
Simple tests of target zones: the Irish case

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In a small open economy with fixed exchange rates, standard theory suggests that domestic inflation and interest rates should equal those abroad. In a credible target zone, the same theories suggest that inflation and interest rates should be 'close'. Here, we seek to make precise this idea of limits on inflation and interest rate differentials consistent with limits on exchange rate movements. We then examine the case of Ireland, which joined the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS) in 1979 attracted by the prospects of lower, German influenced, inflation and interest rates. We find in the early years of the ERM, both Irish inflation and interest rates were inconsistent with credibility of the exchange rate regime, in the latter years, from 1987 on, rates were in the derived range around German rates.

I INTRODUCTION

One of the principal motivations for Ireland joining the exchange rate mechanism (ERM) of the European Monetary System (EMS) in 1979 was the small open economy view of inflation. Prior to 1979, the Irish pound link with sterling implied the economy was strongly integrated with the British economy, in particular Britain's high inflation was reflected in correspondingly high Irish inflation. The change to a link with a low inflation country, Germany, was expected to be followed by a decline in Irish inflation.¹ However Ireland's inflation did not approach the low German level until the latter part of the 1980s.²

As Irish interest rates tracked British rates closely during the pre-1979 period, another anticipated benefit of EMS membership was the convergence of Irish interest rates with those lower rates prevailing in Germany. However, like inflation, the gap between Irish and German rates only began to narrow towards the end of the 1980s.

Theory suggests that in a small open economy with quasi-fixed exchange rates, domestic inflation and interest rates should be 'close' to that of the country to which the currency is linked.³ If the exchange rate regime is fully fixed, then equality of inflation and interest rates are predicted. In a target zone, where exchange rate fluctuations are possible although restricted, limited differences in inflation and interest rates are consistent with the exchange rate regime (Svensson, 1992 and Krugman, 1991). Here we seek to make precise this notion that domestic inflation and interest rates should be close to foreign rates in a target zone. In particular we show how 'closeness' may be used as a simple test of the credibility of an exchange rate regime.

Using the theories of purchasing power and interest rate parity we define limits around foreign inflation and interest rates that are consistent with the exchange rate regime. Our simple tests involve comparing the actual domestic rates to target zones around foreign inflation and interest rates. We have stylized Ireland's exchange rate regime as being a target zone vis-a-vis the Deutsche Mark (DM).⁴

¹One of the factors underlying Ireland's decision to join the EMS, according to the Governor of the Irish Central Bank, was 'the benefits in terms of a reduction in inflation to be obtained from adherence to a hard currency regime' (Murray, 1979). Stressing the importance of adopting 'sensible domestic policies' the Governor believed that the rate of price inflation would decelerate rapidly towards the lower levels common in other EEC countries.

²Walsh (1983), reviewing the first two years of EMS membership, showed that the small open economy view of inflation did not hold in Ireland. Later studies, including those by Thom (1989) and Leddin (1988), more formally reject the hypothesis of purchasing power parity and thus implicitly the small open economy view of inflation.

³During the 1970s a number of studies showed that domestic (Irish) price inflation was determined by world inflation, in particular UK inflation (Geary, 1976 and Geary and McCarthy, 1976).

⁴Giavazzi and Giovannini (1989) suggest that the ERM has effectively worked as a DM zone.

Under the rules of the ERM, bilateral exchange rates are restricted above and below by intervention limits.⁵ If no changes in the central rate are expected these limits form well-defined bounds on the expected rate of change of the exchange rate. Restrictions on exchange rate movements limit the degree of price change, hence bands can be derived around foreign inflation. The first test of credibility then is to see whether the domestic inflation rate falls within the bands around foreign inflation. If the domestic inflation rate falls outside the bands under the maintained assumptions of relative purchasing power parity (PPP) and no expected realignments then the exchange rate regime is not credible. A similar test can be derived using interest rates, given uncovered interest parity and limits on exchange rate movements. In this case if the domestic interest rate is outside the bands around the foreign rates the policy adopted is not credible.

Sections II and III of the paper include a more detailed analysis of these simple credibility tests based on inflation and interest rates. Using simple non-parametric methods we apply these tests to Irish and German data for the period 1979–92.⁶ Concluding comments discuss the effect of sterling on the Irish/DM target zone.

