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<tr>
<td><strong>Authors(s)</strong></td>
<td>Walsh, Brendan M.</td>
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<tr>
<td><strong>Publication date</strong></td>
<td>1993-01-06</td>
</tr>
<tr>
<td><strong>Series</strong></td>
<td>UCD Centre for Economic Research Working Paper Series; WP93/1</td>
</tr>
<tr>
<td><strong>Publisher</strong></td>
<td>University College Dublin. School of Economics</td>
</tr>
<tr>
<td><strong>Item record/more information</strong></td>
<td><a href="http://hdl.handle.net/10197/1689">http://hdl.handle.net/10197/1689</a></td>
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<td><strong>Notes</strong></td>
<td>A hard copy is available in UCD Library at GEN 330.08 IR/UNI</td>
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CENTRE FOR ECONOMIC RESEARCH


BY

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WORKING PAPER NUMBER WP93/1

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Credibility, Interest Rates and the ERM: The Irish Experience, 1986-92

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Abstract: As one of a set of policies designed to reduce inflation and interest rates to the levels prevailing in Germany the Irish pound has been stabilised in the Exchange Rate Mechanism (ERM) of the European Monetary System since 1986. This paper examines the effect of this policy on short-term interest rates in Ireland. Only limited evidence is found that the exchange rate policy contributed to the reduction in the German-Irish interest rate differential. Sterling interest rates and the level of the Irish pound/sterling exchange rate have continued to influence the level of Irish interest rates. This was borne out by the impact of the turbulence of September 1992 on Irish money markets. It is suggested that the costs of rigidly pegging the Irish pound in the ERM may outweigh the benefits of this policy.

6 January 1993
INTRODUCTION

Recent events on currency markets have created a major policy dilemma for the Irish authorities. The benefits to Ireland of the commitment to a fixed exchange rate in the European Monetary System's Exchange Rate Mechanism (ERM) have been undermined by the fall of sterling relative to the ERM currencies. The defence of the Irish pound has been costly in terms of increased foreign borrowing, depletion of official foreign reserves and, above all, the loss of competitiveness and high interest rates that have been imposed on the economy since September 1992.

This paper explores some background issues raised by these events. In particular, it examines the factors influencing Irish short-term interest rates over the period since mid-1986 and the extent to which the policy of pegging the Irish pound in the ERM succeeded in reducing the role of British monetary developments in Irish money markets. The organisation of the paper is as follows. The second section presents a brief review of recent Irish exchange rate policy. In the third section a model of Irish short-term interest rates is estimated. The final section discusses some implications of the findings.

POLICY CONTEXT

During the first five years of the ERM's operation, its effectiveness was undermined by high and divergent rates of inflation among the participating economies which necessitated frequent realignments. The stronger currencies, especially the German mark (DM), were periodically revalued and the weaker currencies, including the Irish pound, were able to operate something akin to a crawling peg without formally devaluing. The only occasion during the first seven years of the operation of the ERM when Ireland devalued was in March 1986, when the central rate of the pound was lowered by three per cent.

1I am grateful to Rodney Thom, who made numerous helpful suggestions on the contents of this paper. I am also grateful to Joseph Durkan, Antony Leddin, and Desmond Norton for comments on earlier drafts. Of course, the "usual disclaimer" applies: in particular, responsibility for the views expressed is solely mine.

2The only occasion during the first seven years of the operation of the ERM when Ireland devalued was in March 1986, when the central rate of the pound was lowered by three per cent.
quarter of 1979 and the first quarter of 1986 the central rate of the Irish pound in the ERM fell from IR£1=DM3.79 to IR£1=DM2.79 or by 26 per cent. However, over the same period rate cumulative inflation in Ireland was 130 per cent, compared with only 32 per cent in Germany, so that despite the slide of the pound against the DM there was a significant rise in the real exchange rate. Thus membership of the ERM entailed a deflationary influence, as had been intended from the outset, but there was little evidence of convergence of Irish interest rates or inflation to German levels over these years. At the end of 1985, Irish short-term interest rates were more than 10 per cent above German rates.

