Lags in the Transmission of Inflation: Some Preliminary Estimates

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Précis: This paper provides some preliminary estimates of the structure of the lags in the relationships between the quarterly proportionate rates of change of the consumer price index, wholesale price index, export unit value index and import unit value index, using the Almon procedure. The relationship between the consumer price index and the UK retail price index is also investigated. The data period is 1962 (1) to 1974 (2). The lag structures of the relationships between the consumer price index and the other Irish price indices are similar and may be rationalised in terms of the distinction between consumer and capital goods; they indicate that the imposition of geometrically declining lag structures may be inappropriate. However, these and especially the remaining relationships require further investigation before they could be used for policy and forecasting purposes.

I. *Introduction*

It is widely recognised that import and export prices affect both consumer and wholesale prices, but that their influence operates with a lag. Similarly, changes in wholesale prices induce a lagged response from consumer prices. Surprisingly, in view of their relevance to short-term policy issues, there are no published estimates of the nature of these lags. In an earlier study, Black, Simpson and Slattery (1969) investigated the nature of the relationship between the wholesale price of industrial output and labour and material costs, on the assumption of full cost pricing by firms. They estimated the lag structures using a combination of

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unconstrained and geometrically declining lags and quarterly data from 1954 (1) to 1967 (2); for the most part they worked with price and cost levels rather than inflation rates.

The purpose of this paper is to provide some preliminary estimates of the structure of the lags in the relationships between the quarterly proportionate rates of change of the consumer price index (CPI), wholesale price index (WPI), export unit value index (PX) and import unit value index (PM), using the Almon procedure. The relationship between the quarterly inflation rate of the CPI and the UK Retail Price Index (RPI) is also investigated. The data period for the study is 1962 (1) to 1974 (2).

Part II contains a brief outline of the Almon procedure for estimating lag structures and a discussion of data employed in the estimation. In Part III the results are presented and illustrated and the paper concludes with an assessment of their implications and suggestions for further research.

II. *Estimation and Data*

The estimation of relationships of the form

$$Y_t = \sum_{i=0}^{n-1} w(i) X_{t-i} \qquad (1)$$

by means of the Almon procedure is extensively discussed elsewhere; see, for example, Almon (1965) or Johnston (1972). The Almon procedure is based on the concept of polynomial approximation; it assumes that successive weights lie on a polynomial, the degree of which is to be chosen. In this study, a fourth degree polynomial is used, which allows the lag structure to have three stationary points. This is in contrast to the Koyck and related approaches which assume geometrically declining lag coefficients (see Johnston (1972)). Almon does not assume that the length of the lag is known; it is determined by experimentation. In this study, lags of from five to ten quarters were employed in the estimation of (1) and the $\bar{R}^2$ was used as the criterion for choosing the best distributed lag in each case.

The model underlying equation (1) is, of course, extremely simplified, since it implies that Y_t is completely determined by current and lagged values of X. When Y and X refer to the inflation rates of different price indices, the extent of the simplification is evident. The justification of this approach lies in the fact that the nature of the lags in the relationship between consumer and other price indices is of considerable interest in its own right, and is especially useful for short-term forecasting purposes.

The data employed are the quarterly inflation rates of the published price series listed above. CPI and RPI include the effects of indirect taxes and subsidies while the WPI is also affected by some taxes. No attempt has been made to produce indices which are net of taxes and subsidies for the purposes of this study. The

issue of seasonality in the data was not pursued because up to the end of 1974, the *Quarterly Economic Commentary* of the ESRI, which publishes seasonally adjusted quarterly series, indicated the absence of seasonal patterns in Irish price indices. The method of seasonal correction employed by the *Commentary* is that set out in Leser (1965).[1]

III. *The Results*

Equation (1), with a constant term was estimated using lags of from five to ten quarters. With a single exception, which is noted below, the lag patterns displayed

