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Devaluation Expectations and Fundamentals: Some New Evidence For Ireland 1979-1994

DON WALSHE
Goodbody Stockbrokers
MARY O'DONNELL
University of Limerick

Abstract: This paper uses a Probit model to link economic fundamentals with devaluation expectations for the Irish pound over the period 1979-1994. The estimates relate to both the probability as well as the size of an expected devaluation. The model performs well in predicting the size and timing of actual realignments and estimates of devaluation expectations are consistent with previous estimates based on UIP. While the Maastricht Treaty stipulated the need for exchange rate stability prior to joining EMU, the results here show that economic variables other than those referenced in the Maastricht Treaty can lead to exchange rate instability.

I INTRODUCTION

The purpose of this paper is threefold. First, we empirically estimate devaluation expectations for the Irish pound during the EMS. The methodology employed differs from much of the previous work on exchange rate expectations (for example, Bertola and Svensson (1993), Svensson (1991)) which invokes the assumption of uncovered interest rate parity (UIP) to estimate the expected rate of depreciation of the exchange rate. In using a Probit model previously applied by Edin and Vredin (1993) and others, we gain an additional insight into the expected rate of devaluation regarding the probability of that devaluation, a feature not captured in the UIP model which generates estimates only of the size of an expected devaluation.

Second, both Eichengreen (1993) and De Grauwe (1994) note that a speculative attack may precede, rather than follow, imbalances in domestic policies; Gerlech and Smets (1994) also document how there may be no evidence of budget deficits or rapid monetisation, for example, in the period leading up to an attack. The implication is that certain fundamentals may not be reliable indicators of speculative pressure on a currency. In the context of European Monetary Union (EMU), economic variables other than the Maastricht convergence criteria may be important in the formulation of devaluation expectations which can ultimately lead to currency realignments. Thus, a government's fundamentals may satisfy the Maastricht criteria but violate the currency stability requirement and so not be admitted to such a monetary union. Here, the methodology used allows us to see how the probability of a devaluation is related to certain economic variables, or "fundamentals", other than those specified in the Maastricht criteria and so indicate the extent to which these factors lead to exchange rate instability.

Third, by comparing results from the Probit and UIP models, this allows us to establish how consistent estimated devaluation expectations from both models are. While it has been noted by Kaminsky and Peruga (1990) that there is weak support empirically for UIP, similar devaluation expectations from the two different methodologies should indicate that UIP is a reasonable assumption for Ireland over the period 1979-1994. The fact that a fundamental factor such as the Stg£/£IR exchange rate emerges as a significant influence on devaluation expectations is a by-product of the analysis rather than a conclusion in itself. The benefit of consistent results with other studies, both domestic and international, is that the application of the probit model in an Irish context appears justified. In this regard, the key contribution of the paper is centred around the methodology employed rather than establishing the key drivers of devaluation expectations. The analysis which seeks to relate the probability and, ultimately, the continuous expectation of a devaluation, to fundamentals using a probit model has not been carried out for Ireland before.

The layout of this paper is as follows. In Section II, we present the Probit model used to estimate devaluation expectations. The empirical estimates of this model are presented and discussed in Section III. Section IV compares the results with others obtained for Ireland using UIP as well as with Probit results for other currencies estimated using Edin and Vredin's (1993) methodology. Finally, Section V summarises the main points of the paper and concludes.

II METHODOLOGY AND DATA

Assuming rational expectations (RE), the expectation of a future devaluation is equivalent to the mathematical "expected value" of the future increase in the IR£/DM central rate, conditional on all available information. Forming a rational expectation of the exchange rate involves, as a prerequisite, forecasting the fundamentals. Thus, the rational expectations assumption is critical in that it amounts to assuming that economic agents know the true structural model linking the exchange rate to fundamentals. This allows us to conclude that the same structure will link expectations of these variables. We begin by setting out how we select the dependent variable for the Probit regression, based on a shadow floating exchange rate. Following this we specify the regression model and address the specification problems which arise due to selection bias. Finally, we outline exactly how the devaluation expectations are calculated.

