A Study of Consumer Prices, Part 3

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SECTION 4: A STUDY OF CONSUMER PRICES, PART 3

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§4.1 *Introduction*

This article is the third part of a study of the determinants of consumer prices over the past twelve years. The first part (Quarterly Economic Commentary, Section 4, March 1971) discussed certain influences which might prejudice a regression analysis of the consumer price index, and tabulated a set of indices from which the effects of one of the factors considered—changes in indirect taxes—had been netted out. The second part (Quarterly Economic Commentary, Section 4, Autumn 1971) presented some estimated regression equations which made exclusive use of these "net of tax" indices as dependent variables. While some of the more promising equations in each group were provisionally selected as forecasting tools, no tests of their stability or predictive ability were made. As a sufficiently long period has now elapsed since the end of the sample period to which the equations referred, these tests have now been carried out, and form the main subject of this Part of the Study.

First, however, some further analysis is necessary to complete the range of possible forecasting equations, and to attempt to resolve a paradox which became apparent in sections 4.7 to 4.9 of Part 2. It was shown there, by means of an analysis of simple correlation coefficients, that quarter to quarter percentage changes in the consumer price index may be decomposed into changes in its food and total non-food components. These latter disaggregated indices were shown to be related to different independent variables, and to be little related to each other. Yet when they were subjected to regression analysis the results were not so good as those obtained for the percentage first differences of the overall index (Part 2, Table 4.2). Further refinement in the treatment of the disaggregated indices appears necessary, and is attempted in §4.2 to §4.4.

§4.2 *Disaggregated indices: moving averages*

In the analysis of the overall index (net of tax) in Part 2, it was discovered that smoothing the variables by converting them to 3-quarter moving averages produced considerably better results than working in terms of simple percentage changes. However in the case of the disaggregated indices, only the simple percentage changes were considered. It seems logical to recast the analysis of the disaggregated indices in terms of the percentage changes in the smoothed form of the variables.

Table 4.1 sets out the simple correlations between the percentage changes in the total net of tax index, the disaggregated indices, and the principal explanatory variables, all expressed in 3-quarter moving averages. This table is directly comparable with Table 4.4 in Part 2, which set out the correlations on a simple percentage change basis.

In general, Table 4.1 confirms the impressions gained in Part 2, that there is a considerable divergence between the food components of the index and the non-food. This is shown both by the relatively low correlation between the food and non-food components in part B of the Table and by the differing correlations with independent variables in Part A. The pattern of associations illustrated by Table 4.1 is broadly

TABLE 4.1: CORRELATION COEFFICIENTS

Components of the consumer price index and selected independent variables. Percentage 1st differences, 3-quarter moving averages, 1958 IV to 1970 III.

Variables	Components of Consumer Price Index (all net of tax)				
	All Items	Food	All Manufactures	Non-Food Manufactures	All non-food
A Independent:					
Industrial Earnings—1	.544**	.255	.407**	.611**	.717**
Output per head—1 (smoothed)	−.329*	−.377**	−.363*	−.151	−.135
Wholesale Price Index (Consumer Imports)	.360*	.293*	.332*	.292*	.333*
Unit Value Index (All Imports)	.460**	.381**	.421**	.334*	.397**
(All Imports)—2	.519**	.284*	.410**	.565**	.644**
Agricultural Price Index (Total)	.611**	.663**	.635**	.238	.313*
Overdraft Rate—1 (absolute value)	.560**	.358*	.476**	.566**	.615**
Capacity Utilization Dummy	.093	.048	.081	.146	.156
B Components of CPI:					
All Items	1.000	.888**	.970**	.746**	.785**
Food		1.000	.957**	.378**	.395**
All Manufactures			1.000	.628**	.626**
Non-Food Manufactures				1.000	.945**
All Non-Food					1.000

* Significant at 5%   ** Significant at 1%

what would be expected. Industrial earnings, import prices (all imports) and the bank overdraft rate are all more closely related to non-food than to food items, while the agricultural price index is more closely related to the food index. The capacity utilisation dummy is not significantly related to either index, while the wholesale price index for consumer imports is weakly related with both. The only puzzling feature of the table is that output per head in industry appears to be more closely related (in the "correct" negative direction) with food than with non-food items. There appears to be no satisfactory explanation for this result.

The facts that the values of the correlation coefficients in Table 4.1 are generally higher than those found in Table 4.4 of Part 2, while import prices appear to be related to the price indices in a more logical manner, gives rise to hopes that regression analysis of the disaggregated indices will prove more fruitful in terms of the smoothed series than with the simple series. As in the previous exercise, the similarities between columns 2 and 3 on the one hand and columns 4 and 5 on the other, suggest that the simple disaggregation into a food index and a non-food index should be sufficient to test the utility of a disaggregated approach.

§4.3 *Regression Analysis: Moving Averages of Non-Food Index*

Table 4.2 gives the results of regressing the consumer price index for non-food items on those independent variables to which, judging from Table 4.1, we would expect it to be related.

