

Lags in the Transmission of Inflation*

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1. INTRODUCTION

In the July 1976 issue of *The Economic and Social Review*, P. T. Geary presented some preliminary results on the analysis of lags in the transmission of inflation. Essentially his paper consisted of the following points.

- (a) An examination of six simple bivariate relationships connecting the percentage rates of change of the Irish CPI (Consumer Price Index), WPI (Wholesale Price Index), PX (Export Unit Value Index), PM (Import Unit Value Index), and the UK RPI (Retail Price Index).
- (b) The use of the Almon lag procedure to estimate polynomial lags of order four and of lengths varying from four to eight quarters.
- (c) An economic rationalisation of the bimodal nature of the lags estimated in terms of the distinction between consumer and capital goods.

In this note we comment on the statistical methodology used by Geary and isolate some points which, we feel, may invalidate some of Geary's conclusions. We then show how the technique of spectral analysis (Fishman 1969) can be used to gain further insight into the mechanisms of the transmission of inflation. We believe this to be the first attempt to use spectral analysis on Irish economic data. This note is an abbreviated version of an unpublished report (Bradley 1976), where further details are presented.

2. STATISTICAL METHODOLOGY OF GEARY (1976)

Geary ignores the problem of seasonality in his (quarterly) data. For the levels form of, say, the WPI, this is not a major assumption since the seasonal factors do not depart much from 100 (e.g., for 1974, the factors were 100.9 (Q1), 101.4

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(Q2), 99.3 (Q3) and 98.3 (Q4), and if the seasonally adjusted series is superimposed graphically on the original series, they are almost identical (Central Bank of Ireland 1976). Hence, in correlating two such series in levels form, the question of seasonality can be ignored. However, Geary uses percentage rates of change (denoted by a "dot" superscript) and here seasonality is vitally important (Figure 1 shows \dot{WPI} v time and the highly regular quarterly seasonal pattern is apparent). Many of the negative coefficients found by Geary in his regressions have probably been caused by lagged values of independent variables acting as proxies for the missing seasonal dummy variables (Bradley (1976) for examples).

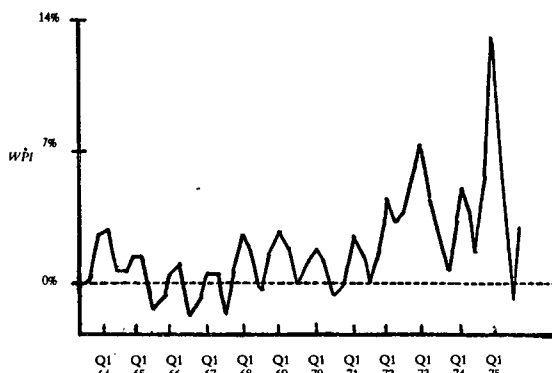


Figure 1: Plot of rate of change of \dot{WPI} against time

The Spectral analysis to follow will be shown to cast doubt on the reality of the long lags found by Geary. In addition, using the usual maximum \bar{R}^2 criterion, but incorporating seasonal dummies, the following pattern emerges for the \dot{WPI} - \dot{PX} relationship, and is typical of all others in the study.

Lag up to and Including	\dot{PX}	\dot{PX}_{-1}	\dot{PX}_{-2}	\dot{PX}_{-3}	\dot{PX}_{-4}	\dot{PX}_{-5}	\dot{PX}_{-6}
\bar{R}^2	0.59	0.59	0.61	0.60	0.60	0.59	0.59

A strong indication of a zero lag is apparent whereas Geary reports a five-period lag on the same basis, but excluding seasonal dummies.

The anomalous result for the \dot{WPI} - \dot{PM} relationship in Geary's paper can be explained easily (particularly the low value 0.2759 of \bar{R}^2). Between Q4 (1973) and Q1 (1974), the change in \dot{PM} was 16.68 per cent. Four quarters later, between Q4 (1974) and Q1 (1975), the change in \dot{WPI} was 13.53 per cent. A large fraction of the variance of \dot{PM} is accounted for by this one observation (due mainly to the oil-price increase), and this non-characteristic distortion has seriously dominated the lead-lag relationship between \dot{WPI} - \dot{PM} . Geary's data period includes Q1 (1974) but excludes Q1 (1975).

Finally, Geary uses a fourth order Almon polynomial in all his regressions. When the lags are poorly determined by the data or mis-specified as to maximum length (as we believe them to be), the degree of polynomial chosen can impose a spurious type of lag structure (e.g., a "U" shape for a quadratic or a bimodal shape for a quartic). Even when the lag length is correctly specified, it is important (and indeed logical, from the point of view of possible efficiency gain in the estimation) to search over the degree of polynomial used.

