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Pricing to Market, Exchange Rate Changes and the Transmission of Inflation

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Abstract: This paper examines the short-run pass through of exchange rate changes to consumer prices in Ireland. Reflecting the importance of exchange rate expectations, we develop a model of inflation where the deviation of the UK price level from its equilibrium level affects the rate of pass through of external shocks into Irish inflation. This model explains better the behaviour of the Irish rate of inflation in the 1990s and it indicates a reduction in the speed of adjustment of prices to their equilibrium after the ERM crisis.

I INTRODUCTION

The focus of much of the research into the determinants of Irish inflation has concentrated on whether Purchasing Power Parity (PPP) does or does not hold. The results of this research suggest that PPP probably does hold in the long run but that the long run can be quite long. It is clear that short-run changes in the exchange rate do not have an immediate effect on the rate of inflation in consumer prices in Ireland and the deviations from PPP can be quite large and sustained for some considerable time. This paper concentrates on the factors driving consumer price inflation in the short run in Ireland.

If markets were perfectly competitive then price would be equal to marginal cost and any change in the marginal cost of supplying a good in a particular country would be passed through as a rise in the price. However, there is clear evidence that pass-through of exchange rate changes is not instantaneous (see

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Hooper and Mann (1989), for the US; Menon (1996), for Australia; and Kenny and McGettigan (1997), for Ireland; Goldberg and Knetter (1997), review the evidence for all countries).

For many of the individual goods and services bought by consumers the markets are better characterised as being imperfectly competitive. In equilibrium, firms are likely to charge a price that is above marginal cost, with the mark-up being a function of the elasticity of demand in individual markets. Under these circumstances individual firms may pass through less than the full amount of any change in exchange rates, with a consequential change in the margin. In a fully integrated market the possibility of arbitrage prevents firms from discriminating between different countries to maximise profits. However, where firms are able to discriminate between markets, producers will maximise profits by charging different prices in each market. Under these circumstances there is a real possibility that some of the effects of a change in exchange rates may not be fully passed through in the short run.

Pricing to market is a well-established phenomenon (Krugman, 1987) and there is evidence of its importance in explaining price changes in other small open economies (Naug and Nymoen, 1996). There are a range of possible models which might explain the behaviour of firms under these circumstances. Venables (1990), develops a model where, because of sunk costs in entering a market (marketing etc.), the option value of holding prices unchanged in a foreign market may outweigh the benefits from passing through the effects of a change in exchange rates. Where firms value the option of market access and where they are faced with an uncertain future exchange rate, the result is an extension of the range of exchange rates over which there will be no entry or exit and, hence, no change in prices. Delgado (1991) shows that even with quite small menu costs (fixed entry costs in this model), exchange rates may have to change by large amounts before prices might change. Dixit (1989) indicates that the greater the exchange rate volatility, the more valuable the entry and exit options and, therefore, the less likely they are to be exercised. Because this uncertainty about the future is much greater for exchange rate changes than for changes in other costs, it is to be expected that prices will react more slowly to changes in exchange rates than to changes in foreign country costs.

Froot and Klemperer (1989), model firms as targeting market share and the return a firm expects to make on its investment in market share is sensitive to the expected future exchange rate. When the price in the domestic market is expected to remain permanently higher, foreign firms may price more aggresively to gain market share, while expectations that the real appreciation is temporary can have the opposite effect.

These models of firm behaviour provide a basis for explaining why the rate of pass through of exchange rate changes into domestic prices may differ from

that of foreign costs. What makes the Irish case unusual is the extent of integration of its retail sector with that of the United Kingdom. Many of the retailers in Ireland are branches of UK chains and many of the goods sold by Irish retailers are sourced in the UK. With the growing integration of retail chains in Europe it is likely that this pattern of behaviour may be extended throughout the EU. The implication of this for firms was early recognised in Smith and Venables (1988); with monetary union the ability to operate a differentiated pricing policy between different markets may be significantly reduced putting downward pressure on profitability and consumer prices.

While there was a fixed relationship between the Irish pound and sterling up to 1979, there was evidence that the Irish rate of inflation was externally determined by developments in the UK and that Irish prices adjusted quite rapidly to price changes there (Geary and McCarthy, 1976, and Bradley, 1977).[1] While the retail sectors in the two jurisdictions were much less integrated than they are today, with effective monetary union between Ireland and the UK, the pass-through of price changes was not affected by any uncertainty concerning the bilateral exchange rate.

With the breaking of the sterling link in the first quarter of 1979 the situation changed markedly. Models of the inflationary process for the years after 1979 show a more uncertain picture with much slower adjustment to external shocks, in particular to changes in the exchange rate (see, for example, O'Connell and Frain (1989), and Kenny and McGettigan (1997)). Callan and Fitz Gerald (1989) examined the pass-through of exchange rate changes into domestic output prices and found that, while PPP probably held, the pass-through of exchange rate changes was much slower than was the case for changes in foreign currency prices. They also found evidence of a change in regime in 1979, around the time of the break in the link with sterling when Ireland joined the EMS. Wright (1994), using output prices, also concluded that PPP held in the long run.