The year 1986 was a watershed in Irish exchange rate policy. During the first half of the year the weakness of sterling relative to the narrow-band currencies led to a sharp appreciation of the Irish pound relative to sterling. In response to the strains this imposed on the economy, the Irish pound was unilaterally devalued by eight per cent at the beginning of August. However, when the pound stabilised at a lower level against sterling at the beginning of 1987, the stage was set for a more rigid exchange rate policy and since then it has been held in a narrow zone around IR£1=DM2.67. The Governor of the Central Bank recently described Irish policy as follows:

Since 1987, exchange-rate policy has been expressed clearly in terms of the ERM commitment and the Government remains committed to a policy similar to the "franc fort" policy pursued in France. Over this period, financial markets in Ireland have become more closely integrated with continental markets... Generally speaking, developments in Irish financial markets-particularly movements in interest rates-strongly mirror developments in our narrow band partners...\footnote{"From EMS to EMU: The Case of Ireland", Central Bank of Ireland, Quarterly Bulletin, Winter 1992, p. 45.}
building up the credibility of the ERM peg will outweigh the costs of the (presumably temporary) loss of competitiveness due to the currency’s sudden real appreciation. The high short-term interest rates that have prevailed in Dublin since September 1992 are viewed as a temporary cost of persuading markets of the permanency of the Irish commitment to the ERM.

It is claimed by those who are opposed to a devaluation in current circumstances that the experience of 1986 shows that a devaluation is not the way to secure lower interest rates: the Irish pound was devalued by eight per cent in August 1986, but short term interest rates rose both absolutely and relative to those in Germany over the following six months.

To respond to the current weakness of sterling by devaluing would, it is argued, undermine the credibility that was built up by maintaining a fixed exchange rate in the ERM over the past six years. However, according to an alternative view of the 1986 devaluation, the reversal of the downward trend in the Irish-German interest rate differential in mid-1986 was due to the further weakness of sterling relative to the narrow-band ERM currencies in the second half of the year, which led to renewed pressure on the Irish pound (Walsh, 1992). Furthermore, as will be shown in the next section, this conclusion may be generalised. A study of the period since 1986 suggests that the sterling/Irish pound exchange rate has remained an important influence on the level of short term interest rates in Dublin. When, as during mid-1986 and late 1989, sterling fell relative to the ERM currencies, and as a result the Irish pound rose relative to sterling, the downward trend in the interest rate differential was halted or reversed. While there has been a tendency for the Irish-German interest rate differential to narrow, other things being equal fluctuations in the level of sterling relative to the ERM currencies continue to
influence Irish interest rates.

Figures 1 and 2 show the level of Irish, British and German short-term interest rates, and Figure 3 shows the Irish-British and Irish-German differentials from 1986 to 1992. The reduction in both differentials over the period to mid-1992 is striking. By mid-1987, a year after the devaluation of the Irish pound, Irish interest rates had fallen below British, and between early 1987 and mid-1992, the Irish-German differential almost disappeared. It is striking that Irish rates were relatively uninfluenced by the upward trend in German rates over the period from mid-1990 to mid-1992. However, over the same period the gap between Irish and British rates began to narrow again, so that even before the events of September 1992, Irish rates were once again above British. Following the outbreak of the crisis in September 1992, Irish rates soared relative to German rates, while British rates declined. At end-October the three month interest rate in Dublin was 14½ per cent compared with 9 per cent in Frankfurt and 7½ per cent in London; by the end of December the gap was even wider, with rates at 17 per cent in Dublin compared with 8¼ in Frankfurt and 7 per cent in London. Moreover, as the recent currency crisis developed, there was an unprecedented level of support by the Central Bank in an attempt to replace the outflow of liquidity from the banking system due to foreign exchange transactions. Over IR£2 billion was advanced to the banking system during September 1992 in the form of sale and repurchase agreements (REPOs). Despite large increases in foreign borrowing, official external reserves fell from over IR£3 billion in August to IR£2.1 billion at end-September. The key issue is the net contribution made by the strong currency policy to

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4When sterling weakened between mid-1989 and mid-1990 the Central Bank also provided a very high level of support for the market and stabilised Irish interest rates.
the convergence of Irish and German interest rates and how much was due to other factors such as the build-up of confidence in domestic economic policies after 1986.