It is apparent that the degree of explanation achieved is quite high. As in previous regressions, the dominant influence is that of $X1_{-1}$, industrial earnings lagged by

TABLE 4.2: CONSUMER PRICE INDEX, NON FOOD, NET OF TAX PERCENTAGE CHANGES OF THREE QUARTER MOVING AVERAGES

A. *Variables*

Dependent Y = consumer price index, non food, net of tax.
Independent X1 = average weekly earnings in manufacturing industry.
X2 = output per head in manufacturing industry, seasonally corrected.
X3 = unit value index, all imports.
X4 = ordinary overdraft rate of associated banks (level).
X5 = do., percentage change.
X6 = capacity utilisation dummy variable.
X7,8,9 = seasonal dummy variables.

Notes. The period of observations for Y is from 4th quarter 1958 to 3rd quarter 1970. Variables Y, X1, X2, X3, X5 are expressed as % 1st differences of 3 quarter moving averages, X4 is expressed in absolute terms, and X6, 7, 8, 9, are dummy variables.
The subscript −1 after a variable denotes a lag of one quarter, −2 two quarters. The seasonal dummies are included in all equations, but for ease of presentation their significence and coefficients are omitted.

B. *Significance and Fit*

Equation No.	Variables Significant at 1%	5%	10%	25%	Not Significant at 25%	$\bar{R}^2$	F Value	S.E.E.	DW
F1	1_{-1}					.586	17.7	.361	0.53
F2	1_{-1}			2_{-1}		.588	14.4	.360	0.57
F3	1_{-1}			2_{-1}	1_{-2}	.584	12.0	.362	0.61
F4	$1_{-1},3_{-2}$					.707	23.7	.304	0.63
F5	$1_{-1},3_{-2}$		4_{-1}			.726	21.8	.294	0.65
F6	$1_{-1},3_{-2}$		4_{-1}	2_{-1}		.730	19.1	.292	0.69
F7	$1_{-1},3_{-2}$				5	.701	19.3	.307	0.61
F8	1_{-1}	6_{-2}				.614	15.9	.349	0.59
F9	1_{-1}		6_{-2}		2_{-1}	.606	13.1	.352	0.61
F10	$1_{-1},3_{-2}$			2_{-1}	6_{-2}	.718	18.1	.298	0.70
F11	$1_{-2},3_{-2}$		6_{-2}	1_{-2}		.724	18.6	.295	0.68
F12	1_{-1}	4_{-1}	$3_{-2},6_{-2}$		2_{-1}	.748	18.4	.282	0.80
F13	$1_{-1},4_{-1}$	$1_{-2},3_{-2}$ 6_{-2}			$2_{-1},3_{-1}$	.768	16.6	.270	0.87

Notes. $\bar{R}^2$ is the multiple correlation coefficient adjusted for loss of degrees of freedom, S.E.E. is the standard error of estimate, and DW is the Durbin-Watson statistic. The standard deviation of Y is .561.

C. *Regression Coefficients*

Equation No.	$X1_{-1}$	$X1_{-2}$	$X2_{-1}$	$X3_{-1}$	$X3_{-2}$	$X4_{-1}$	X5	$X6_{-2}$	Intercept
F1	.398								−.192
F2	.395		−.073						−.121
F3	.431	−.057	−.081						−.117
F4	.317				.236				−.062
F5	.296				.171	.096			−.656
F6	.294		−.069		.185	.082			−.500
F7	.315				.236		.006		−.064
F8	.385							.122	−.180
F9	.385		−.031					.112	−.150
F10	.310		−.068		.229			.057	.007
F11	.370	−.091			.220			.104	−.068
F12	.284		−.012		.128	.126		.118	−.834
F13	.364	−.136	−.010	−.066	−.146	.160		.157	−1.060

D. *Selected Equations*

F4, F5, F10, F12. See Table 4.4 for coefficients.

one quarter. On its own (except for the seasonal dummies), it yields an adjusted R squared of almost .6, while its coefficient is reasonably stable between equations, ranging from .28 to .43. The latter maximum value is only found when $X1_{-2}$ is also included. This variable is rarely significant, and has always a negative sign. It seems fair to conclude, that its significance is a spurious result attributable to random effects, and to conclude, as before, that the effect of earnings on consumer prices is extremely swift, coming mostly within about eight weeks.

The performance of X2, the productivity variable, is much less satisfactory. Although its sign is always in the right direction, it is never significant at over the 10% level, and it does little to improve the fit of those equations which include it. The substitution of a productivity variable relating solely to non-food industries failed to produce any improvement in the significance of the variable or the fit of the equations. The poor performance of any productivity variable seems surprising when we recall that this factor was highly significant in the moving average regressions of the all items index (Part 2, Table 4.3). However, it is less surprising in the light of Table 4.1 above, which showed it to be more highly related to the food than to the non-food index.

The import unit value index is more encouraging. When lagged two periods it is consistently significant and its coefficient varies from .13 to .24. As with the earnings variable, the addition of a further term, $X3_{-1}$, does more harm than good, and its (insignificant) coefficient is usually negative (e.g., equation F13). Experiments were also made with using the wholesale price index for imported raw material, and a specially constructed unit value index for non-food items only. However, although each of these seems theoretically preferable to the overall unit value index, in practice both proved markedly inferior as explanatory variables in the equations.