The advent of monetary union can also be expected to lead to a regime change. Part of the logic behind monetary union is that it will increase competitive pressures on firms throughout the Union and put downward pressure on prices (Emerson, 1988). Calmfors (1997) suggests just such an impact in Sweden if they were to join the Union. There is little micro-economic evidence available which could throw light on such an outcome. Within the Monetary Union itself there will obviously be no further exchange rate changes. However, for Ireland, the fact that the UK remains outside the Union will be important. This does not mean that the UK itself will be immune to the effects of the regime change; any increase in integration of the Union market may have consequential effects on

1. The evidence on the determinants of inflation in Ireland has been reviewed in Kenny and McGettigan, 1997.

the UK market. There could be a change in the speed of transmission of exchange rate shocks to the UK price level in the future. It may also affect the pricing policy of UK firms selling into the Union market. Whereas, before EMU, differentiation between markets in France and Germany, or between markets in the Netherlands and Ireland, may have been the norm, there may be a movement to a common euro price.

In Ireland much recent interest focused on why the rate of consumer price inflation remained low in the face of a substantial fall in the exchange rate against sterling in 1997 and, more recently in early 1998, against the DM. Does the unexpectedly slow adjustment to the fall in the exchange rate indicate that a change is already taking place in the transmission of inflation to Ireland (and possibly to Britain) with the onset of monetary union?

This paper focuses on the speed of adjustment of the domestic price level to changes in exchange rates in the short run, relying on the evidence from Wright (1994) and Kenny and McGettigan (1997) that PPP holds in the long run. Because of the importance of the UK as a source of Irish consumer goods, special attention is given to the effect of external shocks to the UK economy on the UK rate of inflation and on the pricing behaviour of UK firms on the Irish market. While exogenous to the Irish economy, the UK rate of inflation is itself affected by changes in the external price level and in the value of sterling. To understand the forces driving the rate of inflation in Ireland today it is necessary to model the adjustment process in Ireland jointly with that of the UK.

In modelling the inflationary process in Ireland we are interested in establishing:

- the pattern of adjustment in the short-run of Irish consumer prices to external shocks, especially to changes in the exchange rate;
- whether there is evidence that impending monetary union altered firms' pricing behaviour;
- the implications for long-run exchange rate parities.

Section III of this paper estimates the model of price determination for consumer prices in Ireland. Section IV considers the implications of these results and conclusions are set out in Section V.

II MODELLING PRICE DETERMINATION

Firms supplying the Irish market are forward looking. As a result (and because of the significant costs of market entry), foreign firms, in setting Irish pound prices, may be expected to react differently to changes in the exchange rate than to changes in their domestic costs. Any model of price determination on the Irish market must take account of the deviation of British prices from what

firms perceive to be their long-run level. This means that we need to model Irish prices jointly with British prices.

In our model we see UK manufacturers selling into EU markets, including Ireland, choosing their price in Irish pounds (and DMs etc.) conditional on their domestic costs, the current value of the bilateral exchange rate, and its expected future value. For temporary changes in the value of sterling against all other currencies, it is likely that they will not fully pass through the effects of the change into foreign (including Irish pound) prices.[2] However, if their competitors are other EU firms, where the Irish pound changes against all other currencies, there may be lower costs to changing their Irish pound price (because their competitors face the same pressures) and, as a result, a more rapid pass through.

Most models of British consumer prices use some sort of purchasing power parity relationship augmented in the short run by variables such as the unemployment rate, the level of capacity utilisation or interest rates (see, for example, Johansen and Juselius (1992), or Henry, Nixon and Williams (1997), and Greenslade *et al.* (1998)). Greenslade's conclusion that, for a vector autoregressive system of domestic (British) prices, wages and import prices, each dependent variable is subject to only one long-run relationship (i.e., that there is only one cointegrating vector in each equation) is quite useful in this regard. It means that for our purposes we need only estimate a reduced form of the three vectors, (i.e., consumer prices as a function of world prices and the effective exchange rate) independent of changes in UK import prices or wages.

We use initially the methodology suggested by Johansen (1988), and Johansen and Juselius (1990) to identify the long-run relationships in a system of Irish prices, British prices and the bilateral exchange rate. We hope to identify two cointegrating relationships, one confirming purchasing power parity between Irish and British prices and another between British prices and their long-run determinants. Ideally, we would like to build up a full vector-error correction model, but since most available evidence suggest deviations from purchasing power parity may be sustained for a considerable time, the limited number of observations in the post-EMS period (1979 onwards) suggests an alternative approach.