An examination of the relationship between the sterling/Irish pound exchange rate (Figure 4) and Irish-German interest rate differentials suggests that the level of the Irish pound relative to sterling influenced the interest rate differential throughout the period since 1986. The marked decline in the differential over the period from mid-1987 to early 1989 coincided with a sustained fall in the value of the Irish pound relative to sterling. As the slide in sterling was reversed during 1989 and 1990 there was a temporary widening of the Irish-German interest rate differential, while when sterling strengthened from mid-1990 to mid-1992 there was a renewed narrowing of the interest rate differential. Thus the behaviour of Irish interest rates in the last quarter of 1992 was in line with the persistent influence of the sterling exchange rate even following the implementation of the Irish version of the franc fort policy. The markets continued to view the level of the Irish pound in the ERM as conditional on the level of sterling relative to the ERM. The credibility of Ireland's exchange rate commitment to the DM dissipated instantly during the September 1992 crisis. The surge in Irish interest rates occurred, not as a consequence of a change in inflationary expectations in Ireland or a new policy departure by the Irish authorities, but because the fall of sterling raised the value of the Irish pound to a level that the markets viewed as unsustainable.

MODELLING SHORT TERM INTEREST RATES

There has been a considerable amount of research on the topic of whether countries gained
credibility in financial markets by participating in the ERM. While there is some evidence that adherence to the ERM improved the monetary authorities' anti-inflationary reputation, in general "there is little evidence that [interest] rate differentials came down in anticipation of reduced inflation differentials." Dornbusch (1989) found that the differential in inflation with Germany was a significant influence on long-term interest rates in other European countries, including Ireland. He also found that while a high debt/GDP ratio did not lead to higher national interest rates, a large primary (that is, non-interest) budget deficit did. He reports that membership of the ERM per se did not have the expected moderating influence on interest rates. The main factor behind the gradual convergence of Ireland's interest rates on Germany's was, according to Dornbusch, the corrective fiscal action that was put in place in the course of the 1980s. (The Irish primary budget balance went from a deficit of 8.9 per cent of GNP in 1981 to a surplus of 7.3 per cent in 1989.) He pointed out that this was accompanied by an exceptionally large increase in the rate of unemployment. On the basis of the closer correlation between German and Irish discount rates after 1986, Weber (1991) claims that Ireland gained some credibility by its strong exchange rate policy. The possibility that the sterling exchange rate continued to influence market expectations about Ireland's ability to sustain its commitment to the ERM has not been explicitly explored. However, in a comment on Dornbusch's paper Honohan (1989) pointed out that "the three-month forward discount on the Irish pound relative to sterling is strongly correlated with the spot sterling value of the Irish pound."

"Egebo and Engander, 1992, p. 60. This article provides a comprehensive summary of the research on this topic."
In order to test the effect of the ERM peg on Irish interest rates, a model of Irish short-run interest rates must be specified. Under a quasi-fixed exchange rate regime, uncovered interest rate parity suggests that the interest rate of a small, open economy will be determined by the interest rate in the country to which the currency is pegged minus the expected change in the nominal exchange rate. Thus

\[ i = i^* - (\Delta e/e)^* \]

where

- \( i \) = domestic interest rates,
- \( i^* \) = "world" interest rates,
- \((\Delta e/e)^*\) = the expected rate of change in the exchange rate, defined as the foreign currency price of a unit of domestic currency.

In the Irish context our membership in the ERM makes the DM the hegemonic currency, and hence the DM interest rate, \( i^{DM} \), is the key external variable. However, the influence of the London money market on Dublin would not be expected to have evaporated immediately Ireland fixed its exchange rate in the ERM and thus British interest rates, \( i^B \), would be expected to continue to influence Irish interest rates for some time after the adoption of the hard currency policy in 1986. As the commitment to the DM gained credibility, the importance of German interest rates should have increased and that of British rates diminished.

The modelling of exchange rate expectations is crucial. The approach taken here is based on the following logic. Because sterling was not participating in the ERM for much of the period being studied, the Irish pound/sterling exchange rate fluctuated as sterling floated relative to the narrow band currencies. Given the importance of Britain to the Irish
economy, these fluctuations in the Irish pound/sterling exchange rate generated expectations about the sustainability of the Irish pound's value in the ERM. The expected change in the nominal exchange rate relative to the narrow-band ERM currencies, or the DM for short, would therefore depend on the deviation of the real exchange rate, \( \varepsilon \), from its normal or equilibrium level, \( \varepsilon^\text{eq} \):

\[
(\Delta e^\text{DM})^* = f(\varepsilon^\text{STG} - \varepsilon^\text{STG})
\]

where

\[
\varepsilon^\text{STG} = \varepsilon^\text{STG}(P/P^K)
\]

\( P, P^K \) = the Irish and British price levels, respectively.