3. THE USE OF SPECTRAL ANALYSIS

The idea of decomposing an economic variable into components (e.g., long-run, medium-run and short-run), is well known. Spectral analysis extends this concept and bases it on a more rigorous foundation using the theoretical result that if a series is "stationary" (essentially trend-free), then it can be uniquely decomposed into many uncorrelated components, each of which is associated with a period or frequency. A graph of the amplitudes of these components against the period (or frequency) is called a "power-spectrum". If the spectrum is flat then the series is merely a sequence of uncorrelated observations (white-noise). If the spectrum has a peak at some frequency, this suggests that a "Cycle" may be in the series. In Figure 2 we show the spectrum of WPI. A very pronounced one-year seasonal frequency is apparent, confirming the seasonality of the WPI series (refer Figure 1).

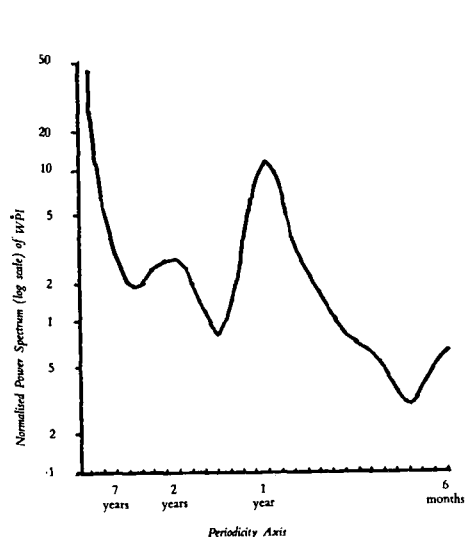


Figure 2: Power Spectrum of WPI

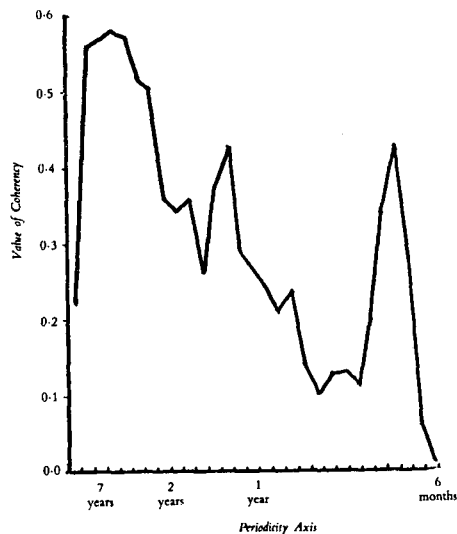


Figure 3: Coherency plot for CPI v PM

Using the technique of Cross-Spectral analysis, one can explore the (linear) relationship between two different series and attempt to answer the following important questions.

- (a) To what extent is a frequency component in one series (say $\dot{P}M$) correlated with the same frequency component in another series (say $\dot{C}PI$)? Correlations with *other* frequency components can be ignored since they are identically zero.
- (b) To what extent does a particular frequency component in one series lead or lag the same component in another?
- (c) What is the relationship between the frequency amplitudes?

The "coherence" function helps to answer (a) essentially by taking the ordinary correlation coefficient of regression analysis and expanding it out as a function of frequency, from zero (long periods) to the highest frequencies measurable (in our case, corresponding to a period of six-months).

The "phase-diagram" provides evidence of time lags between components which are coherent to some degree. Briefly, if the phase diagram shows random oscillations about zero phase, there is no lead or lag, but if the diagram appears to contain a trend over some frequency range (where coherence is high), a lead or lag is indicated, the extent of which can be measured by the slope of the trend.

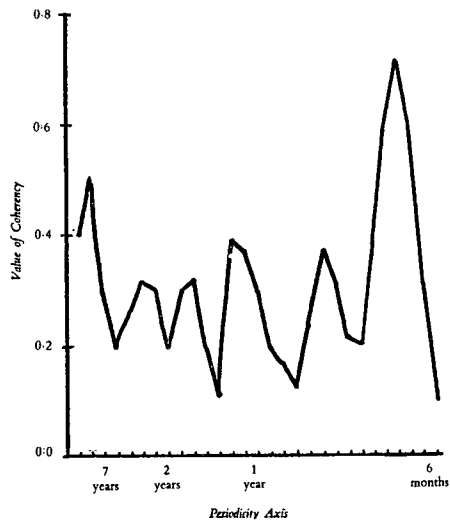
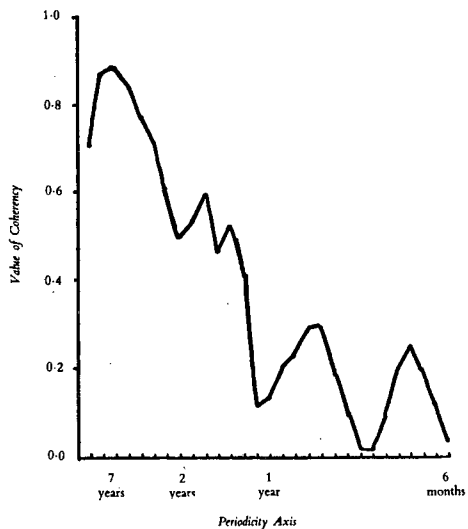
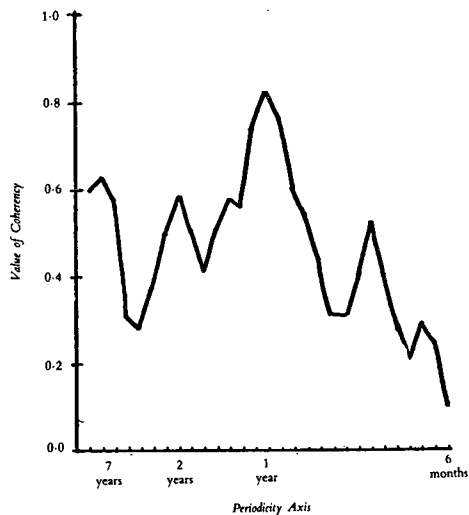
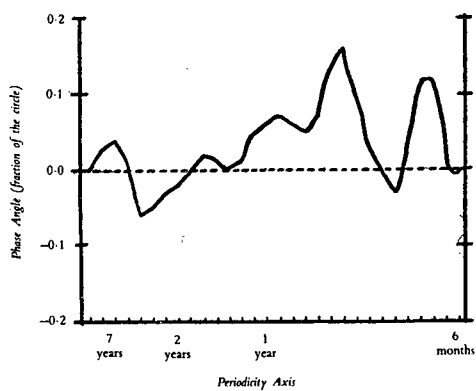
Finally, if the direction of causation is assumed to be from $\dot{P}M$ (say) to $\dot{C}PI$ (i.e., $\dot{P}M$ "causes" $\dot{C}PI$), then the "gain" measures how processes of a particular frequency in $\dot{P}M$ appear magnified or attenuated in $\dot{C}PI$.

