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Notes and Comments

Extensions to 'A Quantitative Analysis of the Degree of Integration between Irish and UK Financial Markets'

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In a recent issue of this Review, Browne and O'Connell (1978) find a close relationship between the Irish and the UK interest rates simultaneous in time with the magnitudes of the UK fluctuation "completely transmitted to the Irish rate". The authors' methods are well adapted to the discovery of lags (UK rates the earlier, of course) if they exist. A typical conclusion is that the 3-month inter-bank rates are correlated only simultaneously. As regards deposit rates, "If we consider all changes in the UK rates (except for one instance . . .) the average lag in the adjustment of the Irish rate to the UK is just less than five weeks".

The data relate to 201 consecutive weeks during the period 1973-1977 and deal with nine types of interest rates for both Ireland and the UK or eighteen series in all. Five pairs were selected for examination, using sophisticated methods of time series analysis. In the latter sense the paper is a pioneer in Ireland.

The Browne-O'Connell paper, composed entirely from the financial viewpoint, is useful also for its incidental comments, for instance, that some UK rate changes are automatically operative in Ireland. Thus, "in this category (in which pairs of interest rates practically coincide) are the following pairs of interest rates: inter-bank rates, Exchequer Bill and UK Treasury Bill rates

*The authors very kindly made available to the writer their complete computer sheets for the purpose of this commentary. No comment is made here on the data for the cross-spectral density function of which the authors make considerable use. The note has been improved by comments on the first draft kindly made by the authors of the main paper.

(90-day Government paper). In fact, the Exchequer Bill rate is set by reference to short-term rates in the UK (Central Bank, 1975, p. 87)."

The comments that follow are based on the Browne-O'Connell computer sheets, using methods with which the writer has been associated in his researches or mere commonsense, but avoiding the more esoteric reaches investigated by the authors with which he is unfamiliar. His main objects would be (i) to detect any periodicities in the interest rate weekly time series and (ii) to speculate on the time-lag (in weeks), if any, between changes in Irish rates following those in the UK. The computer data to be used are correlograms and power density spectra (linearly related to the simpler spectral functions used in Section III) for Irish and corresponding UK rates separately, and cross-correlations for a succession of lags between Irish and UK rates – the UK, of course, leading.

Much of the comment will depend on the identification of the largest member of a sequence of positive values on a scale of probability (Geary, 1967). Every sequence has a largest value but the problem arises: is it significantly so and is it out of kilter with the rest? This is surely a fundamental issue in statistical technique. For instance, do researchers in multivariate regression with more than one indvar realise that by using the standard Student-Fisher t-table to infer that the coefficient values are significantly different from zero, having arrayed the coefficients in descending order of their t-values, they are making false probabilistic inferences?

All the following comments are based on what statisticians term the "prewhitened series" (taken as the first differences of the data as distinct from the "original series"). Remarks are confined to only a few of the series.

Correlograms

(i) *7-day inter-bank interest rates.* 50 autocorrelations are produced for Ireland and the UK. Both have nearly equal positive and negative values, indicating overall absence of significance in the phenomenon. However, the first Irish autocorrelation (i.e., one time lag) has the value of –.51 (null hypothesis probability (NHP) $<.001$), indicating that an increase in the rate in one week is very likely to be followed by a decrease the week following and vice versa, which is a periodicity of a kind. This oscillation is absent from the UK series. The oscillatory effect is amply borne out from the authors' Chart A in which the Irish and UK rates are graphed (weekly, 1973-1977), especially in the years 1973-1974.

Incidentally, the four charts the authors use (graphing UK and Irish interest rates, respectively, for (a) 7-day inter-bank, (b) 3-month inter-bank, (c) commercial bank deposit and (d) commercial banks' prime lending rates) are a liberal education in themselves, clearly showing the close relation between the respective rates in the two countries. Moreover, the lag in the Irish adjustment in the case of commercial bank rates ((c) and (d) above) cannot only be seen, but even the average lag is roughly calculable. The charts show relationships in general appearance to the eye which correlation coefficient (cc) analysis may conceal.

(ii) *3-month inter-bank interest rates.* The largest values of the ccs amongst the 50 values for either Ireland or the UK are not significant nor is the sequence of sign changes. Therefore, any indication of periodicity is absent. A curious fact is that the largest value, though small, occurs at a lag of two weeks in both cases.

(iii) *Bank deposit rate.* Two featureless sequences, of small values.

(iv) *Prime lending rate.* As (iii).

(v) *Exchequer (Treasury) bill rate.* Large numbers of negative signs to small values of the 35 ccs – 28 for Ireland and 25 for the UK.

The overwhelming impression is of nullity; all the values of the ccs are like those that would be found on 200 pairs of numbers random to one another. There is no sign of periodicity.

Power density spectra

These spectra were produced for all the series of interest rates for which there were correlograms.

(i) *7-day inter-bank.* In the Irish case the maximum value occurs for angular frequency, $J = 37$, which is also the case of the second highest, at $J = 36$. This conjunction ($J = 36$ or 37, and the 3rd highest is at $J = 38$) would seem to establish a valid periodicity of nearly $2\pi/37 = 0.17$ weeks (say, a day) which does not seem meaningful. But what is interesting is that the corresponding UK maximum occurs at $J = 36$, nearly identical with the Irish maximum, though not statistically significant, with null hypothesis probability (NHP) $> .05$ as it is in the Irish case.

