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A Statistical Study of Wages, Prices and
Employment in the Irish Manufacturing Sector

by

C. St.J. OHERLIHY

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INTRODUCTION

This paper is concerned with the estimation of certain economic relationships in the Irish economy. It seems important that attempts be made to put figures on relationships believed to exist (for instance between the level of unemployment and annual changes in earnings) rather than to speculate on these relationships. This study tries to do this but it is important to emphasise that this is an exercise in statistics and that the statements made about these relationships are essentially probability statements. This means that the degree of certainty attached to any set of figures in this study is far from being of the same order as found in, say, calculations of future eclipses. As it would be tedious to repeat this qualification at almost every step in the paper the author trusts it will be borne in mind. The figures we get may be more usefully regarded as fairly reliable orders of magnitude. This study was completed in the summer vacation of 1964 and the author realises only too clearly that it is an exploratory venture and as such cannot be expected to provide complete answers on the topics covered. But it is hoped that it provides a useful starting point for further studies.

We now survey the work done in the paper and also discuss the methodological approach used.

The paper attempts two things; first it provides an explanation of wage and price determination for the Irish manufacturing sector; and secondly, it estimates short run relationships explaining quarterly movements in prices and employment.

We are concerned with the factors that determine wage increases from year to year. An empiric examination provides measures of the influence of unemployment, consumer prices, productivity and British labour market factors. One of the important

questions examined is to what extent British influences determine Irish wage levels? We also examine the factors that determine levels of industry output prices. The short run relationships estimated should be of assistance in forecasting movements in industry output prices, retail prices, and manufacturing employment up to a year ahead. Clearly, reliable short run forecasts are necessary for policy decisions.

The paper is broken into eight sections: the first, demonstrating the method of short run analysis, examines the relationship between employment and total hours worked on the one hand and output on the other; the second describes the system of wage price interaction; the third examines in some detail wage determination; the fourth, a small section, considers emigration in relation to wage determination theories; the fifth examines the factors influencing industry output prices; the next which is also short, considers retail price movements and in the seventh section the results of the paper are summarised with some discussion. (This last section is recommended to those who only wish to know the 'tenative' answers.) Section eight includes an appendix on time lags as well as tables of the data used and their sources.

The wages data we examine are hourly earnings in the Transportable Goods Industry; the employment, hours worked and output statistics also relate to the Transportable Goods Industry. The industry output price used is the wholesale price index for industry output and we use the consumer price index to measure retail prices. Analyses of annual data generally cover the period 1953 to 1963, while quarterly data is analysed from 1954 to 1963. The coverage of some of these series is not identical and pose problems of interpretation. (This matter is discussed in Section 8.) We are obliged to use series which do not have the exact coverage required because they are the best readily available. Although

the Central Statistics Office provides statistics for Irish Manufacturing Industry which are rich by any country's standard, the author understands that this paper is the first statistical analysis undertaken on them. It may be well to emphasise that on these hitherto uncharted seas we have used a very experimental approach.

Methodological approach

Fundamentally we have tried to quantify in the form of an equation the behavioural relationship between a set of determining factors (called independent variables) and a determined (or dependent) variable. Thus we express the current level of employment in the Transportable Goods Industry (E) as being functionally dependent on the current level of output (Z) in that industry, the current level of productivity (D) and so on. If we postulate a linear relation then we have

$$E = aZ + bD + \ldots$$

This will mean that if Z increases 10 units then E will increase simultaneously by $10a$ units all other factors (D, etc.) remaining unchanged. Most of the work of practising econometricians postulates linear relationships as these have been found to be quite satisfactory. The paper is largely presenting and interpreting some 96 linear relationships estimated from Irish data. The reason why so many were estimated is that we were testing quite empirically what would happen if we tried to explain our dependent variables (wages, industry output price, retail price level, employment) by introducing a variety of determining factors one at a time. Thus for equations explaining wages (Table 3) we have some which include productivity, GB level of real wages and GB level of unemployment. This procedure enabled us to see the net effect of adding an extra variable; of whether it added significantly to the explanation and whether its coefficient was stable. To make this kind of judgement we are dependent on the technique of estimation used to provide us with the equations.

The technique used for estimating these linear relationships was normally the method of ordinary least squares. Essentially this is a method of choosing a line which best fits the data. The criterion—as to best fit—is as follows: we wish to express x as a linear function of y, w, z . . . . which are called independent variables. For coefficients of y, w, z . . . say a, b, c, . . . we get a calculated x_c which is equal to $x_c = ay + bw + cz$ . . . . The difference between the actual and calculated values, $(x - x_c)$ is often called the residual. By varying the values of the coefficients a, b, c . . . different values of the residuals will result. Our criterion is that the best set of $(a, b, c \ldots)$ will yield the smallest possible sum of the squares of the residuals. Under fairly strict assumptions this method will yield consistent estimators of the coefficients of the linear relationships. This means broadly that for large samples our estimate of a coefficient will be close to the "true" value with a high degree of probability. Attention is focused throughout this paper on the values the regression coefficients attain[*] which can be justified if the conditions associated with the method held. These would include as important absence of multi-collinearity and the independence of the stochastic processes generating the independent variables on the one hand and the "error in the equation" on the other. As large numbers of variables are used which are highly intercorrelated the problem of multi-collinearity arises. The regular inclusion of a trend variable tends to reduce this since in accordance with Frisch's Law the coefficients of the other variables are identical with those which would be found had trend been removed from the variable beforehand. Although there is extremely high correlation between primary and lagged variables in the quarterly regressions, use is made of the sum of their regression coefficients which overcomes this difficulty.

The computations were carried out on the Elliott 803 computer at An Foras Talúntais using a stepwise multiple regression programme entitled M—2. The author wishes to acknowledge the vital assistance he received from Mr. Harrington and his colleagues at An Foras Talúntais.

1. SHORT RUN RELATIONSHIPS BETWEEN EMPLOYMENT AND TOTAL HOURS WORKED AND OUTPUT

(a) Short Run Relationships

In economic affairs an effect often takes place sometime after the cause. This difference in timing is called a time lag. A fall in the price of ducklings would be followed some four months later by a fall in the market supply of ducklings—four months being the approximate rearing time of ducklings. Normally, however, the effect does not take place

after a specific time lag but is spread over a period of time; and this difference in timing is called a distributed time lag. Thus if the price of cigarettes

[*]However Geary in "Some remarks about . . . document", ERI Reprint No. 7, would only accept the type of statement made above (if Z increases 10 units, E increases by (10a) units, all other factors remaining unchanged) only if Z were uncorrelated with D and the other independent variables. The author would think this too extreme an interpretation.

CHART I

(a) TRANSPORTABLE GOODS INDUSTRY
Employment, Hours Worked and Output
Quarterly 1954–63
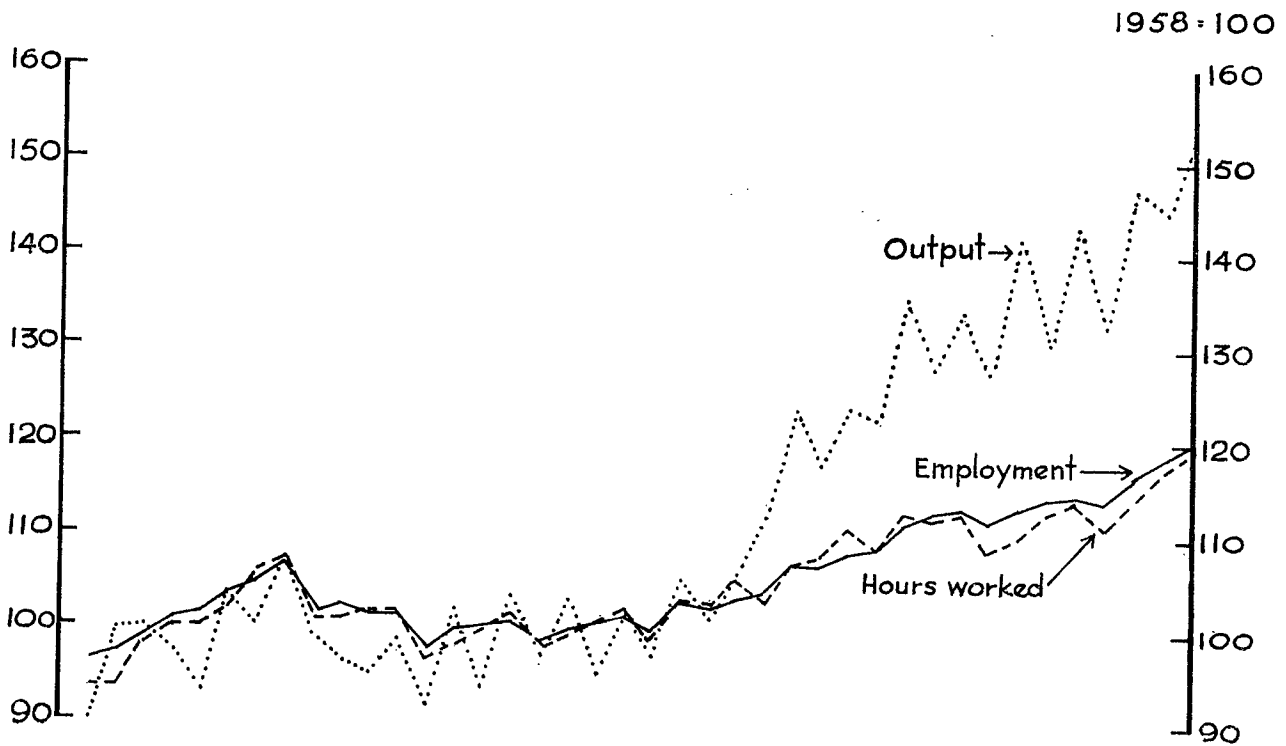
(b) WAGE PRICE DATA
Wages (Hourly Earnings), Industry Output Price, Retail Price
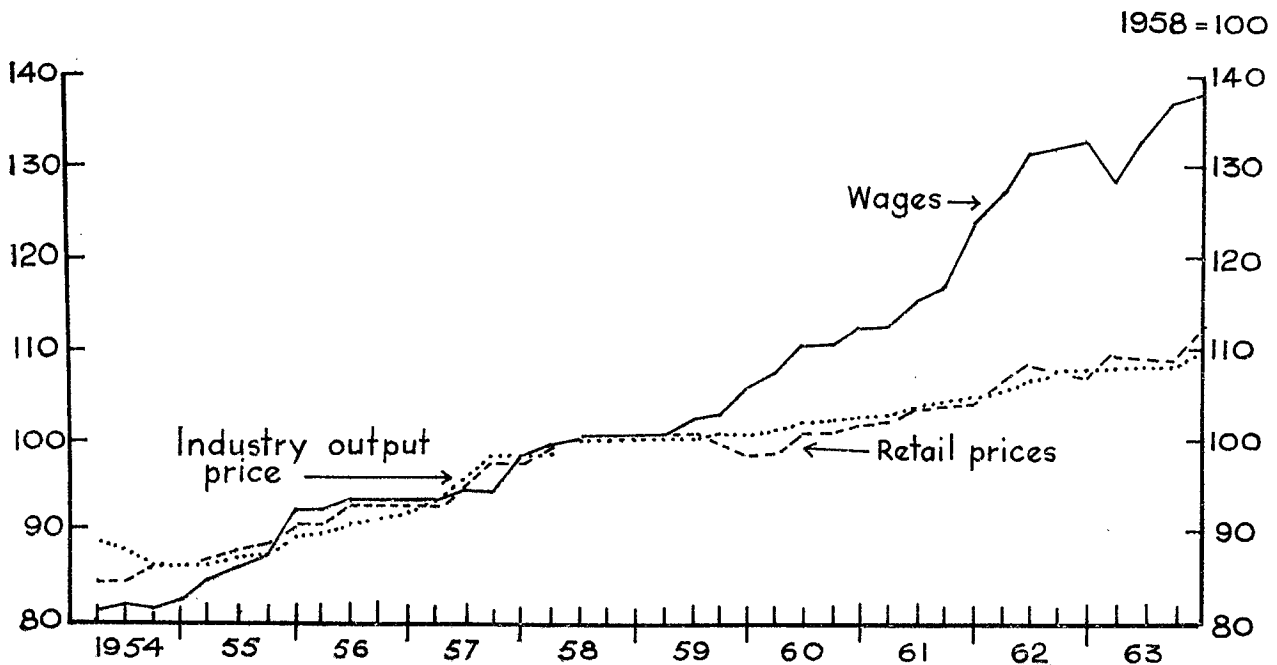
is increased this would lead to a fall in consumption not only in the current quarter but also in the following quarter and it may be a year before the full effects of the price change on consumption have worked through. The causes of distributed lags can be summarised[1] under three headings, psychological, technical and institutional. Under the first, for instance, we find habit delaying consumers' adjustment of their spending patterns as a result of price changes; technical time lags are due to such natural phenomena as the rearing time for ducklings; and an example of an institutional cause was the time taken by the Civil Service to administer the collection of the Turnover Tax.

Generally speaking if we define $\{Y\}$ as our economic effect and $\{X\}$ as the cause then we have the system

$$Y_0 = \beta_0 X_0 + \beta_1 X_{-1} + \beta_2 X_{-2} + \beta_3 X_{-3} + \ldots + \beta_{-n} X_n \quad (1)$$

where the suffixes of the variables refer to the time in which they arose. Thus the effect Y_0 is made up of a fraction β_0 of the cause X_0, a fraction β_1, of the cause X_{-1} (namely X in the previous period) and so on. The complete effect due to a particular cause X_0 will be β_0 in the current period, β_1 in the next time period, β_2 two time periods away and so on, and totals $\beta_0 + \beta_1 + \beta_2 + \ldots$ Regarding the sum of these β_i's $= \beta$ then the values $\frac{\beta_i}{\beta}$ describe in a sense a frequency function. In the first period $\frac{100\beta_0}{\beta}$ per cent. of the effect takes place; in the second period $\frac{100\beta_1}{\beta}$ per cent. of the effect, and so on. We are particularly interested in these values and also in the cumulative (distribution) function which shows how much of the effect has been carried through. Thus $100 \frac{(\beta_0 + \beta_1 + \beta_2)}{\beta}$ per cent. of the effect has been completed after three time periods.

When estimating the coefficients in equation (1) above a variety of methods may be used. In Appendix 1 this is dealt with at some length but here we present briefly the method as used below.

Firstly, the coefficients in an equation such as

$$Y = \alpha + \beta_0 X + \beta_1 X_{-1} + \beta_2 X_{-2} \quad (2)$$

were directly estimated by the method of ordinary least squares where implicitly it is assumed that the effects on Y of such lagged X's as X_{-3}, X_{-4}, etc., are nil. In other words the lag distribution is over three time periods.

Secondly an equation of the form

$$Y = \alpha + \beta_0 X + \beta_1 X_{-1} + \beta_2 X_{-2} + K Y_{-3} \quad (3)$$

was estimated by ordinary least squares where the coefficients β_0, β_1, β_2 relate as before to the first three terms in the lag frequency function and the coefficient K measures approximately the proportion of the effect not measured by the coefficients β_0, β_1, β_2. The advantage of (3) is that the coefficients β_0, β_1, β_2 are directly estimated and not indirectly as would be in the case of the Koyck[2] type of equation where, for instance, β_1 would be a function of the coefficients of X, X_{-1} and Y_{-1}. Clearly if the coefficient K in equation (3) were zero we could say that all the effects of the X's on the Y's take place within three time periods. By dividing the sum of the estimated β_i's by $(1 - K)$ we get an estimate of the full effect on Y due to X.

Note, however, that the linear form assumed will mean that reactions are symmetrical, i.e., when output goes up 10 per cent. or down 10 per cent. it will lead to the same changes in magnitude of employment. It might be argued that employment policy in a boom is different than in a recession— that increased output leads to a sharper change in employment.

(b) Output and Employment

Chart I (a) shows the quarterly movement of Employment, Total Hours Worked, and Output for the Transportable Goods Industries from 1954 to 1963. The original Quarterly Industrial Production Inquiry Series is based on 1953 = 100·0 and was rebased here on 1958 = 100. Employment and Total Hours Worked move very much together, as there was little variation in the average number of hours worked over the period, and rose 19 and 16 per cent. respectively from 1954 to 1963. Output showed greater variation and rose 50 per cent. during this period. Almost all the change in each case dated from 1959.

Now we examine the responsiveness of Employment and Hours Worked to changes in output. Table 1 (a) shows the point estimates of equations of the form

$$E = at + b_0 Z + b_1 Z_{-1} + b_2 Z_{-2} + K E_{-3} \quad (4)$$

where E = Employment

Z = Output

t = linear time trend

K = proportion of response not completed; and suffixes relate to time periods. Equations were

[1] M. Nerlove, "Distributed Lags and Demand Analysis for Agricultural and other Commodities". Agriculture Handbook No. 141 (U.S. Dept. of Agriculture) June 1958. This is the authoritative study on the subject.

[2] See L. M. Koyck, "Distributed Lags and Investment Analysis", North Holland Publishing Company, Amsterdam 1954. By assuming an exponential tail to the lag frequency function an equation of the form $Y = \alpha + Y X + Y_1 X_{-1} + Y_2 X_{-2} + \lambda Y_{-1}$ is estimated where $Y_1 = (\beta - \lambda \beta_0)$.

estimated with and without lagged values of E, the dependent variable. Similar equations were estimated for Total Hours Worked (M) and the coefficients are shown in Table 1 (b). In each case the variables are measured in deviations from seasonal means.

Due to the high correlation between the current level of output, Z, and lagged values of output, Z_{-1}, Z_{-2}, and so on one can expect unreliable estimates of the individual coefficients themselves. We find in equation 1 (Table 1) that the coefficient for current output Z picks up much of the influence of lagged output. The introduction of additional lagged values for Z reduces the coefficient for current output Z to about 0·25; but the total effect of output on employment (shown in the column ΣZ) increases from 0·426 to 0·476. The introduction of lagged dependent variables in the equations provides us with an estimate of the proportion of the effect on employment not passed through the output variables present. Thus equation (5) says that after one

TABLE 1 : POINT ESTIMATES OF TIME LAGS IN OUTPUT/EMPLOYMENT AND OUTPUT/HOURS RELATIONSHIPS

(With s-values in brackets underneath coefficients)

(a) OUTPUT/EMPLOYMENT RELATIONSHIP

Equation number	Trend	Z	Z_{-1}	Z_{-2}	Z_{-3}	ΣZ	K	Adjusted trend	Adjusted ΣZ	Standard error of estimate (a)
Without lagged dependent variable:										
1	—·123 (2·05)	·426 (10·85)				·426				·179
2	—·136 (2·31)	·273 (3·14)	·174 (1·98)			·447				·173
3	—·137 (2·40)	·247 (2·84)	·084 (0·79)	·126 (1·43)		·457				·171
4	—·149 (2·71)	·254 (3·03)	·044 (0·42)	·016 (0·16)	·162 (2·00)	·476				·165
With lagged dependent variables:										
5	—·098 (2·72)	·185 (4·87)				·185	·672 (8·20)	—·298	·564	·108
6	—·153 (3·64)	·270 (4·22)	·186 (2·66)			·456	·492 (5·72)	—·301	·898	·127
7	—·202 (4·39)	·323 (4·61)	·026 (0·31)	·005 (0·07)		·354	·400 (5·00)	—·337	·590	·133

(b) OUTPUT/HOURS WORKED RELATIONSHIP

Equation number	Trend	Z	Z_{-1}	Z_{-2}	Z_{-3}	ΣZ	K	Adjusted trend	Adjusted ΣZ	Standard error of estimate (a)
Without lagged dependent variable:										
8	—·009 (0·13)	·345 (7·67)				·345				·200
9	—·015 (0·22)	·285 (2·82)	·069 (0·67)			·354				·202
10	—·015 (0·22)	·277 (2·64)	·041 (0·32)	·039 (0·37)		·357				·204
11	—·021 (0·30)	·280 (2·67)	·021 (0·16)	—·017 (0·13)	·082 (0·81)	·366				·206
With lagged dependent variable:										
12	—·050 (1·19)	·152 (4·00)				·152	·666 (7·66)	—·150	·456	·126
13	—·081 (1·45)	·307 (3·84)	—·073 (0·84)			·234	·475 (4·70)	—·154	·446	·161
14	—·114 (0·17)	·360 (0·38)	—·003 (0·03)	—·071 (0·73)		·286	·372 (3·54)	—·182	·455	·178

(a) units are index numbers where 100 equals 1958 level of Employment.