To summarise, the idea of an economic time series being made up of a large number of frequency (or periodic) components has important implications when the relationships between two series are considered. Different components may obey different laws e.g., different time lags at different frequencies may be possible. An examination of such relationships using spectral analysis can complement the more conventional regression analysis.

4. SAMPLE RESULTS

Our data sample runs from Q1 (1954) to Q4 (1975) i.e., 87 percentage rate of change observations. Figure 3 shows the coherency plot for $\dot{C}PI$ v $\dot{P}M$. Two frequency bands are clearly identified: the long-term components (2 to 7 years) and the short-term components (between 6 and 9 months). This bimodal behaviour of the coherence plot provides a more reasonable basis for Geary's rationalisation in terms of consumer and capital goods. For example, Figure 4 is a coherence plot for $\dot{C}PINF$ v. $\dot{P}M$ (i.e., the non-food $\dot{C}PI$ index versus the import price index). Movements in $\dot{C}PINF$ are slower than for $\dot{C}PIF$ (food items), and only the long-term frequencies are highly coherent. The exact opposite behaviour emerges when $\dot{C}PIF$ v. $\dot{P}M$ is considered (Figure 5).

In Figure 6 we show the coherency plot for $\dot{C}PI$ v. $\dot{W}PI$. Note the high correlation (0.82) between the seasonal components. The phase diagram for this relationship (Figure 7) clearly indicates no significant lag. A more detailed analysis leads us to suggest that movements in $\dot{W}PI$ are contemporaneous with

Figure 4: Coherency plot for CPI_{INF} v PM i.e. non-food CPI Figure 5: Coherency plot for CPI_{IF} v PM i.e. food-items CPI Figure 6: Coherency plot for CPI v WPI Figure 7: Phase-diagram for the CPI v WPI relationship

movements in CPI. Long-term movements in WPI are attenuated by a factor of 0.90 in CPI, and the important one year cycle by 0.42. Geary's reported eight quarter Almon lag is probably not very meaningful in this case.

Finally, we consider the CPI v. RPI relationship. Geary (1976) commented thus: "While the difference between Irish and UK tax and subsidy policies are doubtless a contributory factor, it remains hard to understand why the weights in the CPI v. RPI case should exhibit severe fluctuations . . .".

The following is a tabular summary of the cross-spectral results for CPI v. RPI.

<i>Coherence</i>	<i>Period</i>	<i>Gain (CPI on RPI)</i>	<i>Lag (CPI on RPI)</i>	<i>Description</i>
0.83	4½ years	0.87	5 months (approx)	Long term
0.58	1 year	0.99	less than 1 month	Annual
0.61	9 months	1.26	less than 1 month	Short term
0.46	6 months	0.27	zero	Half-annual

No doubt it would be possible to provide various economic rationalisations of the above table. The fact that there is almost no attenuation in the transmission of the long-term and annual components of RPI into the Irish CPI is interesting when compared with the very sharp attenuation of the short-term six-month component. We would suggest that different economic mechanisms may govern the transmission of the above components and that Geary's distributed lag model mixes all components. Also, having removed some of the seasonality in both series by seasonal differencing, only the zero-lag cross-correlation is significant. In fact, a zero-lag model with seasonal dummy variables is quite adequate.

5. CONCLUSIONS

We have used the technique of Spectral analysis to study the distributed lags in the transmission of inflation presented by Geary (1976). The Spectral analysis technique indicates that, if any lags are present in the various transmission mechanisms studied by Geary, then such lags are of very short duration, usually less than one quarter.

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