The capacity dummy variable, X6, also performs well, especially when lagged two periods, despite its low simple correlation coefficient in Table 6.1. Apart from equation F10, it is moderately significant, and its regression coefficient is stable within the range .10 to .16.

Finally, the interest rate variable, in absolute terms, has a significant and fairly stable coefficient. A problem arises with this variable, however; on inspection of section C of the table, it can be seen that the value of the intercept in each equation normally ranges between —0.2 and zero. However, when $X4_{-1}$ is included in the equation, the intercept falls to —0.5 or below. This change in the level of the intercept is significant at the 5 per cent level. Also it is interesting to note that the average contribution of the interest variable to the predicted value of the dependent variable (i.e. its mean value multiplied by its coefficient) tends to be very similar to the change in the level of the intercept between equations which include or exclude this variable. It may be recalled from Part 2 that the interest rate was included in absolute terms rather than in terms of percentage changes because it was felt that "the general level of the interest rate is more important than small changes in it". But the fluctuations of the intercept term suggest that the apparent significance of this variable may be spurious rather than genuine. As an alternative method of quantifying the effects of interest rates, a variable representing the percentage changes of three-quarter moving averages of them was constructed. This variable, X5, failed to reach significance in any equation tested. It must be concluded, therefore, that while the variable in absolute terms may have some utility in a purely forecasting equation, the evidence for an appreciable structural influence of interest rates on consumer prices remains uncertain.

On the whole, the results of Table 4.2 must be considered reasonably satifactory. The only serious defect is the presence of positive autocorrelation, as evidenced by the low values of the Durbin-Watson statistic. It is possible that some major systematic influence on consumer prices has been omitted from the list of independent variables. If this is the case, there appears little that can be done at present to offset it; since virtually all relevant published series have been tested at some point of the study.*

With this reservation, it seems reasonable to proceed with selecting the most promising equations from Table 4.2 for further testing. In terms of adjusted R squared and standard error of estimate, equation F13 is marginally the most satisfactory. However, apart from the fact that it includes no less than ten independent variables (including the seasonal dummies), not all of the estimated coefficient values are very plausible. The inclusion of two different lagged values of both industrial earnings and the import price index leads to one of the two in each case being insignificant with a negative sign. Besides this, the simple correlations between the single and double lagged forms of these two variables (.476 and .689 respectively), are sufficiently high to warrant the suspicion that extreme multicollinearity is present in the equation.

Accordingly, F12, which contains only a single form of each of the variables examined, appears to be a more appropriate equation to test for predictive value. Because of the doubt expressed concerning the structural value of the absolute value of the overdraft interest rate (X4), it appears sensible to test also equation F10, which excludes this variable. From a practical point of view, the fewer variables contained in an equation, the easier it is to use for actual forecasting, and it has therefore been decided to test equations F4 and F5, which exhibit a reasonable degree of fit with only two and three independent variables (apart from seasonal dummies) respectively.

§4.4 *Regression Analysis, Food Index*

It was found in §4.8 of Part 2 that the analysis of simple percentage changes in the food price index yielded unstable results, and it was suggested that a major reason for this instability could have been the presence of seasonal variation in both the dependent and independent variables.

Analysis of variance demonstrates that in spite of the fact that some items in the index are corrected for seasonality before publication**, significant seasonal variation remains in the food price index. The degree of seasonal variation is small and barely significant in absolute terms, but in dealing with quarter to quarter percentage changes the seasonal variation is both significant and large enough to interfere with the analysis†.

To counteract this seasonality, all variables have been seasonally corrected (following the practice in studies of exports and imports in previous issues of the Quarterly Economic Commentary). Regression analysis has been carried out both in terms of simple percentage first differences and in terms of percentage first differences of 3-quarter moving averages. The results of the former were not particularly satisfactory with regard to either the overall fit of the equations or the stability of the individual regression coefficients. The results obtained from the smoothed data were more satisfactory and a selection of the equations is shown in Table 4.3.

A feature of this table is the inclusion of industrial earnings and productivity as

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* Other variables tested were: the dependent variable lagged; a quadratic form of the earnings variable; a time trend; and an indirect tax variable in case the tax adjustments described in Part 1 of this Study had imparted some bias to the dependent variable. None of these additional variables produced any significant improvement in the fit of the equations.

** See "Irish Statistical Bulletin", March 1969, p. 30.

† The results of the analysis of variance for the food price index were as follows. The format is similar to that used by Leser [3].

continued overleaf

independent variables. As we would expect from Table 4.1*, they are usually significant, though their coefficients display some puzzling characteristics. Unlike earlier tables, the earnings variable is more significant when lagged two quarters rather than one: when both lags are included in the same equation, as with G12 and G13, X4 loses significance altogether. Furthermore, the productivity variable is normally more significant than the earnings one, and its coefficient is usually greater in absolute value. The only exception to this is equation G3, where $X4_{-2}$ and $X5_{-1}$, the only variables included, have coefficients which are equal and of opposite sign. Moreover, if productivity in the food industries is substituted for productivity in all manufacturing industry, the variable loses all significance, implying that it is productivity in non-food industries which is the relevant factor. It would appear therefore that productivity is not here acting as a negative and relatively minor offset to the influence of industrial earnings on consumer prices, but rather as an independent influence in its own right, although the reason for this is difficult to establish on the grounds of economic theory. Even if industrial productivity is acting as a proxy for general economic expansion, it is not altogether clear why this should exert a strong downward pressure on food prices.