II CREDIBILITY TEST INFLATION

The small open economy view of inflation suggests that home inflation is determined by foreign inflation and the expected rate of change of the exchange rate. Equation 1 describes this relationship

$$\pi = \pi^* + \dot{s} \quad (1)$$

where π is the domestic inflation rate, π^* the foreign inflation rate and \dot{s} is the expected rate of change of the exchange rate. Within the ERM bilateral exchange rates are bounded above (\bar{s}) and below (\underline{s}) by intervention limits

$$s \leq \bar{s} \leq \underline{s} \quad (2)$$

Equation 2 implies there are well-defined limits on the size of a depreciation or appreciation of the domestic currency, provided a realignment is not expected. These bounds on the exchange rate under assumptions detailed below suggest similar bounds on inflation differentials.

To derive the bounds on inflation some assumptions have to be made. First, the ERM is completely 'credible', agents assume the cross parities announced first day will remain in force forever and also that when a realignment occurs, the new cross parity is assumed to last forever. Secondly, relative purchasing power parity is believed to hold and finally agents form expectations of foreign inflation which are correct on average. These assumptions imply that expected

Irish inflation is equivalent to German inflation adjusted for the ERM implicit inflation bounds. More formally these assumptions give the following

$$E(\pi) = \pi^* \quad (3A)$$

$$E(\pi) = \pi^* - \pi \quad (3B)$$

where E is the expectations operator and π_+ and π_- are the ERM implicit inflation bounds. Equations 3A and 3B imply that, if expectations of domestic inflation are correct on average, domestic inflation should lie within the bounds around foreign inflation. The bounds can be calculated with reference to the limits on possible exchange rate movements. Letting π denote Irish inflation and π^* be German inflation, Equation 3 suggests that Irish inflation should be close to German inflation given the limits on the £IR/DM exchange rate. For the period under analysis the margin of fluctuation permissible for the Irish pound around the DM was 2.275% above and 2.225% below the central bilateral cross parity rate.

To clarify the procedure adopted, suppose the start of period spot exchange rate, intervention limits and German Consumer Price Index (CPI) - both start and end of period - are as follows

Spot exchange rate £1 = 3 DM

Upper intervention limit £1 = 3.07 DM

Lower intervention limit £1 = 2.93 DM

German CPI (start of period) = 100

German CPI (end of period) = 104

At the start of the period the purchasing power of 100 DM in Ireland is £33.33. The purchasing power of 104 DM then depends upon what has happened to the exchange rate during the period. To calculate the limiting possibilities (i.e. the upper and lower limits on German CPI defined in Irish pound terms) we divide the German CPI by the upper and lower intervention limits. They are as follows

(1) If the exchange rate moves to its *upper limit*, 104 DM will buy the same as £33.88, the *lower inflation limit* is

$$\ln(33.88) - \ln(33.33) = 0.016 = 1.6\%$$

(2) If the exchange rate moves to its *lower limit*, 104 DM will buy the same as £35.49, the *upper inflation limit* is

$$\ln(35.49) - \ln(33.33) = 0.063 = 6.3\%$$

This implies that expected Irish inflation should be between 1.6% and 6.3% if a German inflation rate of approximately 4% is expected and the intervention limits are assumed unbreachable.

If a realignment occurs during the period, the intervention limits will change. In our formulation this would have an

⁵Honohan (1979) gives a guide to the arithmetic of the ERM.

⁶We would like to thank an anonymous referee for suggesting this approach.

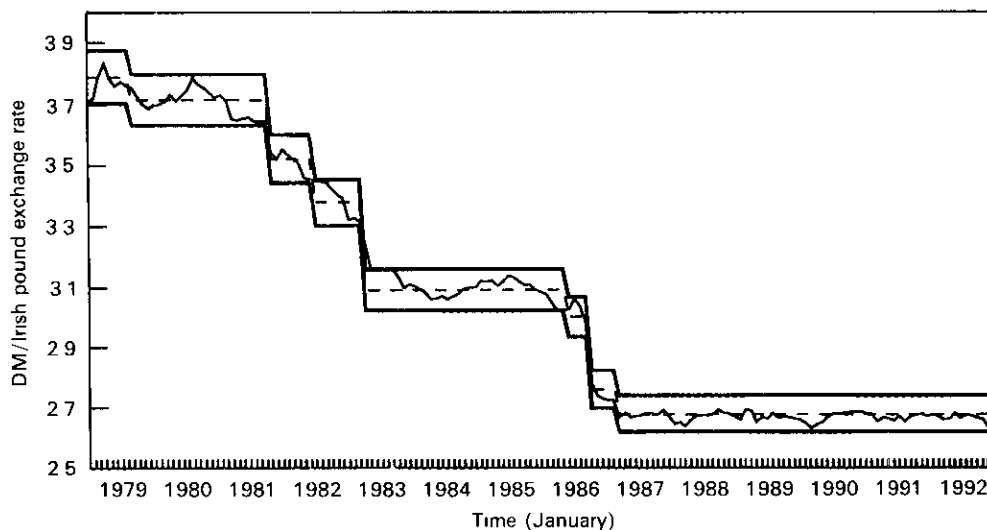


Fig 1 *DM/Irish pound exchange rate (including EMS intervention limits), (—) DM/Irish pound rate, (---) central parity rate, (—) upper limit, (—) lower limit*