Having identified the long-run relationships we consider the error-correction equation in Irish prices. This imposes weak exogeneity upon the exchange rate and it does not allow for feedback effects on British prices caused by sterling misalignment. In interpreting the results it is important to take acccount of this restriction: our model can not be used to evaluate the full effects on Irish

2. The Froot and Klemperer (1989) model allows the possibility that under certain circumstances a rise in the external value of the Irish pound could actually see a rise in Irish pound prices. However, as evidenced by our results, this has not been the case for Ireland in the period examined.

prices of a change in sterling against all other currencies. A full model of the UK price level would be needed to undertake this task.

Data

Data for the UK come from the OECD and the Office for National Statistics' *Economic Trends*. Irish data come from the Central Statistics Office Databank. Both data-sets run from 1979Q1 to 1997Q4. In this study we are examining consumer price inflation in the post-EMS period. We use the Irish constant-tax price index (the consumer price index (CPI) adjusted for changes in indirect taxes). Although there is no British analogue over the requisite period, the rate of indirect taxation has remained relatively constant in the UK since the early 1980s.

Estimation

The first step is to estimate a vector autoregressive system in terms of P^{IR}, p^{UK} and e (as well as exogenous variables, p^{W}, world prices, and e^{UK} the UK effective exchange rate) over a suitably long lag length (nine quarters in this case) and detect the number of cointegrating vectors. Both the maximal eigenvalue statistic and the trace test suggest that the cointegrating space can indeed be spanned by two vectors (Tables 1 and 2 respectively).

Table 1: *Maximal Eigenvalue Test of Number of Cointegrating Vectors*

Null Hypothesis	*Alternative*	*Statistic*	*95 Per Cent Critical Value*	*90 Per Cent Critical Value*
$r = 0$	$r = 1$	58.2	**24.5**	22.2
$r \leq 1$	$r = 2$	26.2	**18.1**	16.0
$r \leq 2$	$r = 3$	8.7	11.4	9.5

Table 2: *Trace Test of Number of Cointegrating Vectors*

Null Hypothesis	*Alternative*	*Statistic*	*95 Per Cent Critical Value*	*90 Per Cent Critical Value*
$r = 0$	$r = 1$	94.2	39.4	36.2
$r \leq 1$	$r = 2$	35.9	**23.4**	20.9
$r \leq 2$	$r = 3$	8.7	11.4	9.5

The next step is to impose just-identifying restrictions on each of the vectors and then to test over-identifying restrictions to see if they can be identified in terms of two purchasing power parity relationships. Table 3 shows the vectors

subject to the just-identifying restrictions: that the first vector is normalised around Irish prices and that world prices have no effect; and that the second is normalised around British prices and is independent of Irish prices.

Table 3: *Cointegrating Vectors Subject to Just-Identifying Restrictions (Standard Errors in Brackets Where Appropriate)*

	Vector 1		*Vector 2*	
p^{IR}	1.00		1.00	
p^{UK}	–1.04	(0.012)	1.00	
e	–1.05	(0.267)	–0.93	(0.312)
e^{UK}	–0.43	(0.473)	2.31	(0.524)
p^{W}	0.00		–1.01	(0.014)

Further restrictions to produce the two purchasing power parity relationships were imposed subject to each restriction passing a likelihood ratio test.[3] All were accepted except for the restriction that the coefficient on the bilateral exchange rate is zero in the second vector. It seems highly unlikely that the Irish pound-sterling exchange rate should have any effect on the long-run relationship for British prices and what this may be picking up is the high level of (negative) collinearity between the bilateral exchange rate and the UK effective exchange rate. Indeed the restriction that the sum of the two coefficients is equal to unity is not rejected. We feel confident therefore that expressing the two vectors as the following purchasing power parity relationships is justified.[4]

$$p^{IR} - e - p^{UK}, \tag{1}$$

and

$$p^{UK} - p^{UK*} \tag{2}$$

Having established long-run relationships for Ireland and the UK we are now in a position to estimate the full error-correction model, conditional on the bilateral exchange rate and British prices being weakly exogenous. With the variables expressed in logarithms and excluding seasonal dummies, this takes the following form:

3. Test statistics are available on request from the authors.

4. With the restriction, discussed above, the UK relationship was estimated in the form $p^{UK*} = b_0 + b_1 (p^{W} - e^{UK})$. Where b_0 is –0.294 with T-statistic of –2.1 and b_1 is 1.048 with T-statistic of 33.0.

$$\Delta p_t^{IR} = \beta_0 + \sum_{i=1}^{k}\beta_{1i}\Delta p_{t-i}^{IR} + \sum_{i=0}^{k}\beta_{2i}\Delta p_{t-i}^{UK} + \sum_{i=0}^{k}\beta_{3i}\Delta e_{t-i} + \sum_{i=0}^{k}\beta_{4i}\Delta p_{t-i}^{UK*} \quad (3)$$
$$+\gamma_1(p^{IR} - e - p^{UK} + 1)_{t-k-1} + \gamma_2(p^{UK} - p^{UK*})_{t-k-1} + u_t$$

This ECM model (3) explains the observed change in Irish prices, Δp^{IR}, by three factors: observed changes in the short-run independent variables, adjustment towards the two long-run equilibrium relationships in British and Irish prices and a random component.

