## Imperfect Asset Substitutability and the Irish Experience in the EMS - A Cointegration Analysis:

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*Paul Scanlon takes as the basis of his analysis the Irish-German short-run interest rate differential from the late 1970s to 1997. Through the use of a carefully defined co-integration analysis, he finds a reasoned explanation of several developments that Ireland experienced in the EMS.*

> *"It is probably fair to say that the subject of non-stationary time series has brought together a wider group of participants and excited more interest than any subject in econometrics since the development of simultaneous equations theory."*
>
> (*Peter Phillips, Yale University).*

In this paper, I invoke some of the major new developments in this area, most notably that of cointegration analysis. We find the technique to be invariably useful and powerful and it affords us a more profound insight into the linkages between Irish and German short-run interest rates over the EMS period.

**The Cointegration Concept**

Many series of economic data are said to be non-stationary. This basically means that the series trends over time in a fairly predicable manner, e.g. the series may trend inexorably upwards. On the contrary a stationary series will typically be of the form

$$Y_t = Y_{t-1} + \varepsilon_t \text{ with } \varepsilon_t \sim N(0, \sigma^2)$$

the so-called random walk model, where this period's value is equal to last period's value plus some random error term. This kind of series is said to contain a *unit root* (since the coefficient of $Y_{t-1}$ is unity) which we may test for using a Dickey-Fuller or Augmented Dickey Fuller test. The autocorrelation function (a.c.f.), which gives the sequence of correlations between $Y_t$ and $Y_{t-k}$ for all $k > 0$ will also indicate, albeit in a less precise way, the presence or absence of a unit root. If $Y_t$ and $Y_{t-k}$ are highly correlated for all k, thereby producing a slowly declining a.c.f., we infer a smooth, trend-like series and hence a unit root. Symmetrically, a rapidly declining a.c.f. is indicative of an erratic and hence stationary series. It is conventional to remove the unit root by taking first-differences of the data, although we may have to difference further. If we have to difference the data k times to attain stationarity, we say the series is integrated of order k or I(k).

It is imperative that we test for unit roots in our data before we administer any econometric analysis. Regression of two non-stationary series will generally produce a high $R^2$ value and in doing so, will effectively delude the researcher into believing the existence of a plausible and causal relationship. This is the case of the *spurious regression* (a typical feature is non-stationary residuals manifesting themselves in the form of autocorrelation and a low DW statistic), a phenomenon that remarkably has only come into vogue in earnest in the last two decades or so.

However, there is a case where the regression of two non-stationary series will produce meaningful results. This will occur when the residuals of the regression *are* stationary and, in which case, by moving the independent variable to the left, we deduce that some linear combination of the variables in question is stationary. If the variables are integrated of the same order and we indeed have such a *stationary linear combination* we say the variables are *cointegrated* and deduce the existence of a long-term relationship. Intuitively, if two series are cointegrated there is some equilibrium relationship causing them to move together over time. A movement in one, for instance, would typically be followed by a movement in the other and although both, by their non-stationary nature drift over time, they do move together in a fairly systematic way. In the case of unidirectional causality, for instance, one will cause movement in the other. A formal and simplistic way to test for cointegration is the Engle-Granger two-step approach. We first test for the orders of integration of the variables and, if the same, then ascertain whether the residuals from the static regression are stationary. If these prerequisites are satisfied we have a cointegrating relationship.

*The Granger-Representation theorem* posits the existence of what we call an *error-correction model* if cointegration is verified. In a very intuitive way, this kind of model depicts an equilibrium relationship where if the dependent variable was very large, say, in the last period, the increase this period will be very small or perhaps even negative. In this way, the series stays on an equilibrium path and never strays too far off. Such models are now ubiquitous in modern econometrics.

