange rate, the real stock price and the real refinancing rate set by the ECB and negatively influenced by the interactive variable $DUM \times \log(\varepsilon^e)$ and the expected inflation rate. The coefficient of the expected real exchange rate is estimated to be 0.550 during 1999.Q2-2001.Q3 and -0.536 (=0.550-1.086) during 2001.Q4-2009.Q1.

Table 1: Estimated Regression of Real GDP for Ireland

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.852880	0.121155	31.80129	0.0000
DUM	0.173057	0.013988	12.37218	0.0000
log(ε^e)	0.550477	0.068031	8.091627	0.0000
DUM x log(ε^e)	-1.086338	0.092368	-11.76101	0.0000
BY	0.000444	0.000895	0.495782	0.6234
log(W)	0.107052	0.027469	3.897227	0.0005
R'	0.005952	0.002651	2.245130	0.0318
π^e	-0.022129	0.009213	-2.401821	0.0223
Adjusted R^2	0.928309			
F-statistic	73.14297			
AIC	-3.495893			
SC	-3.158177			
MAPE	2.762605			
Sample	1999.Q2-2009.Q1			
N	40			

Notes:
The Dependent Variable is Log(Y).
DUM is the dummy variable with a value of 0 during 1999.Q2-2001.Q3 and 1 during 2001.Q4-2009.Q1.
ε^e is the expected real exchange rate defined as the lagged value of the units of the euro per U.S. dollar times the relative prices in the U.S. and the EU.
BY is the ratio of government borrowing to GDP.
W is the real stock price index.
R′ is the real refinancing rate set by the European Central Bank (ECB).
π^e is the expected inflation rate.
AIC is the Akaike information criterion.
SC is the Schwarz criterion.
MAPE is the means absolute percent error.

To determine whether these time series in Table 1 are cointegrated, the ADF unit root test on the regression residuals e_t is performed. The lag length of one is selected based on the AIC. In the regression $\Delta e_t = \alpha e_{t-1} + \beta \Delta e_{t-1}$, the test statistic is estimated to be -2.044,

and the critical value is -1.950 at the 5% level. Hence, these variables have a long-run equilibrium relationship.

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 0.589, the coefficient of the expected real exchange rate is negative and significant at the 1% level, and the positive coefficient of the real refinancing rate is insignificant at the 10% level. This result may be misleading as the positive portion of the relationship is overlooked. When the ECB's refinancing rate is replaced by the U.S. real federal funds rate, its coefficient is positive and significant at the 5% level. When both interest rates are included, their coefficients become insignificant at the 10% level mainly due to a high degree of multicollinearity. When the expected inflation rate is represented by average inflation rate of the past four quarters, its coefficient is positive and 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 inverted J-shape relationship between the expected real 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 Ireland due to its positive impact on real output. The insignificant coefficient of the ratio of government borrowing to GDP implies that the Ricardian equivalence hypothesis (Barro, 1989) may apply and that expansionary fiscal policy may be pursued with caution as it may not be effective in raising real output. As the stock market has shown a rising trend, the wealth effect and the balance-sheet effect of a higher stock price would increase household consumption and business investment. It would be desirable for the central bank of Ireland to maintain transparency and effective communications in order to reduce inflationary expectations.

4. Summary and Conclusions

This paper examined the impacts of expected real depreciation or appreciation and changes in other related variables on output fluctuations in Ireland 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. Real GDP is postulated to be a function of the dummy variable, the expected real exchange rate, the interactive dummy variable with the expected real exchange rate, the ratio of government borrowing to GDP, the real financial stock price, the real refinancing rate of the ECB, 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 an inverted J-shape relationship between the expected real exchange rate and real output, suggesting that expected real depreciation would increase real output up to 2001.Q3 whereas expected real appreciation would raise real output after 2001.Q3. Besides, a higher real stock price index, a higher refinancing rate, or a lower expected inflation rate would help raise real output. Expansionary fiscal policy represented by a higher ratio of government borrowing to GDP is found to be insignificant.

There may be areas for future study. The quadratic function may be applied to test the nonlinear relationship between the expected real exchange rate and real output. If the data are available, the ratio of government deficit to GDP can be selected to represent fiscal policy. Other macroeconomic theories such as the IS/LM model may be considered.