The "adjusted" terms measures complete effects: the K coefficients measure the proportion of total effect not completed and so total effect equals $\dfrac{\text{partial effect}}{1-K}$

thus adjusted trend for equation (5) is $\dfrac{-·098}{1-·672} = -·298$

and adjusted output effect is $\dfrac{·185}{1-·672} = ·564$

Data shown in Appendix Table C and described in Appendix 2.

quarter 67 per cent. of the total effect remains to be transmitted. Equation (6) says that output in the current and preceding quarter account for 51 per cent. of the total output effect on employment.

The estimate of the total effect of a change in output on employment seems to be about 0·6; we can expect it to be higher than the sum of the output coefficients for the first four equations. With equations (5), (6) and (7) we have three estimates of this full or long run effect at 0·564, 0·898 and 0·590 respectively and while there is likely to be no statistically significant difference between the three coefficients the value 0·6 was chosen as it was close to two estimates. This means that in the long run an increase (or decrease) in output of 10 per cent. will be followed by an increase (or decrease) in employment of 6 per cent. The speed at which the reaction takes place is estimated from the values of K. Now the employment figures relate to the middle of the third month in each quarter whereas the production figures are for the entire quarter. We assume that they relate to the middle of the second month of each quarter. It seems that one-third of the full effect of a change in output on employment is shown in the current quarter's employment figure (that is, after a time lag of one month). After 4 months (employment one quarter ahead) about half of the effect is felt; and after 7 months (employment two quarters ahead) only 60 per cent. of the full effect is transmitted. Thus if output fell by 10 per cent. in the Transportable Goods Industry (allowing for seasonal movements) past experience would suggest that employment would fall by 2 per cent. in the following month; that it would fall a further 1 per cent. in the next three months and that after 7 months employment would be some 3·6 per cent. lower than it would otherwise have been due to the fall in output. It might take two years or so for the full effect—a fall of 6 per cent. altogether—to be felt.[3] These coefficients are far from reliable; the figures in brackets in Table 1 are the ratios of the coefficients to their own standard errors and are called s-values. Broadly speaking we will be correct nineteen times out of twenty when we say that the true value of the coefficient is zero when its s-value is less than two. If the s-value is substantially

greater than two then there is reason to believe the true coefficient is nonzero and that its associated variable is adding to the explanation.

It seems probable that the modal point of the distributed lag function is in the first quarter: that the largest short run effect on employment takes place in the first quarter and that later short run effects are all smaller in magnitude. Chart II shows Actual and Calculated movements of Employment from 1954 to 1963 for Transportable Goods Industries. The Calculated Values come from equations (5) Table 1. The figures in the chart are deviations from quarterly averages which eliminates seasonal fluctuation and any linear trend between quarters though not between years.[4] Calculated Employment is made up of the current (short run) output effect; the current (short run) productivity trend effect; and all lagged effects of output and productivity. The discrepancy measures the difference between the actual and calculated values.

(c) Output and Total Hours Worked

As has been noted above average hours worked showed little variation over the period, so it is not so surprising that the results for output and total hours worked in Table 1 (b) should not be very different. One might expect them to be better as entrepreneurs are able to adjust the labour input to production as measured in hours more easily than their employment. These results can be summarised as follows:—

An increase (or decrease) in output of 10 per cent. leads to an increase (or decrease) in Total Hours Worked of about 5 per cent. This is less than the long run change implied for employment of 6 per cent.

The coefficients of K indicate a slightly more rapid rate of adjustment with over 60 per cent. of the adjustment completed after seven months.

The form of the distribution is more difficult to evaluate as some of the coefficients are more unstable than those for employment. It does seem clear that the modal point of the lag distribution is

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[3] A comparison with U.K. experience (reported by Neild "Pricing and Employment in the Trade Cycle", N.I.E.S.R., Cambridge 1963) gives their best equation on quarterly data from 1950 to 1960:

$$E = 0·000013 + 0·132Z + 0·138Z_{-1} + 0·083Z_{-2}$$

where E, and Z are quarterly changes in the logarithms of employment and output for manufacturing industry. These output coefficients in natural form add up to 0·394 implying rather less responsiveness of U.K. manufacturing employment to output changes (however, the differences in method could account for this). The mode of the Irish lag distribution is probably in the first quarter whereas for the U.K. it may be in the second quarter.

[4] If Y_{ij} is the dependent variable for the ith year and jth quarter and is functionally dependent on values of X_{ij} and a trend $t_{ij} = (4i+j)$; thus $Y_{ij} = bX_{ij} + ct_{ij} + a_j$ where a_j is a seasonal constant. This may be rewritten

$$(Y_{ij} - Y._j) = b(X_{ij} - X._j) + c(t_{ij} - t._j)$$

where Y._j is the average of all the j quarter values. The seasonal coefficient is $a_j = Y._j - bX._j - ct._j$ while $(t_{ij} - t._j)$ is constant for a given value of i but varying j. In our case we have 40 values, where t_{1951} I = 1 and t_{1963} IV = 40; $t._1 = 19$, $t._2 = 20$, $t._3 = 21$, $t._4 = 22$; the deviations from seasonal means for the year 1963 are: $adj.t_{1963}$ I = 37 − 19 = 18, $adj.t_{1963}$ II = 38 − 20 = 18, $adj.t_{1963}$III = $adj.t_{1963}$ IV = 18. All the seasonal deviations for the trend within a given year are equal. The adjusted values for 1962 are all equal to 14.

6

CHART II

EMPLOYMENT/OUTPUT RELATIONSHIP (TRANSPORTABLE GOODS)
QUARTERLY 1954–63

Source: Equation 5 Table 1   Units: 1958 = 100

Employment/output relationship

Actual

Calculated

Output effect
(short run)

Trend

Lagged output etc. effects

Discrepancy

1954   55   56   57   58   59   60   61   62   63
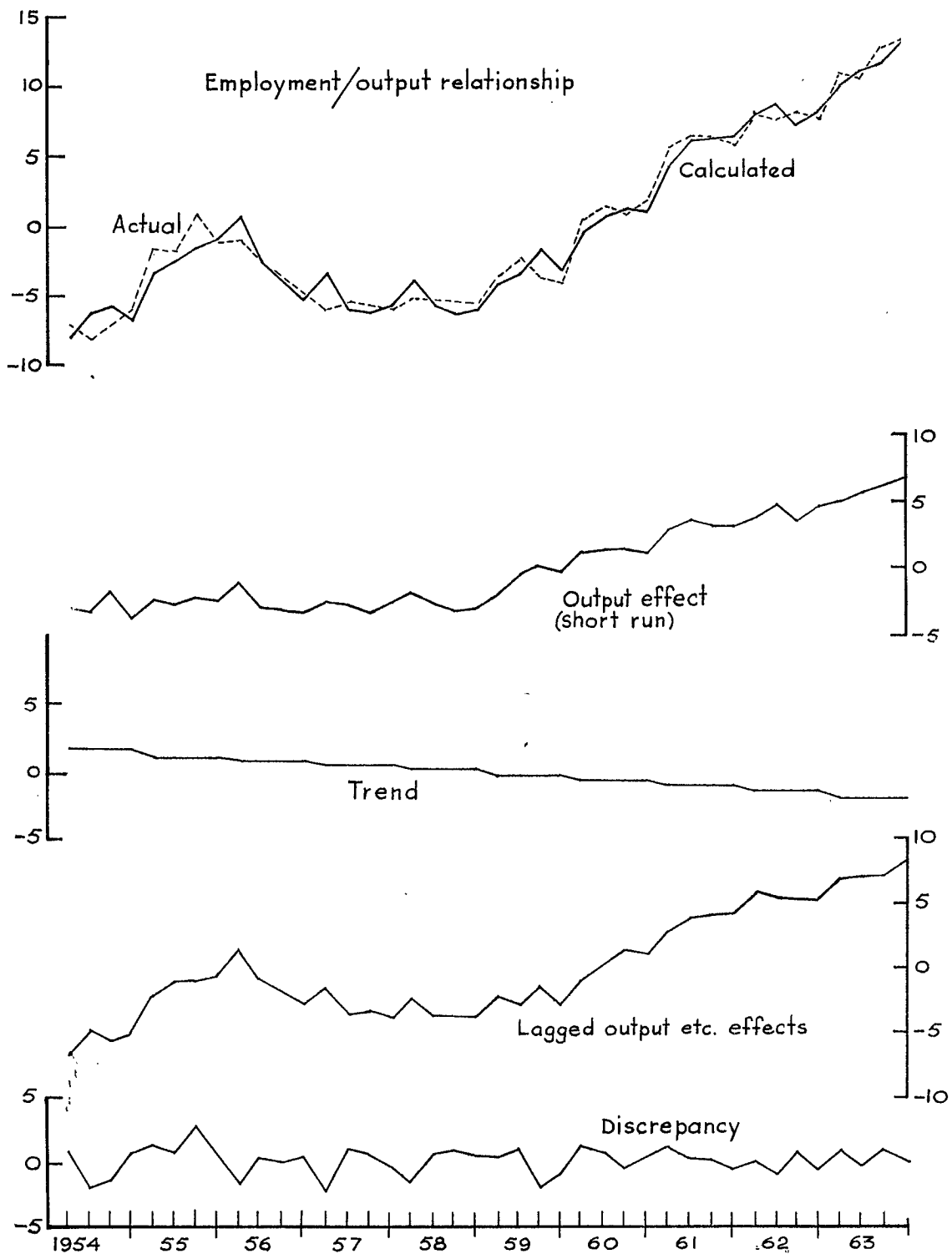
in the first quarter. It is possible that up to one-half of the long run effect on total hours is transmitted in the first quarter.[5] Thus a change in output of 10 per cent. in one quarter might be followed by a change in total hours worked of $2\frac{1}{2}$ per cent. in that quarter.

The column entitled standard error of estimate in Table 1 provides a measure of forecasting efficiency. The units are the index numbers (base 1958=100·0) of Employment and Hours and it can be seen that these are smaller for the employment set of equations. The standard error of estimate is an average (the standard deviation) of the discrepancies derived by subtracting calculated values from actual values and is thus measured in units of the variable being explained.

(d) Long Run Implications

The short term relationships between Employment and Total Hours Worked on the one hand and output on the other are, of course, forms of the familiar Production Function. One common form of this, the Cobb Douglas function is written

$$Z = \alpha L^{\beta} C^{\gamma} e^{\delta t} \qquad (5)$$

where Z, L, and C are output, labour input and Capital utilised respectively and α, β, γ, and δ are all structural coefficients. The term e^{t} measures "technical advance" as distinct from new capital. Writing (5) in a linear form, an approximation that may hold for short time periods, we have

$$Z = \alpha + \beta L + \gamma C + \delta t \qquad (6)$$

rearranging terms this becomes

$$L = -\frac{\alpha}{\beta} + \frac{1}{\beta} Z - \frac{\gamma}{\beta} C - \frac{\delta}{\beta} t \qquad (7)$$

The full effect of a change in output on employment which we have estimated above is equal to the coefficient $\frac{1}{\beta}$ in (7). The additional trend term included in Table 1 is a combination of the effects of changing Capital and technical progress. For the employment equations above, our estimate of β would be about 1·6 whereas most Cobb Douglas Function studies have yielded a value of about

0·75.[6] The effect of capital and technical progress would seem to be contained in the overall quarterly trend term of minus 0·3 per cent.; or minus 1·2 per cent. per annum. Employers tend according to the employment equations to reduce their labour force by 1·2 per cent. per annum reflecting increases in capital and improved technique.

These results from our short term equations are in line with results of R. C. Geary in his paper "Irish Woollen and Worsted Industry 1946–59: A Study in Statistical Method", E.R.I. paper No. 7, where fitting annual data for 1946–1959 he got

$$Z = AH^{1.81} K^{-0.43} e^{0.0113t} \qquad (8)$$

or in the approximate form of (7)

$$H = A^1 + 0·55Z + ·24K - ·62t \qquad (9)$$

where H = hours worked in the Woollen and Worsted industry

Z = net output volume

K = quantum of "fuel, etc." as a measure of capital utilisation.

The negative coefficient for K in (8) is contrary to expectations and common experience. The coefficient for output in (9) is very much in line with our results. When K was dropped from the equation Geary got

$$Z = aH^{1.26} e^{.0189t} \qquad (10)$$

or approximately

$$H = 0·8Z - 1·6t \qquad (11)$$

These estimates of Geary were long run relationships and would compare to the rough equation on Employment above of

$$E = 0·6Z - 1·2t \qquad (12)$$

Geary rejected the equations (8) and (10) as not meaningful mainly due to the inadequate data available for his study.

What conclusions can be drawn from our results? Are they meaningful or useful? These short term relationships probably show that employers have not utilised their work force fully over the whole period 1954–1963. This would partly reflect the strength of trade unions to resist redundancies but more probably it reflects the nature of the production process itself. Production processes will in many cases require a fixed or slightly varying work force

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[5]The corresponding equation for total hours worked for U.K. manufacturing (Neild, *op. cit.*) is

$$M = -0·000401 + 0·212Z + 0·140Z_{-1} + 0·089Z_{-2}$$

where M and Z represent quarterly changes in the logarithms of total hours and output. Adding the antilogs of these coefficients one gets a figure of 0·424 corresponding to ΣZ, which is higher than the Irish figure from equation (10), Table 1 of 0·357. In both Irish and U.K. equations the modal response is in the first quarter.

[6]Thus in C. E. V. Leser's paper "Statistical Production Functions and Economic Development", *Scottish Journal of Political Economy*, Vol. V., pp. 40–49, of the 39 studies of production functions quoted for manufacturing industry or industrial production over varying time periods and for different countries, all but one yield coefficients for β below unity and most are close to the magic number 0·75.

to operate them whether at 50 per cent. or 100 per cent. utilisation. These workers are in effect an overhead cost to the firm. An increase in output can lead to tremendous changes in labour productivity for such firms with spare capacity.

A further factor which encourages this rigidity is future expectations. An employer may find that his well trained and integrated work force may presently be underemployed but if demand picks up in the near future it may well be cheaper in the long run to keep his work force at full (and underutilised) strength.

So the equations estimated during a time of recession and boom will be useful to measure short run changes in Employment and (not so well) in Total Hours Worked particularly in a situation of a down turn in output. For projection for longer periods, to 1970 and beyond, they are likely to be unsatisfactory if the present rapid expansion of industrial output continues.

2. THE WAGE-PRICE FORMATION SYSTEM

Most people are aware of the complexity of the economic system, of how a particular economic variable is related to others which in turn are related to more and how in a sense every economic variable in the system is related to the original one. Some variables are very closely related to each other and it is only by concentrating on certain clusters of closely related variables that it is possible to measure approximately how some events arise in the system. We separate three variables of the system which we try to explain in terms of each other and some other important variables. We are assuming that the latter set affect our dependent variables, namely, wages (hourly earnings) in industry, output price of industry and the retail price level, but are not in turn affected by them. One variable that we use to explain the others is industrial output but it is pretty clear that it in turn is affected by wages (increasing demand) and the output price (reducing demand for most goods). We ignore these reaction effects. The main function of this paper is to examine wage and price formation in the manufacturing sector of the Irish economy which is less interesting than providing all the answers but should be of use in building up knowledge of the system.

It seems useful from an economic point of view to consider wages and prices together. Most people are aware that an increase in wages generally leads to an increase in wage costs to entrepreneurs who respond by increasing prices—all other costs remaining unchanged. But on the other hand an increase in prices by reducing real incomes may cause trade union pressure for wage increases to be higher than it otherwise would be. And so wages push up prices which push up wages. . . . It seems of interest to measure this wage-price reaction.

From 1953 to 1963, wages rose by 70 per cent. odd while the retail price level rose by over 28 per cent. and the industry output price by over 22 per cent. The average annual increase in wages was 5·5 per cent. (this also for 1949–53) but the average hides substantial year-to-year variation. Hourly earnings have always increased annually since 1948, the smallest increases being 2·2 per cent. in 1949 and 2·9 per cent. in 1954; the biggest annual increase was in 1962 when wages increased by 12·7 per cent. Increases in retail prices have been more moderate and since the Korean war induced world inflation— the Irish retail price level increased by 21 per cent. in two years from the end of 1950, an increase that was to take nine years to be reproduced—they have risen by $2\frac{1}{2}$ per cent. per annum. This means that (hourly) wages in real terms rose by 3 per cent. per annum on average over the past decade. Only in one year over the past decade, 1957, did real wages fall. (These wages figures are real hourly wages of persons employed and do not take into account changes in hours worked or changes in numbers employed.)

The analysis of this wage-price system was mostly done using the method of ordinary least squares. Here this method is compared with a better technique, namely the method of two stage least squares, with the intention of justifying the use of the former less reliable technique. Before discussing the problem of statistical estimation we examine the three equations which make up our wage-price formation model. The description below describes a skeleton which receives flesh in the later sections.

The Retail Price Equation

$$p_r = a_0 + a_1 p_z + a_2 p_a + a_3 p_{ic} + a_4 T + a_5 t \quad (13)$$

where p_r = retail price index

p_z = industry output price index (wholesale)

p_a = agricultural products price index (wholesale)

p_{ic} = imports for direct consumption price index (wholesale), this includes import levies

T = an index measuring the level of excise taxes

and t = time trend.

In this equation we are trying to cover each of the elements of costs that face the retailer whose goods

9

and services are covered by the retail price index and purchased by wage earners. We are dealing with aggregates that do not quite fulfil our requirements; the price indices for agricultural and industry output are based on a wider coverage of goods than included in the retail price "basket of commodities". The price of services (including housing) is assumed to be covered by the trend variable. The tax variable is an index of the different rates of excise duties (i.e., on beer, spirits, tobacco, etc.) weighted by the revenue from these duties in 1960. A further assumption made is that retailers maintain a constant percentage mark-up on the goods they sell.

Industry Output Price Equation

$$p_z = \beta_0 + \beta_1 W + \beta_2 p_a + \beta_3 p_{iz} + \beta_4 t + \beta_5 \Omega \quad (14)$$

where p_z =industry output price

W =level of hourly earnings in industry

p_a =agricultural price index

p_{iz} =wholesale price of imported materials for industry (includes import levies)

t =time trend

Ω =an indicator to measure "demand pull" and described below.

We are assuming that Irish industry has three basic inputs contributing to costs and output. These are agricultural products, imported raw materials and labour. From an examination of the input-output table for 1960 shown in Table 4 of R. C. Geary's "Towards an Input-Output Decision Model for Ireland", Economic Research Institute Reprint No. 3, it is possible to provide approximate figures for the costs of these inputs in industry. The net output of manufacturing industry is £346 million; the input from agriculture is £82 million; from imports, £109 million and £75 million from labour. Total costs come to £266 million leaving £80 million for Government income (including income tax), transfer payments, depreciation, saving and profits paid abroad.

Taking costs alone then, labour accounted for 28 per cent. of prime cost, imported materials for 41 per cent. and agricultural materials for 31 per cent. The labour cost is probably underestimated as income tax is already deducted in the original table published in Geary (*op. cit.*). If the simple mark-up principle is applied by entrepreneurs, increases in the prices of their basic inputs will lead to increases in output prices. On the rough figures given above, if the imported materials price rose by 10 per cent., entrepreneurs would increase their output price by 4·1 per cent. Two other factors can be expected to influence their behaviour. First rising productivity due to more efficient use of existing resources should lead to a decline in industry output price (all other

factors remaining constant). Secondly when demand is below expectation it may be difficult to absorb all cost increases in price increases; and, of course, when demand is buoyant and better than expected we may find the reverse process happening, as entrepreneurs will increase their profit margins. We attempt to allow for these effects respectively by use of a trend and a "demand pull" variable in the equation.

The Wage Equation

$$W = \delta_0 + \delta_1 p_r + \delta_2 \Sigma U_e + \delta_3 t + \delta_4 D \quad (15)$$

Where W =average hourly earnings in industry

p_r =retail price level

ΣU_e =aggregate unemployment index

t =time trend

D =productivity per man hour.

Many studies of U.K. wage rates, etc., have shown the fairly strong relationship between changes in wage rates and the level of unemployment.[7] If, as we assume, this relation is linear then we can use a cumulative index of unemployment to explain the level of wages. Changes in productivity and in retail prices are normally used by trade union negotiators in argument for wage increases and so we include the level of productivity and retail prices in our bid to explain the level of wages.

(a) Statistical Estimation

We can expect interaction between wages, retail prices and output prices as an increase in wages (all other factors ignored) will lead to an increase in retail prices which will in turn lead to an increase in wages. If the interaction between the variables takes place simultaneously and if it is strong then ordinary least squares estimation will be biased and inconsistent. However, if the interaction is weak and beset by time lags then the bias may be minor and ordinary least squares be quite satisfactory. Ordinary least squares estimation assumes that the independent variables on the right hand side of equations can be treated as fixed numbers and not random variables; the dependent variable, on the left hand side of the equation, is treated as a random variable. In (14), the industry output equation, industry output price is a random variable while wages is not if it satisfies OLS estimation; in (13), the retail price equation,

[7]For example: "The relation between unemployment and the rate of change of money wage rates in the United Kingdom 1861–1957" by A. W. Phillips, Economica November 1958. "The relation between unemployment and the rate of change of money wage rates in the United Kingdom 1862–1956: A further analysis" by R. G. Lipsey, Economica. "The determinants of wage inflation: United Kingdom 1946–1956 by L. A. Dicks-Mireaux and J. C. R. Dow, Journal of the Royal Statistical Society, Series A (General) Vol. 122, part 2, 1959.