**The Analysis**

It was hoped that Irish entry to the EMS in 1979 would bring, among other things, convergence of Irish interest rates to German levels. For almost a decade thereafter, however, rates continued to differ significantly with Irish rates at stubbornly high levels. Indeed, on this theme, Walsh[1] claims that over the 1979-1992 period a German purchasing Irish government bonds would have earned 40% more than placing funds in similar domestic bonds. This brief paper examines these excess returns by comparing the yields on the Irish three-month Treasury bill rate and the

[1] Walsh (1998)

Frankfurt three-month loan rate over the period 1977-1997. I find that rates of return on both bonds are cointegrated once a structural dummy variable has been added after the 1988 period. By invoking the conventional uncovered interest rate parity condition, we see that it acts as a proxy for a significantly higher expected depreciation of the Punt and a higher risk premium in the pre-1988 period. Our dummy thus facilitates a simple quantification of this large compensation differential over the two periods. I finally allude to some of the possible explanations for the diminution of the aforementioned premia and indicate how these explanations are effectively explanations for the celebrated Irish recovery

**The European Monetary System and Credibility Theorists**

Irish membership of the EMS in the late 70s broke over 150 years of monetary union with Britain. Many reasons were expounded, all advocating membership: to sever the debilitating *British link,* (sterling was perceived to be a weak currency), to hasten our integration with mainland Europe but, most significantly, to enhance credibility in Irish economic policy. By linking our currency to that of a traditionally low inflation, low interest rate country, it was believed that inflation and interest rates would converge (by weak purchasing power parity and uncovered interest rate parity[2] respectively), and that by a commitment to maintain a fixed peg, confidence in economic policy would be bolstered. Most importantly, though, given the commitment, it was contended that *expectations* of inflation would fall, ultimately reducing *actual* inflation rates.

However, membership did not confer an immediate credibility bonus. It was perhaps too ambitious to believe that the Sterling link could just be severed immediately - for many years thereafter financial markets easily discerned that Ireland's fundamental flaw was in having broken the link with her main trading partner and establishing a link with a country to which it

[2] The uncovered interest rate parity condition (for Ireland/Germany, say) is $R_{IRL} = R_{GER}$ + (expected rate of depreciation of the Punt). If the Punt is expected to depreciate, for instance, it is clear from the equation that $R_{IRL}$ will be larger. The investor is compensated for the currency risk by a greater return on Irish assets. If the Irish and German assets are imperfect substitutes, then we may also have a risk premium term, $\rho$, on the right. Again, if this term is large (indicating risk), $R_{IRL}$ will again be larger to compensate the investor for increased risk. Under a credible fixed exchange rate regime, note that the expected rate of depreciation of the Punt should, of course, be zero leading to equality of interest rates. (We have an analogous result for inflation rates, by the PPP condition.)

had, at the time, relatively few links. For many years, inflation and interest rates remained high.[3] Nonetheless, had the markets truly believed in Ireland's commitment, benefits therefrom would surely have materialized rapidly and growth would have increased accordingly. It was not until nearly a decade later that inflation rates in Ireland and Germany finally converged.

The late 80s marked a watershed in the Irish economic landscape. In the space of almost three to four years Ireland's moribund economy was transformed into one of the fastest growing economies in Europe (and indeed the world). Interest rates subsided, inflation declined and growth accelerated. The reasons propounded have been diverse and no explanation has been universally accepted. In what follows, I analyse short-run Irish and German interest rates over the 1977-1997 period and, in doing so, throw further light on the timing and reasons for recovery.

## The Cointegration Analysis

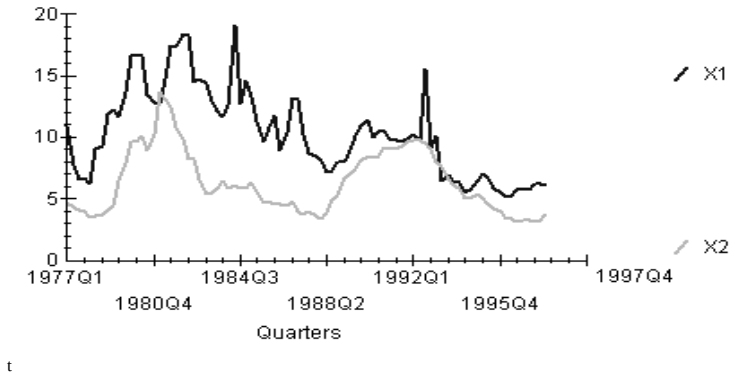
I examine Irish and German short run interest rates ($X_1$ and $X_2$, respectively) over the period 1977Q1 to 1997Q4.[4] I also introduce a dummy variable, D, to be discussed. I first perform Augmented Dickey Fuller tests on $X_1$ and $X_2$, so as to test for the stationarity (and ultimately the order of integration).[5] The following is a plot of $X_1$ and $X_2$:

[3] Walsh states, "*over the period 1979-1988, the yield curve was, with the exception of three quarters, either flat or positively sloped*". Clearly, investors did not find the concept of a sharp disinflation credible.