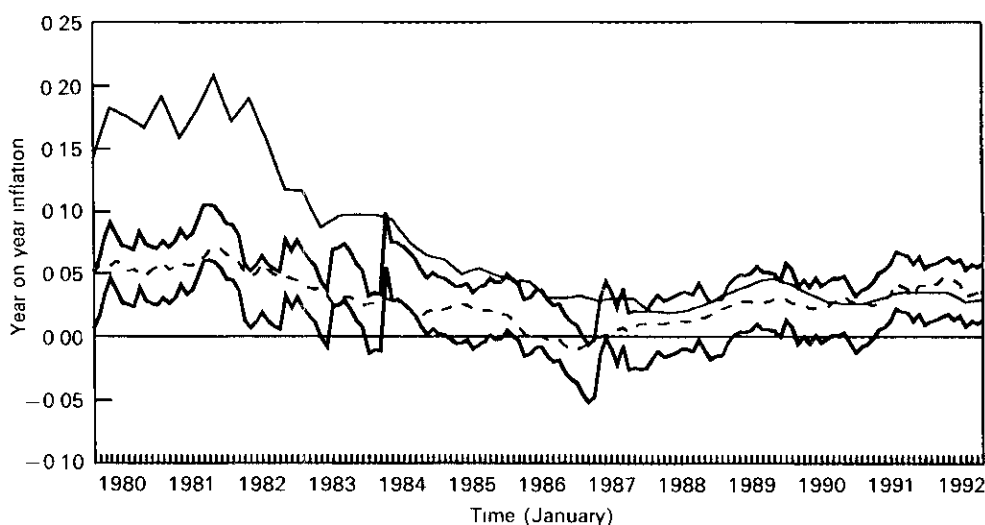


Fig 2 *Irish and German inflation (including EMS implicit inflation limits), (---) German inflation, (—) Irish inflation, (—) upper limit, (—) lower limit*

effect only when the next period's expectations are being formed. The change in the central cross parity rate means that the inflation bounds will be different even if the same foreign inflation is expected.

In summary, the inflation bounds around foreign inflation depend upon the nominal start of period exchange rate, the central cross parity rate and the amount of exchange rate fluctuations allowed under the ERM rules. Figure 1 shows the nominal DM/£IR exchange rate, the central cross parity

rate between the Irish pound and the DM plus the upper and lower intervention limits.

The inflation bounds calculated using this procedure, for data from 1980 to 1992, are shown in Fig 2.⁷ Between 1980 and 1987 Irish inflation was above the upper bound. Since then however it has been within the PPP consistent limits around German inflation. The fact that Irish inflation was outside the upper limit initially implies that either PPP did not hold or the exchange rate policy adopted by the

⁷Calculating the inflation rate from the CPI meant that we lost 12 observations, hence the start date of January 1980.