TABLE 2: COMPARISON OF TSLS AND OLS ESTIMATES OF WAGE/PRICE SYSTEM: ANNUAL DATA 1953–63

s-values in brackets underneath coefficients

RETAIL PRICE EQUATION (p_r)							$S(e)^{(a)}$			
TSLS estimate	49·3	$+\cdot117\hat{p}_z$ (0·97)	$+\cdot173p_a$ (0·89)	$+\cdot187p_{ic}$ (1·07)	$+\cdot070$T (0·36)	$+1\cdot60t$ (5·61)	1·21			
OLS estimate	10·9	$+\cdot580p_z$ (2·13)	$+\cdot177p_a$ (1·17)	$+\cdot215p_{ic}$ (1·64)	$-\cdot090$T (0·50)	$+0\cdot87t$ (1·95)	0·95			
INDUSTRY OUTPUT PRICE EQUATION (p_z)										
TSLS estimate	51·3	$+\cdot177\hat{W}$ (1·66)	$+\cdot012p_a$ (0·06)	$+\cdot473p_{iz}$ (2·97)	$+\cdot269\Omega_3$ (2·79)	$+\cdot685t$ (0·87)	1·22			
OLS estimate	26·8	$+\cdot206W$ (2·32)	$+\cdot015p_a$ (0·10)	$+\cdot489p_{iz}$ (3·59)	$+\cdot286\Omega_3$ (3·39)	$+\cdot647t$ (1·10)	1·06	Unemployment effect in form K+a (U−29·6)		
									K	a
WAGE EQUATION (W)										
TSLS estimate	114·7	$+\cdot754\hat{p}_r$ (1·55)	$-\cdot917\Sigma U_e$ (4·18)	$+15\cdot91t$ (4·18)	$+\cdot518$D (1·95)		1·62		2·26	$-\cdot461$
OLS estimate	41·8	$+\cdot959p_r$ (3·75)	$-\cdot934\Sigma U_e$ (6·62)	$+15\cdot56t$ (6·13)	$+\cdot554$D (3·27)		1·05		2·20	$-\cdot470$

(a) Units are index numbers where 100 equals 1958 level. Data shown in Appendix Table A and described in Appendix 2.
NOTE: The coefficients found in the equations relate to variables measured in index numbers. The transformation on the right uses actual numbers of unemployed in thousands.

industry output price is treated as a non-random variable while wages are a random variable in (15) the wage equation. Special techniques are required to estimate sets of equations like these that have inter-action between the dependent variables or, as they are termed, endogenous variables. The most useful method for overidentified systems as are usually met in applied work like this, is the method of two stage least squares due to Theil.[8] The first stage of this method is to estimate predicted values for each of the endogenous variables expressing them as linear functions of all the other (exogenous) variables of the system; the second stage is to replace the actual values of the endogenous variables by the predicted values where they appear as "independent variables." Thus, for the retail price equation, the first stage is to estimate by ordinary least squares predicted values for industry output price (p_z in terms of p_a, p_{ic}), T, t, p_{iz}, Ω, ΣU_e, and D (the exogenous variables of the system). The predicted values are substituted for the actual values of industry output price and the retail price equation (with the new industry output price variable) is estimated by ordinary least squares. The resulting coefficients are consistent, that is, for large samples they will approach the "true" values of the real world parameters.

Table 2 sets out the estimates for these equations by the methods of two stage least squares (TSLS) and by ordinary least squares (OLS). For the retail price equation, TSLS does shift the coefficients significantly though for the other two equations the difference in coefficients between the TSLS and OLS estimates are minor. The fairly close correspondence between the OLS and TSLS estimates is in part due to the small sample size available and the large number of variables thought to be significant in the system.[9]

For retail price equation the effects in either equation are not measured too well but the TSLS estimated equation does show a sensible (positive) coefficient for the tax variable whereas the OLS estimated coefficient was negative; on the other hand the suggested weight of industrial output in consumers' expenditure is only 12 per cent. From Geary's Table 4 (op. cit.) it is possible to derive the structure of inputs for household consumption which is roughly as follows:—

	%	(TSLS)	(OLS)
Products from industry	40	12	58
Products from agriculture	12½	17	18
Direct imports	12½	19	22
Services	30	[*]	[*]
Excise taxes	5	7	−9
TOTAL	100		

*No comparable estimates.

[8] The method is described in H. Theil's "Economic Forecasts and Policy", North Holland Publishing Company, Amsterdam, 1958. Useful accounts of the problems relating to simultaneous equations estimation are given in J. Johnston's "Econometric Methods", McGraw Hill Book Company, New York, 1963 and A. S. Goldberger's "Econometric Theory", John Wiley and Sons Inc., New York, 1964.

[9] The reduced form equations calculated at the first round of estimation had only two degrees of freedom.

As can be seen neither equation is very satisfactory. Further OLS analysis of the retail price data is made in Section 6.

For the other equations the correspondence between TSLS and OLS estimates would seem to justify the OLS analysis reported on later. We note that Dicks-Mireaux in "The Interrelationship between Cost and Price Changes 1946–1959" *Oxford Economic Papers*, October 1961, found for his two equation model that the TSLS estimates of his wage and price equations were quite similar; and this for a more aggregated structure than ours. His two equations have four exogenous variables, demand for labour (a measure analogous to our level of unemployment), import prices, productivity and lagged output prices; and two endogenous variables wages and output prices. Due to the disaggregated nature of our system—which reflects the more complex nature of the Irish economy—we have three equations and nine exogenous variables.

A more exhaustive TSLS analysis on annual Irish data is not possible as many of the series we use such as for industry output price, are only available from 1953. It was clear that to introduce additional variables one would end up with OLS estimation. The same argument holds for the quarterly data and would involve estimation of a larger number of equations. The strong auto-correlation in the wages data due to institutional factors also make the exercise of doubtful value. In the case of the quarterly data model the endogenous variables are less affected by each other and more by past values of the endogenous variables which are therefore exogenous to the system. It is for this reason that quarterly estimates of the relationships are regarded as most reliable. The above results suggest minor bias for the industry output price and the wage equations as estimated by the method of OLS and so justify the extensive use of OLS in ensuing sections.

3. THE WAGE EQUATION

With the justification of minor bias from above, further ordinary least squares equations were estimated to explain movements in wages in the Irish Republic. These are in three sets: the first tries to explain the level of hourly earnings from 1953 to 1963; the second uses annual changes in hourly earnings from 1949 to 1963; and the last set examines quarterly movements in wages—thus estimating short run relationships—from 1954 to 1963. Again hourly earnings relate to the transportable goods sector and the annual figures are census returns for October of each year.

(a) Analysis of Annual Data: Wage Levels 1953-1963

The two sets of regressions reflect the author's development of thought on the subject. The first set, shown in part in Table 3 (*a*), examines the eleven year period from 1953 to 1963. Because the initial assumption relates changes in wages to the level of unemployment, that is,

$$\Delta W = K^1 + aU \qquad (16)$$

then the level of wages has to be written as

$$W = \Sigma \Delta W = K^1 T + a\Sigma U + L \qquad (17)$$

where L is a constant which comes from choking off the infinite series at the time T.

This was necessary as the study examined levels of wages, retail prices and industry output prices. It is difficult to understand the meaning of the coefficients for ΣU and t in Table 3 (*a*) so these

coefficients are transformed on the right hand side of the table to read

$$\Delta W = K + a(U - 29 \cdot 6) \qquad (18)$$

where U is the level of non-agricultural unemployment in thousands and K is a constant. Thus for the second equation in Table 3 when non-agricultural unemployment is at the level of 29,600—the average from 1949 to 1963—wages increase by 2·2 points (approximately per cent.). If the level of unemployment is 1,000 lower than this, the equation means that wages will increase at 2·67 points (or per cent.).* Every 1,000 fewer unemployed in the non-agricultural sector would mean an extra half a per cent. on to the annual increase in hourly wages. The level of unemployment measures the strength of demand for labour with respect to its supply. Thus a fall in level would indicate a tightening of the labour market which would cause an increase in the price of labour; and this is confirmed here. The coefficients for the other variables can be read as follows: for equation (2) again, an increase in retail prices in the current year of 10 per cent. leads to an increase of 9·59 per cent. in wages during the same year; an increase in productivity (measured as output per man hour) of 10 per cent. leads to an increase in wages of 5·54 per cent. in the same year; for equation (3) an increase in average hourly earnings in Great Britain of 10 per cent. leads to a fall of 3·43 per cent. in Irish wages; for equation (4) a decrease in Great Britain un-

*2·67=2·20−·47 (28·6−29·6).

TABLE 3 : WAGE EQUATION REGRESSION COEFFICIENTS : ANNUAL DATA

s-values for regression coefficients in brackets underneath

(a) 1953–1963 annual levels

Equation number	P_r Retail Price Level	ΣU Cumulative unemployment index	D Productivity	WGB GB real wages	UGB GB unemployment level	t time trend	W_{-1} last years wage level	R wage round	S(e)(a) Standard Error of Estimates	Unemployment effect in form $\Delta W = K + a(U-29\cdot6)$	
										K	a
1	·739 (1·94)	−1·242 (7·64)				22·47 (10·31)			1·62	4·71	−·625
2	·959 (3·75)	−·934 (6·62)	·554 (3·27)			15·56 (6·13)			1·05	2·20	−·470
3	·515 (0·81)	−1·228 (7·02)		−·343 (0·46)		23·68 (6·73)			1·72	6·12	−·618
4	·578 (1·28)	−1·215 (7·06)			0·028 (0·73)	22·30 (9·84)			1·68	5·93	−·612
5	·742 (1·80)	−1·269 (4·51)				23·00 (4·60)	−·027 (0·12)		1·75	4·85	−·639
6	·974 (3·57)	−1·008 (5·10)	·566 (3·13)			17·03 (4·59)	−·083 (0·58)		1·11	2·62	−·507
7	·323 (0·41)	−1·363 (4·13)		−·665 (0·64)		27·78 (3·06)	−·150 (0·50)		1·84	8·29	−·686
8	·239 (0·48)	−1·611 (4·77)			·096 (1·54)	31·15 (4·48)	−·468 (1·34)		1·58	7·15	−·811
9	·937 (8·71)	−·896 (15·02)	·655 (8·91)			14·73 (13·67)		1·512 (5·38)	0·44	1·94	−·450

(b) 1949–1963 annual changes

Equation number	Change in retail price level $P\Delta_r$	Unemployment level U	Change in				Standard error of estimate (b) S(e)	Unemployment effect in form $\Delta W = K + a(U-29\cdot6)$	
			Trend Δt	Productivity $D\Delta$	Unemployment ΔU	Wage round ΔR		K	a
10	·716 (4·00)	−·380 (3·45)	14·54 (4·59)				2·30	3·29	−·380
11	·695 (3·86)	−·378 (3·47)	14·61 (4·62)			−·520 (1·88)	2·40	3·42	−·378
12	·659 (8·79)	−·375 (10·42)	14·81 (13·71)	−·063 (·081)		−·474 (2·80)	2·51	3·71	−·375
13	·782 (3·39)	−·354 (2·83)	13·56 (3·51)	−·026 (·048)			2·40	3·08	−·354
14	·754 (10·33)	−·356 (8·90)	13·75 (11·27)		−·023 (1·30)	−·507 (3·21)	2·51	3·21	−·356
15	·700 (8·14)	−·344 (8·39)	13·97 (11·00)	−·146 (1·92)	−·029 (1·61)		2·52	3·79	−·344
16	·715 (2·56)	−·351 (2·64)	13·93 (2·82)	−·074 (0·29)	−·025 (0·44)	−·453 (0·81)	2·65	3·54	−·351

(a) Units are index numbers where 100 equals 1958 level of wages.

(b) Units are percentages.

Data shown in Appendix Tables A and B and described in Appendix 2.

NOTE : The coefficients found in the equations relate to variables measured in index numbers. The transformation on the right uses actual numbers of unemployed in thousands.

employment of 10 per cent. leads to a fall of 0·28 per cent. in Irish wages; and finally equation (5) states that an increase of 10 per cent. in wages last year leads to a fall in the level of wages this year of 0·27 per cent.

The numbers in brackets beneath the coefficients in Table 3 are the s-values for these coefficients, namely the ratio of the coefficient to its standard error; generally speaking, the bigger these are, the more confident one may be that the contribution the associated variables make to the explanation of wages is significant. For the small sample here these s-values would require to be close to 2 before one can feel confident that they add to the explanation or, in other words, that their coefficients are significantly nonzero. The overall effectiveness of the explanation is provided by the column entitled standard error of estimate as this measures the

average amount of error for each observation not accounted for in the equation. By this reckoning, equation (9) offers the best explanation and it further appears that each coefficient in equation (9) is contributing significantly to the explanation.

The coefficients for W_{GB}, U_{GB} and W_{-1} (Level of wages in Great Britain, level of unemployment in Great Britain and Irish wage levels lagged one year) have very low (associated) s-values and the signs of the W_{GB} and U_{GB} coefficients are unexpected. When s-values are so low no significance need be attached to their associated coefficients. If the influence of the British labour market is direct and strong we could expect that an increase in British wages would act to increase Irish wages; the coefficients in equations (3) and (7) say otherwise. Again, when the labour market slackens in Britain and unemployment rises, we could expect this to reduce Irish wage increases but there, too, the coefficient says the opposite. Direct influences of the British labour market as measured by British wages or British unemployment rates do not appear to affect Irish wage levels. This does not exclude the effect of the British labour market on Irish unemployment levels which, as can be seen, are an important factor influencing the change in wages here.

From these tables the influence of unemployment, productivity and retail prices add significantly to the explanation of wages in Ireland. The last equation of this set, equation (9), indicates an almost complete compensation for changes in retail prices; that wages get half the increase in productivity; and that unemployment at an average level of 29·6 thousand leads to increases of 1·9 per cent. per annum while an increase in unemployment of 1,000 leads to a fall in wages of half a per cent. This equation would imply that a rate of unemployment of 34,000 in non-agricultural employment would lead to no change in wages (ignoring all other effects). A feature ignored in the previous explanations of wage changes was the institutional factor called the wage round. D. O'Mahony in his E.R.I. paper, "Economic Aspects of Industrial Relations", shows a strong regular pattern in wage agreements where the agreement for each union tended to last two years. To measure the strength of this factor a dummy variable R was inserted which was unity for the even years when wage rounds were initiated and zero for the odd years when no wage rounds took place. The effect of having a wage round in the year seems to add only 1·5 per cent. to the wage increase—wages rise by 1·5 per cent. less in years without wage rounds initiated.

(b) Analysis of Annual Data: Percentage changes. 1949-63

The second set of equations examine changes in wage levels from 1949 to 1963 and thus one can expect a more accurate estimate of the effect of unemployment levels on changes in wages as the previous analysis used a cumulate unemployment index. The results are shown in Table 3 (b). By taking a longer time period (back in effect to 1948) we may expect to get more reliable estimates of the various effects on wages. This assumes that the period 1948-52 had a common structure to 1953-63. The four variables that helped to explain the level of wages were again used and also the rate of change in unemployment. Phillips (op. cit.) had found that changes in the level of unemployment affected changes in British wage rates. This fact gave rise to loops in his diagrams as, for a given level of unemployment, the change in wage rates would be lower if unemployment had been rising than if it had been constant. The strength of this influence is measured by the coefficient of ΔU and can be seen to be weak in magnitude as well as failing to contribute to the explanation; the associated s-values are low. The effect as measured, equation (14) Table 3, means that a fall of unemployment of 20 per cent. in a year would in itself increase wages by one half a per cent. The level of unemployment generates a given wage increase but if this level is significantly different from the previous year an additional effect is given to wages.

The retail price coefficients are all about 0·7 a lower figure than found above and suggesting, in line with British experience, that wages never quite fully compensate retail price changes. Dicks-Mireaux and Dow (op. cit.) explained quarterly wage rate changes from 1946 to 1956 with the following equation

$$W_t = 1·9 + 0·54P_{-\frac{1}{4}} + 2·62D_{-\frac{1}{4}}$$

where W = annual percentage change in aggregate weekly wage-rate index,

$P_{-\frac{1}{4}}$ = annual percentage change in the retail price index lagged half a quarter,

$D_{-\frac{1}{4}}$ = annual level of the index of excess demand for labour lagged half a quarter.

Here wages, on that count alone, never appear to achieve full compensation for price increases. For the Dicks-Mireaux and Dow equation, an increase in retail prices of 10 per cent. generate an increase in wages of 5·4 per cent. For the Irish results, an increase in retail prices of 10 per cent. generates a 7 per cent. increase in wages. But as the TSLS estimate of this (Table 2) was lower than the OLS estimate, a consistent estimate may be even lower than 0·7.[10]

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[10] It may have been wiser to use the average of the quarterly hourly earnings figures as our wage variable rather than the October figure.

14

The effect of unemployment on wage changes is marked, according to these results, and would continue to show even if a very high level of statistical significance were demanded. The coefficients in these equations (9)—(15), are all substantially lower than found for the first set. For equation (10) which is the best of this set, non-agricultural unemployment at annual rate of 29,600 would lead to wage increases of 3·4 per cent. per annum; an increase in unemployment of 1,000 heads per annum leads to a fall of 0·38 per cent. in wages. According to this equation unemployment would have to be about 38·5 thousand before the net effect on wages would be zero. This is higher than the worst year in our sample, 1957, when non-agricultural unemployment reached 37,300. Unemployment in the past three years has averaged 23,600 in the non-agricultural sector and, according to equation (10) Table 3, this will generate an increase in wages of 5·7 per cent. annually. These estimates are assumed to be net of all other influences.

Productivity does not add significantly to the explanation and, in each of the four regressions, is associated with negative coefficients. This would mean that an increase in productivity would lead to a fall in wages. We could expect that an increase in overall labour productivity would include some due to workers paid on a piece time basis and thus would be associated with an increase in wages. These negative coefficients were not statistically significant.

With the exclusion of productivity as a factor explaining wage movements the best equations are either (11) or (14). The coefficients are pretty identical except that in (14) we have an extra variable ΔU. Chart III shows the contribution of the different factors in equation (14) to the explanation of changes in wages from year to year. In the early 1950's the price inflation caused by the Korean War boom generated most of the wage increases, while in the 1960's the low level of unemployment, which implies a high demand for labour, generated most of the wage increases. The wage round variable which is just 1 per cent. measures inadequately the timing of rounds. The errors may in part be due to the use of October figures for wages. When quarterly figures are used and averaged over the year the change from 1961 to 1962 falls from 12·7 per cent. to 11·9 per cent.; and from 1962 to 1963 the change increases from 3·2 per cent. to 3·4 per cent.

(c) Short Term Wage Equation: Quarterly Levels

The third set of regressions computed were on quarterly levels of wages from 1954 to 1963. When dealing with the annual data, one might hope to eliminate the influence of wage round timing but as we have seen even this is not quite possible. Therefore, short term equations on wages are not likely to be very good. Table 4 shows the results of some of the best equations. Other equations fitted with the variables unemployment levels in Great Britain, and wage levels in Great Britain resulted in odd coefficients. Thus when Great Britain levels of unemployment were introduced in the equations, the coefficients of the retail price variable tended to turn negative; while the coefficients of the Great Britain wage variable were negative when it was introduced. The full effect coefficients for the retail price and productivity variables can be compared directly to the annual results. There is a reasonable consistency in the results showing that an increase of retail prices of 10 per cent. in a quarter will generate an increase in wages of some 5 per cent. in the long run; an increase in productivity (output per employee hour) of 10 per cent. in a given quarter will generate an increase in hourly wages of some 2 per cent. in the long run. The "long run" is determined as usual by the coefficient of lagged wages and, surprisingly, it appears to take only six months for all the effects to work through. As it stands the equations imply that the full effect of productivity and retail price changes and the level of demand for labour (as measured by unemployment) in the current quarter works through to wages within half a year. It would be unwise to take the coefficient of the lagged variables in this case too seriously as it is affected by substantial bias. Lagged dependent variable coefficients are biased when estimated by ordinary least squares for small samples; with the presence of autocorrelation the bias is more serious. However, the coefficients are consistent estimators which means that for large samples the bias diminishes. The autocorrelation of residuals is due to the wage rounds which affect quarterly movements in wages and have not been allowed for in any way.