References

Bahmani-Oskooee, M., (1998), 'Are devaluations contractionary in LDCs?' *Journal of Economic Development*, 23, pp. 131-144.

Bahmani-Oskooee, M., Chomsisengphet, S., Kandil, M., (2002), 'Are devaluations contractionary in Asia?' *Journal of Post Keynesian Economics*, pp. 25, 69-81.

Bahmani-Oskooee, M., Miteza, I., (2003), 'Are devaluations expansionary or contractionary: a survey article', *Economic Issues*, 8, pp. 1-28.

Bahmani-Oskooee, M., Miteza, I., (2006), 'Are devaluations contractionary? evidence from panel cointegration', *Economic Issues*, 11, pp. 49-64.

Bahmani-Oskooee, M., Kutan, A. M., (2008), 'Are devaluations contractionary in emerging economies of Eastern Europe?', *Economic Change and Restructuring*, 41, pp. 61-74.

Barro, R. J., (1989), 'The Ricardian approach to budget deficits', *Journal of Economic Perspectives*, 3, pp. 37-54.

Chou, W. L., Chao, C. C., (2001), 'Are currency devaluations effective? a panel unit root test', *Economics Letters*, 72, pp. 19-25.

Christopoulos, D. K., (2004), 'Currency devaluation and output growth: new evidence from panel data analysis', *Applied Economics Letters*, 11, pp. 809-813.

Edwards, S., (1986), 'Are devaluations contractionary?' *The Review of Economics and Statistics*, 68, pp. 501-508.

Gylfason, T., Risager, O., (1984), 'Does devaluation improve the current account?' *European Economic Review*, 25, pp. 37-64.

Gylfason, T. and Schmid, M., (1983), 'Does devaluation cause stagflation?' *Canadian Journal of Economics*, 25, pp. 37-64.

International Monetary Fund, (2009), 'Ireland: 2009 article IV consultation - staff report; and public information notice on the executive board discussion', Series: Country Report No. 09/195, June 24.

Kamin, S. B., Rogers, J. H., (2000) 'Output and the real exchange rate in developing countries: an application to Mexico', *Journal of Development Economics*, 61, pp. 85-109.

McKinlay, B. and Kulkarni, K. G., (2010), 'The J-curve and Kulkarni hypotheses: an evidence from Guatemala, Honduras, El Salvador and Costa Rica, 1977-2008', working paper.

Rogers, J. H., Wang, P., (1995), 'Output, inflation and stabilization in a small open economy: evidence from Mexico', *Journal of Development Economics*, 46, pp. 271-293.

Krugman, P., Taylor, L., (1978), 'Contractionary effects of devaluation', *Journal of International Economics*, 8, pp. 445-456.

Kuttner, K. N., Mosser, P. C., (2002), 'The monetary transmission mechanism: some answers and further questions', *Federal Reserve Bank of New York Economic Policy Review*, 8, pp. 15-26.

Moreno, R., (1999), 'Depreciation and recessions in East Asia', *Federal Reserve Bank of San Francisco Economic Review,* 3, pp. 27-40.

Newey, W. K., West, K. D., (1987), 'A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix', *Econometrica,* 55, pp. 703-708.

Romer, D., (2000), 'Keynesian macroeconomics without the LM curve', *Journal of Economic Perspectives*, 14, pp. 149-169.

Romer, D., (2006), *Advanced Macroeconomics*, 3rd edition, New York, McGraw-Hill/ Irwin.

Spencer, A. and Kulkarni, K. G., (2010), 'Evidence of exchange rate effect on the trade balance of 5 countries: Cases of multiple devaluations,' working paper.

Svensson, L. E. O., (2000), 'Open-economy inflation targeting', *Journal of International Economics*, 50, pp. 155–183.

Taylor, J. B., (1993), 'Discretion versus policy rules in practice', *Carnegie-Rochester Conference Series on Public Policy*, 39, pp. 195-214.

Taylor, J. B., (1999), 'A historical analysis of monetary policy rules', *Monetary Policy Rules*: 319-341; NBER Conference Report series, Chicago and London, University of Chicago Press.

The Economist, (2009), 'Country briefings: Ireland', http://www.economist.com/countries/ Ireland/

Upadhyaya, K. P., (1999), 'Currency devaluation, aggregate output, and the long run: an empirical study', *Economics Letters*, 64, pp. 197-202.