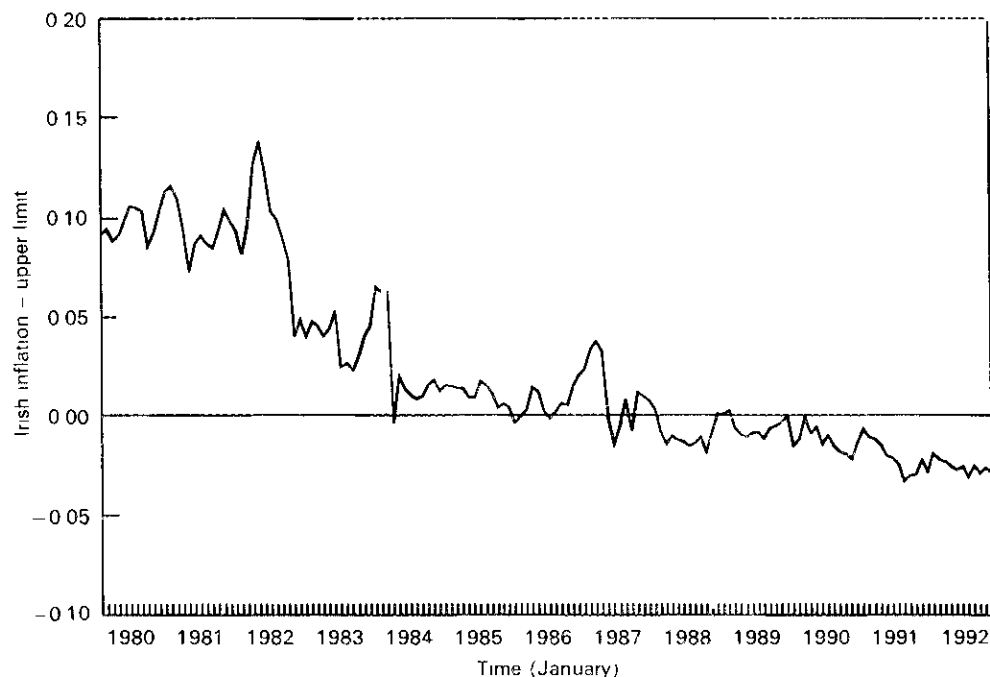


Fig 3 Excess inflation

government was not credible. Our findings suggest that up to 1987 the ERM was not a tightly binding constraint on inflation. Under the maintained assumptions of static expectations and relative PPP, Irish inflation during the 1980s was not consistent with a credible exchange rate regime.

Excess inflation is defined as the difference between actual Irish inflation and the upper limit. Prior to 1987 the value of excess inflation was mainly greater than zero (Fig 3). The distance between excess inflation and the horizontal line at zero is a measure of the credibility gap. If inflation falls outside the limits, given our assumptions, exchange rate policy is not credible.⁸ Svensson (1991) describes this type of credibility test as 'one-sided, simple and robust'.

We then proceeded to check our graphical results using a simple non-parametric sign test. This test enables us to identify whether two sets of data are centred differently, in this context whether the Irish inflation rate has a statistically different mean to our calculated upper limit around German inflation. We performed the test using the complete data set and the three subsamples of the ERM identified by Gros and Thygesen (1992). The periods are as follows:

- (i) the initial learning period, to February 1983
- (ii) the intermediate period, to January 1987
- (iii) the period of stability, to October 1992

Our results, reported in Table 1, show that for the complete

Table 1 Sign test - inflation, $H_0: P=0.5$, $H_1: P>0.5$

Time period	Sample size	% Outside band	Probability
1980 1-1992 10	154	59	$P=0.012^*$
1980 1-1983 2	38	100	$P=0.000^*$
1983 3-1987 1	47	91.5	$P=0.000^*$
1987 2-1992 10	69	14.5	$P=1.000^{**}$

* reject H_0 , fail to reject H_1

** reject H_0 , reject H_1

data set the mean Irish inflation rate is significantly greater than the upper limit around German inflation. For the first two sample periods almost all Irish data points were above the upper limit. Finally, as is clear from Fig 2, significantly more than half the data points in the final period were inside the band. This confirms the result of lack of credibility in the early years of the EMS.

III CREDIBILITY TEST INTEREST RATES

Svensson (1991) adopts a similar approach to examine the credibility of a target zone, focusing on interest rate differentials. Deriving 'rate-of-return bands' around the foreign

⁸In an earlier draft of this paper, we attempted to explain our excess inflation variable by looking for cointegration with other Irish variables. Details of these results, which were not very illuminating, are available on request.

interest rates (the bands are implied by limits on the size of an appreciation or depreciation of the exchange rate) he tests whether the domestic rates are inside or outside the bands. If the domestic interest rates fall outside the bands, Svensson concludes the target zone is not credible, if they fall within the bands, the test is inconclusive. Hence, the test of credibility is 'one-sided' ⁹

To derive the rate of return bands it is assumed that capital is mobile internationally, hence no arbitrage possibilities remain.

The domestic currency annualized rate of return on a foreign currency investment is equal to

$$R_t^\tau = (1 + i_t^{*\tau})(S_{t+\tau}/S_t)^{12/\tau} - 1 \quad (4)$$

where S_t is the spot exchange rate in period t (the domestic currency per unit of foreign currency), i_t^τ is the domestic interest rate in period t for term τ (τ are months) and $i_t^{*\tau}$ is the foreign interest rate for the same period and term. Equation 4, which is the annualized rate of return in domestic currency suggests that investing one unit of domestic currency is equivalent to investing $1/S_t$ units of foreign currency. The return, when invested for τ months is $[(1 + i_t^{*\tau})^{12/\tau}]/S_t$ and converted to domestic currency is $[(1 + i_t^{*\tau})^{12/\tau} * S_{t+\tau}]/S_t$.