Table 1: *Best distributed lag weights estimated by the Almon procedure*

Dependent Variable		(1) $\dot{CPI}$	(2) $\dot{CPI}$	(3) $\dot{CPI}$	(4) $\dot{CPI}$	(5) $\dot{WPI}$	(6) $\dot{WPI}$
Independent Variable		$\dot{PX}$	$\dot{PM}$	$\dot{WPI}$	$\dot{RPI}$	$\dot{PX}$	$\dot{PM}$
Lag Weights, for quarters	0	0·1591	0·1126	0·2890	0·4970	0·4790	0·1970
		(0·0415)	(0·0332)	(0·0647)	(0·1166)	(0·0560)	(0·0730)
	1	0·0257	0·0861	0·1113	0·4669	0·0190	0·1690
		(0·0347)	(0·0303)	(0·0527)	(0·0789)	(0·0410)	(0·0510)
	2	−0·0293	0·0460	−0·0325	0·2029	−0·1260	0·0260
		(0·0356)	(0·0330)	(0·0510)	(0·1135)	(0·0400)	(0·0680)
	3	0·0422	0·0364	0·0080	−0·0785	0·0877	−0·0990
		(0·0200)	(0·0172)	(0·0233)	(0·1190)	(0·0410)	(0·0820)
	4	0·1544	0·0489	0·1588	−0·2396	0·1981	−0·1523
		(0·0358)	(0·0444)	(0·0505)	(0·1127)	(0·0420)	(0·0983)
	5	0·1980	0·1909	0·1694	−0·1404	−0·0476	−0·0688
		(0·0563)	(0·0826)	(0·0812)	(0·0857)	(0·0590)	(0·0730)
	6	−0·0673	0·0287	0·1988	−0·0383		0·0143
		(0·0922)	(0·0574)	(0·0566)	(0·1247)		(0·1100)
	7		−0·0316	0·0052	0·1927		0·1510
			(0·0914)	(0·0733)	(0·0970)		(0·1080)
	8				0·2983		0·1985
					(0·1451)		(0·1310)
Constant		0·9872	1·0966	0·4418	0·1339	0·5423	1·0113
		(0·1907)	(0·2044)	(0·2629)	(0·3725)	(0·2120)	(0·3891)
Sum of weights		0·4828	0·5180	0·9267	1·1620	0·6102	0·4267
$\bar{R}^2$		0·5946	0·4919	0·6056	0·5472	0·7449	0·2759
D W		2·14	2·00	2·01	1·84	2·25	1·36

Standard errors in parentheses.

1. Since the beginning of 1975, however, a different method has been used which detected a seasonal pattern in the CPI, attributable exclusively to food items, see *Quarterly Economic Commentary*, October, 1975. No allowance has been made for this finding in what follows.

considerable stability as the length of the lag was increased. The sensitivity of $\bar{R}^2$ to the length of the lag varied across the six estimated relationships; the lags which maximised the values of $\bar{R}^2$ are presented in Table 1. The best lags for the relationships between $\dot{CPI}$ and $\dot{PX}$, $\dot{PM}$ and $\dot{WPI}$, respectively, are illustrated in Figure 1, the dot on the variables denoting quarterly proportionate rates of change. Allowing for the fact that a fourth degree polynomial was employed in all cases, the similarity in the shapes of the illustrated lag structures is notable. All three exhibit a peak in the current period's weight and another five to six periods later; $w(5)$ exceeds $w(0)$ in the $\dot{CPI}$-$\dot{PX}$ and $\dot{CPI}$-$\dot{PM}$ relationships. Not surprisingly perhaps, the $\dot{CPI}$-$\dot{WPI}$ relationship provides the highest $\bar{R}^2$ of the three, although it is only marginally higher than that in the $\dot{CPI}$-$\dot{PX}$ case. In the $\dot{CPI}$-$\dot{PX}$ case, $\bar{R}^2$ was highly insensitive to changes in the length of the lag between six and eight quarters; it was most sensitive in the $\dot{CPI}$-$\dot{WPI}$ case, although the lag structure itself was stable. The large t-statistics associated with the constants in columns (1) and (2) of the table are accompanied by sums of weights of about 0·5, while the much lower t-statistics (and size) of the estimated constant in column (3) accompanies a sum of weights of 0·9. In all cases, there is no evidence of autocorrelation in the residuals.