[4] The Irish short-term rate represents the 3-month Treasury bill rate, while the German rate represents the rate of 3-month loans (Frankfurt).

[5] Hall *et al* (1992) claim, however, "*it is generally accepted that interest rates and Treasury bill yields, in particular, are well described as I(1) processes*".

*Figure 1:*




An Augmented Dickey Fuller test (without trend) on $X_1$ confirms the observation that the series contains a unit root. It is noteworthy, however, that an ADF test with trend leads to a marginal rejection of the null hypothesis of a unit root thereby suggesting trend stationarity. This latter result is dubious however, given the presence of a very *weak* deterministic linear trend.[6] Given that the series tends to move to a different mean after 1988 (*a structural shift*), I carry out a Phillips-Perron type test; this *is* indicative of a unit root. Given the first differences of the series are stationary, I infer that the series is I (0) i.e. stationary.[7]

A regression of $X_{1t}$ on $X_{1(t-1)}$ yields the following:

$$X_{1t} = .98X_{1(t-1)} + \varepsilon$$

[6] Indeed Dickey, D., Bell, W., & R. Miller (1986) recommend against the inclusion of a trend since this would make a random walk look stationary.

[7] The autocorrelation and spectral density functions confirm this. Also, the Ljung-Box and Box-Pierce statistics are highly significant (based on the first 28 lags).

clearly suggestive of a unit root.

With regard to $X_2$, we cannot reject the null of a unit root under ADF tests without *and* with trend. First differences are stationary. Hence $X_2$ is I(1).

A regression of $X_{2t}$ on $X_{2(t-1)}$ yields the following:

$$X_{2t} = .91X_{2(t-1)} + \varepsilon_t$$

**The Cointegrating Regression**

Observation of the movement of both time series clearly indicates Irish rates moving to a lower level around 1988Q3. Here, convergence of rates is evident. To enhance the explanatory power of the regression I include a dummy variable, which takes the value 1 prior to 1988Q2 and 0 thereafter. Regression using *Microfit* yields:

$$X_1 = 2.61 + .85X_2 + 4.37D$$

$$(4.18)\ (10.03)\ (10.11)\ \ldots \textit{t-values}$$

$$R^2 = .72,\ R^2(\text{adj.}) = .71$$

$$DW = 1.03,\ F(2, 79) = 102.30$$

An ADF test performed on the residuals indicates they are stationary or I(0) and hence cointegration is confirmed.[8] Our cointegrating vector is X = (1, -. 85, .4.37).[9] This result is corroborated by invoking the CRDW test (we have $DW > R^2$). Various diagnostic tests are subsequently performed. A Wald Test, testing the restriction that the coefficient of $X_2 = 1$, is not significant. ARCH tests on the residuals do not indicate periods of excessive (relative) volatility. A Lagrange Multiplier test, however, is indicative of some serial correlation in the residuals. The superconsistency property of the estimators (where convergence to true values takes place at a rate T rather than $T^{.5}$, where T is the sample size), however, does not really come into play, since we are dealing with a relatively small

[8] Cointegration precludes the possibility of spurious results, since all variables in the regression are I(1) and indicates the presence of a long-term relationship. I note that without the addition of D, we have non-stationary residuals so that the dummy is crucial in attaining cointegration.

[9] A deeper analysis would entail the invocation of the Johansen procedure (1988). Under this procedure, the maximal eigenvalue and trace tests lead to the cointegrating vector is found to be (1, -.87, -4.46)

sample. I note too the possibility of small-sample bias (proportional to 1 - $R^2$), typically a feature of most cointegrating regressions. The following depicts the autocorrelation function of the residuals. The fast decline of the function underlines their stationary nature.