Selection Mechanism

Following Baxter (1987) and Edin and Vredin (1993), the central parity is treated as a censored variable, in that it is only observed when the equilibrium floating exchange rate deviates far enough from the prevailing peg, i.e. only immediately after devaluations.[1] Although we wish to examine what variables drive the floating exchange rate, we are only interested in observations in which changes in the floating exchange rate are large enough to cause a devaluation. Specifically, the central parity at time "t"(c_t) is set as follows:

$$c_t = \begin{cases} s_t + \gamma_t & \text{if } s_t + \gamma_t > c_{t-1} + x \\ c_{t-1} & \text{if } s_t + \gamma_t \leq c_{t-1} + x \end{cases} \qquad (1)$$

where s_t is the "shadow floating exchange rate".

The floating exchange rate is a "shadow" in the sense that it is not observed unless it deviates far enough from the prevailing central rate to yield a new central parity. Therefore, we only observe the change in the shadow floating exchange rate if it is large enough to cause a change in central parity, i.e. large enough to cause a devaluation. How large the deviations of the

1. Realignment Dates of the Irish pound are given in Appendix B.

floating rate have to be before the central parity is changed, is determined by the threshold x and by a stochastic policy disturbance[2] term γ.

The (log of the) equilibrium floating exchange rate s_t is assumed to be proportional to some fundamental variable or vector of fundamental variables:

$$s_t = k + \beta' H_t \tag{2}$$

where Ht is a vector of fundamental variables.

It is assumed that H_t follows a first order autoregressive process:

$$H_t = \theta_1 + \theta_2 H_{t-1} + \nu_t \tag{3}$$

Under weak rationality, the information set on which to base an expectation of next periods exchange rate is simply this period's fundamentals plus a random error ν_t. The error arises from the mistakes made by economic agents in forecasting the future fundamentals, which, if we can assume rationality, must be attributable to newly-arrived information or 'news' for short.

Let us define a devaluation, $d_t = c_t - c_{t-1}$. From Equation (1), the probability that $d_t > 0$ is equal to the probability that $s_t + \gamma_t > c_{t-1} + x$. Using Equations (1) to (3) and by substitution, the probability of a devaluation occurring at time t+1 based on information at time t is

$$\text{Prob}\,(d_{t+1} > 0) = \text{Prob}\,(\alpha + \beta\theta_2 H_t - c_t + \eta_{t+1} > x) \tag{4}$$

where, α is $k + \beta\theta_1$, and $\eta_{t+1} = \gamma_{t+1} + \mu\nu_{t+1}$.

This is equivalent to

$$\text{Prob}\,(\eta_{t+1} > -I_t) \tag{5}$$

where $I_t = \alpha + \mu\theta_2 H_t - c_t - x$.

Assuming that η is normally distributed, the parameters of Equation (5) can be estimated as a Probit model by the "Maximum Likelihood" method

[2] Such policy disturbance may include Central Bank intervention in the foreign exchange market, to prevent the shadow floating rate from actually emerging.

of estimation. The estimated coefficients are then multiplied by the independent "fundamental" variables to yield predicted values of I_t. The predicted values are then converted to probabilities using the standard normal distribution function as follows

$$\text{Prob}\ (d_{t+1} > 0) = \Phi(\hat{I}_t) \tag{6}$$

where Φ is the standard normal cumulative distribution and $\hat{I}_t$ is the predicted value of I_t based on the Probit regression.

Equation (6) yields a time series of probabilities which can then be plotted.

Specification of OLS regression model

Having established a mechanism for calculating the probability of observing a change in central parity, the next step is to specify the actual regression model with the dependent variable being a vector of these observed central parities. These observed central parities are regressed on "H", a vector of fundamental variables. The regression model takes the form:

$$d_t = \delta H_t + \varepsilon_t \tag{7}$$

where d_t is the change in the log of the central parity, or the expected rate of devaluation. The vector of coefficients, "δ", can be used to generate predicted values of the expected change in central parity or the expected size of devaluation.

Again, using Equations (1) to (3) and by substitution, the expected change in central parity, given that a change has taken place, can be written as

$$E(d_{t+1} / \ d_{t+1} > 0) = \alpha + \beta\theta_2 H_t - c_t + E(\eta_{t+1} / \ d_{t+1} > 0) \tag{8}$$

From Equations (4) and (5) we know that:

$$E(\eta_{t+1} / \ d_{t+1} > 0) \ = \ E(\eta_{t+1} / \ \eta_{t+1} > - I_t) \tag{9}$$

Because we are omitting all observations where $\eta_{t+1} \leq - I_t$, the mean of the residuals in η_{t+1} is non-zero which produces a sample selection problem. Recall that the central rate is treated as a censored variable. We are only observing changes in the £IR/DM central rate despite the fact that the exchange rate also moves around freely. Thus, we are only observing part of the £IR/DM distribution. As a result, the mean of the normal distribution is

no longer zero which gives rise to a specification problem for the OLS regression.