$\sum_{i=0}^{k}\beta_{2i}$ gives the short-run adjustment to changes in actual British prices, Δp^{UK}, while $\sum_{i=0}^{k}\beta_{4i}$ gives the adjustment to changes in the long-run British price level, Δp^{UK*}. If the change in British prices is not a unilateral deviation from its trend level, the short-run effect of a price change is equal to the sum of the coefficients on both Δp^{UK} and Δp^{UK*}. The short-run effects of changes in the exchange rate (sterling per Irish pound), Δe are captured by $\sum_{i=0}^{k}\beta_{3i}$. However, the long run British price level, p^{UK*}, is a function of both world prices and the UK effective exchange rate. If a change in the exchange rate is not justified by a change in world prices (i.e., if sterling is misaligned), the effects of this change on Irish prices will be moderated by a change in the long-run British price level of opposite sign. Thus the coefficients $\sum_{i=0}^{k}\beta_{3i}$ will be moderated by $\sum_{i=0}^{k}\beta_{4i}$. In a similar fashion, γ_1, which captures the residual adjustment to the long-run PPP relationship, after the short-run effects of a price or exchange rate-change have been worked through, is counteracted by γ_2, the coefficient on the equilibrium British relationship, if such changes are unilateral.

Initial estimation over the period 1979Q1 to 1997Q4 suggested a structural break in 1993.[5] The effect of the ERM crisis at that time was to greatly increase uncertainty about the future path of the exchange rate after 1993 compared to the immediately preceding years. Dixit (1989) shows that the effect of increased exchange rate uncertainty is to increase the option value of delaying price changes. Thus it might be expected that the speed of adjustment of prices to exchange rate changes slowed as a result of the developments in late 1992 and early 1993. To test this possibility we re-estimated the model, this time including a dummy variable for the post 1993Q1 period (Equation (4)).

We also tested whether the addition of German consumer prices to the model would add to its explanatory power. However, they did not materially alter the results. The results of estimating Equation 4 are shown in Table 4, below.

5. Initial estimates are available on request from the authors.

$$\Delta p_t^{IR} = \beta_0 + \beta_{11}\Delta p_{t-1}^{IR} + \beta_{20}\Delta p_t^{UK} + \sum_{i=0}^{6}\beta_{3i}\Delta e_{t-i} + \sum_{i=0}^{6}\beta_{4i}\Delta p_{t-i}^{UK*} + \gamma_1(p^{IR} - e - p^{UK} + 1)_{t-7} + \gamma_2(p^{UK} - p^{UK*})_{t-7} + \delta_1 d^{93} + u_t \quad (4)$$

Table 4: *Results of Estimation of Error-Correction Model*

	Coefficient	*T-Ratio*	*P-Value*		*Coefficient*	*T-Ratio*	*P-Value*
β_0	0.056	3.410	0.001	β_{40}	0.080	3.233	0.002
β_{11}	0.169	1.447	0.154	β_{41}	0.048	1.609	0.114
β_{20}	0.233	3.137	0.003	β_{42}	0.064	2.248	0.029
β_{30}	0.057	2.265	0.028	β_{43}	0.071	2.850	0.006
β_{31}	0.066	2.124	0.031	β_{44}	0.002	0.076	0.940
β_{32}	0.074	2.520	0.015	β_{45}	0.033	1.234	0.223
β_{33}	0.093	3.374	0.001	β_{46}	0.058	2.176	0.034
β_{34}	0.021	0.686	0.496	γ_1	-0.055	-3.587	0.001
β_{35}	0.035	1.292	0.202	γ_2	-0.065	-3.891	0.000
β_{36}	0.080	2.996	0.004	δ_1	-0.005	-2.875	0.006

$R^2 = 0.91$. Standard Error = 0.0043

Lagrange Multiplier Test for Serial Correlation: Chi-Sq. (12) = 17.22 (0.142); F (12, 41) = 1.001 (0.465)

RESET Test of Functional Form: Chi-Sq. (1) = 4.43 (0.035); F (1, 52) = 3.22 (0.079)

ARCH: Chi-Sq.(12) = 4.36 (0.976); F (12, 41) = 0.21 (0.997)