Given Equation 2, the lower and upper rate of return bands are as follows

$$\underline{R}_t^\tau = (1 + i_t^{*\tau})(\underline{S}/S_t)^{12/\tau} - 1 \quad (5A)$$

$$\bar{R}_t^\tau = (1 + i_t^{*\tau})(\bar{S}/S_t)^{12/\tau} - 1 \quad (5B)$$

Similar to the first test of credibility we take Ireland as the domestic country and Germany as the foreign country.

However, before looking at whether the Irish interest rate falls within the bounds around the German rate an example helps clarify the procedure used to derive the bands. At the start of the period suppose

Spot exchange rate £1 = 3 DM

Upper intervention limit £1 = 3.07 DM

Lower intervention limit £1 = 2.93 DM

hence investing £100 is equivalent to investing 300 DM in Germany. If this money is invested for three months at an interest rate of 9.35% the return on the investment is equal to

$$\frac{(1 + 0.0935)^{0.25}}{0.33} * 100 = 309.88 \text{ DM}$$

Converting this into Irish pounds, if the exchange rate moves to its upper limit this is equivalent to £100.94, if it moves to its lower limit this is worth £105.76. Therefore the return on the investment is between 0.94% ($\ln 100.94 - \ln 100$) and 5.6% ($\ln 105.76 - \ln 100$). Calculating the annualized rate of return, the Irish interest rate should lie somewhere outside the range of 3.76% and 22.4% to reject the null hypothesis of credibility.

Note, the rate of return bands tend to be quite wide for short-term interest rates, since the probability of short-run exchange rate movements to the edges of the band are much less likely than in the long run. Therefore, it is possible that the short-term rate may be within the band but the risk of devaluation may still exist. For longer terms the rate of return bands are narrower and the width diminishes since

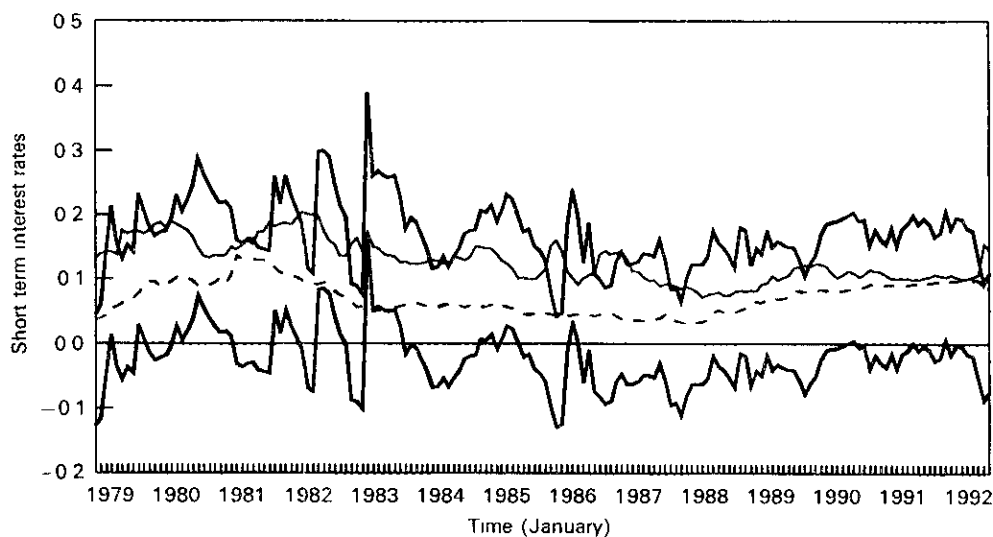


Fig 4 Irish and German short term interest rate (including EMS implicit interest rate limits), (- -) German interbank rate, (- - -) Irish interbank rate, (—) upper limit, (—) lower limit

⁹Svensson (1991, p 664) details the one-sided nature of these tests

Table 2 *Sign test – interest rates, H₀ P=0.5, H₁ P>0.5*

Time period	Sample size	% Outside band	Probability
1979 1–1992 10	166	23	P=1.000**
1979 1–1983 2	50	36	P=0.976**
1983 3–1987 1	47	26	P=1.000**
1987 2–1992 10	69	10	P=1.000**

** reject H₀, reject H₁

the maximum amount of adjustment per unit decreases over the term¹⁰

In summary, the domestic interest rate must fall within the lower and upper bands if the exchange rate regime is credible and the no arbitrage assumption holds. If the domestic rate is outside the bands profit opportunities exist or some change in the central parity rate is expected. More specifically if the domestic interest rate is above the band, an agent can make a profit by borrowing abroad and lending at home, i.e. arbitrage opportunities exist. If it is below the band profits can be made by borrowing at home and lending abroad. Either situation is not consistent with equilibrium in the world capital market, and suggests lack of credibility in the exchange rate regime.