We address this problem using the Heckman procedure. This two-step estimation procedure involves:

1. Estimating the Probit equation (Equation (5)), over the entire sample, by maximum likelihood to obtain estimates of It. For each observation in the selected sample, compute:

$$\lambda = \phi\ (I/\sigma)\ /\Phi\ (I/\sigma) \tag{10}$$

where Φ is the standard normal cumulative distribution function, ϕ is the associated density function, and σ is the standard deviation of the residual η.

2. Re-writing Equation (8) using the formula for the mean of a truncated normal distribution[3] to give:

$$E(d_{t+1} / d_{t+1} > 0) = \alpha + \beta\theta_2 H_t - c_t + \sigma\lambda_{t+1} \tag{11}$$

The correction term λ, calculated in the first step, is used as an additional variable in Equation (11). Using only positive values of d_t, we then estimate (11) by ordinary least squares (OLS).[4]

Calculation of Devaluation Expectations

As mentioned earlier, only part of the normal distribution is being observed due to the fact that the central parity is treated as a censored variable. As such, a continuous distribution of devaluation expectations is calculated as a product of two separate entities; namely, (1) the probability that the central parity is in the selected part of the distribution, and, (2) the expected changes in central parity within that part of the distribution. For example: a devaluation probability of 0.4 is interpreted as a 40 per cent chance of a change in central parity; an additional value of 0.1 indicates an expected change in the central rate of 10 per cent. Thus, the unconditional expected devaluation rate is calculated as the product of (1) and (2), in this example, 4 per cent (0.40 x 0.10). In terms of the methodology outlined

3. See Appendix C.

4. The entire Econometric analysis(Probit, OLS, "Heckman" Procedure) is carried out using the Shazam 7.0 statistical package.

above, this represents the product of Equation (6) and Equation (11) which can be specified as a continuous distribution of devaluation expectations as follows:

$$E(d_{t+1}) = \text{Prob}\,(d_{t+1} > 0) * E(d_{t+1} / \; d_{t+1} > 0) \qquad (12)$$

The estimates of Equation (12) can be interpreted as devaluation expectations over time.

Which Fundamentals?

Hitherto, the discussion of the econometric model did not include an examination of the fundamental vector "H". There is little agreement in the literature as to what variables should be included in such a vector. Even allowing for differences in definitions, there is considerable heterogeneity in the results, regarding the importance of different variables in determining devaluation expectations (Moreno, 1995).

There is no reliance on any particular model of exchange rate determination. The approach, rather, is to look for systematic relations between actual devaluations and fundamental economic conditions. While the obvious candidates for inclusion as fundamentals in "H" are the variables figuring in the monetary model of a pegged exchange rate regime (output, prices etc.), there is no reason to insist on this. Simply by respecifying the list of fundamentals, the same framework can accommodate any other economic variable.

Money stock (m) is included to facilitate a discussion on the importance of monetary policy in forming devaluation expectations. Such a discussion may lead to clearer thinking on the possible effects of surrendering monetary autonomy through joining EMU. While domestic credit growth may be a more appropriate indicator of monetary policy, we use data on money stock to facilitate comparability of our results with previous estimates on the Irish economy (O'Donnell, 1995) and also with previous Probit estimates (Edin and Vredin, 1993), both of which use money stock.

The inclusion of the real Stg£/IR£ exchange rate (rer) highlights the strong link between the Irish and UK economies. Ireland's entry into EMU without the UK, a depreciation of sterling threatens Ireland's competitiveness with the UK imposing a real cost on the Irish economy in terms of a deterioration of the balance of trade and higher unemployment. For Ireland, the volume of imports (imp), volume of exports (exp) and unemployment (U) are included to analyse the cost of an overvalued exchange rate. We also follow Edin and

Vredin (1993) and include the foreign interest rate as an influence on the expected devaluation rate; the obvious choice here is to include German interest rate (r*). The German-Irish inflation differential (π) are also included in "H".