The dummy variable is significant even at the 1 per cent level. It is also correctly signed: it moderates the pass-through of price changes after 1993. The results of the model are also consistent with our hypothesis. When British prices are at their equilibrium level, $p^{UK} = p^{UK*}$, the effect of change in the UK price level on Irish prices is equal to the sum of the coefficients on both Δp^{UK} and Δp^{UK*}. Over 30 per cent of the effect of a change in the UK price level is passed through to Irish prices after the first quarter and, when one takes account of the effect of the lagged dependent variable, a further 40 per cent is passed through within two years:

$$\frac{\beta_{20} + \sum_{i=0}^{6}\beta_{4i}}{1-\beta_{11}} = 0.71 \quad (5)$$

In contrast, changes in the bilateral exchange rate are passed through to Irish prices much more slowly. Only 51 per cent of a change is passed on within two years if such a change is consistent with the UK's long-run equilibrium:

$$\frac{\sum_{i=0}^{6}\beta_{3i}}{1-\beta_{11}} = 0.51 \tag{6}$$

If, however, such a change in the exchange rate represents a departure from the UK's long-run relationship, the negative sign on the UK effective exchange rate counteracts the effects of a change in sterling on Irish prices. In other words, the coefficients on the change in the bilateral exchange rate are moderated by the coefficients on the change in the long-run level of UK prices and there is only a negligible impact by the end of the second year:[6]

$$\frac{\sum_{i=0}^{6}(\beta_{3i}-\beta_{4i})}{1-\beta_{11}} = 0.08 \tag{7}$$

This mechanism captures the expectation by UK firms selling into the Irish market that the deviation from trend will eventually be unwound, so that the option value of holding Irish pound prices unchanged is worth more than the value of exercising that option.

The coefficients on the long-run relationships increased, both in significance and magnitude compared to the estimation without the dummy: after the sixth quarter, any remaining gap between Irish and British prices is closed at a rate of 5.5 per cent per quarter when the British price level is in equilibrium. If the UK price level is at variance to its long-run trend level, however, the effect of any remaining Irish deviation from purchasing power parity, is almost exactly counteracted by the UK's deviation from its long-run level. The two coefficients on the long-run relationships, γ_1 and γ_2, cancel each other out and there is no further convergence. This corresponds with the implications of Greenslade *et al.*'s (1998) results that, in the long-run, adjustment in the UK to the equilibrium price level occurs more through exchange rate changes than through prices changes.

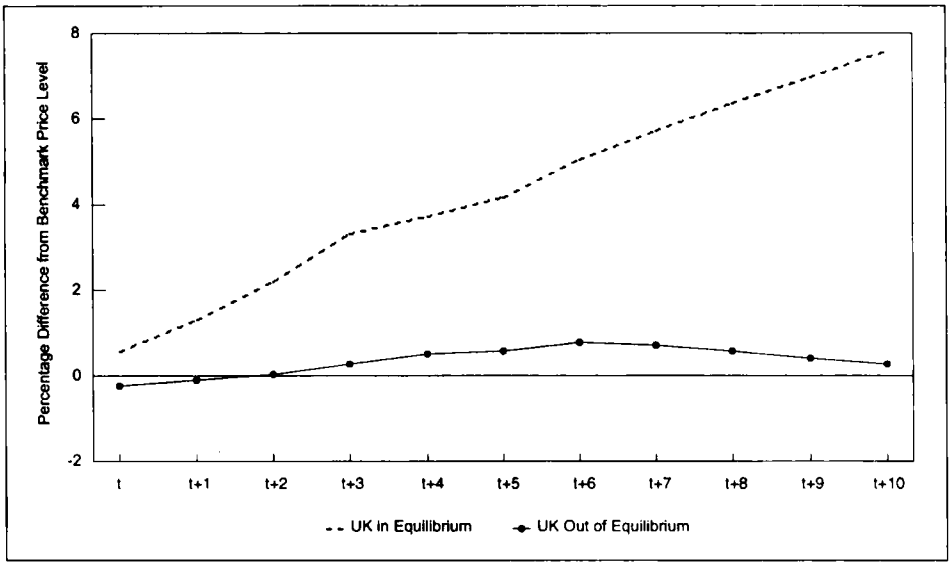
6. This does not take into account the effects of possible changes in British prices caused by the misalignment of sterling.

III IMPLICATIONS

Irish Constant-Tax Price Inflation

Figure 1 shows an example of how changes in the exchange rate are passed through to Irish inflation.[7] For a 10 per cent appreciation in the value of sterling *vis-à-vis* the Irish pound the rate of pass-through differs depending on whether or not UK prices are in equilibrium.