If we treat \( \varepsilon^\text{STG} \) as a constant (which is plausible over a six-year period) we can conclude that the level of the Irish pound relative to sterling, adjusted for relative price levels, would influence expectations about changes in the Irish pound exchange rate in the ERM and hence affect Irish interest rates.⁶ A high Irish pound relative to sterling would raise expectations of a devaluation in the ERM, leading to upward pressure on short-term interest rates in Ireland. If, however, the peg to the DM gained credibility over time the influence of the sterling exchange rate on Irish interest rates should have decreased.

Taking these points into account, we can specify the relationship as follows:

\[
i = \alpha_1 i^\text{DM} + \alpha_2 i^\text{STG} - \alpha_3 (\varepsilon^\text{STG} - \varepsilon^\text{STG})
\]

Rearranging, and treating \( \varepsilon \) as a constant, we may write

\[
i = -\alpha_3 \varepsilon^\text{STG} + \alpha_1 i^\text{DM} + \alpha_2 i^\text{STG} + \alpha_3 \varepsilon^\text{STG}
\]  

(1)

---

⁶If purchasing power parity holds with sterling, the expected value of \( (\varepsilon^\text{STG} - \varepsilon^\text{STG}) \) will be zero. On this point the evidence is mixed (see Thom, 1989). There were marked fluctuations in the real exchange rate over the period 1986-92 (see Figure 4), but as noted below, the series is non-stationary.
We expect $\alpha_1$, $\alpha_2$, $\alpha_3 > 0$. If the ERM commitment gained credibility over time, we should see a structural shift in the coefficients of model, with $\alpha_1$ increasing and $\alpha_2$ and $\alpha_3$ decreasing.

The four key variables in this model are Irish and German interest rates and the sterling exchange rate. Before estimating the model we need to establish the properties of these time series. We confine our attention to the period between Ireland's devaluation at the end of July 1986 and the turbulence in September 1992. Appendix Table A1 shows the results of testing for unit roots in the levels and first differences of these variables. The Dickey-Fuller tests and Augmented Dickey-Fuller\(^7\) tests show that the levels of these variables should be regarded as non-stationary, while the first differences are stationary. Thus the variables are all integrated to the same degree, I(1), and, provided they are cointegrated, estimation of an Error Correction Model (ECM) is appropriate. When working with more than two I(1) variables Johansen's ML procedure is the relevant test for cointegration (Pesaran and Pesaran, 1991). This test was applied in the context of a one-period lag vector autoregression to combinations of the variables included equation (1). A highly significant test statistic for the null hypothesis that there is no cointegrating vector was obtained when all four variables, $i$, $i^{STO}$, $i^{DM}$, and $e^{STO}$ were included, and for the combination $i$, $i^{DM}$, and $e^{STO}$; the statistic for the combination $i$, $i^{STO}$, and $e^{STO}$ is borderline, while that for $i$, $i^{STO}$, and $i^{DM}$ is not significant (Appendix Table A2). The last finding is important, because it indicates that Irish interest rates cannot be modelled exclusively in terms of "world" interest rates over the period since 1986.

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\(^7\)Up to 12 lags were included because the data are monthly, but only the first four are reported in Table A1. The statistics for higher lags did not alter the conclusions.
This evidence that the variables are cointegrated justifies estimation of an ECM version of equation (1) above. Table 1 reports the results. The following F statistics were obtained for tests of the effects of the deletion of the individual variables on the explained sum of squares:

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<th>F (2.65)</th>
<th>Prob (F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( l_{t}^{\text{TG}} , \Delta l_{t}^{\text{TG}} )</td>
<td>4.23</td>
<td>0.019</td>
</tr>
<tr>
<td>( l_{t}^{\text{DM}} , \Delta l_{t}^{\text{DM}} )</td>
<td>7.50</td>
<td>0.001</td>
</tr>
<tr>
<td>( e_{t}^{\text{TG}} , \Delta e_{t}^{\text{TG}} )</td>
<td>11.74</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Thus three variables make significant contributions to our understanding of Irish interest rates over the period are significant.

The results in the first equation in Table 1 are satisfactory in as much as the long-run effects (that is, the coefficients of the lagged values of the regressors) are all in the expected direction and are very well-determined. However, among the short-run coefficients (on the first differences of the regressors) only that of \( e_{t}^{\text{TG}} \) is significant. These findings show that while all three variables affect the level of Irish interest rates in the longer run, the level of the real exchange has a dominant role in the short-term adjustment process.