Turning to the other independent variables, it is evident that the most important of all are those representing agricultural prices. This is in accordance with expectations, and with the results of regressions using quarter to quarter changes of uncorrected data (Part 2, Table 4.5). Unlike the earlier results, however, the agricultural price index for all items is marginally superior to that for livestock alone (compare equations G5 and G6). When both are included together, as in equation G13, their high mutual correlation (.955) causes both to lose significance. In a number of equations not shown in the table, different lags of these variables were tested. In all cases a lag of one period gave the best results. When more than one lag was included in the same equation the degree of multicollinearity appeared to become excessive, and one of the

Consumer Price Index, food items net of tax, 1958-70	F-ratio		Residual Coefficient of Variation %
	Between years	Between quarters	
Absolute levels	188.9++	4.1+	1.90
Percentage quarter-to-quarter changes	1.5	15.7++	173.9

+F-value significant at 5%
++F-value significant at 1%
While both forms of the index exhibit significant seasonal variation, after correcting for variation between years, the between quarter F-value for the absolute index is little greater than could be expected as a result of a trend effect on variation between quarters. With 14 years in the sample, even if no genuine seasonal variation were present, this trend effect could be expected to yield a between quarters F-ratio equal to 2.08% of the between years F-ratio, that is, a value of 3.9.

*It should be emphasised that none of the variables in Table 4.1 is seasonally corrected (with the exception of industrial output per head). The corresponding simple correlation coefficients between the seasonally corrected values of the food price index and relevant independent variables have been calculated. While they tend to exhibit a slightly higher degree of correlation than the raw data, they in no way alter the general pattern illustrated in Table 4.1.

TABLE 4.3: CONSUMER PRICE INDEX, FOOD, NET OF TAX, SEASONALLY CORRECTED, PERCENTAGE CHANGES OF THREE QUARTER MOVING AVERAGES.

A. *Variables*

Dependent Y = consumer price index, food items, net of tax, seasonally corrected.
Independent X1 = agricultural price index, all items, seasonally corrected.
X2 = agricultural price index, livestock, seasonally corrected.
X3 = unit value index, imports of food, drink and tobacco, seasonally corrected.
X4 = average weekly earnings in manufacturing industry, seasonally corrected.
X5 = output per head in manufacturing industry, seasonally corrected.

Notes. The period of observation for Y is from 4th quarter 1958 to 3rd quarter 1970.
All variables are expressed as % 1st differences of 3 quarter moving averages of seasonally corrected data.
The Subscript −1 after a variable denotes a lag of one quarter, −2 two quarters.

B. *Significance and Fit*

Equation No.	Variables Significant at 1%	5%	10%	25%	Not Significant at 25%	$\bar{R}^2$	F value	S.E.E.*	DW
G1		4_{-1}				.116	7.2	.948	0.66
G2	$4_{-1},5_{-1}$					.273	9.8	.859	0.59
G3	$4_{-2},5_{-1}$					.357	14.0	.808	0.62
G4	1_{-1}					.494	46.9	.717	0.88
G5	$1_{-1},4_{-2}$					.574	32.7	.657	1.07
G6	$2_{-1},4_{-2}$					.562	31.1	.667	0.97
G7	3					.143	8.9	.933	0.63
G8	$4_{-2},3$					.322	12.2	.829	0.80
G9	5_{-1}	$3_{-1},4_{-1}$				.336	8.5	.821	0.72
G10	1_{-1}		4_{-1}		3_{-1}	.515	17.7	.701	0.96
G11	$1_{-1},5_{-1}$	4_{-1}		3_{-1}		.685	26.6	.566	1.26
G12	$1_{-1},5_{-1}$	4_{-2}		3_{-1}	4_{-1}	.709	23.9	.543	1.30
G13	5_{-1}	4_{-2}	3_{-1}	$1_{-1},2_{-1}$	4_{-1}	.711	20.3	.541	1.20
G14	$1_{-1},4_{-2},5_{-1}$			3_{-1}		.716	30.6	.537	1.30
G15	$1_{-1},4_{-2}$ 5_{-1}					.711	39.6	.541	1.28

* Standard Deviation of Y = 1.006.

C. *Regression Coefficients*

Equation No.	$X1_{-1}$	$X2_{-1}$	X3	$X3_{-1}$	$X4_{-1}$	$X4_{-2}$	$X5_{-1}$	Intercept
G1					.343			.096
G2					.330		−.521	.610
G3						.458	−.458	.343
G4	.566							.370
G5	.488					.313		−.144
G6		.304				.373		−.163
G7			.474					.547
G8			.372			.445		−.217
G9				.341	.252		−.505	.611
G10	.583			−.148	.189			.059
G11	.589			−.177	.181		−.515	.566
G12	.556			−.158	.020	.251	−.480	.396
G13	.286	.206		−.262	.048	.269	−.470	.364
G14	.555			−.154		.266	−.478	.404
G15	.494					.259	−.473	.392

D. *Selected Equations*

G14, G15. See Table 4.4 for coefficients.

lags normally yielded a negative coefficient. By thus eliminating the alternatives, it appears that the best representation of agricultural prices is the inclusion of $X1_{-1}$ alone.