Figure 1: *Effects of a 10 per cent Sterling Appreciation on Irish Prices*



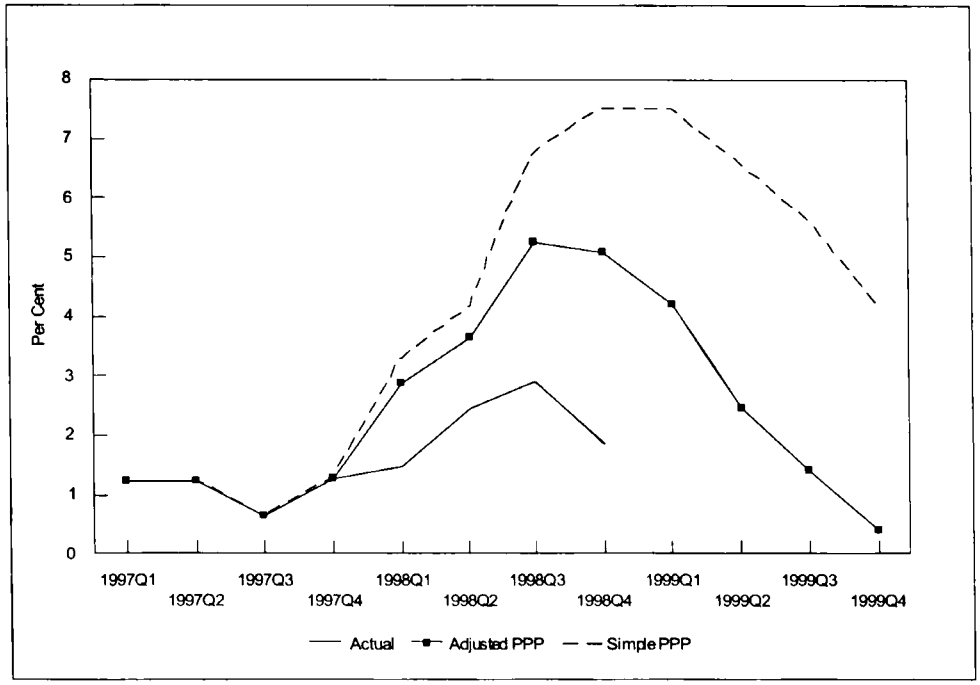
If the appreciation of sterling means that the price level is now out of equilibrium, UK firms, expecting this to be a temporary phenomenon, are much slower to pass through this change to the Irish market than if the appreciation represents a change in the long-run relationship.

Figure 2 considers the forecasting power of this model in the present situation. It contrasts the forecasts produced by the model from 1998Q1 to 1999Q4 with those produced by a simple PPP model between Ireland and Britain which takes no account of the position of the UK price level relative to its equilibrium level.[8]

7. This analysis can not take account of the effect of UK misalignment on UK prices.

8. We take our forecasts for the UK from the National Institute of Economic and Social Research's NiGEM model (NIESR, 1997).

Figure 2: *Forecasts of Irish Constant Tax Price Inflation*



As one would expect, the significant appreciation in sterling in 1997-98 feeds through fully into the simple PPP model, an inflation rate of almost 8 per cent being predicted by the end of 1998. The adjusted PPP model, which allows for the fact that the UK exchange rate in 1998 was not expected to persist produces forecasts which are much lower. It takes account of the UK's position compared to its equilibrium price level.

Both, however, give significantly higher predictions for 1998 than was actually the case. The Irish pound fell against both sterling and the Deutschmark during this period, so much of the change in the exchange rate was not counteracted by an increased deviation of UK prices from trend, resulting in a prediction of accelerating inflation. This over-prediction may be evidence that a regime change is under way as more and more British firms begin to price in euros, or it could be that the fall against the Deutschmark was fully discounted as expectations hardened regarding Ireland's commitment to economic and monetary union.

Equilibrium Exchange Rates

One widely used measure of a sustainable real exchange rate is the concept of the Fundamental Equilibrium Exchange Rate (FEER) (Williamson, 1991). This is defined as the exchange rate which is consistent with external balance as well as internal equilibrium. In this sense it is the rate which should be sustainable in the long run, given the structure of the economy and the current values of the other exogenous variables in the model. In calculating the FEER for a country, knowledge is needed of the key relationships determining the external balance — the elasticities of demand for imports and exports — as well as the factors determining internal balance. The NiGEM model of the National Institute of Economic and Social Research (NIESR) can be used to determine the FEER for the UK or other countries. In using such a world model it is possible to simultaneously calculate FEERs for all countries so that they are mutually consistent, representing the appropriate combination of rates that would simultaneously leave all economies in long-term equilibrium. However, this approach is quite complex requiring an (albeit small) model of the UK and other economies.