The positive coefficient of the exchange rate indicates that the level of the Irish pound relative to sterling, adjusted for the two countries’ price levels, was used by the market as an indicator of the probability of a change in the nominal exchange rate in the ERM. As the Irish pound rose relative to sterling, it was believed increasingly likely that it would have been devalued in the ERM in order to restore a more sustainable rate against sterling; the anticipated fall in the value of the Irish pound relative to the DM necessitated a premium on Irish relative to German interest rates. The estimated coefficients imply that an increase of 10 pence in the real exchange rate over the longer run raises Irish interest

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8The equations were estimated OLS, not by IV as is indicated in the case of an ERM. The paucity of monthly series makes the choice of appropriate instruments problematic.
rates by almost 400 base points.  

(It should, however, be borne in mind that in the long run there is no trend in this variable: see footnote 6, above.) The results also show that while the influence of German interest rates was dominant, British rates also exerted a significant influence. The long-run relationship implies that Irish interest rates are a weighted average of British and German rates, with a weight of 0.729 attached to German rates and of 0.224 to British rates\(^{10}\), and an adjustment to take account of the level of the real exchange rate. The equilibrium or normal real exchange rate, \(e^{n}\), implied by these results is IR£1=STG£0.77, which is at the lower end of the range in which \(e^{n}\), the real exchange rate, moved between 1986 and 1992. To lower the real exchange rate to this from its current level would require a devaluation of 16 per cent in the nominal exchange rate, bringing it back to STG£0.93, which is where it was in mid 1992.

The model was formulated in terms of the real, rather than the nominal, exchange rate. As may be seen from Figure 4, movements in the real exchange rate were dampened relative to those in the nominal rate after the end of 1987 as British inflation ran ahead of Irish. That movements in the real exchange rate give a better measure of the pressure on Irish money markets is confirmed by the regression results. When the nominal exchange rate, \(e^{ng}\), is substituted for the real exchange rate \(e^{n}\), the overall result is markedly worse (Table 1).

To see whether Irish exchange rate policy gained credibility as the period over which the Irish pound had been pegged in the ERM lengthened, equation (1) has been reestimated for sub-periods of the six years from August 1986 to August 1992. The results of the tests for the stability of the relationship show some evidence of structural breaks. The Chow test rejects the hypothesis of stability comparing the sub-periods 1986-88 and 1988-92, and 1986-91 and 1991-92 but not, for example, comparing 1986-89 and 1989-92. The coefficients of the real exchange rate are very stable over all sub-periods, while those for the German interest rate are quite unstable. The long-run coefficient of the British interest

\(^{9}\) Derived from the coefficients as 0.134/0.343=0.394. The equation was also estimated using the log of the exchange rate, but the arithmetic version gave a better fit.

\(^{10}\) The restriction that the two weights add to unity is not rejected.
rate is highest in the first two years and much lower in subsequent periods. This is what would be expected as Irish money markets came increasingly under the influence of German conditions. However, the British interest rate remains influential even when the first four years of the period are dropped, indicating the persistence of its direct influence on Dublin rates despite the commitment to the ERM. The stability of the exchange rate variable is even stronger evidence that the attempt to persuade markets to ignore British factors in forming expectations about the Irish exchange rate was not wholly successful. Moreover changing the perception of the normal real sterling exchange rate, $e^{st}$, would appear to be a long and difficult process.

Finally, it may be seen that the equations for various sub-periods easily pass the test for the adequacy of the predictions: the behaviour of Irish short-term interest rates over the later sub-periods could have been satisfactorily predicted on the basis of its relationship with German and British interest rates and the real sterling exchange rate over the earlier sub-periods.

All but the second last regression in Table 1 exclude the last three months of 1992, when turbulence in the currency markets led to the near-collapse of the ERM. Sterling’s departure from the ERM in September and subsequent sharp depreciation caused the Irish pound to appreciate from about STG£0.92 at the end of the summer to over STG£1.07 by the end of the year. As already noted, the determination of the Irish authorities not to devalue to offset this appreciation led to exceptional pressure on Irish interest rates. When equation (1) is applied to forecasting Irish interest rates for end-October and end-November 1992, they completely fail the prediction test. The massive increase in short-term interest rates that occurred in October 1992 falls far outside the range that is predicted on the basis of the relationship that proved very stable over the previous six years. If equation (1) is reestimated over the extended period August 1986 to October 1992, the weight attached to the sterling exchange rate increases markedly. Thus, the relationship that existed over the six years from mid-1986 completely broke down at the end of 1992. The process of gaining credibility through the DM peg, which had always been modified by regard to the level of the Irish pound against sterling, was abruptly halted. Since then the Irish economy has been burden with a truly extraordinary level of
real interest rates. The results presented in this paper suggest that Irish interest rate will not fall to an average of German and British levels unless there is a significant reduction in the value of the pound relative to sterling.