On the other hand the estimates of the retail price, unemployment and productivity long run effects may be reasonably consistent with those derived from the annual data.[11] The full effect of the retail price variable seems to be about one half, which is lower than the earlier estimates. This means that an increase in retail prices of 10 per cent. leads in the long run to an increase in wages of 5 per cent. The unemployment figures indicate that when unemployment is at the level of 29,600 wages rise by about 1 per cent. per quarter; and if unemployment were 1,000 higher per quarter it would reduce wages by one-tenth of a per cent. per quarter. Unemployment

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[11]Autocorrelation by itself without a lagged dependent variable does not bias OLS estimates. Further the full effect estimates are the ratio of coefficients usually biassed in the same direction. We may reasonably hope that the bias for full effects is minor. For large samples the bias is reduced.

CHART III

ANNUAL CHANGES IN HOURLY EARNINGS : 1949-1963
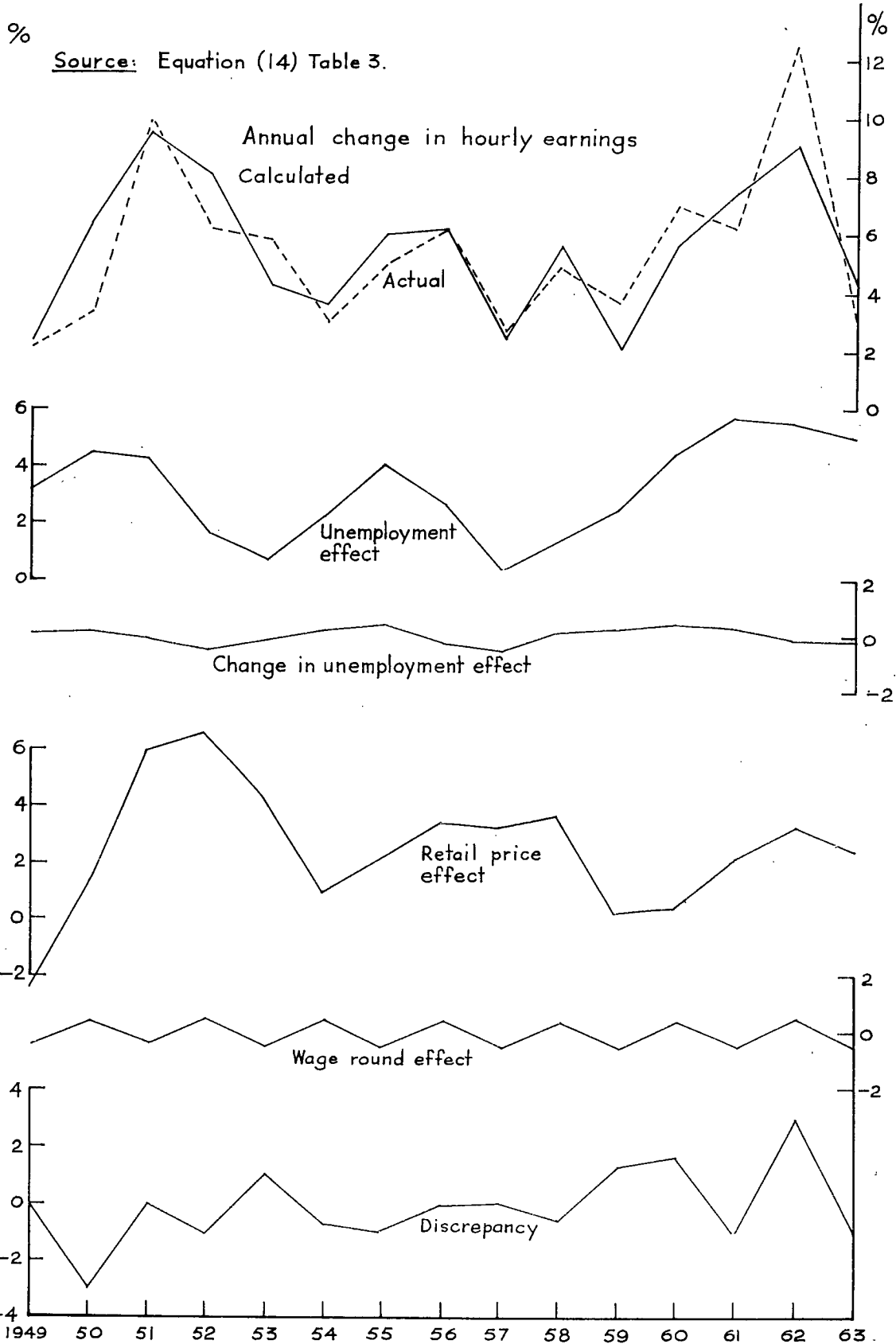### (Transportable Goods Industry)

Annual change in hourly earnings

Calculated

Actual

Unemployment effect

Change in unemployment effect

Retail price effect

Wage round effect

Discrepancy

1949 50 51 52 53 54 55 56 57 58 59 60 61 62 63

16

TABLE 4: REGRESSION COEFFICIENTS AND LONG RUN EFFECTS FOR WAGE EQUATION: QUARTERLY DATA

Equation	RETAIL PRICE VARIABLE					UNEMPLOYMENT VARIABLE					TREND VARIABLE	
	P_r	P_{r-1}	P_{r-2}	SP_r	Full effect	Σ	Σ_{-1}	Σ_{-2}	S	Full effect	t	Full effect
1	·334			·334	·334	—·0364			—·0364	—·0364	4·19	4·19
2	·063			·063	·133	—·0137			—·0137	—·0294	1·71	3·62
3	·311	·244		·555	·555	—·0802	·0455		—·0347	—·0347	3·87	3·87
4	·302	·310		·560	·512	—·0801	·0412		—·0389	—·0356	4·32	3·95
5	·336	·195	—·038	·493	·493	—·0816	·0643	—·0172	—·0345	—·0345	3·91	3·91
6	—·108	·437	·538	·867	·469	—·1025	·1034	—·0798	—·0789	—·0427	8·69	4·70

Equation	Unemployment effect in form $\Delta W = K + a(U - 29·6)$		PRODUCTIVITY VARIABLE					LAGGED TERM		Standard error of estimate $S(e)^{(a)}$
	K	a	D	D_{-1}	D_{-2}	S	Full effect	Coefficient	Rate of adjustment	
1	1·12	—·1038	·216			·216	·216			1·81
2	1·14	—·0838	·132			·132	·279	·527	·473	1·64
3	·94	—·0989	·114	·105		·219	·219			1·81
4	·94	—·1015	·116	·122		·238	·218	—·093	1·093	1·84
5	1·00	—·0984	·087	·019	·128	·234	·234			1·82
6	1·10	—·1217	·030	·075	·224	·329	·178	—·848	1·848	1·28

NOTE: S=symbol for sum. Data shown in Appendix Table C and described in Appendix 2.

(a) units are index numbers where 100 equals 1958 level of retail prices.

Full effect defined as the sum of the measured short run effects divided by the proportion of the total effect already measured. Thus the full effect due to retail price variable in Equation (2) is ·063÷(1—·527)=·133.

NOTE: The coefficients found in the equations relate to variables measured in index numbers. The transformation on the right uses actual numbers of unemployed in thousands.

would require on these figures to be about 40,000 to keep wages from increasing. At such a level of unemployment the demand for labour would be so weak that trade unions would not be able to push wages up (exclusive of other effects). The quarterly figures of the unemployment effect require to be multiplied by four to make them directly comparable to the annual results. They indicate on average that wages rise by 4 per cent. per annum with unemployment at 29,600 and that an increase in unemployment of 1,000 leads to a fall in wages of 0·4 per cent.

Productivity, according to these results, contributes to wage increases. An increase of 10 per cent. in productivity (output per employee hour) pushes up wages in the long run by 2 per cent.

The reliability of these estimates is not too high and the standard error of estimate which is a measure of its forecasting efficiency is nearly 2 per cent. With the chance of being correct only two-thirds of the time, this would give a quarterly forecast with a range of about plus or minus 3·6 per cent. for equation (3).

Because of the unreliable estimates of the lagged variable coefficients as well as the massive interference from institutional factors consideration of the time lag distribution is best left aside.

(d) Comparison of the Results

Table 5 sets out the best equation from each of the three sets reported above. The evidence is somewhat mixed but shows considerable stability for the effect of unemployment levels for non-agricultural occupations on wage changes in transportable goods industries. Throughout it has been assumed that unemployment measures (inversely) the strength of entrepreneurs' demand for labour relative to the supply. If unemployment is very high, entrepreneurs have no difficulty in obtaining labour and it becomes difficult for trade unions to achieve substantial wage increases; on the other hand, when unemployment is low, the labour market is tighter, and entrepreneurs find it difficult to obtain the staff they want, it is easier for trade unions to get higher wage increases. The people involved in the negotiations at the level of the firm—trade union officials, managers, personnel officers, etc.—may themselves be unaware of the direct influence of the factors found here to be influencing wage increases although they would agree that, when unemployment is high, wage increases are likely to be less than when it is low. Many of the people involved at firm level may be incredulous at these results. They, being very aware of the institutional factors, elements of luck, timing and so on which affect negotiations at firm level, find that these appear to be almost unimportant for an explanation of annual changes in wages for the transportable goods industry as a whole. It is precisely in the degree of aggregation that the "individual" factors became unimportant and

TABLE 5 : BEST WAGE EQUATIONS

(Hourly earnings for Transportable Goods)

Percentages

Equation	Retail prices	Productivity	Percentage change in unemployment	Presence of wage round start adds	Average* non-agricultural unemployment adds annually to wages	Unemployment at 1,000 heads higher cause a change in wages annually of
	a 10 per cent increase leads to the following percentage change in wages					
Table 3 : (9) Annual 1953–63 (levels) ..	9·37	6·55	n.a.	1·51	1·94	—·45
Table 3 : (14) Annual 1949–63 (changes) ..	7·54	nil	—·23	1·14	3·21	—·36
Table 4 : (3) Quarterly 1954–63 (levels) ..	5·55	2·19	n·a.	n.a.	3·84	—·40

*at 29,600 average for 1949–63.

general factors emerge more and more as important.

The major effect as measured in these equations that contributed to wage increases in Irish industry during the post war period was the level of non-agricultural unemployment. When we consider the second equation in Table 5, we find that over 60 per cent. of the change in wages from 1949 to 1963 can be attributed to the (relatively low) levels of unemployment. With unemployment at the average level for the period 29,600, wages would increase by about 3 per cent. per annum. The estimates in Table 5, range from 1·9 to 3·8 and, of course, our estimates are not sufficiently precise to be certain of a given figure but probably the best figure to accept would be 3 per cent. The effect of an additional 1,000 unemployed would reduce the annual change in wages by about 0·4 per cent. (the figures range from 0·36 to 0·45). The level of unemployment which these equations would imply to cause no changes in wages would be close to 40,000. This figure, which would involve an enormous amount of misery and waste resources, is a consequence in part of the linearity assumption built into the equation. An extra thousand unemployed at a level of 25,000 is likely to make greater impact on wage changes than an extra thousand at a level of 40,000 but the form of the equation used gives an equal weight to both effects. One could not be sure that non-agricultural unemployment at an annual level of 40,000 would cause wage increases to cease, though it certainly would dampen them severely. The average annual rate of unemployment for the past three years would appear to cause annual wage increases of about 5½ per cent.

The evidence for the other factors affecting wage changes is not so clear. Retail prices showed their largest variation at the time of the Korean War and so the coefficients yielded from the equation that covers that period are probably the best: it may be that for small changes in retail prices trade unions are able to extract full compensation in wage increases while for large changes only partial compensation is possible. On the other hand the estimate from the quarterly data is the lowest of the three. Since the TSLS estimate of the effect of retail prices on wages was 0·75 compared to the equivalent OLS estimate of 0·96 it is probably wiser to assume a value lower than the "best" OLS estimate. It seems best to regard the retail price coefficient to be between 0·5 and 0·75. There is not full compensation in wage changes for increases in retail prices. An increase of 10 per cent. in retail prices leads to an increase in wages of between 5 and 7½ per cent. (ignoring all other effects).

Productivity adds to the explanation for two sets of equations but not for the set explaining annual changes from 1949 to 1963. This is not reassuring but it seems best to assume it has some effect, maybe of the magnitude as comes from the quarterly analysis where an increase in productivity of 10 per cent. leads to an increase in wages of 2 per cent.

For the other factors it seems that the presence of the two-yearly wage round adds about 1 per cent. to wage changes in the year of the round; and that an increase in unemployment of 10 per cent. leads to a fall in wages of one quarter of a per cent. (as distinct from the effect of the unemployment level). There appears to be no direct effect on Irish wages of such British labour market influences as British wages, and British demand for labour (measured by the rate of unemployment).

To summarise this section we find that current annual changes in wages are strongly affected by the current level of unemployment, the current change in retail prices, and the presence or absence of the start of a wage round; less strong in their influence

are changes in productivity and changes in the level of employment.

Wages increase by about 3 per cent. annually with non-agricultural unemployment at 29,600 (the average for 1949–63); an extra 1,000 on unemployment reduces wage increases by 0·4 per cent.;

Wages increase by 5 to 7½ per cent. in response to an increase of 10 per cent. in the retail price level;

Wage changes are about 1 per cent. higher in the year a wage round starts;

A 10 per cent. increase in productivity probably increases wages by 2 per cent.;

A 10 per cent. increase in the current year's level of unemployment causes a fall of 0·25 per cent. in the current year's wage increase;

Past years influences (except for the last factor) do not appear to affect current year's wage changes.

4. EMIGRATION

The evidence regarding the determination of wages above suggests that it is dominated by domestic Irish factors rather than by any direct influence from the British labour market. This conflicts with some opinion on the subject.[12] In O'Mahony's "Economic Aspects of Industrial Relations", *op. cit.*, the point is argued that when the gap between wages in Britain and Ireland widens, it leads to a movement to Britain from Irish industrial employment. Thus if the money (or real) gap in earnings between Britain and Ireland widens it causes a fall in employment in Ireland and an increase in emigration. It is at this point an additional test may be made comparing the two theories. Is emigration closely related to the gap measured in money (or real) terms between Irish and British wages?

Before examining the regression equations on the net emigration statistics, it is useful to refer to the "Commission on Emigration and Other Population Problems: 1948–54 Reports". Paragraph 282 reports an analysis of net emigration from 1926 to 1951 by counties and concludes "it is clear from the statistical data presented that emigration tends to be heavy from densely-populated areas, from areas where the land is poor (as indicated by its valuation), from areas where there is relatively little urbanisation, and from small-farm areas".

Factors influencing net emigration can be divided into two categories: those that push and those that pull the emigrants. In the former category we have the fairly rapid rate of population natural increase. The natural increase, which is defined as births minus deaths, rose from about 5·5 per 1,000 of population per annum in the inter-war period to 8·6 for 1946–51, 9·2 for 1951–61, and 9·6 for 1960–62. At the same time total employment has been declining. The number at work fell from

1·22 million in 1951 to 1·05 million in 1963. The fall has been greatest for agricultural employment which causes the emigration from rural areas to be much heavier than from urban areas. In the regressions we use a linear time trend to reflect the pressure from an increasing work force on shrinking employment prospects. To measure urban employment prospects we use the level of non-agricultural unemployment. We also introduce the level of "agricultural, etc." unemployment to reflect rural job prospects. This is probably inadequate and perhaps a better measure would be the total money income generated by the agricultural sector. Emigration pressure from rural areas probably arises from under-employment on small family farms (and the consequent low income) rather than unemployment.[13]

The "pull" factors affecting emigration used are the level of demand for labour in Great Britain as this is the main destination for emigrants and the gap in money (or real) terms between Irish and British wages. The latter is the variable that is thought to play such an important role in determining Irish wages. The former can be expected to explain emigration from all areas—clearly if the demand is low then we may expect a reduction in emigration—while the latter explains urban emigration. The level of demand for labour in Great Britain is assumed to be measured (inversely) by the percentage level of unemployment there. We have estimated regression equations on annual data for the periods 1948–63 and 1953–63 by the method of least squares which should give a fairly reliable guide on the strength of different factors. This analysis emphasises the short run and should be interpreted with care as providing a long run analysis. This is due to the interaction of the variables—thus Emigration affects employment

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[12]Such as: G. O'Brien, "Economic Progress of Ireland", *Studies*, Spring 1962; E. Nevin, "Wages in Ireland, 1945–62", Economic Research Institute, Paper No. 12, (particularly p. 10); these hint at a direct relationship between Irish and British wage levels.

[13]In very many Irish farms the money income per worker (usually the owner) is less than the official agricultural wage. This can be found by examining "The National Farm Survey 1955–56—1957–58; Final Report", published by the Central Statistics Office, (Pr. 6180).

prospects—which is assumed away in this single equation analysis.

(a) Regression Results for Emigration

Table 6 sets out the regression coefficients for four equations estimated. Not only are the point estimates of the equations given but the regressions are also shown for variables accepted at the 5 and 1 per cent. levels of significance. The regression equations were re-estimated dropping all those variables that did not add significantly (using an F-test) to the explanation. The point estimates of the four equations indicate the following:

an increase in non-agricultural unemployment of 1,000 leads to an increase in emigration of between 1,736 and 2,449; the equations based on the shorter period tend to give greater weight to this factor;

an increase in agricultural unemployment of 1,000 leads to a reduction in emigration of between 215 and 715;

an increase in the Great Britain percentage level of unemployment by 1 percentage point, that is by about quarter of a million, reduces emigration by between 8,354 and 17,283;

the trend factor increases an annual increase in emigration each year by between 1,735 and 3,842 independently of the other factors included in the equation;

if the ratio of Irish money wages to British money wages widens by 1 per cent. this would increase emigration by between 664 and 936;

alternatively if the ratio of Irish real wages to British real wages (adjusted in each case by retail prices) widens by 1 per cent. this would increase emigration by between 489 to 919.

It is true that a 1 per cent. change in some of these variables is of a different likelihood than for others. Thus a 1 per cent. increase in Great Britain unemployment adds $\frac{1}{4}$ million to the live register and is a very big change by post-war standards. Comparing the coefficients for 1948–63 and 1953–63 it will be seen that, in the latter period, Irish unemployment levels, British unemployment and the "trend", all had bigger effects; the influence of the ratio of money wages and real wages gets smaller.

When stricter limits are accepted—only variables

TABLE 6 : EMIGRATION EQUATIONS : REGRESSION COEFFICIENTS

(with s-values underneath in brackets)

	Constant (000s)	Non-agricultural unemployment (000s)	Agricultural unemployment (000s)	GB % unemployment	Trend	Ratio of money wages × 100	Ratio of real wages × 100	S(e) (000s)
POINT ESTIMATES								
1948–63								
(1)	80,124 (1·64)	1·736 (3·57)	—·215 (0·33)	—8,354 (2·06)	1,735 (2·97)	—936·4 (2·02)		4,290
(2)	89,276 (1·80)	1·992 (4·47)	—·705 (1·03)	—10,106 (2·89)	1,999 (4·43)		—918·5 (2·17)	4,195
1953–63								
(3)	44,930 (0·63)	2·382 (2·37)	—·338 (0·20)	—14,781 (1·92)	3,315 (1·94)	—664·1 (1·15)		4,450
(4)	27,590 (0·36)	2·449 (2·27)	—·237 (0·13)	—17,283 (2·34)	3,842 (2·31)		—489·0 (0·81)	4,700
FIVE PER CENT SIGNIFICANCE LEVELS								
1948–63								
(1)		2·005 (8·56)		—11,711 (3·29)	2,556 (8·18)	—192·3 (2·19)		4,410
(2)		1·635 (8·87)		—16,098 (4·81)	2,758 (8·14)			5,014
1953–63								
(3) and (4)		1·770 (6·43)		—19,751 (3·18)	3,431 (3·50)			5,468
ONE PER CENT SIGNIFICANCE LEVELS								
1948–63								
(1) and (2)		1·635 (8·87)		—16,098 (4·81)	2,758 (8·14)			5,014
1953–63								
(3) and (4)		0·922 (9·61)			694 (1·04)			7,755

Data shown in Appendix Table B and described in Appendix 2.

that add significantly to the explanation at the 5 per cent. level of significance,[14] we find that non-agricultural unemployment, percentage rate of Great Britain unemployment, trend and in one case, the ratio of money wages, are significant in explaining movements of emigration. At the 5 per cent. level of significance we find that an increase of 1 per cent. in the ratio of Irish to British money wages would reduce emigration by 192.