The only remaining influence tested was that of import prices for food, drink and tobacco. When included on its own or with earnings and productivity this variable was significant and had the correct sign, whether in current or lagged form. However, when agricultural prices were included in the same equation (numbers G10 to G14), its significance fell markedly, and it reversed its sign. This would suggest that it was erroneously picking up some of the significance of agricultural prices.

Overall, the equations explain the dependent variable well, though, as in Table 4.2, this is marred by the very high level of positive autocorrelation. The equation with the best fit is G14. However this includes $X3_{-1}$, which, as just discussed, has an implausible negative sign. Therefore, equation G15 is also chosen for further testing.

§4.5 *Stability Tests*

A total of twelve equations have been selected in this article and in Part 2 of the study for further testing. The selected equations are set out in Table 4.4. For convenience a common numbering system for the independent variables has been adopted for this table. Some of the equations may therefore appear slightly different from the form in which they were first presented.

The principal object of the study is to obtain suitable models for forecasting purposes. The forecasting ability of the equations is therefore tested directly below, with respect to the quarters which have elapsed since the end of the period to which the equations refer. First, however, a different test is applied, in order to ascertain whether the equations refer with equal validity to all parts of that period.

It may be remembered that Part 1 of this study suggested two points at which a significant shift in the relationship between the consumer price index and other economic variables might have taken place: October 1965, when price control was introduced, and November 1968, when the index itself was revised.* It is worth testing, therefore, whether the coefficients of our selected equations vary significantly between the sub-periods concerned. In addition, the results of these tests will indicate how useful these equations might be in forecasting future price movements.

The tests reported below were carried out by re-estimating the selected equations for the different sub-periods, and testing the stability of the coefficients, using the Chow test.** The results are set out in Table 4.5.

In general, the relatively low F-values indicate that the coefficients of the equations being tested are reasonably stable as between the different pairs of time-periods.† Most of the significant F-values (indicating unstable coefficients) appear when one of the sub-periods being tested is that from the first quarter of 1969 to the

*The discontinuity at this point might be significant, even though the discussion of the alleged "bias" due to the revision of the index was in error (see the introductory note to Part 2 of this study). In addition, a further source of discontinuity at this point is the fact that the quarterly data on earnings and productivity for all years up to and including 1968 are final, whereas those for 1969 and 1970 are subject to revision. It is worth testing, therefore, whether the coefficients of our selected equations are significantly altered when the observations on the unrevised data are excluded.

**See Johnston: [3] pp. 136-8 for an exposition of this test.

†For example, equation B5 for the period 1958 IV to 1965 III is

$$Y_c = -0.232 + .329X1_{-1} + .307X4 + .496X7 + 1.605X8 - 1.082X9$$

while for the period 1965 IV to 1970 IV it is

$$Y_c = -0.113 + .269X1_{-1} + .222X4 + .344X7 + 1.312X8 - .205X9$$

TABLE 4.4: EQUATIONS SELECTED FOR TESTING

Dependant Variables

Y = consumer price index, all items, net of tax simple, % changes.
Y^s = consumer price index, all items, net of tax, % changes of 3 quarter moving average.
Y^n = consumer price index, non-food items, net of tax, simple % changes.
Y^{ns} = consumer price index, non-food items, net of tax, % changes of 3 quarter moving average.
Y^{fs} = consumer price index, food items, net of tax, seasonally corrected, % changes of 3 quarter moving average.

Independent Variables

X1 = average weekly earnings in manufacturing industry.
X2 = output per head in manufacturing industry (smoothed).
X3 = unit value index, all imports.
X4 = unit value index, imports of food drink and tobacco.
X5 = agricultural price index, all items.
X6 = ordinary overdraft rate of associated banks.
X7 = capacity utilisation dummy variable.
X8,9,10 = seasonal dummy variables.

Notes. The subscript $_{-1}$ after a variable denotes a lag of one quarter, $_{-2}$ two quarters. Variables X1, X3, X4, X5, are expressed in the same form as the dependent variable in each equation (e.g. simple % change, smoothed % change seasonally corrected, etc.). X2 is smoothed and seasonally corrected in all equations, X6 is in absolute values, smoothed or not as appropriate, and X7,8,9,10 are dummy variables with a value of either 1 or 0.