It is worth noting the implications of such a cointegrating regression. We may deduce that a long-run relationship indeed existed between Irish and German short run interest rates over the given period. Overall the cointegration indicates a reasonably stable influence of German on Irish rates, with an important structural shift in 1988Q3. Indeed, a cursory observation of the two series shows how movements in the German rate precede movements in the Irish rate. In a sense, we can see this as a vindication of the so-called *German dominance hypothesis*, GDH, the belief that Germany was the prevalent force behind interest rate determination over the EMS years.[10]

The Granger Representation Theorem (1987) postulates the existence of an error correction mechanism describing the short-run (or error-correcting) relationship between the variables. Invoking Hendry's General to Specific (or testing down) procedure yields the following error correction model:

$$\Delta X_{1t} = .29\Delta X_{2t} - .49\ \varepsilon_{(t-1)}$$

$$(1.23)\ (-5.27)\ \ldots\ldots t\text{-}values.$$

$$R^2 = .28,\ R^2(\text{adj.}) = .27$$

$$DW = 2.103,\ F(1, 80) = 30.52$$

The crucial part of the equation, the coefficient of $\varepsilon_{(t-1)}$ (known as the *speed of adjustment* coefficient) indicates that almost 50% of the disequilibrium error in period t is made up for in period t+1. The small $R^2$ values are attributable to the fact that we are attempting to explain movement in first differences, as opposed to levels. It is interesting that none of the short-run (high frequency) terms are significant, even at the 10% level. This indicates that while $X_2$ affected the level of Irish interest rates in the long run, it did not play a significant *direct* role in the short-run. Engle and Granger (1987) have shown that the existence of an error correction mechanism attests to Granger-causality in at least one

[10] In this case, this would, of course, only pertain to Ireland. With regard to the GDH, de Grauwe finds very mixed evidence. Biltoft & Boersch (1992) however find evidence of unidirectional Granger causality from Germany to all other EMS interest rates, with the exception of Italy.

direction. Hence, given the circumstances, we can infer the German rates Granger-caused the Irish rates. Indeed, observation of the series shows movements in German rates preceding corresponding movements in Irish rates.

**The Analysis**

With *imperfect* asset substitutability the uncovered interest rate parity[11] condition (UIP) is:

$$R_{IRL} = R_{GER} + ( E_{(t+1)} - E_t) / E_t + \mu$$

where R represents the interest rate, E represents the exchange rate (the price per unit of German currency) and μ represents the risk premium (encompassing a number of factors).

Our cointegrating regression yielded:

$$R_{IRL} = 2.61 + .85R_{GER} + 4.37D$$

Manipulating this and making the assumption that $.15R_{GER} \approx .95$ we have[12],

$$R_{IRL} = R_{GER} + 1.66 + 4.37D \text{ where } D=1 \text{ for } t \quad 1988Q2$$

$$D=0 \text{ otherwise.}$$

The equation is now in a form amenable to comparison with the adjusted UIP equation. Thus, the combined expected rate of depreciation and risk premium on Irish assets was considerably smaller after 1988Q2, the average difference being 4.37. With a fixed exchange rate, of course, we should ideally have had $R_{IRL} = R_{GER}$. However, it is important to note that ERM was a system of *quasi-fixed* rates, where rates moved within bounds and where countries could intermittently administer devaluations. As already alluded to, this resulted in an almost continual expected rate of depreciation in the early EMS years, given our main trading partner, Britain, was outside the system.[13] Irish assets were thus perceived as substantially riskier before the time in question. Thus, we had the presence of a significant currency premium on Irish assets. In addition, there was something of a liquidity problem with domestic assets; in many cases, the prices of such assets had to fall to ensure sale. Given our burgeoning public debt before 1988, default risk was also an

[11] See Note 2.

[12] The mean value of German short run interest rates over the period in question is approximately 6.36.

[13] This was especially true when Sterling depreciated or most notably when Britain left the ERM in 1992 (and subsequently depreciated by 15%). See any discussion on "*Black Wednesday*".

issue, albeit a minor one. Also the general economic landscape was far from healthy - ERM was not, at that stage, deemed a success and prospects for growth in an already lacklustre economy were dismal. Such factors led investors to construe Irish assets to be risky and illiquid and accentuated fears of Irish assets in general, and thereby led to a significant country risk. This combination of country and currency risk meant that Irish and German bonds were imperfect substitutes and led to considerably higher Irish interest rates for many years.