At all levels of significance we find non-agricultural unemployment in Ireland contributing to the explanation of emigration. This variable is a reasonable indicator of the demand for Irish labour. When Irish entrepreneurs do not need labour, unemployment swells and with it emigration. This relationship does not mean that when unemployment figures go up by 1,000 it hides the departure of 1,635 who otherwise would have increased unemployment (equation (1) 1 per cent. significance level). The level of non-agricultural unemployment may be regarded as an indicator of job prospects within Ireland. From an earlier section we have seen the relation between industrial output and employment. More generally we could say that Irish employment levels are mainly determined by the output generated here; the level of unemployment is inversely related then to Irish output generated. Thus the strongest factor influencing emigration is an indicator of job prospects in the Irish economy.

Two other factors that do well in explaining emigration are the percentage rate of Great Britain unemployment and the trend. The percentage rate of Great Britain unemployment is an indicator of demand for labour in the British labour market and clearly when demand is high (and unemployment low) it pulls Irish emigrants in. When jobs are not so easy to get in Britain, emigration is deterred. The trend factor shows an alarming tendency for emigration to rise possibly by two to three thousand a year. This probably reflects the expansion in the labour supply as a result of the increased natural increase and the decline of agricultural employment. The strength of this effect somewhat limits the reliability of our results.

The introduction of the ratio of money wages or real wages in Ireland and Britain did not add successfully to the direct explanation of emigration. There is no strong evidence to support the view that the Irish and British labour markets are so closely linked that a widening of the gap in wages (money or real) would lead to a substantial increase in emigration. An increase in emigration could occur, coincidental to such a situation, if there were a boom in Britain and a slump in Ireland. Here the mechanism would be quite direct as the number without jobs, or the prospect of getting jobs in Ireland, would be attracted to Britain where jobs could be got in plenty. Chart IV shows equation (1) at the 5 per cent. level of significance where the various factors contributing to emigration are compared with actual emigration. (The reliability of the year to year emigration figures is questionable and is discussed in section 7). It seems clear that a major part of the explanation of the emigration peak of 1957 is due to the Irish unemployment effect. Similarly the reduction in emigration in the following period seems related to the corresponding fall in Irish unemployment.

5. INDUSTRY OUTPUT PRICE EQUATIONS

In this section we examine the pricing policy of Irish entrepreneurs (in aggregate) by reporting further regression analyses on annual and quarterly data. The primary assumption is that prices are calculated on the constant mark-up principle. The prime cost per unit of output is assumed to be composed of the cost of labour, imported, and domestic agricultural, raw materials per unit of output. All other costs are assumed to be constant per unit of output. Thus costs per unit of output (C_z) could be written

$$C_z = a + bw + dp_{iz} + fp_a \qquad (19)$$

where b, d and f are the proportions these inputs are used in production; w, p_{iz} and p_a are the prices of the inputs, namely hourly wages, imported materials price and agricultural products price; and a is the "overhead" cost of production.

We then assume the price p_z of output is marked-up cost and so

$$p_z = KC_z \text{ (where } K > 1) \qquad (20)$$

$$= Ka + Kbw + Kdp_{iz} + Kfp_a \qquad (21)$$

It may be hoped that this simple model will catch sufficient of the features by which prices are determined to be useful for aggregate post-war analysis.

Over time, productivity can be expected to act reducing prices. Generally productivity changes show up in changes in labour productivity rather than material productivity and this would indicate for equation (19) above a declining b coefficient. We try to allow for the effect of changing productivity by introducing direct indicators of productivity as
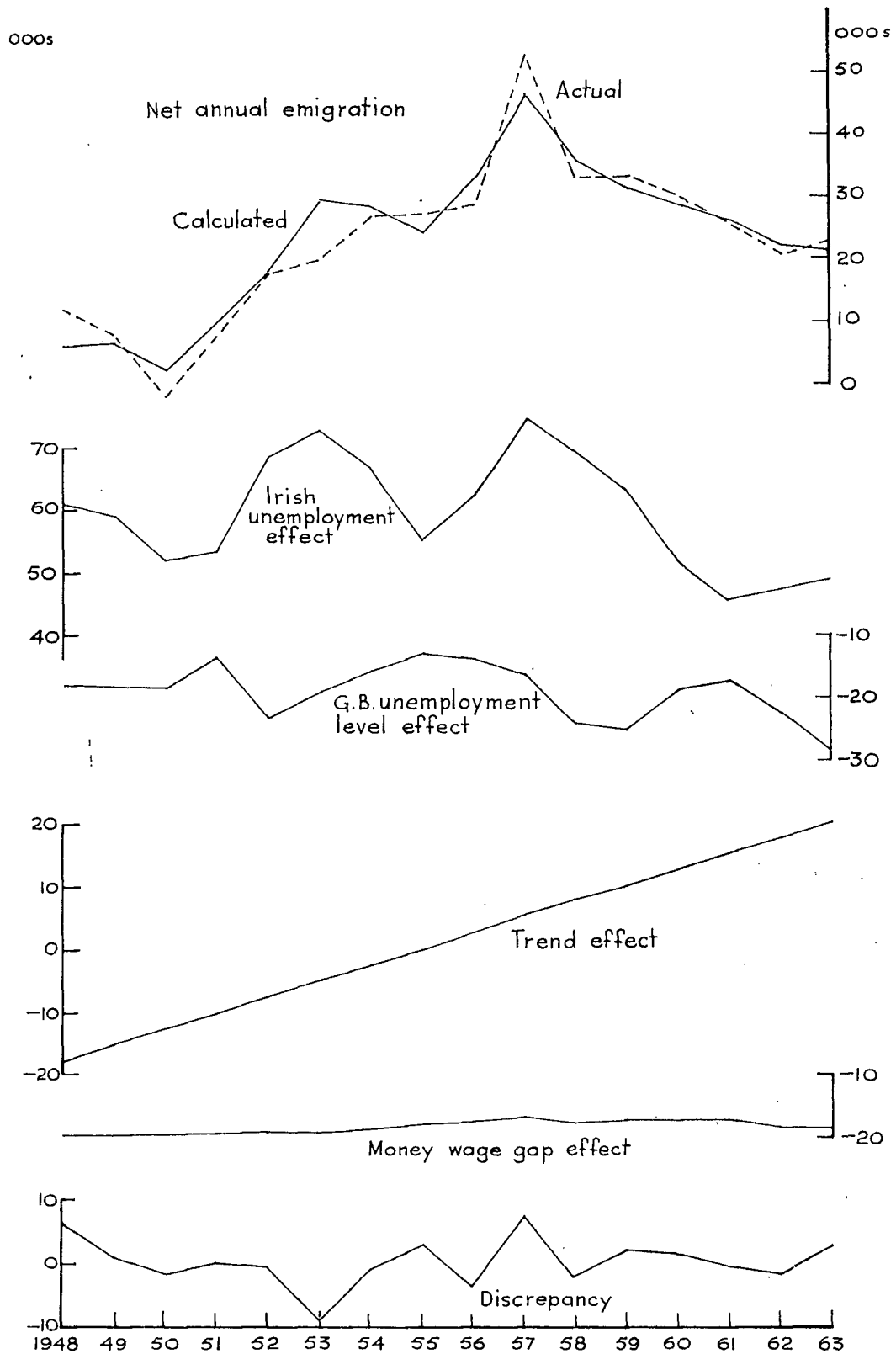
[14]If the dropping of a variable from an equation leads to a significant (5 per cent level) loss in the explained variation, as determined by an F-test, then the variable should be retained. This involved the recalculation of regression equations.

CHART IV

NET ANNUAL EMIGRATION 1948–63

Source: Equation (1) 5 per cent level of
significance Table 6.

an extra variable rather than by adjusting the labour coefficient.[15]

Subsidiary to the primary assumption, three effects likely to be important were examined. First, to what extent if any, do entrepreneurs respond to demand conditions in their pricing. Thus, if output is expanding rather better than expected, does this encourage additional price increases leading to above "normal" profit margins? In the reverse situation, when demand is low, do entrepreneurs tend to absorb more of cost increases by reducing profit margins? Secondly, how long does it take price changes of the different cost elements to work through into output prices? Thirdly, do changes in the price of imported goods directly competing with Irish products induce comparable changes in prices.

It may be noted that the mark-up principle is a hypothesis that helps to explain the long run stability of labour and business shares in industrial income noticeable in most countries.[16]

(a) Statistical Results: Annual Data

From 1953 to 1963, the industry output price index rose by 22·4 per cent. Over the same period the prices of labour, imported materials and (Irish) agricultural materials—the inputs of industry—rose by 69·7 per cent., 12·7 per cent. and 2·0 per cent. respectively. Over this period output per man hour (for Transportable Goods Industry) rose by 33·1 per cent. This substantial increase in labour productivity helped to keep industry output prices from rising too fast. From the rough figures on the structure of industry (from Geary's Input-Output table already referred to) it would seem that there was a rise in profit margins:—

CHANGES FROM 1953–63

		Weight* in 1960	Total effect
Costs:			
Wage cost per hour ..	69·7		
Labour productivity ..	33·1		
Wage cost per unit (adjusted for labour productivity) ..	27·5	28	7·7
Imported material cost ..	12·7	41	5·2
Agricultural material cost ..	2·0	31	0·6
		100	
Increase in prime costs ..	13·5		
Industry output price ..	(22·4)		

*Geary Table 4 (*op cit.*). More accurately these weights should be adjusted pricewise to 1953 but this was not considered necessary.

[15]As done in Neild, "Pricing and Employment in the Trade Cycle", where instead of wages (w), wages divided by the productivity trend (w/d) was used. The productivity trend was 2½ per cent. per annum.

[16]It is fair to say that some economists doubt the existence of the phenomenon, e.g. Edward Denison. See his remarks in "The Behaviour of Income Shares", Studies in Income and Wealth, Vol. 27, Princeton 1964.

A note of caution must be added here; not only are we dealing with rough aggregates, some not of the precise coverage required, but also these are index numbers which (when used over long periods) can be misleading indicators of such derived ratios as profit margins.

The results of the annual regressions are shown in Table 7. The first three are concerned with how significantly current cost changes influence output price. Productivity changes are allowed for by introducing a trend, actual productivity, and output. The first equation says that the current output price is a function of current costs (wages, imported materials price and agricultural prices) and a trend to allow for the long run trend of productivity. If entrepreneurs did their calculations in this way, thinking not of the actual productivity changes likely to be gained in the current year but fixing their prices in accord with some "long run" average we could expect a negative trend coefficient. We do not get one. When actual (labour) productivity levels are introduced in equation (2) we get another positive coefficient. This would imply that an increase in labour productivity would lead to an increase in output price. In this equation we find the wage cost element is almost eliminated so it would appear that the wage cost effect has shifted on to the productivity variable. In equation (3) when output is introduced as an explanatory variable, its coefficient is negative. This would suggest that entrepreneurs use output increases as the indicator of productivity changes and appear to expect that an increase of about 6 per cent. in the volume of output would be sufficient to absorb an extra 1 per cent of total costs by higher productivity. Equation (3) gives coefficients with equal weight for the prime cost elements although they add up to less than unity. The trend term measures factors not otherwise included (like lagged cost changes) and with a coefficient of 1·11 per cent. per annum would account for half of the change in industry output price from 1953 to 1963. None of the coefficients of these equations are very reliable though this may in part be due to the short time period we are examining.

The next four equations (4) to (7) introduce last year's industry output price as an explanatory factor for this year's prices. This improves the explanation substantially as can be seen by the halving of the standard error of estimate. The coefficients of the lagged variable range from ·544 to ·674 and this measures the proportion of the total cost effects not due to the current year. Thus equation (4) says that 39·6 per cent. of the current changes in costs will be felt in this year's prices; previous changes in costs have a weight equal to 60·4 per cent. on the current output price. These equations indicate that previous years cost changes play a very important role

23

TABLE 7: INDUSTRY OUTPUT PRICE: ANNUAL REGRESSIONS
(With s-values underneath in brackets)

	Wages	Agricultural price	Imported materials price	Trend	Productivity	Output	Imports for personal consumption price	last years output price	Expectation variables*				Standard error of estimate[a]
	W	p_a	p_{iz}	t	D	Z	p_{ic}	$(pz)_{-1}$	Ω_1	Ω_2	Ω_3	Ω_4	S(e)
(1)	·121 (0·85)	·267 (1·16)	·443 (1·97)	1·05 (1·09)									1·75
(2)	·015 (0·06)	·251 (1·01)	·548 (1·72)	·80 (0·70)	·227 (0·50)								1·87
(3)	·288 (0·95)	·249 (1·02)	·257 (0·68)	1·11 (1·10)		—·160 (0·64)							1·84
(4)	·099 (1·27)	·029 (0·21)	·552 (4·36)	—·20 (0·32)				·604 (3·87)					·96
(5)	·202 (1·39)	·017 (0·12)	·459 (2·71)	—·09 (0·14)	—·228 (0·85)			·674 (3·74)					·98
(6)	·311 (2·45)	—·001 (0·01)	·318 (2·01)	—·16 (0·32)		—·204 (1·93)		·625 (4·95)					·77
(7)	·304 (2·28)	—·003 (0·03)	·298 (1·78)	—·27 (0·51)	·301 (0·79)	—·328 (1·71)		·544 (3·27)					·81
(8)	·077 (0·49)	·193 (0·74)	·917 (1·33)	1·30 (1·23)			—·322 (0·73)						1·82
(9)	·122 (1·36)	—·047 (0·31)	·279 (0·59)	—·49 (0·62)			·193 (0·67)	·672 (3·47)					1·01
(10)	·167 (1·41)	·115 (0·56)	·703 (3·11)	0·42 (0·49)					·316 (1·99)				1·43
(11)	·119 (0·96)	·045 (0·18)	·355 (1·73)	1·25 (1·46)						·173 (1·65)			1·54
(12)	·206 (2·32)	·015 (0·10)	·489 (3·54)	0·65 (1·10)							·286 (3·39)		1·05
(13)	·320 (2·30)	—·022 (0·10)	·655 (3·34)	—·24 (0·26)								·323 (2·28)	1·34
(14)	·106 (1·15)	·027 (0·17)	·578 (3·27)	—·19 (0·27)				·561 (2·25)	·041 (0·24)				1·06
(15)	·099 (1·15)	·017 (0·10)	·538 (3·37)	—·12 (0·15)				·577 (2·54)		·018 (0·19)			1·07
(16)	·137 (1·27)	·012 (0·08)	·535 (3·83)	·05 (0·06)				·415 (1·11)			·104 (0·57)		1·03
(17)	·083 (0·51)	·038 (0·22)	·542 (3·25)	—·17 (0·22)				·635 (1·96)				—·023 (0·11)	1·07

*Described on page 25.

(a) Units are index numbers with 100 equal to 1958 industry output price level.

Data shown in Appendix Table A and described in Appendix 2.

in determining the current year's output price.

One effect of introducing the lagged variable has been to eliminate any effect on output prices that agricultural prices might have. On the other hand it is true that the price index of agricultural products rose only 2 per cent. from 1953 to 1963 and, due to its long run stability, may not contribute to output price changes.[17] Another is to increase the weight of the imported materials price to an unrealistic degree. With the presence of the lagged variable, coefficients of the trend variable, the productivity variable in equation (6) and the output variable are all negative. The productivity term in equation (6) is of the same order of magnitude as the wage term which is as one might expect. When productivity and output are both entered, the latter still does better which suggests that for entrepreneurs it may be a more useful indicator of productivity movements. This incidentally reflects the results in the earlier section where we examined output and employment (and employee hours). Secular movements in productivity were hardly present and it was only when output rose that labour productivity increases were realised.

For these equations the coefficients of wages, imported materials price, output, and last year's output price are just about statistically significant. The sum of the coefficients of the first two, when adjusted by the coefficient of the lagged variable, gives a long term value greater than unity in each equation. We would expect a figure less than unity in the long run as we assume that profit margins tend to be constant. If, however, profit margins have risen substantially over the period—and the text table above tends to suggest it—then we might expect these cost coefficients to add to more than unity. The first part of the period, from 1953 to 1958, output showed little change and we can expect it to be a time of hard pressed profit margins; since then output has boomed and we might expect entrepreneurs to exploit this situation to expand their profit margins to more "normal" levels. If this is the case, then we will not be likely to get reliable prime cost coefficients, (i.e., that add to unity), unless, as we try below, specific account is taken of demand conditions.

Equations (8) and (9) investigate the influence of (apparently) competitive price movements on the Irish output price. The competitive price index used is the wholesale index of imports for direct personal consumption (and includes import duties). The co-efficient changes sign when the lagged output price is introduced and is quite reasonable in the second equation indicating that some degree of price competition exists between imports and home output. However, with the small s-values and the changed sign, a fair assessment would be that there is no evidence here of a change in import prices leading to a corresponding change in Irish output prices.

Equations (10) to (17) investigate the effect of expectational factors on Irish entrepreneurs pricing policy. If demand (or output) is better than "expected" will this encourage entrepreneurs to increase their profit margins. The question then arises, what is better than "expected"? Four variables were used: Ω_1 is the difference between the actual change in output and a trend line of 3 per cent. and measures the improvement on the expectation of a steady trend against actual movements. Thus if output rose faster than the trend of 3 per cent., conditions would be better than expected. Ω_2 is the difference between the current change in output and last year's change in output—entrepreneurs are basing their calculations on last year's experience being repeated. Ω_3 is the difference between the current change in output and the average change of the two preceding years. In other words "normality" is what happened the last two years; and Ω_4 is the difference between the current change in output and the average change of the three previous years. Thus output rose by an average of 6·9 per cent. in the years 1961, 1962 and 1963. The "normal" increase for 1964 would be 6·9 per cent.

Equations (10) to (13) introduce these variables one at a time. Equations (14) to (17) add the lagged output price. For the first four equations, these variables have strong positive effects indicating the influence of demand pull on output prices. Taking equation (12), for instance, (which is best by the criterion of low standard error of estimate) if output rises in a given year by 1 per cent. more than the average change of the past two years, then entrepreneurs will add 0·29 per cent. on to output prices—pushing profit margins above their normal level. If on the other hand, as in 1962, output is lower than the average of the two previous years then profit margins are squeezed and, for this equation, would have meant that prices were 0·95 per cent. lower than if it had been a "normal" year.

When the lagged output price is introduced in equations (14) to (17) and adjustment is made for the time lag effect[18] only in the case of Ω_3 does the full effect of the demand pull variable approach

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[17] This could be investigated more directly by examining price movements for the Food Processing Industry which is almost the only user in "industry" of agricultural products as a direct input; on the other hand the price index used may be inappropriate. See Appendix 2.

[18] See notes to Tables 1 and 4. We have Model of form $y = a(1 - K) x + K y_{-1}$ where, a, the full effect is calculated by dividing the complement of the coefficient of y_{-1} into the coefficient of x.

the estimate in the set given in equations (10) to (13). For Ω_4 the coefficient is negative.

Full effect due to	Equation without lag	Equation with lag
Ω_1	·316	·090
Ω_2	·173	·043
Ω_3	·286	·176
Ω_4	·323	—·063

Source: Table 7, equations (10) to (17).

Unfortunately none of the equations (10) to (17) included output or productivity as an explanatory variable so that the time trend had to reflect the effect on output prices of changing productivity.

The residuals errors were calculated for equation (6) which is the best equation of the lot and includes the level of output to measure the effect of changes in productivity. These residuals were then regressed against the four demand pull variables and none even achieved an R^2 of 0·20. This is not a conclusive test but one would have expected some correlation to show.

To summarise the results then on the annual data:

> the sum of the prime cost variable was above unity for each equation thus suggesting that in the period 1953–63 gross profit margins (before depreciation) were being increased;

> it appears that entrepreneurs expect to realise productivity increases only in conditions of expanding output;

> it appears to take quite some time before cost increases are finally passed on to output prices, probably over a year, but the next part will deal with this at some length;

> there is some evidence of demand pull operating, namely, that entrepreneurs attempt to improve profit margins when output is better than expected and to accept reduced profit margins when output is worse than expected;

> there is less evidence on the annual data that output prices are influenced by prices of imported goods directly for personal consumption.

(b) Statistical Results: Quarterly Data

A set of regressions were computed on the quarterly data from 1954 to 1963 to get a better picture of the time lags involved. Table 8 shows the point estimates for 21 equations estimated. The first 15 examine the effects of output and productivity on output prices as well as the effect of lagged prime cost changes. On this occasion some of the produc-

tivity coefficients are negative but are positive when in competition with the output variable and with such small s-values that productivity is again ousted from the explanation. The trend had been introduced initially to reflect any effect on behaviour from a long term productivity trend. Again the coefficients for the trend are strongly positive and may be measuring the effect on prices of increasing capital or other changes which we had assumed constant per unit. With such a large number of closely correlated variables it is not surprising to find instability in the coefficients.[19] The second set, equations (16) to (21), examine more carefully (but unfortunately without output as a variable) the effect on the output price of changes in price of (competitive) imports.