The domestic price level and domestic interest rate are treated as endogenous and are not included as explanatory variables in the analysis. The domestic price level is eliminated through the definition of the real exchange rate which is calculated using the wholesale price index:

$$rer_t = s_t - p_t^* + p_t \tag{13}$$

where rer_t is the (log of the) real Stg£/IR£ exchange rate p_t^* and p_t are the foreign and domestic price levels respectively.

The domestic interest rate is eliminated through the assumption of uncovered interest rate parity:

$$r_t = r_t^* + E(s_{t+1} - s_t) \tag{14}$$

where r_t is the domestic interest rate, r_t^* is the foreign interest rate, and $E(s_{t+1} - s_t)$ is the expected future depreciation of the domestic currency.

All data are monthly and cover the time period 1979-1994. Our motivation for using monthly data arises from the use of a Probit model which requires at least 50 degrees of freedom; thus over the sample period here, quarterly data would have provided just 60 observations, whereas monthly data provided over 170 degrees of freedom. Furthermore, the use of monthly data facilitates comparability of our results with other Probit models which have used monthly data.[5]

III EMPIRICAL RESULTS

> I think that the Irish pound, as far as fundamentals are concerned, is on solid ground, and I don't see the need for a change in their central rates....I am sure, because of the economic fundamentals, that the Irish pound can survive at the present rates.
>
> Bundesbank Vice President Mr. Tietmeyer 1/12/92

[5] Data definitions and sources are detailed in Appendix A.

Table 1: Two-Stage Parameter Estimates of Probit and OLS Regressions

Dependent Variable	Pr (dt > 0)	(dt / dt > 0)
Intercept	-80.144-	0.71787
	(38.5930)[1]	(3.504)
c_{t-1}	-17.255 *2	0.069256
	(8.6112)	(0.09662)
m_{t-1}	6.5132 *	0.10713
	(3.78020)	(0.5051)
imp_{t-1}	-2.229	
	(2.2512)	
exp_{t-1}	0.35306	
	(2.2163)	
rer_{t-1}	17.880 *	0.10168
	(6.5829)	(0.5628)
π_{t-1}	0.019277	
	(0.092992)	
r^*_{t-1}	0.10480	
	(0.15428)	
U_{t-1}	1.4331	0.02808
	(1.6172)	(0.09483)
λ_t		0.0087197
		(0.04548)
R^2		0.9167
n	192	8
No. of Devaluations	8	8

Notes: 1. Standard errors are in parentheses.
2. * indicates significance at the 10 per cent level of significance.
3. All variables, except r* and the German-Irish inflation differential, are in logs and are lagged one period.

6. The specification of (H_t) for the OLS regression is slightly different. Given that there are only 8 observations in the sample where a devaluation actually took place, the number of explanatory variables included in (H_t) is reduced to conserve degrees of freedom. Therefore, there are only 4 explanatory variables specified in (H_t) in Equation (9). These are the lagged central parity, money stock, the real Stg£/IR£ exchange rate and unemployment. Again, these variables are in logs and lagged one period.

Table 1 shows the two-stage parameter estimates of the Probit and OLS regressions. The first column shows the results of the Probit regression (Eq.(6)) while the corresponding estimates of the OLS regression (Equation (11)) are presented in the second column.

The real Stg£/IR£ exchange rate and money stock have a significant positive influence on the probability of a devaluation. On the other hand, the lagged central parity exerts a significant negative influence on devaluation probabilities. This result is intuitive in the fact that a depreciation of the central parity (a devaluation) in this period significantly reduces the probability of a devaluation in the next period. The significance of the real Stg£/IR£ exchange rate shows that competitiveness with the UK is a major influence on the probability of a devaluation of the Irish pound within the ERM. This result is consistent with previous results in Honohan and Conroy (1994), Walsh (1993) and Thom (1995) although the results here are obtained using a somewhat different methodology. Although Ireland's joining the EMS formally broke a 150 year link with Sterling, there would still appear to be an informal "competitiveness target zone" vis-à-vis the UK.

The positive influence of money stock on devaluation probabilities is consistent with the monetary approach to exchange rate determination. Increases in money stock can fuel inflationary expectations which can lead to higher expectations of a devaluation due to the threat of a loss in competitiveness.