Using this approach Barrell and Pain (1998) suggested that in mid-1998 a rate of exchange for sterling equivalent to DM2.40 to DM2.60 per pound would have constituted the FEER for the UK. While Barrell and Pain consider that some long-term improvements in the performance of the UK economy might suggest that a slightly higher rate might be appropriate, it would not greatly differ from the range obtained using their current model. This would suggest that if the UK were to join EMU at the sterling rate in the first half of 1998 it would have had to experience 10 to 15 years in which inflation was below its UK competitors before it reached its FEER. This mirrors the position in which the UK joined the EMS in the early 1990s.

In modelling the long-run relationship between the UK price level and the foreign price level, or between the Irish price level and either the UK or foreign price level, we are considering the "equilibrium" real exchange rate from a different point of view. In this paper we have considered what level of prices would be consistent with a given nominal sterling exchange rate. However, we can reverse this relationship to consider what exchange rate is consistent with current price levels. This in turn reflects the views of a myriad of individual firms as to what price level would be consistent with their own internal objectives in the long run, given their cost structures and the demand curves which they face. The difference between the actual price level and the long-run level is then a measure of the overvaluation or undervaluation of the currency from the point of view of individual firms. However, it has no direct relationship with the appropriate balance on internal or external account and may not be an "equilibrium" level in that sense.

In addition, because it is calculated separately for each country (or jointly with the UK in the case of the Irish measure) the rate arrived at may not be consistent with equilibrium (in this sense) for firms world wide. The world prices used in the equations may not represent the appropriate long-run level of prices for firms operating on the global market.

Nonetheless, even taking account of these caveats, this measure of the long-run exchange rate can convey interesting information concerning the sustainability of a particular exchange rate. If the long-term rate for Ireland were substantially below the actual rate, implying an overvaluation, then it would indicate that domestic firms selling on the Irish market would be facing fairly severe competition and that the deflationary pressures would be painful for them. On the other hand, if, at present, the current rate is below the long-term rate, then there is a likelihood that prices will tend to rise, while foreign (UK) competitors on the Irish market will face reduced margins. Subject to these conditions it is possible to reverse the Irish long-run relationship (given in Equation (1)) and calculate the exchange rate at which the two price levels are in equilibrium:

$$e = p^{IR} - p^{UK} \tag{8}$$

This is shown in Figure 3, below.