CONCLUSION

Ireland’s firm commitment to the narrow band ERM is strongly influenced by the possible benefits of this policy at Community level, but it is also frequently claimed that there have been direct economic benefits from this policy. These benefits appeared to be materialising over the period 1986-92, but the recent weakness of sterling raised the premium of Irish interest rates over German and British rates and showed that the gain in credibility from the exchange rate policy pursued since 1986 was conditional on the market’s perception of the sustainability of the level of the Irish pound relative to sterling. The findings of the analysis in this paper show that this conditionality was in force throughout the period since 1986 and that there was little evidence, even before the crisis of late 1992, that it was being removed by the durability of our exchange rate peg in the narrow band of the ERM.

Exchange rate policy should be at least as heavily influenced by the need to maintain a competitive cost structure as by the hope that a strong currency will in the long run lead to an improved environment for business. The relative importance of the first consideration has been increased by the sharp rise in the level of Irish unemployment since 1990 and the prospect of continued rapid growth in the labour force. The appropriateness of a rigid commitment to the narrow-band ERM in these circumstances is questionable. Its costs have already been dramatically illustrated by the repercussions of the September 1992 crisis on the Irish economy. The costs of continuing to pursue this policy in the hope of gaining credibility for a strong currency policy could be extremely high relative to any benefits that might be expected to flow from it.
References


Table 1: Regression of Irish short term interest rates ($i_t$) on German interest rates ($i^G_m$), British interest rates ($i^B_k$), the Irish pound/sterling real ($e^{mR}$) and nominal ($e^{mN}$) exchange rates.

Dependent variable = $\Delta i_t$

| Period | Intercept | $\Delta i^G_m$ | $\Delta i^B_k$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}$ | $\Delta e^{mN}$ | $\Delta e^{mR}
APPENDIX: Data and Tables

Data

\[ i = \text{Irish three month interest rate, end of month.} \]
\[ i^D = \text{German three month interest rate, end of month.} \]
\[ i^B = \text{British three month interest rate, end of month.} \]
\[ e^{\text{th}} = \text{spot Irish pound/sterling exchange rate. (Pence sterling per £1.) Monthly end of period data.} \]

Source: Central Bank of Ireland, Quarterly Bulletins.

\[ e^{\text{th}} = e \text{ multiplied by the ratio of Irish (consumer) prices to UK (retail) prices. The UK price index is monthly, the Irish index quarterly.} \]
### Table A1: Tests for Unit Roots for Variables $i$, $i^\text{dm}$, $i^\text{mg}$, $e^\text{mg}$. August 1986-August 1992

(a) = without trend. (b) = with trend

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<tr>
<th></th>
<th>i</th>
<th>$i^\text{dm}$</th>
<th>$i^\text{mg}$</th>
<th>$e^\text{mg}$</th>
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<td>-3.65</td>
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Note: DF = Dickey Fuller test; ADF(n) = Augmented Dickey Fuller test with n lags. 
95% confidence levels: without trend = 2.9, with trend = 3.5

### Table A2: Tests for Cointegration between Variables over period August 1986-August 1992

Johansen ML Procedure

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<td>10.57</td>
<td>20.97</td>
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</table>

| Variables included: $i^\text{mg}$ |
| 0           | 1                               | 27.23         | 20.97              |
| 1           | 2                               | 6.92          | 14.07              |

| Variables included: $i^\text{mg}$ |
| 0           | 1                               | 19.82         | 20.97              |
| 1           | 2                               | 4.20          | 14.07              |

| Variables included: $i^\text{dm}$ |
| 0           | 1                               | 10.82         | 20.97              |
| 1           | 2                               | 6.13          | 14.07              |

Note: Trended case, maximum lag in VAR = 1.
Figure 3: Short-term Interest Rate Differentials

Figure 4: Sterling/Irish Pound Exchange Rate