When a 1 per cent. level of significance is applied to the variables, equations (5), (10) and (15) yield the following coefficients which present a consistent and sensible picture.

The full effect is, as before, the short run coefficient divided by the complement of the lagged (p_z) coefficient. Thus for wages in (5) we have $\frac{·092}{1-·681}=·286$. The complement of the lagged (p_z) coefficient measures the proportion of (time) lag passed.

Equation (5)[1] says that only 32 per cent. of the full effect of the current quarter's factors have been transmitted into output prices after one quarter; after two quarters, according to (10)[1] the amount has risen to 54 per cent. and from (15)[1] we find that 71 per cent. of the current quarter's influences in costs will be transmitted after nine months. The sum of the long run cost coefficients for wages and imported material prices (which should be equal to their weight in total costs if the mark-up principle is a useful assumption) is about 0·70 for (10)[1] and (15)[1], rather less for (5)[1]. The input-output estimate given above is also about 0·70. It appears that (10)[1] and (15)[1] are more consistent with each other than (5)[1] and this in part may be due to nature of the time lag distribution of the response of output prices to imported material prices. In equation (10) both variables (p_{iz}) and $(p_{iz})_{-1}$ were introduced but only the latter was accepted at the high level of significance; in equation (15), (p_{iz}), $(p_{iz})_{-1}$ and $(p_{iz})_{-2}$ were all introduced and this time only the last was able to add significantly to the output price explanation in (15)[1]. This would seem to imply that the mode of the time lag distribution for (p_{iz}) is one or two quarters after the initial effect; one might expect

[19] We can expect W, W_{-1} and W_{-2} to be very highly correlated between each other; similarly for p_a, $(p_a)_{-1}$ and $(p_a)_{-2}$, etc. This problem of serial correlation can give rise to indeterminate regression coefficients and the primary defence against it, as here, is a large sample.

Table 8: INDUSTRY OUTPUT PRICE EQUATIONS: QUARTERLY DATA

No.	W	W_{-1}	W_{-2}	p_a	$(p_a)_{-1}$	$(p_a)_{-2}$	p_{iz}	$(p_{iz})_{-1}$	$(p_{iz})_{-2}$	t	Z	Z_{-1}	Z_{-2}	D	D_{-1}	D_{-2}	$(p_z)_{-1}$	$(p_z)_{-2}$	$(p_z)_{-3}$
1	−·047			·058			·271			6·061									
2	·140			·059			·127			6·160	−·171								
3	−·007			·059			·240			6·108				−·066					
4	·018			−·019			·144			0·763							·775		
5	·092			−·007			·097			1·559	−·089			·022			·664		
6	−·035	·090		−·001	·160		−·001	·453		4·135									
7	·033	·091		·013	·123		−·003	·343		4·593	−·072	−·012							
8	−·053	·055		−·025	·194		−·007	·532		4·001				−·005	−·100				
9	·109	−·039		−·047	·096		·038	·337		1·334								·463	
10	·145	−·026		−·035	·090		·027	·271		2·500	−·128	−·009		−·074	·045			·347	
11	·047	·040	·012	−·082	·019	·131	−·015	−·064	·614	3·305									
12	·043	·073	−·008	−·055	·013	·110	−·021	−·105	·601	3·77	−·041	−·036	·047						
13	−·034	·101	−·058	−·067	·016	·173	−·016	·140	·501	3·46				·005	·021	·098			
14	·086	·151	−·144	−·120	·041	·097	·030	·197	·281	1·328									·350
15	·085	·101	−·073	−·072	·036	·096	·011	·143	·275	3·231	−·096	−·072	−·004	·075	·075	·046			·146
											p_{ic}	$(p_{ic})_{-1}$	$(p_{ic})_{-2}$						
16	−·039			·140			·142			5·888	·121								
17	·021			·041			·059			8·319	·083						·750		
18	·013	·057		−·062	·142		·010	·522		3·912	−·195	·134							
19	·103	−·041		−·043	·098		·032	·246		1·484	−·028	·084						·468	
20	·086	·065	−·047	−·148	−·002	·139	−·001	·083	·477	3·223	−·151	−·009	·134						
21	·099	·139	−·154	−·136	·041	·103	·025	·181	·165	1·576	−·030	−·028	·138						·342

Note : W=wages (hourly earnings); p_a=price agricultural products; p_{iz}=imported materials price; t=time trend; Z=output; D=productivity; p_z=industry output price; p_{ic}=imports for direct consumption price; suffixes relate to time periods, i.e., W_{-1}=wages in the previous quarter. For sources see Appendix 2.

At 1 per cent. level of significance

$(5)^1$	·092W	$+·096p_{1z}$	−·074Z	$+·142t$	$+·681(p_z)_{-1}$
$(10)^1$	·133W	$+·245(p_{1z})_{-2}$	−·082Z	$+·196t$	$+·460(p_z)_{-2}$
$(15)^1$	·172W	$+·335(p_{1z})_{-1}$	−·091Z	$+·234t$	$+·289(p_z)_{-3}$

	Full effect of				Sum of prime cost coefficients	Proportion of lag passed
	W	p_{1z}	Z	t		
$(5)^1$	·286	·301	−·232	·445	·587	·319
$(10)^1$	·246	·454	−·152	·363	·700	·540
$(15)^1$	·242	·471	−·128	·329	·713	·711

this to cause a shift in all the coefficients of the first equation where only the current value of (p_{iz}) is introduced.

Chart V pictures equation $(5)^1$ explaining quarterly movements in the industry output price in terms of the short run effects due to wages, imported materials price, output and the trend in the current quarter. The effects of wages, etc., in previous quarters are gathered together in the lagged output price effect. These lagged effects altogether can be seen in the chart to be a much bigger influence on the industry output price level than the current effects.

We may summarise the conclusions from these equations as follows:

the full effect prime costs coefficients seem to imply that a 1 per cent. increase in wages leads to an increase in industry output price of about 0·25 per cent.; an increase of 1 per cent. in imported materials price would lead to an increase of 0·45 per cent.;

an increase in output of 10 per cent. would lead to a fall in output price of about $1\frac{1}{4}$ per cent.; this result is consistent with the hours worked/ output relationship estimated earlier where, approximately, we find that an increase in output of 10 per cent. lead to a $4\frac{1}{2}$ per cent. increase in hours worked and thus an increase of over 5 per cent. in labour productivity; the effect on total costs is $-5\frac{1}{2} \times 0·25$, where we multiply the change in productivity by the weight of labour in the cost equation, or $-1\frac{1}{4}$ per cent. as shown above;

factors not accounted for but represented by the trend appear to increase industry output price by some 1 per cent. per annum; this may in part be due to "demand pull" factors not measured in this section; and of course could also reflect an increase in the capital stock greater than that of output. The following figures give estimates of the time lag distribution:

PERCENTAGES

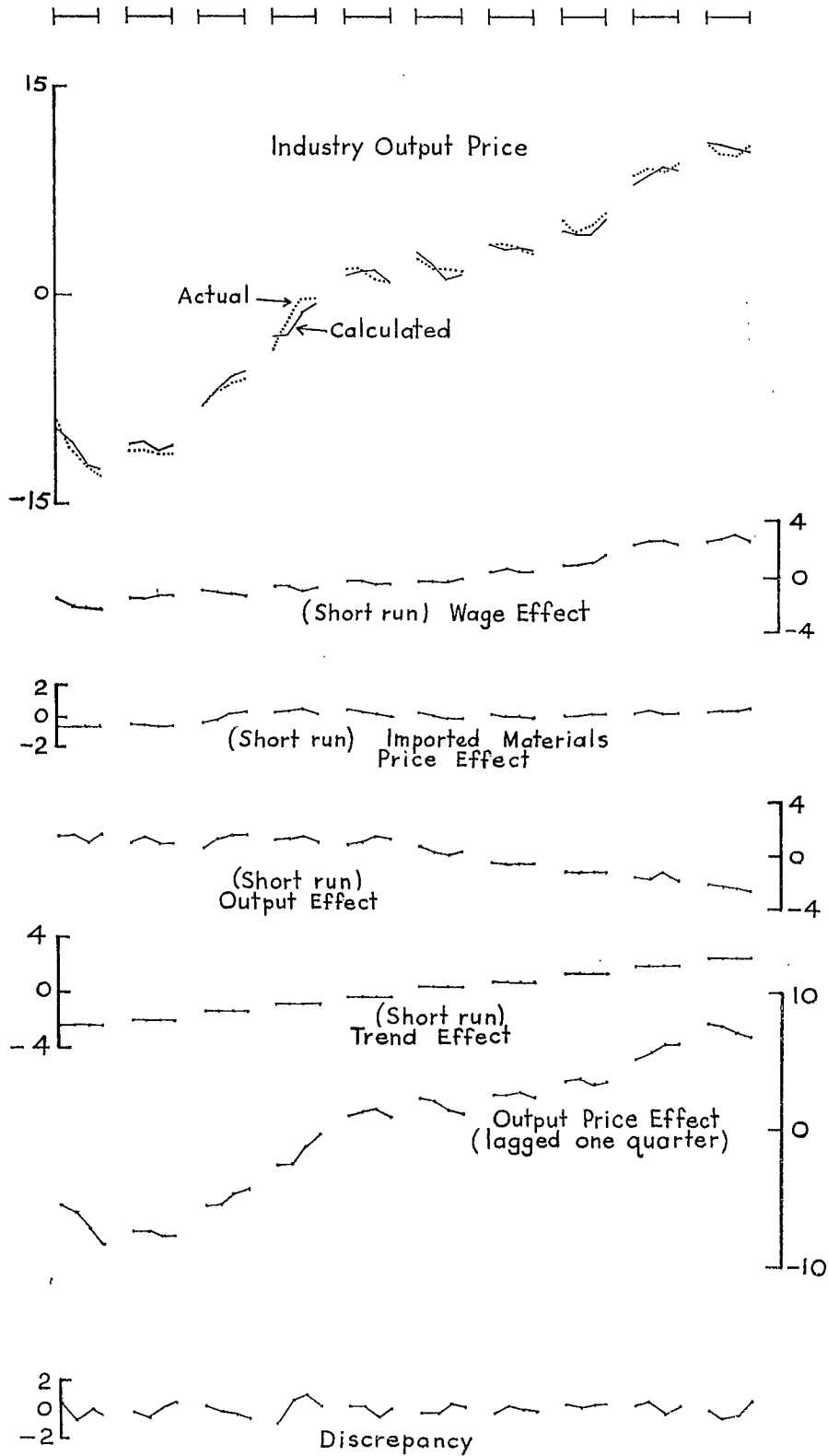| Effect felt on	Due to wages	Due to imported material prices	Output	Total effect
	in the current quarter			
Output price: in current quarter	36·8	21·3	59·2	31·9
one quarter later	16·4	33·1	6·4	22·1
two quarters later	15·6	20·0	7·2	17·1
three or more quarters later ..	31·2	25·6	27·2	28·9
Total effect on: output price of 1 per cent. change ..	0·25	0·45	−0·125	

In the current quarter over a third of the change in wages is passed on to the current output price but only one-fifth of the change in imported materials price; one quarter later the major effect from the imported materials price, one-third of the change, comes through onto the output price while only one-sixth of the wage change. 60 per cent. of the effect from changing output is felt on prices within the quarter the change takes place. After six months just six-elevenths of the change in wages and import (raw material) prices will have been transmitted into output prices. After nine months 70 per cent. of changes in costs in a particular quarter will have worked through. It may be reasonable to expect a full eighteen months to pass before almost all (i.e., over 95 per cent.) of the effects of changes in prime costs and productivity in a particular quarter are felt on the output price.

If wages go up by 12 per cent. in a particular quarter, then our equation says that in the long run (eighteen months) this will push up the industry output price level by $2\frac{1}{2}$ to 3 per cent.; in the current quarter one could expect an increase of $1·1$ per cent., in the next quarter $0·5$ per cent. and a further quarter later another $0·5$ per cent. increases in output price.

The quarterly analysis has not provided informa-

CHART V

INDUSTRY OUTPUT PRICE LEVEL QUARTERLY MOVEMENTS 1954-1963

units: index numbers 1958=100. See also p.7 footnote(4).
Source: Equation (5)' Table 9.

tion on the effect of changes in agricultural prices on industry prices; nor on the influence of "demand pull".

Finally, we consider equations (16) to (21). In some cases the net effect of competitive import price (i.e., the sign of the coefficient) is negative which would mean that an increase in these import prices would cause a fall in Irish output prices.

The sum of the coefficients of the prime cost variables here (including the agricultural prices) is about 0·70 as against 1·00; where one takes a higher level of significance—thus accepting variables that add to the explanation at the 10 per cent. level of significance—only one equation includes wages as adding to the explanation. These equations are not satisfactory largely due, perhaps, to the absence of the output variable and so any conclusion on this matter must be indecisive.

Throughout this section we have ignored movements in capital. It may well be that in the last decade the capital stock in Irish manufacturing grew more rapidly than output. If entrepreneurs calculated their prices by regarding a normal rate of return on capital as a prime cost then the combination of both these factors would help to explain the suggested increase in gross profit margins.

6. RETAIL PRICE EQUATIONS

From 1953 to 1963 the consumer price index[20] rose by 28.4 per cent., which is rather more than the industry output price, up 22.4 per cent., and much more than the price of imports for consumption, up 12.7 per cent. Agricultural prices rose by 2.0 per cent. during this period while excise tax rates rose 29 per cent. Wages increased 69.7 per cent. Using the input-output weights above one finds that, assuming no change in retailing margins or productivity, consumer prices could be expected to rise by close to 32 per cent. They actually rose by 28.4 per cent.

	Weight in 1960*	Change in price	Effect on consumer prices
Agricultural products ..	13	+ 2	·26
Industrial products ..	42	+22	9·24
Imported products ..	13	+13	1·69
Services	27	+70	18·90
Tax	5	+29	1·45
			31·54
	ACTUAL ..		28·4

*Consumer expenditure from Geary, Table 4 (op. cit.).

The difference could be attributed to increased productivity or reduced margins but in this case it would be unwise to take the difference too seriously and be glad they correspond approximately.[21]

Regression equations estimated by the method of ordinary least squares show constant negative

[20]The consumer price index is described in an article in the December 1953 issue of the *Irish Trade Journal and Statistical Bulletin*.
[21]Additional qualifications arise : Geary's table itself is approximate. We have used industrial wages as an indicator of movements in the price of services as labour accounts for nearly 90 per cent. of total output of that sector; excise tax rates are an index described above. More generally the consumer price index relates the consumption pattern of average income groups in 1951–52 whereas the weights here relate to all consumption.

coefficients for the tax variable; as shown in Section 2 the coefficients shifted considerably when estimated by two stage least squares. In such a situation it seems wiser to examine only the regressions on the quarterly data. Table 10 sets out the point estimates for the equations—where no levels of significance are applied to the entry of variables—and it may be noticed that, while for the first five equations the coefficients of the tax variable are positive, when lagged values are introduced the total effect of the tax variable is negative. This could be due to a deeper relationship between tax changes and retail prices. The Excise Tax rate index has shown three major changes from 1954 to 1963; in early 1956 and 1957 and at the end of 1963. The first two changes coincided with and contributed to a decline which may have forced retailers to absorb cost increases in reduced profit margins—demand pull in reverse. Then we might expect a negative relationship between lagged values of the tax rate index and retail prices. And this has apparently happened. The last change does not enter our period as the lagged tax variables will only effect 1964, which is not in the period we cover.

Probably the best equation is (4) whose weights are most in line with the input-output figures below, though as can be seen, they probably underestimate the weights for agricultural products, imports and industry outputs.

IMPLIED INPUT–OUTPUT WEIGHTS

	1960*	Equation (4)
Agricultural products	13	11
Imports	13	11
Industry output	42	30
Tax	5	12
Services	27	—
Trend	—	1·4 per cent. per annum

*Source: Geary, Table 4 (op. cit.).

Equation (4) suggests that half of the increases in price of the inputs to the retail sector are passed on to retail prices in the current quarter. Equations (9), (10), (14) and (15) indicate that the transmission is more or less complete between six and nine months after the event. Thus, for instance, if the price of an input to the retail sector, say wages in the service industries,[22] rose by 10 per cent., half of it would show in retail prices in the current quarter; as the weight for services is about 27 per cent. in consumption (though possibly less in the current weighting of the consumer price index) this would mean an increase of 1·35 per cent. in the total index. In the next two quarters the total retail price would rise by another 1·35 per cent. On the other hand, the trend term which in part reflects the price of services, has been measured here at 1·4 per cent. per annum, which would account for half of the change in the retail price level.

On the precise time lag distribution for each cost effect the regressions are not so clear. When variables are only permitted in the equation if they add significantly (at 10 per cent. level) to the explanation, the prime cost variables that remain are $(p_a)_{-2}$, (p_x), $(p_{ic})_{-2}$ and T (and also T—2 with a strong negative coefficient). This would suggest that the mode of the response to changes in industry output price (p_x) and the excise tax level (T) is in the current quarter, but that the mode of the response to changes in agricultural prices and (direct) imports for consumption prices is two quarters later. For agricultural prices this delayed response rate seems decidedly odd though it is reasonable for imported goods. As the annual regressions were not so successful either it seems safer to regard the results which we summarise here as tentative:

retailers appear to adjust their prices quite rapidly in response to changes in the prices of their inputs, particularly to changes in the excise tax level and the industry output price; A less rapid response to price changes of imports for personal consumption appears. It seems, on average, to take at most three quarters for the retail price level to reflect changes in input prices.

7. SUMMARY

Here we present the results of our work in a less tentative manner than before compensating, in part, for the torturous arguments of the preceding sections. But it must be remembered that the figures used here are more accurately orders of magnitude and should not be interpreted precisely.

Industrial Wages

The diagram (Chart VI) sets out the links in the system of wages and prices centred on explaining industrial wages and prices. The wages box has five incoming arrows showing the important direct influences on Irish industrial wages. The co-efficients alongside these lines indicate the quantitative relationship.

We have established that a very strong link exists between the *level of non-agricultural unemployment* and changes in annual average of hourly earnings: at a level of 29,600 unemployed—the average for 1949–63—industrial hourly earnings will rise at 3 per cent. per annum. For every 1,000 fewer unemployed, wages increase by an extra 0·4 per cent. per annum. Unemployment at the level of the past three years 1961–63, some 6,000 fewer than the fifteen year average, would generate changes in hourly earnings of nearly 5½ per cent. per annum.

We have established too that the *rate of change* in the level of non-agricultural unemployment has its effect on hourly earnings. If unemployment rises by 20 per cent. from last year to this, it will reduce the change in hourly earnings in the current year by ½ per cent. This is quite distinct from the effect on wages of the level of unemployment in the current year.

Productivity changes do not appear to be so closely linked to changes in wages. It does seem that an increase in productivity of 10 per cent. would generate an increase in hourly wages of about 2 per cent. (ignoring all other effects).

Changes in retail prices also contribute to changes in hourly industrial wages, but the compensation is not complete. An increase in retail prices of 10 per cent. would generate an increase in wages of between 5 and 7½ per cent. This would indicate that rapid price inflation is not to the advantage of wage earners as it tends to reduce, in real terms, their gains due to productivity, demand for labour, (i.e., unemployment), etc. Thus in 1952 when retail prices rose by 8·7 per cent., wages rose by only 6·2 per cent.

Finally, we find that on average during the past decade wages rise by an extra 1 per cent. or so in the year a *wage round* commences. This institutional effect is essentially one of condensing the economic effects measured above at a given time. The four

[22]We had no quarterly figures for hourly earnings in the service industries and have assumed that their movement can be adequately represented by a time trend. Obviously this is not a realistic assumption but neither would be the use of wages in the Transportable Goods industries.