Tested Equations

B5. $Y = -0.203 + .312\,X1_{-1} + .226X3 + .412X8 + 1.504X9 - .725X10.$

B10. $Y = -.615 + .239X1_{-1} + .148X3 + .134X5_{-1} + .141X6_{-1} - .257X8 + .517X9 - 1.070X10.$

C3. $Y^s = -0.707 + .234X1_{-1} - .197X2_{-1} + .245X5_{-1} + .131X6_{-1} + .423X8 - .045X9 + .292X10.$

C5. $Y^s = -0.842 + .173X1_{-1} + .012X1_{-2} - .194X2_{-1} + .047X3_{-2} + .150X5 + .116X5_{-1} + .143X6_{-1} + .124X7_{-1} + 302X8 + .331X9 + .398X10.$

E5. $Y^n = 0.429 + .295X1_{-1} + .152X3_{-2} - .573X8 + .381X9 - .556X10.$

E7. $Y^n = -0.601 + .268X1_{-1} + .107X3_{-2} + .154X6_{-1} - .527X8 + .331X9 - .483X10.$

F4. $Y^{ns} = -0.062 + .317X1_{-1} + .236X3_{-2} + .376X8 + .160X9 + .366X10.$

F5. $Y^{ns} = -0.656 + .296X1_{-1} + .171X3_{-2} + .096X6_{-1} + .346X8 + .150X9 + .351X10.$

F10. $Y^{ns} = 0.007 + .310X1_{-1} - .068X2_{-1} + .229X3_{-2} + .057X7_{-2} + .362X8 + .164X9 + .388X10.$

F12. $Y^{ns} = -0.834 + .284X1_{-1} - .012X2_{-1} + .128X3_{-2} + .126X6_{-1} + .118X7_{-2} + .320X8 + .150X9 + .370X10.$

G14. $Y^{fs} = 0.404 + .266X1_{-2} - .478X2_{-1} - .154X4_{-1} + .555X5_{-1}.$

G15. $Y^{fs} = 0.392 + .259X1_{-2} - .473X2_{-1} + .494X5_{-1}.$

last quarter of 1970. Since this period has only 8 (or, in the case of the moving average regressions, 7) observations, it evidently provided an extremely stringent test of stability. The fact that many of the equations appear to have fairly stable coefficients over even this short period is therefore highly encouraging.

A further point to note from the table, is that most of the equations which are significantly unstable over more than one pair of time-periods have the consumer price index for non-food items as dependent variable (whether in first difference or moving

TABLE 4.5: TESTS OF STABILITY OF SELECTED EQUATIONS

Equation	Dependent Variable	F-value between sub-periods			
		1958 IV–1965 III 1965 IV–1970 IV	1958 IV–1968 IV 1969 I –1970 IV	1958 IV–1965 III 1965 IV–1968 IV	1965 IV–1968 IV 1969 I –1970 IV
B5	Consumer price index, all items, net of tax, % 1st differences	0.77	1.04	0.69	1.21
B10	do.	1.67	0.82	2.43*	3.12*
E5	Consumer price index, non-food items, net of tax, % 1st differences	1.15	3.30**	1.15	1.63
E7	do.	1.41	1.95	1.48	0.74
Equation	**Dependent Variable**	1958 IV–1965 III 1965 IV–1970 III	1958 IV–1968 IV 1969 I –1970 III	1958 IV–1965 III 1965 IV–1968 IV	1965 IV–1968 IV 1969 I –1970 III
C3	Consumer price index, all items, net of tax, % 1st differences of 3 quarter moving averages	1.37	0.39	1.34	0.54
C5	do.	3.12**	1.12	1.96	0.29
F4	Consumer price index, non-food items, net of tax, % 1st differences 3 quarter moving averages	0.92	3.21*	1.60	7.33**
F5	do.	2.46*	1.97	2.25	2.75
F10	do.	0.83	3.04*	0.86	3.66*
F12	do.	1.49	2.34*	0.97	1.90
G14	Consumer price index, food items, net of tax, seasonally corrected, % 1st differences of 3 quarter moving averages	0.88	0.70	1.41	3.88*
G15	do.	0.28	0.46	0.22	0.66

*F-value significant at 5%
**F-value significant at 1%

Note: A high F-value indicates that the coefficients of the equation being tested vary significantly between the two sub-periods.
A zero F-value would indicate identical coefficients.

average form). It must be concluded that this variable is less well explained than the all items and food indices, in the sense that the coefficients of the variables on which it is regressed are not so stable over adjacent time-periods. This further implies that less can be expected in terms of forecasting ability from these equations, than from those dealing with the food or all item indices.

§4.6 *Forecasting Tests*

Turning from tests of stability to a more direct test of forecasting ability, Tables 4.6 and 4.7 compare the actual changes in the relevant dependent variables, with the out-turn predicted by the selected equations for quarters outside the sample period to which the equations referred. The tables also show the actual levels of the dependent variable for the most recent quarter available (at time of writing), compared with the predicted levels calculated by two alternative methods. The first method, leading to level A, applies the calculated percentage changes from the first four columns of the table to the actual level in the last quarter of the equation's sample period. This provides a stringent test of predictive ability; however this procedure is not usually feasible in practice, since it requires detailed knowledge (or, at worst, accurate prediction) of the future time-path of all the independent variables. A simpler procedure, though with less theoretical justification, leads to the predicted level B. This simply calculates a predicted annual percentage change in the dependent variable, by applying the regression coefficients of the relevant equation to the actual annual percentage changes in the independent variables, and adding four times the intercept to the total. This is a much more practical method of forecasting, since to predict the dependent variable a year in advance, it only requires assuming values for the year-on-year changes in the independent variables. Finally, the last column of the tables gives the Verdoorn and van Eijk "Inequality Coefficient" for each equation.* This is a measure of the accuracy of the predictions in the first four columns, calculated by taking the ratio of the average (root mean square) error of forecast to the average actual percentage change over the period.