The remaining lag structures are illustrated in Figure 2, which reveals a broadly similar overall pattern, although with much greater variation than is apparent in Figure 1. For example, the $\dot{WPI}$-$\dot{PX}$ and $\dot{WPI}$-$\dot{PM}$ relationships exhibit considerable differences. The former provides the shortest lag structure and highest $\bar{R}^2$ in Table 1, as well as the largest current period weight in the relationships between Irish price indices; the latter provides by far the lowest $\bar{R}^2$ and Durbin-Watson statistic, a long (eight period) lag, and a lag structure more sensitive to changes in the length of the lag than in any other case. The variation in the weights of the $\dot{CPI}$-$\dot{RPI}$ relationship is much greater than that of the others in Table 1, the range being from 0·497 to −0·240, while the weight on the eight-period lag is 0·298.

The implications of these results are now discussed.

IV. *Implications*

While the bimodal nature of the lag structures illustrated in Figure 1 is a reflection of the degree of the polynomial used in the estimation, their marked similarity is an interesting finding and indicates that estimation by means of a Koyck type procedure, which imposes a geometrically declining lag structure, may be inappropriate. The finding may be rationalised in terms of the distinction between consumer goods, goods for further processing and capital goods. It seems reasonable to expect that changes in the import and export prices of consumer goods would be reflected in the $\dot{CPI}$ with a short lag. In the case of food export prices, for example, the transmission mechanism would be almost instantaneous.

The effect of changes in the prices of semi-finished goods, raw materials and capital goods, however, might be expected to operate with longer and varying lags. It is clear that this provides a possible explanation of the structures in Figure 1. In each case, about 40 per cent of the adjustment of *CPI* in a given period is attributable to the current and previous quarter's inflation rate of the appropriate price index, while most of the remainder is attributable to the inflation rates four to six quarters previously. Such lags are certainly not implausible.

The relative performances of the $C\dot{P}I$-$P\dot{X}$ and $C\dot{P}I$-$P\dot{M}$ relationships are somewhat surprising, although a study of Irish inflation using annual data found a stronger relationship between $P\dot{X}$ and the proportionate rate of change of the deflator of personal consumption, net of taxes and subsidies (see Geary and McCarthy (1976)). A partial explanation may lie in the importance of food exports and the relative stability in the prices of raw materials during most of the 1960s. A relationship between *CPI* and both $P\dot{X}$ and $P\dot{M}$ was not estimated, though this is to some extent taken care of in the use of $W\dot{P}I$ as an independent variable. As noted, the performance of $W\dot{P}I$ is only marginally better than that of $P\dot{X}$ although, as might be expected, the sum of the weights is close to one.

The relationships between $C\dot{P}I$ and $R\dot{P}I$ and between $W\dot{P}I$ and $P\dot{M}$ are more difficult to rationalise. While differences between Irish and UK tax and subsidy policies are doubtless a contributory factor, it remains somewhat hard to understand why the weights in the $C\dot{P}I$-$R\dot{P}I$ case should exhibit such severe fluctuations, which lead to a statistically significant estimate of $-0{\cdot}239$ for $w(4)$ and a positive and significant estimate as large as $0{\cdot}293$ for the weight of the *eight*-period lag. It is, of course, a property of the Almon procedure that negative weights can arise but they make little economic sense and indicate a need for further investigation. The weights sum to $1{\cdot}16$, while the constant is small ($0{\cdot}134$) and not significant. The most surprising aspect of the $W\dot{P}I$-$P\dot{M}$ relationship is the very low $\bar{R}^2$; this may be due in part to the fact that the wholesale price index includes the effect of tariffs, while $P\dot{M}$ does not.[2]

V. *Conclusions*

Some of the results presented above are suggestive, but their preliminary nature is evident; others raise problems. Further research is clearly necessary before the estimated relationships could be used for policy and forecasting purposes. This could take a number of forms. Firstly, a disaggregation of the price indices might allow the rationalisations suggested above to be tested; there are sufficient data

2. These results are not strictly comparable with those obtained by Black *et al* (1969). They found that the adjustment of output price to changes in input price was almost complete after four quarters and that the weights peaked in the second or third quarter. This is in contrast to both the $W\dot{P}I$-$P\dot{X}$ and $W\dot{P}I$-$P\dot{M}$ relationships. However, a full examination of the two sets of results is beyond the scope of this paper.