The insignificance of the German-Irish inflation differential may imply that a central bank's reputation, with respect to inflation, is more important in influencing devaluation expectations than the convergence of inflation rates prior to joining a monetary union. This point is also made in De Grauwe (1994) with regard to the difficulties, which can be experienced by countries like Italy, in trying to bring down inflation when the Banca d'Italia has a poor anti-inflationary reputation.

In comparing the coefficient estimates from the Probit regression with those from the selection-corrected OLS, none of the fundamentals in the OLS regression were significant. However, we know from the Probit model that since the probability of a devaluation is generated using information on fundamentals, which are significant in that model, and that these probabilities in turn are used to generate the expected devaluation rate over time; this indicates that fundamentals are in fact important in influencing devaluation expectations. Thus, if one was relying solely on the results from the selection-corrected OLS model, this may lead to incorrect inference regarding the importance of fundamentals in determining the devaluation

rate; furthermore, the results here indicate that the Probit model appears to capture important timing elements influencing devaluation risk which may not be reflected in other models. This could be taken as evidence either that the fundamentals which influence devaluation expectations are more likely to be indicated by the Probit model than the OLS, or alternatively that certain fundamentals are likely to be critical in influencing the probability of the timing of a devaluation or change in central parity, a feature which is not captured by the OLS model.

The selection-corrected estimates of the expected rate of devaluation are reported in the second column. These are rather disappointing in that none of the explanatory variables enter significantly. Notwithstanding the selection bias, accounted for by "Heckman's Lambda", the OLS regression was carried out on eight observations with only one degree of freedom. This is essentially a data problem as devaluations are relatively rare events.

Figure 1: Estimated Devaluation Probabilities for the Irish Pound 1979-1994

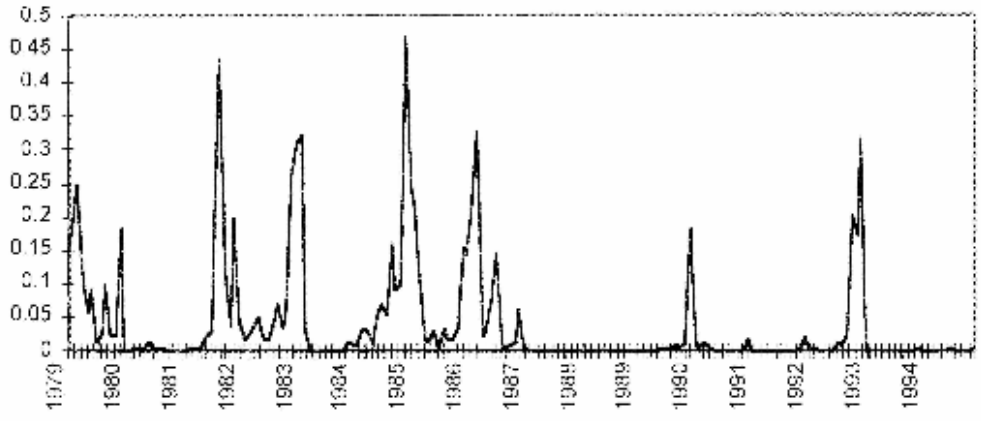
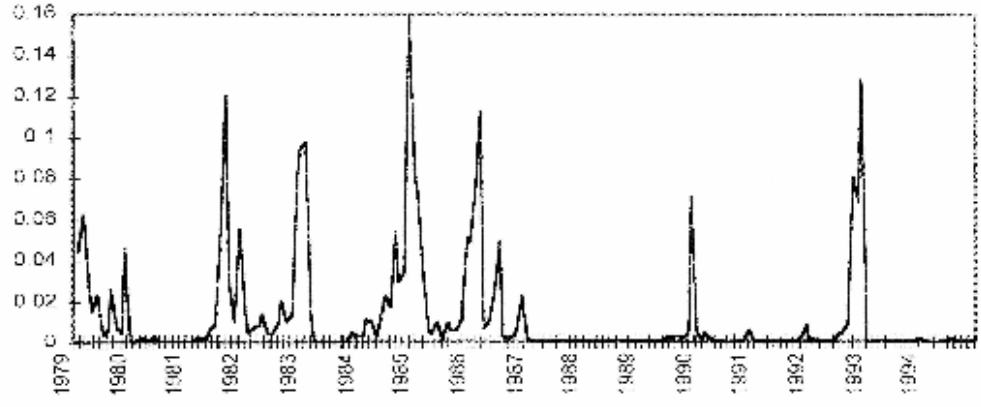