The first point to be remarked on from Tables 4.6 and 4.7 is the relatively high level of explanation attained by all the equations. None of the predicted quarter-to-quarter percentage changes diverges very markedly from the corresponding actual changes, and the value of the inequality coefficient is substantially below 0.5 in nearly all cases.

While the degree of prediction is reasonably high, it should be noticed that there is a pronounced tendency towards underestimation rather than overestimation of changes. This could imply either that a fundamental shift in the underlying relationship has taken place in the period, or that some powerful temporary factor has acted on prices in 1971. The evidence, however, is too scanty to permit such a definite conclusion to be drawn: this must await further tests such as those shown in Table 4.5 above, when more data becomes available.

The final point to be noticed from the tables, is the close correspondence between levels A and B for each equation. This is an encouraging result from the viewpoint of practical forecasting, since it implies that the relatively naive method of prediction underlying the B levels may be no less efficient than the more orthodox procedure from which the A levels are calculated. Of course it is possible that the relatively smooth movement of the consumer price index over the forecasting period is responsible for this, and that the B level would not be as efficient in predicting turning points in the index. In the absence of relevant evidence, however, use of the more convenient B method would appear to be justified in normal circumstances.

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*For a discussion of this statistic, see Quarterly Economic Commentary, December 1970, page 21, and the references cited therein.

TABLE 4.6: FORECASTING TESTS OF SELECTED EQUATIONS: PERCENTAGE CHANGES

Dependent Variable		1971						Inequality Coefficient
		Percentage quarter to quarter changes				Level of Index in 1971 IV		
		I	II	III	IV	Level A	Level B	
B. Consumer Price Index, All Items, Net of Tax Actual (1970 IV=175.1)		1.77	2.64	2.13	2.25	191.0		
Predicted by equation	B5	1.96	1.89	0.53	1.23	185.1	185.3	.46
	B10	2.15	2.50	0.72	1.42	187.3	187.3	.38
E. Consumer Price Index, Non-Food Items, Net of Tax Actual (1970 IV=178.6)		1.57	2.54	2.20	2.26	194.4		
Predicted by equation	E5	0.89	1.16	1.64	2.04	189.1	189.2	.38
	E7	1.26	1.48	1.81	2.17	190.9	190.9	.27

Notes: Predictions for each quarter are based on the actual changes of the relevant dependent variables.
Level A is the value of the index for mid-November 1971 calculated by cumulating the percentage changes in the first four columns, and applying the result to the actual level of mid-November 1970.
Level B is obtained by applying the regression coefficients to the annual percentage changes in the independent variables.
The inequality coefficient measures the forecasting ability of the equation in question.

TABLE 4.7: FORECASTING TESTS OF SELECTED EQUATIONS: MOVING AVERAGES

Dependent Variable		Percentage Changes of 3-Quarter Moving Averages, 1971				Level of Index (Moving Average) in 1971 IV		Inequality Coefficient
		I	II	III	IV	Level A	Level B	
C. Consumer Price Index, All Items, Net of Tax								
Actual (1970 IV=174.9)		2.19	2.18	2.34	2.30	191.2		
Predicted by Equation	C3	2.18	1.69	1.59	1.20	186.8	186.9	.29
	C5	2.03	1.66	1.44	1.37	186.5	186.6	.29
F. Consumer Price Index, Non-Food Items, Net of Tax								
Actual (1970 IV=177.8)		2.34	2.11	2.33	2.03	194.0		
Predicted by Equation	F4	1.68	1.34	1.79	1.60	189.5	189.7	.27
	F5	1.82	1.49	1.85	1.65	190.3	190.4	.23
	F10	1.62	1.25	1.72	1.44	188.8	188.9	.31
	F12	1.70	1.37	1.72	1.48	189.2	189.3	.28
G. Consumer Price Index, Food Items, Net of Tax, Seasonally Corrected								
Actual (1970 IV=171.1)		1.56	1.86	2.83	3.32	188.0		
Predicted by Equation	G14	2.18	1.61	1.63	1.29	182.7	182.9	.50
	G15	2.37	1.66	1.63	1.21	182.9	183.1	.53

See Notes to Table 4.6.

§4.6 *Summary and Conclusions*

In concluding this study it is worth emphasising once more that its main concern has been with identifying empirical relationships of sufficient stability to form the basis of usable models for short-term forecasting of consumer prices. This is a rather different orientation from previous works in this area which attempted to identify the structural relationships linking wages, industry output prices and consumer prices. This is not to say that the present study throws no light on some of the relationships—on the contrary, it has led to some interesting conclusions, which are summarized below. However, no attempt has been made to discriminate between or test different hypotheses about the underlying causes of inflation: ranging from the conjecture that Ireland's experience can be explained in terms of a Phillips curve analysis of the labour market* (O'Herlihy [6] and Cowling [1]), through Smith's suggestion that progessive taxation may accelerate inflation [7] to the Mulvey-Trevithick wage leadership hypothesis [4]. An adequate comparison of these alternative theories must await both further theoretical elaboration and probably a more elaborate process of statistical testing than that adopted here.