TABLE 10 : RETAIL PRICE REGRESSION EQUATIONS ; QUARTERLY ANALYSIS : POINT ESTIMATES

(s-values in brackets underneath)

	p_a	$(p_a)_{-1}$	$(p_a)_{-2}$	p_z	$(p_z)_{-1}$	$(p_z)_{-2}$	p_{ic}	$(p_{ic})_{-1}$	$(p_{ic})_{-2}$	T	$(T)_{-1}$	$(T)_{-2}$	t	z	$(z)_{-1}$	$(z)_{-2}$	D	$(D)_{-1}$	$(D)_{-2}$	$(p_r)_{-1}$	$(p_r)_{-2}$	$(p_r)_{-3}$
1	·107 (1·60)			·564 (3·28)			·064 (1·46)			·035 (0·68)			·243 (2·83)									
2	·137 (2·04)			·635 (3·70)			·094 (2·05)			·058 (1·14)			·082 (0·66)	·066 (1·76)								
3	·117 (1·62)			·554 (3·14)			·075 (1·43)			·040 (0·75)			·225 (2·27)				·022 (0·39)					
4	·056 (0·94)			·151 (0·79)			·057 (1·50)			·060 (1·35)			·174 (2·25)							·495 (2·51)		
5	·056 (1·05)			·501 (2·45)			·048 (1·22)			·084 (2·13)			−·185 (1·64)	·226 (3·57)			−·223 (2·45)			·493 (3·98)		
6	·097 (1·22)	·113 (1·41)		·573 (1·51)	·246 (0·83)		·005 (0·06)	·130 (1·28)		·067 (1·35)	−·207 (3·26)		·160 (1·66)									
7	·099 (1·20)	·106 (1·24)		·634 (1·55)	·233 (0·76)		·008 (0·08)	·122 (1·12)		·064 (1·26)	−·230 (2·19)		·164 (1·33)	·024 (0·41)	−·038 (0·59)							
8	·114 (1·43)	·048 (0·54)		·815 (2·00)	·307 (1·03)		−·010 (0·11)	·065 (0·60)		·069 (1·40)	−·306 (3·43)		·151 (1·55)				−·039 (0·57)	−·080 (1·20)				
9	·091 (1·15)	·090 (1·10)		·715 (1·82)	·010 (0·03)		·001 (0·01)	·114 (1·12)		·059 (1·19)	−·195 (3·06)		·104 (0·99)							·185 (1·26)		
10	·090 (1·17)	·057 (0·06)		1·006 (2·50)	·088 (0·24)		−·029 (0·33)	·055 (0·52)		·067 (1·37)	−·163 (1·52)		−·173 (1·04)	·162 (1·54)	·067 (0·56)		−·207 (1·65)	−·123 (0·93)		·200 (1·26)		
11	·109 (1·67)	−·003 (0·03)	·245 (3·39)	−·142 (0·42)	·768 (1·69)	−·060 (0·22)	·010 (0·14)	·022 (0·21)	·251 (2·96)	·076 (1·95)	−·111 (1·36)	−·196 (1·36)	·317 (3·94)									
12	·084 (1·22)	·003 (0·04)	·276 (4·09)	−·151 (0·44)	·775 (1·68)	−·054 (0·20)	·011 (0·16)	·072 (0·66)	·241 (2·44)	·066 (1·69)	−·069 (0·69)	−·217 (2·58)	·242 (2·55)	·078 (1·71)	·014 (0·25)	−·060 (1·23)						
13	·096 (1·43)	·024 (0·30)	·279 (3·56)	−·368 (0·93)	·868 (1·95)	−·054 (0·20)	·020 (0·29)	·061 (0·56)	·264 (2·58)	·069 (1·80)	−·038 (0·40)	−·249 (3·02)	·307 (3·49)				·083 (1·44)	·047 (0·74)	−·071 (1·43)			
14	·111 (1·65)	−·004 (0·04)	·248 (3·79)	−·154 (0·44)	·776 (1·66)	−·036 (0·12)	·012 (0·16)	·021 (0·19)	·253 (2·91)	·079 (1·89)	−·109 (1·30)	−·200 (2·46)	·325 (3·59)									−·023 (0·20)
15	·094 (1·20)	−·002 (0·02)	·269 (2·78)	−·183 (0·38)	·794 (1·55)	−·022 (0·06)	·012 (0·16)	·061 (0·50)	·238 (2·19)	·064 (1·44)	−·043 (0·39)	−·207 (1·97)	·181 (0·82)	·124 (1·23)	−·097 (0·86)	·062 (0·54)	−·055 (0·43)	·148 (1·15)	−·151 (1·23)			·001 (0·01)

NOTE : p_a=price agricultural products; p_z=industry output price;
p_{ic}=price of imports for personal consumption; T=excise tax level index;
t=time trend; Z=output; D=productivity; p_r=retail price index.
Suffix numbers relate to time periods (i.e. $(p_z)_{-1}$=industry output price in previous quarter).
For sources see Appendix 2.

CHART VI

IRISH WAGE/PRICE SYSTEM
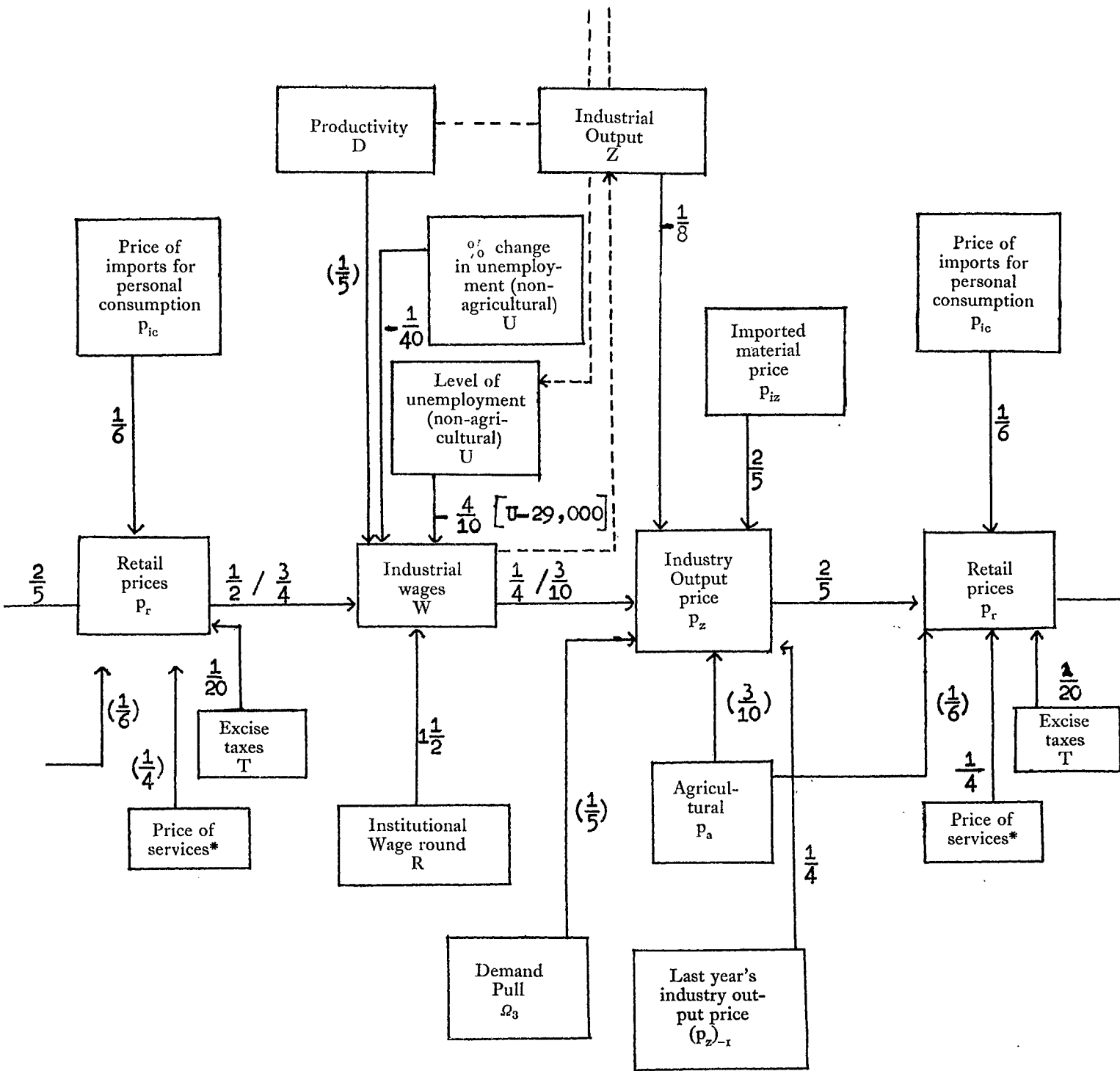
influences enumerated above could be regarded as determining the amount by which wages will rise over time. As wage increases are becoming increasingly institutionalised in national wage rounds, this wage round effect will be to compress the wage increase more in one year than the next but need not be expected to influence the sum total of the wage round. In recent years the wage round effect has become greater. Thus in the second quarter of 1964 hourly earnings are nearly 12 per cent. higher than the fourth quarter 1963 level showing the Ninth Round to be almost completed for manufacturing.

The variables that explain movements in wages are internal domestic factors in the economy. Direct influences, such as the level of wages in Britain, or the level of unemployment (an indicator of British demand for labour), did not contribute to the explanation. Clearly the British labour market effects the amount of non-agricultural unemployment and this may be a significant influence; it also effects the agricultural work force but this is not likely to be an important factor for industrial earnings. The difference between farm work and factory work is probably sufficient to make the industrial and agricultural labour markets quite distinct and, for industry, not competitive. An analysis of how non-agricultural unemployment levels are affected by the British labour market and the Irish agricultural labour market would quantify these missing links but it is probably fair to say that it is not anything as strong as is often thought.[23] There are certainly very strong links between the British and Irish economies—three-quarters of Irish exports go to the United Kingdom and one-half of her imports come from there thus ensuring that Irish domestic demand will be closely linked to that of the United Kingdom—but the labour market connection is not one of them.

One version the strong link theory takes is that when the money, or real, gap in industrial wages between Britain and Eire widens, Irish industrial workers leave employment in Ireland and go to Britain. If this were an important influence we could expect it to account for much of the emigration from Ireland. Regressions were calculated to explain annual net emigration[24] from 1948 to 1963 (and also for the shorter period 1953 to 1963). Although no satisfactory variable was introduced to account for emigration from the agricultural sector,[25] the ratio of Irish to British money wages (but not real wages) did help to explain movements in emigration for the period 1948 to 1963 (but not for 1953 to 1963). The major factors affecting emigration were found to be: the *level of non-agricultural unemployment* in Eire where an increase in the level of unemployment of 1,000 was associated with an increase in emigration of 2,000 odd. This unemployment figure may be taken as an indicator of demand for labour and thus of job prospects within Ireland and an internally generated variable; *the level of unemployment in Britain*, the indicator of demand for labour in Britain, where a decrease in British unemployment by 100,000 would increase Irish emigration by some 5,000 per annum; *a trend variable*, which is probably reflecting the rise in natural increase in Ireland over the post-war period and the decline of agriculture, suggests that emigration from those factors not directly in the equation rose by some 2,500 each year; *the ratio of money wages in Ireland to that in Britain* indicates that when Irish money wages rise by 1 per cent. less than British money wages then 192 emigrate as a result. If this factor had been important in the situation, we could have expected a much larger effect.

There is clearly scope for a closer study of the effect of emigration on unemployment in Ireland and, indeed, on the statistics of emigration.

Industry Output Price

Six major factors, as can be seen in the diagram, influence the current level of industry output prices. An important fact is the fairly slow response in output price to changes in the respective input prices and so we find that *last year's industry output price* influences the current year's level. This last year's level of output price is a stand-in variable doing the work of all the past influences on the output price, namely wages, imported materials price, agricultural price and output in previous years. Because of this fairly slow response—after a year perhaps as much as three-quarters of the cost changes will have been transmitted through to output prices—we distinguish between full effects that may take up to two years to complete and short run effects. (The full effect coefficients are shown on the arrows running into the output price box.)

A change of 10 per cent. in *wages* in the long run would increase the industry output price by 2·5 to 3 per cent.; in the quarter when wages rise by 10 per cent. one-third of the full effect is transmitted, about 0·9 per cent., on output price. In each of the

[23]Even the O.E.C.D. Report "The Problem of Rising Prices" takes the view that "wage movements in Ireland can hardly be considered an independent factor in the Irish economy as they are so intimately linked with developments in the United Kingdom labour market".

[24]Net passenger movement during the calendar year. Criticism has been raised at the reliability of these figures. A further complication is that the year ends during a holiday period. The timing of the holiday, any worse-than-usual weather etc., can delay or speed holiday emigrants back to England and cause large swings in the year to year fluctuations of net emigration.

[25]A more detailed analysis would probably use total real income for the agricultural sector.

succeeding two quarters one-sixth of the full effect goes through, about 0·5 per cent., in each quarter. It probably takes as long as eighteen months before 95 per cent. of the full effect is felt. It will be noted that the peak of the response is felt in the quarter when wages are increased.

A 10 per cent. change in the *imported materials price* will, in the long run, increase the output price by 4 to 4½ per cent.; in the quarter of the change one-fifth of the final effect works through raising the output price by 0·9 per cent.; in the next quarter the response is largest, about one-third of the full effect goes through and the output price would rise by a further 1·5 per cent.; in the following quarter the effect is equal to one-fifth of the full effect and the output price rises by a further 0·9 per cent.

A 10 per cent. change in the *agricultural price* probably leads to a long run effect of 3 per cent. on industry output prices; unfortunately this was not satisfactorily measured.

An increase in *output* of 10 per cent. will lead to a fall in output prices of about 1¼ per cent.; 60 per cent. of this effect is felt in the current quarter. In Ireland entrepreneurs appear to expect productivity increases only with expanding output.

There is some evidence that entrepreneurs tend to increase prices by rather more than their costs, thus increasing their margins when times are "good"; and when times are "bad", to absorb cost increases in reduced profit margins. This phenomenon, termed here as demand pull, has already been noted by Nevin in "The Cost Structure of Irish Industry, 1950–60", The Economic Research Institute, Paper No. 22, when he compares the period 1954–56 when profit margins fell and the periods 1950–53 and 1957–60 when profit margins rose. Thus in paragraph 20 he says:

> ". . . it is apparent that changed demand conditions must underlie the contrast between 1954–56 on the one hand and both 1950–53 and 1957–60 on the other, so far as the behaviour of profits is concerned. In the latter periods increased costs were not only passed on wholly in the form of higher prices: they were augmented by purely inflationary increases in profits. That this did not happen in 1954–56 is most convincingly explained by the reduced buoyancy of final demand, at home and abroad."

If output rose by more than expected, entrepreneurs tend to increase prices more than cost consideration would require. Some results here suggest that if output rose by 5 per cent. more than expected then output prices would be increased by 1 per cent. The best estimate of the "expected" seems to be the continuation of the previous two year's experience. A careful study of profit margins,

etc., would be required to get a mere reliable measure of the demand pull influence.

There is less evidence of the effect on industry output price due to changes in the price of imported goods for personal consumption. The scale of aggregation involved probably contributed to this— we deal with the transportable goods industry—and a more detailed industrial analysis would be required before a reliable statement could be made about this effect.

Retail Prices

The analysis of retail price movements was not so clear partly as we had no direct indicator of the price of services. However, certain results emerge.

A 10 per cent. increase in *industry output price* leads to an increase in the retail price level of about 4 per cent. in the long run; about 2½ per cent. occurs in the current quarter with the rest following in the next quarter.

A 10 per cent. change in the *price of imported goods for personal consumption* would lead to a change in retail price of about 1·3 per cent. in the long run. The full effect would be through to retail prices in nine months. The response of retail prices is fairly slow in this case with the largest short run response coming between six and nine months after the price change.

An *agricultural price* change of 10 per cent. contributes 1·3 per cent. to retail prices in the long run. An increase of 10 per cent. in the *Excise Tax Index* calculated here would increase retail prices by over half a per cent. and this change takes place instantly. A change in the *price of services* of 10 per cent. would lead to a change in retail prices of perhaps 3 per cent.

Again there is some evidence that retail pricing policy has been affected by "*demand pull*" considerations. Retailers seem likely to increase prices rather more than needed to maintain profit margins when times are good; and by rather less when times are bad.

Employment and Output

In the examination of the short run relationship between employment and output it was found that a 10 per cent. increase in output would cause a 2 per cent. increase in employment in the current quarter, a 1 per cent. increase in the following quarter and 0·6 per cent. increase in the next. In the long run— perhaps eighteen months to two years—employment would have risen 6 per cent. altogether as a result of this change in output. At the same time an underlying productivity trend independent of levels of output though no doubt related to the introduction of capital intensive equipment, etc., has been

reducing employment at the rate of about 1 per cent. per annum.

The results for total hours worked and output seem to indicate a more rapid adjustment than that for employment and output. A decline in output of 10 per cent. leads to an immediate cut in hours worked of about $1\frac{1}{2}$ per cent. and another $1\frac{1}{2}$ per cent. in the following quarter. The next quarter would see a fall of a further 0·6 per cent. and within eighteen months or so, total hours worked would be some $4\frac{1}{2}$ per cent. lower than they otherwise would have been. The underlying productivity trend for hours worked seems to be reducing hours worked by about $\frac{1}{2}$ per cent. per annum.

These equations provide a useful link in analysing short run movements in the Irish economy. Multiplying hourly earnings by total hours worked gives an estimate of total wages generated in the transportable goods industrial sector.

Conclusions

We now will consider some current problems in the light of the relationships established above. One has to be careful when using these equations by themselves as these are a few specified equations of a very large number of equations that conceptually describe the complex Irish economy. We have to say that we do not really know how prices and wages in the service sector behave (although we will make crude estimates later on thereby pretending we do), but more important, we do not know how changes in wages by increasing demand react on output. An expansion in wages will lead to increased demand for consumers' goods and services, this causes a temporary run down of retailers' stocks and ultimately to higher output with concomitant productivity and employment increases; the wage increases will also affect output price and retail prices. Increased home demand also leads to increased imports which can only be sustained in the long run by increased exports. But what determines the increase in exports? Is demand for Irish manufactured exports in the past few years generated more by Irish salesmanship and "push" than by competitive price advantages? There is no need to expand on the complexities involved but it should be clear that it is not so easy to make quantitative assessments of ultimate effects. The author would take the view that it is even difficult to estimate the qualitative answer to some questions (i.e., whether the effect will be plus or minus), unless we know not only the relationships within the system but also some of the variables external to the economy, such as the British rate of economic growth, that play such an important role in Irish economic development.

Having made these qualifications we now consider

the *ninth round* which is still current. The wage-price system we have described can be reduced to the following:

$$\Delta W = a + \tfrac{1}{2}\Delta p_r \tag{22}$$

$$\Delta p_z = \tfrac{1}{5}\Delta W + \tfrac{1}{10}\Delta W_{-1} \tag{23}$$

$$\Delta p_r = \tfrac{1}{4}\Delta W + \tfrac{2}{5}\Delta p_z \tag{24}$$

where (Δ) means we are concerned with annual changes in the variables. W, p_z, p_r are as before annual averages of wages, industry price and retail price. We have thrown out of the system all other prices and thus statements concerning the system here ignore effects of other variables. a is the sum of effects on wages from demand from labour (i.e., unemployment effect) and productivity. Industry output price change is a function of this year's wage change and last year's wage change. For the final equation we have assumed that industrial wages move identically to wages in service industries and as the service industry has a labour input equal to 90 per cent. of all inputs we have used $\tfrac{1}{4}$ as its weight for retail prices. The system can be solved to express ΔW, Δp_z, Δp_r in terms of a and ΔW_{-1}. Thus we get

$$\Delta W = 1\cdot2a + \cdot024\Delta W_{-1} \tag{25}$$

$$\Delta p_z = \cdot24a + \cdot105\Delta W_{-1} \tag{26}$$

$$\Delta p_r = \cdot40a + \cdot048\Delta W_{-1} \tag{27}$$

a here is compounded of unemployment and productivity effects and if unemployment and changes in productivity in 1964 and 1965 are of the same order as for the previous three years then a will be about 6 per cent. By solving these we find the following results for 1964 and 1965.

	ΔW	Δp_z	Δp_r	ΔW_{-1}
1964 ..	7·3	1·8	2·6	3·3
1965 ..	7·4	2·2	2·8	7·3

We have ignored all other influences and some of these are likely to push industry output and retail prices (and on this model wages) higher than shown here.[26] It will be noted that the total change in wages over the two years is above the ninth round's 12 per cent. agreed to last two and a quarter years. So it would appear that the present 12 per cent. agreement is not so high. Our results indicate that it is

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[26]The agricultural price index in the second quarter of 1964 was 10 per cent. higher than in the corresponding period a year earlier. In the first quarter 1964 the wholesale price index of "imported materials for further production" was $5\frac{1}{2}$ per cent. higher than in the first quarter 1963. Both these should increase retail prices which according to (22) would push wages up further.

less than market relationships were likely to have evolved. It remains to be seen if the market relationships in the labour market as measured in this paper will be controlled in the next year or two. In the present inflationary situation it certainly will be a major achievement if the changes in hourly earnings over the next two years can be maintained at 12 per cent.