Figure 2: *Estimated Devaluation Expectations of the Irish Pound 1979-1994*



Turning now to the devaluation expectations. As set out in the methodology, Equation (6) yields actual probabilities of devaluations which can be plotted over time. Using the estimates in Table 1, predicted values of the probability and expected rate of devaluation are calculated, with the former values depicted in Figure 1. An important aspect of Figure 1 is the time dimension of the estimated devaluation probabilities. That is, the Probit model seems to perform particularly well in predicting the timing of the actual devaluations which have occurred. Furthermore, in comparing Figures 1 and 2 the patterns are almost identical, that is, the devaluation expectations and the devaluation probabilities. However the important thing to note here is the difference in scale when we move from Figure 1 to Figure 2; the latter is generated when the discrete probabilities are multiplied by the conditional expectations (Equation (11)) and this generates the continuous expected devaluations (Equation (12)). Thus, when this adjustment to the discrete probabilities is made, we end up with expected rates of devaluations which are close to what actually occurred. For example, in 1993 the probability of a devaluation based on fundamental factors was approximately 30 per cent; but the same datapoint in Figure 2 indicates an expected devaluation of 12 per cent, which is very close to the actual devaluation of 10 per cent in January 1993.

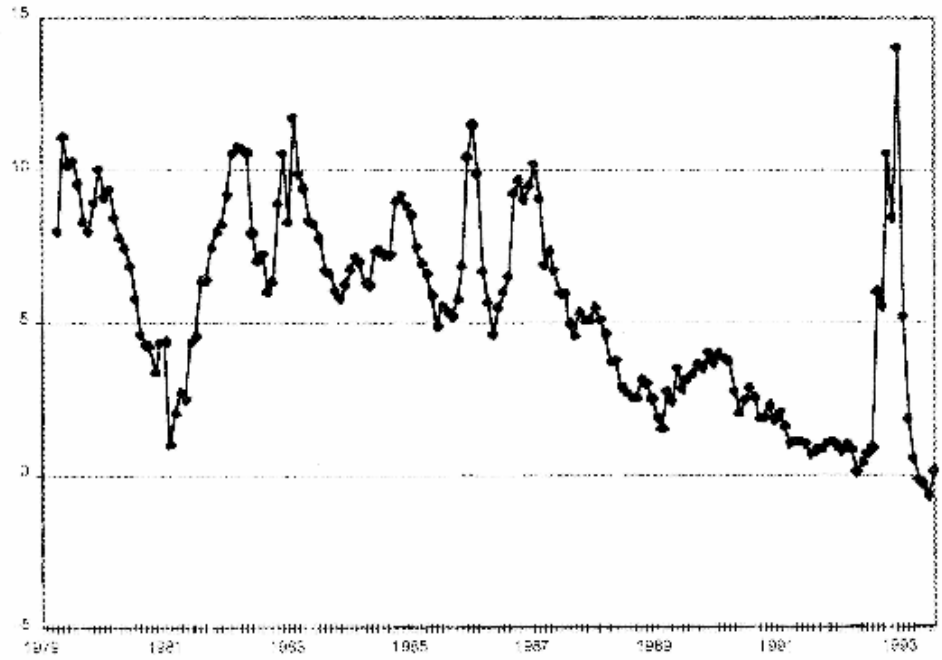
Second, with regard to the general trends evident in Figure 2, there are five distinct periods of high and variable devaluation expectations. These are (i) January 1979 to January 1980; (ii) May 1981 to April 1983; (iii) October 1984 to January 1987; (iv) October 1989 to February 1990; (v) September 1992 to January 1993. There is virtually no expectation of a devaluation for time periods other than the five selected time periods above. For periods two, three and five, a spell of relatively high and variable expectations has culminated in a devaluation. In addition to these general trends, the results also perform well regarding the actual size of the devaluations as can be seen by comparing the values indicated in Figure 2 around the times of actual realignments, with the actual size of those realignments, set out in Appendix B.[7] These estimates thus indicate that in between the periods outlined above, Ireland's exchange rate policy was not dogged by a lack of credibility.