Figure 3: *Estimated Equilibrium Sterling Exchange Rate 1979Q1-1998Q2*

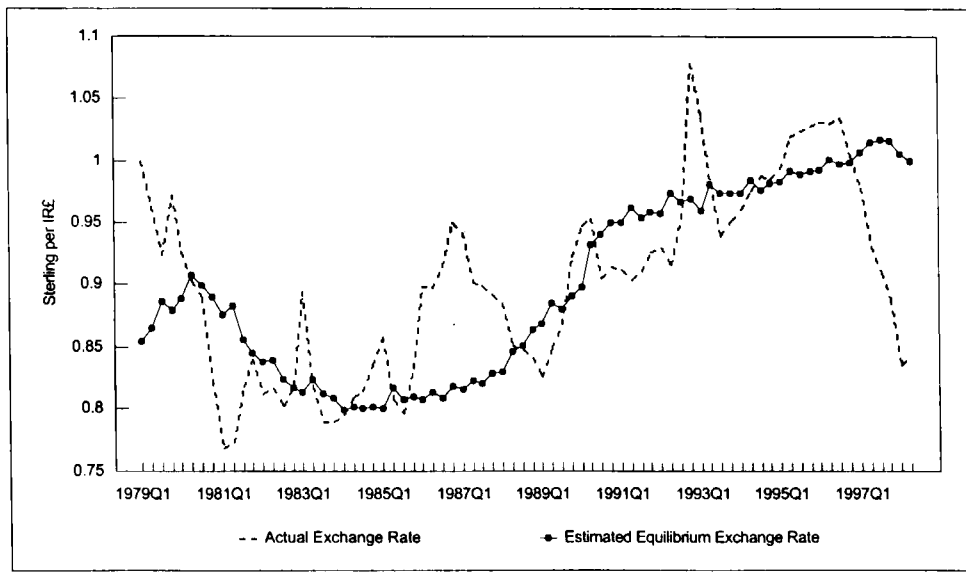


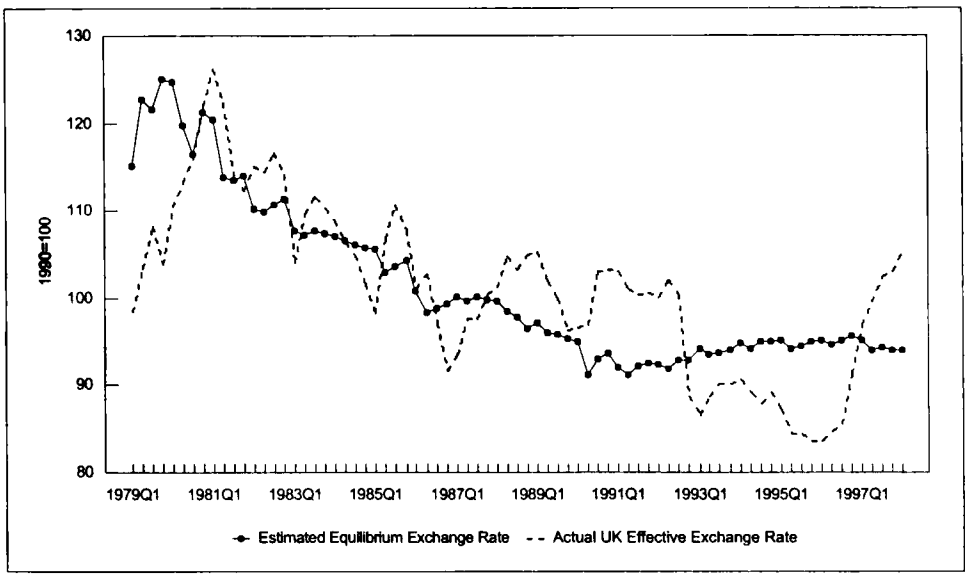
Figure 3 suggests that the "equilibrium" exchange rate between Ireland and the UK has been on an upward path since the 1986 devaluation (before which the Irish pound was seemingly considerably overvalued), with a sharp rise in the period September 1992 to February 1993. Although the "equilibrium" rate fell slightly in 1997, the appropriate bilateral rate with the UK should, according, to this estimate at least, still be around parity.

It is also possible to conduct a similar analysis for the UK. By relating British prices to world prices we can determine the "equilibrium" effective exchange rate for the UK:

$$e^{UK*} = \frac{-0.294 + 1.048p^{W} - p^{UK}}{1.048} \tag{9}$$

Figure 4 plots the UK effective exchange rate against this estimated equilibrium value.

Figure 4: *Estimated Equilibrium UK Effective Exchange Rate 1979Q1-1998Q2*



The pattern is fairly familiar and consistent with that shown in other studies (see, for example, Barrell and Pain (1998), or Parker (1998)) and would indicate, as one would expect, that by the end of 1997 sterling was approximately 10 per cent overvalued. On a trade-weighted basis, over 60 per cent of the change in

the world prices faced by British firms is accounted for by changes in European prices. If one assumes that these European prices cointegrate closely with German prices, and that, therefore, the misalignment of the effective exchange rate is an indication of the level of misalignment of sterling *vis-à-vis* the Deutschmark, one can calculate a crude equilibrium value for the bilateral sterling-Deutschmark rate. For 1998Q2 this worked out as Stg£1 = DM2.66, roughly in line with Barrell and Pain's calculations. Since the equilibrium Irish pound rate *vis-à-vis* sterling is parity, the implication is, therefore, that the bilateral Irish pound-Deutschmark rate should also be DM2.66 in equilibrium — somewhat higher than the rate agreed for entry into EMU.

IV CONCLUSIONS

The results suggest that world inflation is transmitted to Ireland through UK consumer prices; the addition of inflation in Germany added nothing to the model of Irish consumer price inflation. This contrasts with the findings in Callan and Fitz Gerald (1989) that German prices play a significant role in determining Irish manufacturing output prices.

The speed of adjustment to shocks in the UK inflation rate is rapid. There is a much slower response to shocks to the bilateral exchange rate. This is consistent with the behaviour one would expect from firms operating in imperfectly competitive markets where market segmentation is possible. Under such circumstances, the uncertainty associated with firms' expectations of future values of the exchange rate can be expected to lead to slow pass-through of exchange rate changes.

The model developed here differentiates between changes in the bilateral sterling-Irish pound exchange rate: due to movements in sterling against all other currencies; and changes due to movements in the Irish pound against all other currencies. Where sterling moves away from its expected long-run value there is a much more attenuated impact on the Irish inflation rate. However, where the Irish pound moved against all other currencies there was a more rapid and complete pass-through into the Irish inflation rate. These results suggest that UK firms, when exporting, are effectively tending to price in euros. When sterling is out of line with their expectations the danger of losing market share on the European market constrains them from passing through the effects of the change in exchange rates. However, if the Irish pound is changing against all other currencies the dangers of losing market share through changing prices is reduced as their potential foreign competitors face the same problems on the Irish market.

The forecasts produced by this model, while better than those from any model which excludes the term for UK misalignment, seem poor out of sample, with a

substantial over-prediction of the inflation rate in 1998. This could be due to a change in regime as EMU approaches with increasing integration of the EU market *including* the UK. However, it will be some considerable time before such a possibility can be tested.

Finally, the long-run relationship between Irish and UK prices suggests that current price levels in the two countries are consistent with a bilateral exchange rate of parity.

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