From my analysis, it is clear that the premia subsided to a considerable extent around the 1988 period. Something happened around this time that would cause the Irish-German interest rate relationship to change indefinitely. Whatever happened clearly made such large premia unnecessary. This *"thing"* whatever it was, was surely instrumental in precipitating the Irish recovery around the very same time.[14] So what was it that the financial markets perceived that was so propitious? Firstly, there were belated benefits from EMS membership. Ireland's integration with mainland Europe had increased considerably in the preceding decade. A PPP relationship between Ireland and Germany was, at this stage, finally established. Around this time, the Irish-German real exchange rate reached a plateau at which it would remain for many years. Such a predictable relationship ensured a degree of stability and inspired confidence in Ireland's commitment to a (quasi) fixed exchange rate. Also, a devaluation of the Punt occurred in 1986, following another one in 1983. Perhaps the market construed that, by 1988, the Punt had reached a *"comfortable"* position on the exchange markets and that further devaluations were unlikely. Furthermore, domestic policies changed considerably over this period. A system of corporatism was introduced which would ultimately lead to wage moderation and hence subdued inflation. Most importantly, though, a *credible* policy of fiscal retrenchment was implemented and government expenditure subsequently declined. In light of the preceding years of fiscal profligacy this was deemed a major step towards stabilizing the already enormous public debt (heretofore, we had the real interest rate greater than the rate of growth, some *unpleasant monetary arithmetic*). Although the stabilization *per se* restored confidence in the governmental policies it had the added benefit of creating wealth effects due to the obvious decrease in the future tax burden. Indeed, it is this explanation that has been deemed the most plausible and is doubtless also the most intriguing.

[14] The prospect of causation going the other way is just not tenable. The recovery was not officially recognized until many years later.

The Ricardian Equivalence Proposition (RE) posits that an increase in the public debt will be offset by an increase in private saving, thereby nullifying the original stimulus. In the case of high debt, for instance, the rational and perspicacious consumer will discern an onerous future tax burden and will hence increase saving and reduce consumption.

It has been debated that the proposition has been instrumental to the Irish recovery in that late 80s. As public debt was almost about to spiral out of control around this time, a rather severe policy of fiscal rectitude was put in place. At the same time, private consumption began do increase considerably, as did growth. It has been argued that a causal relationship indeed existed.

A cursory glance at the figure below reveals a striking positive relationship between the increase in real private consumption and the improvement in the general government financial balances in Ireland over late 1980s. Thus the RE hypothesis does indeed appear to be a credible (or even partial) explanation for recovery over this period. Following the implementation of an austere fiscal policy, consumers rationally believed that the future tax burden would be reduced and hence decreased their saving and increased consumption. Furthermore, the fact that the government sent clear signals to the public that it was striving to *tidy it's act* also accentuated feelings of general confidence about the future and clearly had corresponding wealth effects. The prospect of a reduced tax burden and the subsequent reduction in the adverse distortionary effects of taxation increased work effort.


The financial markets, of course, also highly prize fiscal prudence and quite possibly perceived the change of policy as a step in the right direction and ultimately as a move towards more constructive, less extravagant policy. Credibility in government policy was henceforth enhanced and confidence was restored in the financial markets.

## Conclusion

In this paper, I have analysed the Irish-German short-run interest rate differential over the twenty-year period from 1979 to 1997. I find that, with the addition of a dummy, Irish and German short-run rates are cointegrated over the period and movements can be detailed with an error correction model. The cointegration property facilitates a quantification of aggregate currency and country premium, which was found to be 4.37 points greater in the period to 1988, evidently reflecting the burgeoning public deficit and the general parlous domestic state of affairs over this time. A number of explanations for the reduction in risk premium in the post-1988 period are proposed. I posited the belated credibility bonus from the EMS and the "*expansionary fiscal contraction*" effects of fiscal rectitude as plausible reasons for reduced premia - these are also explanations for the Irish recovery, which was incipient in 1988. Overall, then, we can see how these factors, most notably the latter, contributed to such a radical turnaround both in goods *and* financial markets.

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