[7.] On this point, there is the question of the extent to which the results generated here by the Probit model are peculiar to the Irish data set. That is, would the Probit model perform as well in predicting the timing of realignments for other exchange rate regimes? We have applied the model to pooled time series data for Denmark, Spain and Portugal (given the frequency of realignments) and results indicated that the probability of a realignment matched closely actual realignments. We do not report these results here but they are available from the authors upon request.

IV COMPARISON WITH EXISTING EVIDENCE

As stated at the outset, most previous studies on exchange rate expectations are based on the assumption of UIP. An issue of interest then, is how the estimates generated here from the Probit model compare with those generated from UIP; in particular we are interested in comparing these two sets of estimates for Ireland. Recall that the latter estimates will be based entirely on interest rate differentials which are adjusted for the expected rate of depreciation within the band. Below, devaluation expectations for Ireland based on UIP calculated by O'Donnell (1995) are presented; these estimates are similar to those generated by Bartolini (1995) for Ireland, although the method of estimation and time period differed slightly in both studies.[8]

Figure 3: *Estimated Devaluation Expectations DM/IR£, based on UIP*



Source: O'Donnell (1995).

[8] Knot (1998) also estimates devaluation expectations for the Irish pound against the DM but with a view to using these estimates in Granger causality tests to uncover fundamental determinants of these devaluation expectations and so do not present the estimates themselves; however, these were "UIP" estimates based on Svensson's drift adjustment method, as in O'Donnell and Bartolini.

Comparing the trend here with that in Figure 2, we find that the development of devaluation expectations over the period in both studies is broadly similar. What this means, in essence, is that the devaluation expectations based on the Probit model are consistent with earlier estimates based on UIP. What additional insight then is provided by the Probit estimates? First, the probability of a devaluation is an important feature of the Probit model not captured in the devaluation expectations generated by UIP. Second, since this probability is estimated using only a vector of fundamentals, we are provided with a link between individual fundamentals and the probability of a devaluation at any given point of time, a feature again absent from the UIP model; of course fundamentals can still be linked to the size of an expected devaluation in the UIP model (by regressing the expected rates of devaluation on a set of fundamentals), but no account is taken of the probability of a devaluation. Considering the two models then, the UIP model illustrates how interest rate differentials influence devaluation expectations, while the Probit model indicates how devaluation expectations are determined by fundamentals and in this way, the two models are complementary to each other, rather than one being a substitute for the other.

In comparing the significance of fundamentals in the Probit model with those significant in other studies, we find first that our results are consistent with other Probit generated results for the Irish pound by Otker and Pazarbasioglu (1997). They are also consistent with the results from Edin and Vredin (1993) who find the real exchange rate has a significant effect on the probability of a devaluation in the Nordic countries. Bartolini (1995) found that the real exchange rate was significant in influencing devaluation expectations (based on UIP) of the IR£ vis-à-vis our ERM partner currencies, as did Knot (1998). However, other studies (for example, Chen and Giovannini (1997), Lindberg et al. (1993), Rose and Svensson (1994)) which include the real exchange rate found that it did not have a significant effect on devaluation expectations for either the Irish pound or various other ERM currencies. The Stg£/IR£ nominal exchange rate was also significant in influencing devaluation expectations based on UIP in both O'Donnell and Bartolini and the link with the UK is also evident in the significance in that study of nominal wages vis-à-vis the UK in O'Donnell (1995);[9] thus again, there is a degree of consistency between the UIP and Probit models.

Chen and Giovannini (1997) and Lindberg et al. (1993) also include money

[9] Knot (1998) finds also that inflation, unemployment and the current account "Granger cause" devaluation expectations for the Irish pound vis-à-vis the DM.

stock, as do Rose and Svensson (1994), but again, in all instances it is not found to have a significant effect on the formulation of devaluation expectations generated based on UIP, whereas it is significant here in influencing the probability of a devaluation and also in Edin and Vredin's paper. Siklos and Tarajos (1996) also found that domestic money stock had a significant influence on devaluation expectations for Belgium, France, Italy and the Netherlands, generated using Edin and Vredin's methodology. This suggests that the significance of certain fundamentals may be related to the methodology employed. Thus, in an attempt to uncover the fundamentals important in determining devaluation expectations, it may be worthwhile to re-estimate devaluation expectations using the Probit model which were previously estimated based on UIP.