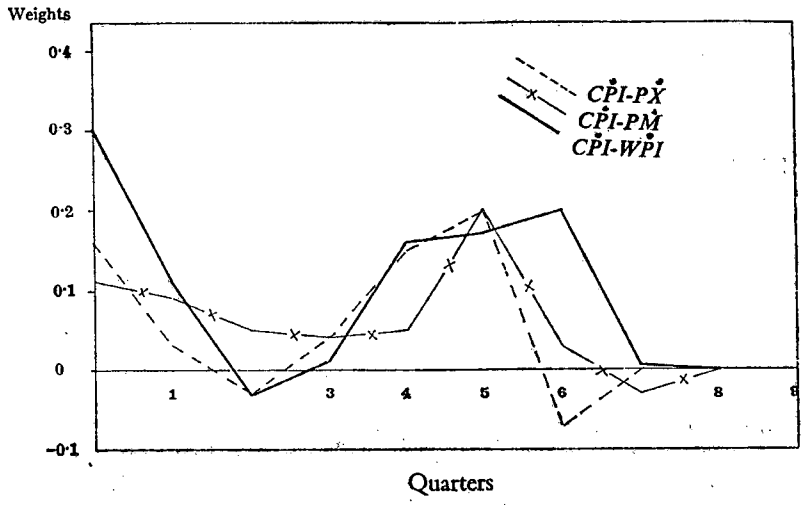

FIGURE 1: *Lags in the relationships of $\dot{CPI}$ to $\dot{PX}$, $\dot{PM}$ and $\dot{WPI}$.*

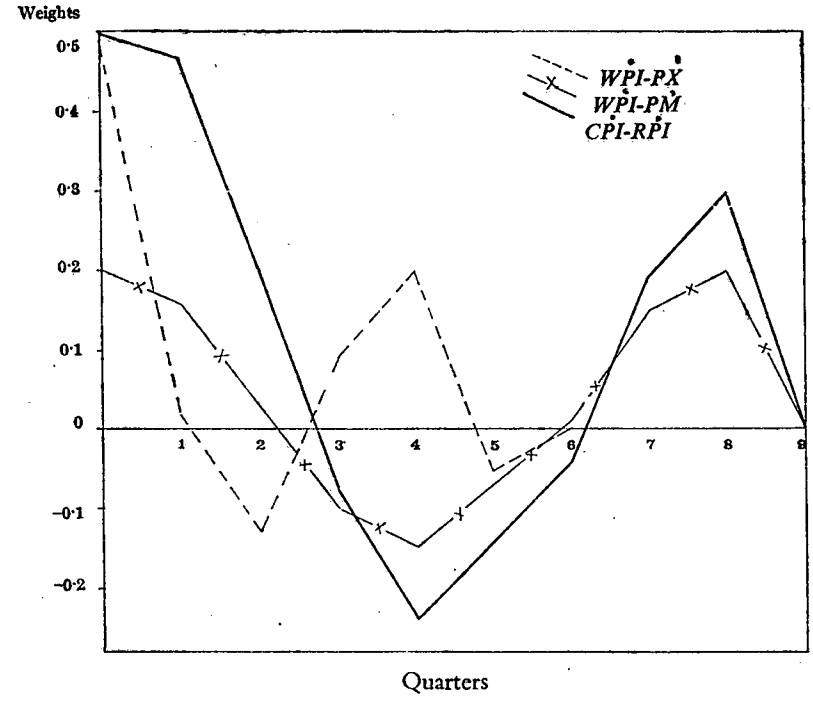

FIGURE 2: *Other Lag relationships*

available to allow some progress in this direction. Secondly, alternative procedures which constrain all weights to be non-negative but not geometrically declining might be applied. Thirdly, the issues of seasonality and the effects of tax changes might be investigated in more detail, perhaps using a longer data series.

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