8. APPENDICES

APPENDIX 1

We commence with the relationship

$$y = \beta_0 x + \beta_1 x_{-1} + \beta_2 x_{-2} + \ldots + \beta_n x_{-n} + \ldots \quad (1)$$

and

$$y_{-1} = \beta_0 x_{-1} + \beta_1 x_{-2} + \ldots + \beta_{n-1} x_{-n} + \ldots \quad (2)$$

$$y - K y_{-1} = \beta_0 x + \sum_0^\infty (\beta_{i+1} - K\beta_i) x_{-i-1} \quad (3)$$

Consider the relation

$$Y = \beta_0 x + K y_{-1} + e \quad (4)$$

where we assume the disturbance term e to be independently distributed and the x and y_{-1} variables are distributed independently of contemporaneous and succeeding disturbances. Then the least squares estimators of β_0 and K are consistent and thus asymptotically unbiased, and this holds for

$$y = \beta_0 x + \beta_1 x_{-1} + K y_{-2} + e \quad (5)$$

and so forth.

The least squares estimator of K in (4) is

$$K = \frac{-(\Sigma x y_{-1})(\Sigma x y) + (\Sigma x^2)(\Sigma y y_{-1})}{(\Sigma y^2_{-1})(\Sigma x^2) - (\Sigma x y_{-1})^2}$$

We may note that the procedure of minimising the function $\Sigma(y - \beta_0 x - K y_{-1})^2$, from (3) and (4), with respect to β_0 and K is identical by our assumptions to minimising $\Sigma_t [\sum_0^\infty (\beta_{i+1} - K\beta_i) x_{-i-1,t}]^2$ with respect to β_0 and K. Making the fairly strong assumption that the (x) variable either follows a first order Markov scheme or is randomly distributed over time we find that for large samples K approximates to

$$K \doteq \frac{\beta_1 + \beta_2 + \ldots}{\beta_0 + \beta_1 + \beta_2 + \ldots} = \frac{\sum_1^\infty \beta_i}{\sum_0^\infty \beta_i}$$

It may have been wiser to have used the distributed lag models due to Koyck which would have meant keeping y_{-1} in every equation with lagged variables of x.

APPENDIX 2

(a) Dependent Variables

Wages are *Hourly Earnings* in the *Transportable Goods Industry*. The annual figures to 1961 are census estimates for a week in October each year; the annual figures for 1962 and 1963 are estimates for a week in September from the Quarterly Industrial Production Inquiry. The quarterly figures are from the Quarterly Industrial Production Inquiry adjusted up to 1961 in accordance with Census results and relate to a week in the final quarter. The source of the annual figures is the "Statistical Abstract of Ireland 1963" Table 125 and for the quarterly figures, the "Irish Trade Journal and Statistical Bulletin", (The "Irish Statistical Bulletin" since March, 1964).

Industry Output Price is the *Wholesale Price Index for the total output of industry* published for each month in the Irish Statistical Bulletin. The March 1955 issue explains the wholesale price index dating from 1953. Annual figures are published and the quarterly figures are averages of the monthly statistics. The industry output price index covers goods flowing from the transportable goods industry as well as the Building and Construction industry; all inter-industry flows (which include certain service industries) are excluded; the index is weighted by the net output for the year 1950 of the commodities moving out of "industrial production" sector. The price index is a Laspreye index. A comparison with the implicit price index of gross output of the transportable goods industry was made when the study was completed. The implicit price index is found by dividing the value of gross output index numbers for transportable goods by the volume of production index numbers (Table 116: Statistical Abstract of Ireland 1963). The comparison is as follows:

(1953=100)	1954	1955	1956	1957	1958	1959	1960	1961
Implicit index	97·6	96·7	96·9	102·1	105·9	105·3	106·9	108·6
Wholesale index	98·0	98·4	102·8	108·7	112·3	112·8	114·4	116·4

However, from a practical point one has to use the wholesale index numbers as these are the only up-to-date figures available; and they are available monthly. Thus in mid-September 1964 only the 1961 figure for the implicit price index is available whereas the wholesale index is available up to March 1964.

Retail Price Index used is the *consumer price index* where the weighting is based on the average income group's behaviour in 1951–52 (details given in the December 1953 issue of the I.T.J.S.B.). This index is published quarterly in the I.S.B. with estimates for mid-February, mid-May, mid-August and mid-November. Annual figures are averages of the quarterly estimates. Figures before 1953 are based on the 1947 Interim Cost of Living index (essential items). All are published in the June 1964 issue of the I.S.B. A comparison between the implicit consumers expenditure price index is as follows:

Table 33 S.A.I. and previous issues, 1963 estimate from data in I.S.B.

(b) Independent Variables

Three input price variables were used, namely that for imported raw materials; for personal consumption; and for agricultural products. Each are wholesale price indices published in the I.S.B. for each month and year under the titles "*Imported materials for further Production*" (Table 3A), "*Imports for personal consumption*" (Table 3A) and "*Total products of agriculture*" (Table 7) respectively. This last is probably not such a good indicator of the price of agricultural goods entering the industrial sector and the personal sector as direct inputs, as the index reflects to a large extent changes in the export price of agricultural products which are structurally different from domestic flows of agricultural products.

(1953 = 100)	1954	1955	1956	1957	1958	1959	1960	1961	1962
Consumer expenditure index ..	100·5	103·9	105·8	110·5	114·5	114·8	115·6	117·9	122·5
Consumer price index	100·1	102·7	107·1	111·3	116·5	116·5	117·0	120·2	125·3

The implicit consumers expenditure price index is derived by dividing consumers expenditure at current prices by consumers expenditure at constant 1953 prices (Table 251 and 252; Statistical Abstract of Ireland, 1962).

"*Employment*": figures come from the quarterly industrial production inquiry and relate to the transportable goods industries. Quarterly estimates (adjusted to census returns up to 1961) are provided in issues of the I.T.J.S.B. and relate to a week in the final month of the quarter.

Total Hours Worked: is the product of employment and average hours worked per week in the transportable goods industry; sources as for employment.

Emigration: figures are the calendar year figures of net passenger movement from Ireland by sea, rail, road and air. The road traffic relates to bus traffic only across the border to Northern Ireland. Timing of the Christmas and New Year holiday, when many emigrants return to Ireland, can lead to inflation of one year's figure at the expense of the next year. Thus in December 1961, 154 thousand entered the Republic while 117 thousand left; in January 1962 90 thousand arrived and 121 thousand left. The day of the week on which the New Year falls could thus contribute to a higher figure for one year over the next. (Net passenger movement from the year ending January may be a better guide.) *Source:*

Non-Agricultural Unemployment figures for Ireland are calculated as the total live register minus the industry groups Agriculture, Fishing, Private Domestic Service and "Other Construction". Annual figures are given in Table 177 of the S.A. 1963 and preceding issues. The quarterly unemployment figures are taken from the same table and relate to February, May, August and November. For the annual (level) and quarterly regressions the unemployment variable used was the cumulative sum of the unemployment figures. *The agricultural, etc. unemployment* figures are the difference between the total live register and non-agricultural unemployment.

Industrial Output is the *volume of transportable goods production;* annual figures to 1961, based on Census returns came from Table 116 S.A. 1963. The annual figures for 1962 and 1963 are derived from the quarterly Industrial Production Inquiry. Quarterly figures came from this Inquiry. Sources as described for Employment.

Productivity figures are defined as Output per Employee hour in transportable goods industry. These are calculated for the regressions by dividing the output figures by the product of employment and average hours worked. The annual figures for hours worked relate to October to 1961 (Table 125, S.A. 1963) and September for 1962 and 1963. Source for quarterly figures as employment.

The *Excise Tax Level* variable was calculated by constructing separate price indices for the consumption elements of Excise Taxes using as weights the revenue returns for 1960/61.

The expectational variables Ω_1, Ω_2, Ω_3 and Ω_4 are derived from the output figures above.

Ω_1 is defined as percentage change in output over the previous year minus 3 per cent. The choice of three is arbitrary as this will only shift the value of the constant term in the equation.

Ω_2 is defined as the difference between the current year's percentage change in output and last year's change.

Ω_3 is defined as the difference between the current year's percentage change in output and the average of the two previous year's output changes.

Ω_4 is defined as the difference in output between the current year's percentage change in output and the average of the three preceding years.

The unemployment figures for Great Britain are the annual percentage rate of unemployment taken from Appendix Table 6, National Institute Economic Review, May 1964 and previous issues. The quarterly figures used are the total number registered unemployed in the middle of February, May, August and November. (Table 20, Monthly Digest of Statistics, April 1964, and preceding issues).

Real Wages in Britain for the annual figures are hourly earnings in manufacturing industry divided by the British Retail price index. (*Source:* Table C, Wages in Ireland 1946–62, E.R.I. Paper No. 12 by E. Nevin, and the April 1964 M.D.S.) Quarterly figures are real "wages and salaries" per head derived by dividing the national income estimates of wages and salaries before income tax, by the number at civil work and by the retail price index. The first comes from Table 3, M.D.S. April 1964, the Economic Trends, October 1963 and preceding issues while the second comes from the statistical appendix to the "London and Cambridge Economic Bulletin". The retail price index comes from the M.D.S., April 1964 and earlier issues.

The *Wage Gap* between Britain and Ireland was the ratio of money or real hourly wages. The money wage figures are given in Table A for Ireland and Table C for Britain in Nevin's "Wages in Ireland 1946–62". More recent figures came from the I.S.B. and M.D.S.

Appendix Table A : ANNUAL DATA, 1953–63

1958 = 100·0

Variable	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Wages (W)	80·9	83·3	87·4	92·8	95·3	100·0	103·5	111·0	119·7	133·0	137·3
Industry Output Price (p_z)	89·1	87·3	87·6	91·5	96·8	100·0	100·4	101·9	103·7	107·6	109·0
Retail Price (p_r)	85·8	85·9	88·2	91·9	95·7	100·0	100·0	100·4	103·2	107·6	110·3
Imported Materials Price (p_{ix})	91·3	89·9	91·2	97·2	102·9	100·0	98·4	99·3	99·3	100·8	102·9
Imports for Personal Consumption price (p_{ic})	83·3	83·6	85·7	97·1	102·7	100·0	96·7	95·5	98·3	99·6	100·9
Agricultural Products Price (p_a)	97·6	96·3	100·6	91·2	97·4	100·0	99·9	97·2	97·6	99·2	99·6
(Cumulative) Non-Agricultural Unemployment Index ΣU_e	18·2	34·6	48·3	63·9	82·6	100·0	116·0	129·1	140·6	152·4	164·6
Output (Z)	93·9	97·0	100·9	98·9	98·1	100·0	110·3	118·3	129·1	135·7	144·7
Productivity (D)	93·7	94·9	96·9	96·8	99·0	100·0	107·7	110·4	116·1	121·1	124·7
Excise Tax Level (T)	80·6	79·6	79·3	86·5	97·3	100·0	99·7	98·5	98·2	100·4	104·0
Ω_1	6·2	0·3	1·1	−5·0	−3·8	−1·1	7·3	4·2	6·1	1·9	3·6
Ω_2	11·8	−5·9	+·8	−6·1	1·2	2·7	8·4	−3·1	1·9	−4·2	1·7
Ω_3	9·1	0·0	−2·2	−5·7	−1·9	3·3	9·7	1·1	0·3	−3·3	−0·4
Ω_4	4·7	0·2	0·8	−7·5	−2·6	1·5	10·6	3·4	2·6	−4·0	−0·5
Unemployment in G.B. (U_GB)	74·9	62·4	50·8	56·3	68·5	100·0	104·0	78·8	74·7	101·4	125·5
Real Wages in G.B. (W_GB)	89·0	91·9	95·1	97·8	99·2	100·0	103·6	108·6	111·9	111·5	115·0
Wage Round (R)	0	1	0	1	0	1	0	1	0	1	0

For Sources see Appendix 2.

Appendix Table B : ANNUAL DATA, 1948–53

Year	Change in Wages ΔW	Change in Retail Prices Δp_r	Change in Productivity ΔD	Change in Non-Agric. Unemployment ΔU_e	Change in Wage round ΔR	Non-Agric. Unemployment level U	Net Emigration	Agric. etc. Unemployment level U_r	% G.B. unemployment level U_{GB}	Ratio of Eire to U.K. wages in money terms	in real terms
	Percentages					Thousands				1953 = 100	
1948						30·62	12·59	30·58	1·50	102·1	99·8
1949	2·2	−·3	8·4	−3·2	−1	29·63	7·83	30·98	1·52	101·2	100·3
1950	3·5	1·5	7·4	−12·2	1	26·03	−·20	27·39	1·53	100·7	101·4
1951	10·0	7·9	−0·6	2·2	−1	26·61	9·86	23·85	1·19	100·7	104·4
1952	6·2	8·7	·0	27·6	1	33·95	17·69	26·74	1·99	99·4	102·4
1953	5·8	5·5	5·3	7·1	−1	36·36	19·94	31·20	1·64	100·0	100·0
1954	2·9	0·1	1·2	−10·2	1	32·66	26·90	29·78	1·34	96·9	99·0
1955	5·0	2·6	2·3	−16·4	−1	27·30	26·98	27·93	1·08	93·6	96·8
1956	6·2	4·3	0·3	13·6	1	31·00	28·98	30·42	1·19	92·2	95·5
1957	2·7	4·1	2·1	20·5	−1	37·34	53·45	32·34	1·43	88·6	91·0
1958	4·9	4·5	1·9	−7·3	1	34·63	32·81	30·65	2·10	90·2	91·3
1959	3·5	·0	7·3	−8·2	−1	31·78	33·33	29·91	2·17	90·0	92·5
1960	7·2	0·4	2·7	−17·4	1	26·26	30·89	26·60	1·62	90·3	92·9
1961	6·4	2·7	4·3	−13·0	−1	22·86	25·56	23·76	1·52	89·9	93·3
1962	12·7	4·2	2·2	3·2	1	23·60	20·97	22·97	2·03	97·3	100·7
1963	3·2	2·4	3·1	2·9	−1	24·29	22·79	25·91	2·50	96·5	99·8

For Sources see Appendix 2.

	Wages	Industry Output Price	Retail Price	Employ-ment	Total Hours Worked	Imported Materials Price	Imports for Personal Consumption Price	Agricul-tural Products Price	Irish Non-agricultural Unemploy-ment Index ΣU	Output	Produc-tivity	Excise Tax Level	GB Unemploy-ment level	Real GB Wages
	W	P_z	P_r	E	M	P_{iz}	P_{ic}	P_a	ΣU	Z	D	T	U_{GB}	W_{GB}
1953														
1	79·6	88·9	84·5	89·7	87·2	92·4	83·0	95·6	−300·4	85·3	97·9	80·5	92·5	91·9
2	80·7	89·2	86·5	90·9	89·6	91·5	84·0	97·1	−188·7	95·2	106·3	80·5	73·4	91·3
3	80·5	89·1	85·8	93·3	92·3	90·6	83·6	93·9	−94·0	96·1	104·2	80·5	63·3	89·3
4	81·0	88·9	85·9	94·7	94·8	90·9	82·8	96·2	0	98·8	104·2	80·5	69·6	92·3
1954														
1	81·3	88·2	85·3	96·5	93·6	89·6	82·9	94·2	111·9	90·4	96·6	80·5	83·5	93·9
2	82·2	87·5	85·4	97·3	93·8	89·8	82·9	93·6	207·6	99·5	106·2	79·3	62·4	93·7
3	81·8	86·8	86·8	99·1	97·9	90·1	84·3	92·4	291·3	100·0	102·2	79·3	51·7	92·9
4	82·7	86·3	86·2	101·1	100·2	89·7	84·0	97·1	380·5	97·7	97·6	79·3	56·7	96·1
1955														
1	84·9	86·6	86·8	101·8	100·1	90·6	83·2	99·5	474·0	94·1	94·1	79·3	60·7	95·1
2	86·1	87·2	87·5	103·6	102·5	91·2	84·7	101·2	556·3	102·8	100·8	79·3	48·2	94·1
3	87·5	87·8	88·1	105·4	105·5	91·3	85·2	94·7	625·1	100·7	95·5	79·3	43·1	93·8
4	91·8	88·1	90·1	106·2	106·9	91·9	89·6	99·9	696·8	106·6	99·7	79·3	48·7	95·2
1956														
1	91·9	89·5	90·5	102·6	101·6	92·3	90·6	95·1	787·1	99·6	98·2	79·3	59·4	97·3
2	93·2	91·3	92·3	103·0	101·5	95·9	95·6	91·5	870·5	102·1	100·7	88·2	51·2	95·7
3	92·7	92·5	92·5	102·4	102·3	99·4	99·7	87·3	951·0	95·0	92·9	89·2	57·5	97·0
4	93·3	92·9	92·3	102·4	102·3	100·9	102·4	89·5	1,054·5	99·3	97·2	89·2	57·1	99·4
1957														
1	93·3	93·5	92·4	97·9	96·4	101·8	103·7	94·4	1,189·3	92·3	95·8	89·2	82·0	99·8
2	94·7	96·3	94·7	99·9	98·1	103·0	103·8	94·8	1,298·0	102·1	104·2	100·0	67·6	97·6
3	94·5	98·6	97·9	100·5	100·1	103·9	103·9	96·6	1,392·7	95·4	95·3	100·0	57·3	98·4
4	97·8	98·6	97·7	101·2	102·2	102·7	101·5	99·8	1,487·9	104·1	102·0	100·0	68·3	100·3
1958														
1	98·7	99·2	99·0	98·3	97·7	102·1	101·0	98·9	1,605·8	96·9	99·1	100·0	91·6	101·8
2	100·1	100·2	100·1	99·7	98·8	99·8	101·1	100·5	1,703·4	104·0	105·3	100·0	96·5	97·3
3	100·2	100·2	100·3	100·6	101·2	99·3	99·7	100·1	1,790·8	96·4	95·3	100·0	96·1	99·2
4	101·0	100·2	100·3	101·4	102·2	98·8	98·2	100·7	1,887·9	102·6	100·4	100·0	115·6	101·6
1959														
1	100·8	100·2	101·0	99·9	99·0	98·9	91·9	99·4	2,000·2	97·8	98·9	100·0	131·3	102·0
2	102·9	100·3	100·9	103·2	103·2	98·2	91·2	98·7	2,091·1	115·2	111·7	99·6	103·6	102·0
3	103·1	100·6	99·2	102·8	102·9	98·3	91·3	99·3	2,170·3	111·9	108·7	99·6	92·1	102·9
4	106·3	100·6	98·6	103·5	104·8	98·4	91·2	100·5	2,257·5	115·5	110·3	99·6	92·8	106·0
1960														
1	107·5	100·8	99·0	104·3	103·5	99·5	95·1	97·3	2,352·6	111·7	108·0	99·6	97·1	106·5
2	110·3	101·9	100·6	106·9	107·0	99·3	95·4	96·9	2,427·5	122·7	114·8	98·2	73·6	107·0
3	110·3	102·3	100·6	107·4	108·1	99·3	96·1	93·1	2,484·6	117·5	108·9	98·2	69·3	108·5
4	112·4	102·3	101·4	108·8	110·9	99·0	95·5	95·4	2,554·7	122·8	110·7	98·2	75·9	110·0
1961														
1	112·6	102·7	102·0	109·3	109·4	98·4	96·5	97·6	2,632·0	122·0	111·5	98·2	84·0	112·4
2	115·2	103·2	103·2	111·8	112·4	98·6	97·7	96·4	2,698·7	134·7	120·0	98·2	64·5	111·9
3	116·7	103·9	103·4	112·6	112·4	99·7	100·0	93·0	2,762·6	128·1	114·1	98·2	65·8	110·6
4	124·2	104·7	103·9	113·2	112·5	100·1	99·0	96·7	2,830·5	134·0	119·1	98·2	83·6	111·5
1962														
1	127·0	105·9	105·8	111·8	109·0	100·0	98·1	98·2	2,907·8	128·0	117·5	98·2	97·9	112·4
2	131·2	107·6	108·6	113·0	110·1	100·9	101·1	97·0	2,973·6	141·2	128·3	102·1	91·4	110·1
3	132·0	108·2	108·0	114·2	112·9	101·2	100·7	94·9	3,036·8	131·2	116·3	102·1	100·2	111·8
4	133·1	108·4	107·8	115·1	114·3	101·1	98·4	95·5	3,104·7	142·1	124·5	99·2	117·5	113·5
1963														
1	128·3	108·5	109·6	114·6	110·9	101·3	98·4	96·4	3,191·5	133·7	120·5	99·2	189·5	114·1
2	132·8	108·7	109·3	116·1	114·1	102·3	100·7	96·6	3,263·2	146·7	128·7	99·2	119·4	114·1
3	136·3	109·1	109·3	118·5	117·5	103·2	103·4	95·5	3,326·1	144·7	123·2	99·2	108·3	115·8
4	138·0	109·7	112·6	120·3	119·6	104·8	100·9	97·7	3,391·9	153·4	128·3	118·5	102·3	118·4

Sources: See text of Appendix 2.
*Cumulative index of unemployment index based on 1958=100.

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