V CONCLUSIONS

This paper set out to empirically estimate devaluation expectations for the Irish pound during EMS membership. The methodology used to generate these estimates was based on the assumption that a devaluation is related to certain fundamentals. The results of this Probit model indicated that in particular the real Stg£/IR£ exchange rate and money stock were significant in determining devaluation expectations. The insignificance of other fundamental variables included here is consistent with findings from similar empirical studies in this area. The results also indicated that the significance of particular fundamentals may be related to the methodology employed.

With regard to the estimates of both the probability of a devaluation and the size of the devaluation, the Probit model performed well on both counts in predicting the timing and size of actual devaluations. Furthermore, a comparison of the Probit based estimates with previous estimates based on the assumption of UIP indicated that since the two estimates were fairly consistent, UIP appears to be a reasonable assumption for Ireland during the period of this study.

Finally, the implications of these results for countries which may aspire to joining a monetary union is that careful consideration should be given to the cause of any exchange rate instability. For Ireland, elements other than those specified in the Maastricht Treaty were significant in the formulation of devaluation expectations, thus the argument can be made for differential treatment of internal versus external factors which contribute to exchange rate instability in assessing a country's eligibility to join a monetary union.

APPENDIX A

Data Definitions and Sources

$Pr\ (d_t > 0)$: Binary choice variable; 1 if a devaluation took place, 0 if not.

c_{t-1} : The one-month lag of the prevailing central parity (IR£/DM central rate), Central Bank Quarterly Bulletin, various issues 1979-1994.

m_{t-1} : The one-month lag of the money supply(M1), Statistical Appendix, Table10, Central Bank Quarterly Bulletin, various issues 1979-1994.

imp_{t-1} : The one-month lag of the volume of Irish Imports(index 1979=100), EIRESTAT, Data Bank of Central Statistics Office, File TSAM203, Dublin, 1996.

exp_{t-1} : The one-month lag of the volume of Irish Exports(index 1979=100), EIRESTAT, Data Bank of Central Statistics Office, File TSAM202, Dublin, 1996.

rer_{t-1} : The one-month lag of the Real Stg£/IR£ Exchange Rate. Nominal Stg£/IR£,Statistical Appendix, Table 75, Central Bank Quarterly Bulletin, various issues 1979-94. Real exchange rates calculated using the monthly Wholesale price index for Ireland. Wholesale Price Indices available from Datastream, OECD Databank, Program 150C.

π_{t-1} : The one-month lag of the German-Irish Inflation differential. Wholesale Price Indices available from Datastream, OECD Databank, Program 150C.

r^*_{t-1} : The one-month lag of the German 3-month interbank lending rate, IMF, International Financial Statistics Yearbook, line 71, various issues 1979-94.

U_{t-1} : The one-month lag of the number of registered unemployed in Ireland, Datastream, OECD Databank, Program 150C.

λ_t : Heckman's sample selection bias-correction term.

Note: All Data seasonally unadjusted.

APPENDIX B

Realignment Dates and IR£/DM Central Parities

Date	Central Parity	Per Cent Devaluation
February, 1979	0.263932	
September, 1979	0.269212	2.0
October, 1981	0.284018	5.5
June, 1982	0.296090	4.25
March, 1983	0.323703	9.0
April, 1986	0.333416	3.0
August, 1986	0.362405	8.0
January, 1987	0.373281	3.0
January, 1993	0.414757	10.0

Source: O'Donnell (1995).

APPENDIX C

If x is normally distributed with a mean μ a variance σ^2, and α is a constant,

$$E[x/\text{truncation}] = \mu + \sigma\lambda(\alpha)$$

where $\alpha = (a - \mu)/\sigma$ and

$\lambda(\alpha) = \phi(\alpha)/1-\Phi(\alpha)$ if truncation is $x > a$.

The function $\lambda(\alpha)$ is called the inverse Mill's ratio. It is also known as the hazard function for the distribution. A useful way of viewing truncation is in terms of the probability that x is less than a. This would be a measure of the degree of truncation and would be an increasing function of a. As this probability rises, a greater proportion of the distribution is being discarded, and the mean rises accordingly.

Heckman (1979) uses this function to account for the degree of truncation in the OLS regression (Equation 7) when only the observations in which a devaluation actually took place are included. "Heckman's Lambda" was

calculated from the Probit equation (Equation 6).

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