With these reservations about the limited aim of the present study, the following would seem to be its most interesting conclusions:

1. By a direct comparison of changes in indirect tax rates and concomitant changes in the components of the consumer price index, a group of indices were constructed which reflect the increase in consumer prices between mid-February 1958 and mid-November 1970 exclusive of the direct impact of changes in indirect taxation. These indices make no allowances for the secondary effects of tax changes nor do they correct for changes in local authority rates; in addition the estimation methods used are relatively crude. Nevertheless they almost certainly provide a good approximation to the true trend of consumer prices net of indirect taxation over the period. Consequently they have been used exclusively as dependent variables in the regression analysis of Parts 2 and 3 of this Study.

2. As well as providing useful material for econometric study, these indices are also of direct interest in themselves. Thus it was possible to estimate that 22.8% of the total increase in consumer prices between February 1958 and November 1970 is directly attributable to increases in indirect taxes. This figure varies greatly between commodity groups, with drink and tobacco and (to a lesser extent) durable household goods and transport being the groups most subject to indirect taxes. These conclusions have obvious implication for fiscal policy, especially since it appears that virtually all of a given tax change is passed on almost immediately to the consumer and so has an immediate impact on the consumer price index.

3. Turning to the results of regression analysis, no attempt was made to develop forecasting models with the data cast in absolute value terms, because of the high degree of multicollinearity between all variables and because the focus of interest in forecasting is on changes in rather than absolute levels of the consumer price index. Instead, equations were fitted to the percentage changes of both the quarterly level and the three-quarter moving average of the all items consumer price index and quite satisfactory results were obtained. Among a large list of independent variables, the rate of change of average weekly earnings in manufacturing industry and of the agricultural price index were consistently significant. Their estimated coefficients suggest that a 1% increase in those variables will tend to be followed by increases of about 0.3% and 0.25% in the consumer price index, after lags of eight weeks and three months respectively. Other variables which were moderately significant were the

*See [5] pp. 68-76 for a recent attempt to fit Phillips-type curves to data on six OECD countries, and for further references.

commercial banks' ordinary overdraft rate and a dummy variable for capacity utilization in transportable goods industries. These results imply that the rate of price inflation tends to accelerate in times of high interest rates, and of high levels of capacity utilization. Finally, a number of different variables representing productivity in manufacturing industries and import prices failed to give conclusive evidence of stable and measurable links between these influences and the consumer price index, although in most cases the signs for these variables were in the right direction.

4. The next stage of the study attempted to discriminate between the determinants of different components of the consumer price index. Both a study of the matrix of simple correlation coefficients of the data, and the results of subsequent regression analysis, revealed a significant dichotomy between movements in the food and total non-food components. The former was related more to agricultural prices, and the latter more to industrial earnings, the rate of capacity utilization, and the level of interest rates, while the two indices did not move very closely together. A curious result, for which no satisfactory explanation has been found, is that changes in productivity were significant in the food equations but not in the non-food ones. Finally the food items index was subject to substantial seasonal variation despite the fact that some corrections are made for seasonal influences in calculating it, and consequently our analysis had to make use of seasonally corrected data before meaningful results were obtained.

5. The final part of the study involved further testing of those estimated equations which were selected as the most promising. When the Chow test was applied to the equations, no evidence of serious instability in their coefficients over the original sample period was adduced. The second test procedure, which involved comparing the actual values of the dependent variables for quarters subsequent to the sample period with the values predicted by the equations, also gave satisfactory results. It is therefore concluded that the equations, when used with care, could provide a usable method of obtaining consumer price forecasts compatible with given assumptions concerning the major independent variables.

One final point to note is that the performance of the all items index equations was actually better than the performance of the equations referring to the components of the index. It would appear that, from a forecasting point of view, there is little to be gained by considering the different components of the consumer price index separately.

In conclusion, this study has tried to contribute to a deeper understanding of linkage between such variables as earnings and input prices and the consumer price index, and has developed some simple forecasting models as an aid in predicting future price movements. No attempt has been made, however, to elucidate the structural process of price determination at the macro level: further progress in this area will require the specification of more comprehensive models as well as the use of more elaborate estimating methods.

REFERENCES

(1) Cowling, K. 'Determinants of Wage Inflation in Ireland', E.S.R.I. Paper No. 31.

(2) Johnston, J. *Economic Methods* (McGraw-Hill, 1963).

(3) Leser, C. E. V. 'Seasonality in Irish Economic Statistics', E.S.R.I. Paper No. 26.

(4) Mulvey, C. and Trevithick, J. 'Wage Inflation and Wage Leadership in Ireland 1954-69'. Chapter VIII of A. A. Tait and J. A. Bristow (eds.). *Ireland—Some Problems of a Developing Economy* (Gill and Macmillan, 1972).

(5) O.E.C.D. 'Inflation—The Present Problem', 1970.

(6) O'Herlihy, C. St. J. "A Statistical Study of Wages, Prices and Employment in the Irish Manufacturing Sector', E.S.R.I. Paper No. 29.

(7) Smith, L. 'Direct Taxation and the "English Disease"—A Prime cause of inflation?' Studies, 60, Autumn-Winter, 1971.