Using the three-month interbank rate as a representative of short-term rates, Fig. 4 shows the rate of return bands for the three-month term plus the domestic and foreign interest rates. From Fig. 4, it can be seen that between 1979 and 1987 the Irish short-term interest rate jumped in and out of the rate of return band quite frequently. However, from then up until the beginning of the recent 'currency crisis' (September 1992) Irish rates moved inside the upper band and towards rates prevailing in Germany. We confirmed these findings using the sign test as described above, these results are reported in Table 2.

IV CONCLUDING COMMENTS

Target zone credibility was tested by examining whether the domestic inflation rate and short-term interest rates fell outside exchange rate derived limits around foreign inflation and interest rates. The tests were applied to an Irish target zone vis-a-vis the DM. For inflation our findings are that the target zone lacked credibility from 1979 to 1987. The findings for the short-term interest rate are less conclusive, however, there appears to be a tendency towards increased credibility towards the end of the period.

Applying our credibility tests to a target zone vis-a-vis sterling revealed little. We suggest two reasons for this: first, given that sterling only joined the ERM in October 1990, we have only a limited number of observations for the target zone with an explicit band. Secondly, the bands around sterling were wider since sterling was not a member of the narrow-band currencies (its permitted band of fluctuation was 6%). However, recent studies by Honohan and Conroy (1992) and Walsh (1993) show that the sterling exchange rate and UK interest rates have continued to affect Irish interest rates despite our membership of the ERM.

Finally, we may relate events in the foreign exchange markets over the period September 1992 to January 1993 to our analysis here. This would suggest a lack of credibility in the exchange rate policy adopted by the Irish government. Their policy of trying to operate within two target zones, a formal zone vis-a-vis the DM and an informal zone vis-a-vis sterling, seemed possible while sterling was stable relative to the DM. However, when sterling weakened and left the ERM pressure mounted on the Irish pound. Such pressure resulted in the decline of foreign exchange reserves, a dramatic widening of the Irish–German interest rate differential, the fall in the pound to the bottom of the ERM band and the eventual devaluation of the pound by 10% in January 1993. Clearly foreign exchange markets viewed the level of sterling relative to the DM as having a significant effect on the DM/£IR exchange rate, the implicit sterling target zone and the explicit DM zone were no longer regarded as being compatible.

These observations would suggest two possible areas where further research may be fruitful. First, in the above situation the Irish government faced the difficulty of simultaneously trying to maintain two target zones. When sterling fell sharply against the DM, the intersection area between the two zones vanished, leaving the policy-makers with two distinct target zones but only one target variable. This case of a country attempting to trade-off between two, potentially contradictory, target zones needs to be more formally analysed.

Secondly, the idea of credibility could be usefully extended to include real economy variables, such as output and employment. In January 1993, when Ireland was forced to abandon its then central parity in the ERM, its inflation rate and government borrowing were both lower than Germany and it was also the only ERM country actually running a surplus on current account with Germany. Yet clearly these factors were not sufficient to convince foreign exchange markets that Ireland's parity was credible. It is our belief that other factors such as competitiveness and employment should also be included in a broader analysis of credibility and target zone modelling.¹¹

¹⁰We also examined long-term interest rates, using rates on Government bonds of 60 months or over. In this case the bands were extremely narrow, and Irish rates were consistently above the upper limit except for the final year of the sample.

¹¹This view is echoed by Walsh (1993).

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DATA APPENDIX

- Source: Central Bank of Ireland Bulletins
- End of period Irish pound/German mark exchange rate in the Dublin market
 - Central rates in the European Exchange Rate Mechanism
 - Three-month Irish interbank interest rate
 - Three-month Euro-DM interest rate
 - Irish Consumer Price Index
- Source: OECD Main Economic Indicators
- German Consumer Price Index
- All data is monthly with the exception of the Irish CPI which is only available on a quarterly basis. This index was interpolated for comparison purposes.

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