(ii) *3-month inter-bank.* The Irish maximum occurs at $J = 40$, but values of comparable size are widely interspersed amongst the 45 spectra. In the UK we are again intrigued by the UK's having its maximum at $J = 41$. If graphed over all values of J, the two series would be similar.

(iii) *Bank deposits.* Irish and UK spectra had a maximum at J = 0, indicating a trend in the original series (i.e., an absence of periodicity). Again, in general, there is considerable similarity in the two spectral graphs with small variation in the 30 spectrum values.

(iv) *Prime lending.* The 30 values of the spectrum in each case are nearly equal. The UK has a significant maximum at J = 0 ($.01 < \text{NHP} < .05$), but not the Irish value which, at J = 0, has the second highest value.

(v) *Exchequer (Treasury) bill.* A nearly equal set emerges in the Irish case, the 30 values falling in the range 0.022 – 0.041. The UK range was greater at 0.013 – 0.061.

Cross-correlations

Here we deal with the ccs of the week-to-week differences in rates with displacements (leads and lags) in cross-correlations of up to 50, the UK rate being always the earlier. We are interested in the largest positive values of the ccs, especially when these occur at short intervals, always bearing in mind that in the identification of significance we have to apply order (and not classical) theory.[1] In what follows we confine attention (arbitrarily) to lags of up to 10 weeks. The type of interest rate and the simultaneous (no time lag, J = 0) cc values (between first differences, be it noted) are as follows:

Interest rate	*Simultaneous cc*
(1) 7-day inter-bank	.50
(2) 3-month inter-bank	.84
(3) Bank deposit	.14
(4) Prime lending	.22
(5) Exchequer (Treasury) bill	.07
(6) Building society	–.01

With (1) above there is no indication of any sizeable positive cc in the first ten (weekly) time lags.

All the ccs are based on about 150-200 pairs. NHP significance of difference from zero in this range can be adjudged by normal theory, standard deviation equal to $1/\sqrt{n}$ (i.e., with cc values in the range .16 – .14 for NHP = .05 and .21 – .18 for NHP = .01). This is conventional theory applicable only to one cc. Theory applicable to an appraisal of significance

1. That is, the problem is *not* to adjudge the NHP significance of a single drawing (the classical case), but the NHP significance of the highest magnitude, 2nd highest, etc., in several drawings.

from a series of ccs based on absolute largest magnitudes would require larger values of ccs than these.

By any test the values for simultaneous ccs for (1) and (2) above are overwhelmingly significant. Amongst the first 10 ccs in (1) there is no positive value even conventionally significant. In series (2) there are cc values of .21 and .16 at various lags. These cannot be regarded as significant for, in a sequence of 55 ccs, the same kind of values, negative as well as positive, occurs a few times. This is not a formal order NHP significance test, but it suffices in commonsense.

The same remark applies to the simultaneous cc values in cases (3) and (4). But lagged values show the following interesting phenomena:

Lag in weeks	*2*	*3*	*6*
(3) Bank deposit	.37	.24	.28
(4) Prime lending	.37	.20	.26

Not only do the largest cc values occur at the same lags, but they have almost the same values. Browne-O'Connell validly regard the lag between UK and Irish rates as "just less than 5" weeks; we have a slight preference for stating "sometimes 2, 3 and 6 weeks".

The Exchequer (Treasury) set of ccs, with no simultaneous relation, have the values .29, .47, .20 and .19 for lags (in weeks) of 1, 3, 4, and 5, respectively. The 3-week lag predominates, but the others are clearly significant (again in commonsense), showing that the adjustment in rates is somewhat variable.

The building societies set has its largest value, cc = .22, amongst the first 10 at a lag of 8 weeks but, as the same value is found at a lag of 26 weeks, we must have doubts about its significance. We decided to submit this set to full NHP order significance test treatment. Including zero there are 35 cc values in the set. (25 have negative signs, significant at NHP = .05. The fact of apparent negative relationship would alone make real relationship doubtful.) We regard all cc values as positive. The problem is, amongst a set of 35 positive values, are top values of .220, .216, .175 and .131 to be regarded as significantly different in value from the mean of the whole set? The values of the statistic $(/r/-/\bar{r}/)$ at the four above values are 3.10, 3.03, 2.51 and 1.64, respectively. Reference to a table in the paper mentioned above will show that the critical NHP = .05 values for the 1st, 2nd, 3rd and 4th largest in a positive sequence of 35, assuming normality, are, respectively, 3.18, 2.58, 2.26 and 2.05. Hence, the 2nd and 3rd values found are significant and the 1st and 4th are not significant.

Nevertheless, it is not thought that any real relationship exists between these week-to-week changes, partly from the number of negative signs mentioned above. Also, the order test examined in the last paragraph cannot be relied on because the sequence of 35 is obviously not a normal sample. Resulting from the very infrequent changes in interest rates in both countries, the sequence of ccs is bizarre; it has 6 values greater than .05 and all the remaining 29 values are less than .01, many in sequences of very small equal values.

This subsection on cross-correlation may have little of moment about interest rates. The data are used to call attention to a point in general statistical practice which the author regards as important.

REFERENCES

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