

THE EFFECT OF VARIATIONS IN HOURS WORKED PER WEEK IN IRISH INDUSTRY, 1956-1971

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A recent article by Leslie and Wise (1980) investigated the productivity of hours worked in UK industry. From a technical point of view their work is interesting because they produced acceptable results in a production function for UK industry as a whole by combining cross-section and time-series data. Their reason for doing this was that previous studies, such as those by Feldstein (1967) and Craine (1973), which used either cross-section or time-series data alone, gave results which were either implausible or too imprecise to be of use. However, the practical aspects of the study are the most important. Their main finding may be summarised in the conclusion that "the concept of man-hours as a single homogeneous input is now acceptable". In other words, output will not change if the working week is cut and the numbers at work are increased proportionately. In a time of considerable unemployment, this is clearly of great significance as it gives support to the idea of "work-sharing" and to the reduction or banning of overtime. It must, of course, be kept in mind that any findings only relate to the physical effects of these strategies and that the financial aspects may be important too. For example, "work-sharing" may lead to an increase in the average hourly wage rate because people may not be as willing to share income as they are to share work. However, the study does give us valuable information about one important aspect of the problem. As suggestions about these matters are now common in Ireland, and particularly since the concept of work-sharing has the support of the Irish Congress of Trade Unions [Trade Union Information, Winter 1978, p. 6], it seems to be worthwhile repeating the investigation using Irish data. The need for some systematic investigation is increased by the fact that most discussion on the matter is based on opinion or hearsay information.

The Model

The procedure adopted here is basically the same as that of Leslie and

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Wise (op. cit). In the past, several researchers have attempted to measure the effect of changes in hours worked per week on industrial output either by using time series data for individual industries (Craine, op. cit) or cross-section data for a number of industries at a given time (Feldstein, op. cit). These efforts yielded rather implausible results which were also statistically unsatisfactory. Leslie and Wise showed that much better results could be obtained by combining time-series and cross-section data. They used, in a single study, data from 28 industries over a period of 21 years thus obtaining a total of 588 observations. Using these, they were able to measure the effect on output of variations in the numbers employed and hours worked per week very accurately. This enabled them to conclude that output would not change if hours per week were cut by, say, 10% and numbers employed increased by 10%.

The present study asks whether the same is true of Ireland. The data used cover 23 industries for the period 1956-1971 giving a total of 368 observations. The period and the industries included were dictated entirely by the data available and no extension of the sample seems possible. This arises from the fact that it is necessary to include estimates of materials used by industry at constant prices. These are not available from official sources and had to be prepared by the author. The information needed to do this is available only for the period and the number of industries mentioned above. Details of the method used are given below in the section on data.

Table 1: *Transportable Goods Industries*
Average hours worked per person per week

1938	44.2
1948	44.6
1956	44.9
1971	42.6
1979	42.5

Source: Census of Industrial Production.

Fortunately the period is ideal, since the purpose of the study is to discover the effect on output of changes in the number of hours worked per person per week, and the data span the only substantial change in four decades, as table 1 shows. The industries included in the sample accounted for 53% of the total employment in manufacturing industry in 1971. They include industries from all the main categories and range in size from an employment of 400 to one of 12,000, so presumably they may be taken as being reasonably representative. The basic data

for each industry covered constant price gross output (Q), constant price materials used (M), numbers employed (N), average hours worked per employee per week (H) and constant price capital stock (K). Gross output was expressed as a function of the other four:

$$Q = f(M, N, H, K)$$

and the data were used to estimate the coefficients in the equation. The functional form used was that of the Cobb-Douglas production function. This has many advantages for the present purpose, which explains, presumably, why it has been chosen by Feldstein, Craine, Leslie and Wise and also Hart and McGregor (1983). The greatest benefit from the use of the Cobb-Douglas derives from the fact that it enables elasticities to be measured directly. If, for example, the coefficient of N turns out to be 0.6 then we can say that, at any level, an increase of 1% in N will cause output to grow by 0.6%. It is thus easy to compare the effects of changes in any two variables.

A key feature of both the study done by Leslie and Wise and the present one is the use of a set of dummy variables, one for each industry. These are intended to allow for the effect of factors which might affect output but which are not formally included in the study. For example, in the first industry the management might be particularly good. This would cause output (Q) to be higher than the values of the variables M , N , H and K would suggest. The effect of this would be 'captured' by the dummy variable for that industry. In general, dummies help to increase the precision of the results. They are referred to below as "the d_i ". Leslie and Wise found it advantageous to use a second set of dummies to allow for different rates of technical progress in the various industries. These were tried in the present study but did not, on the whole, make any important addition to the precision of the results. When they are used, these dummies are referred to as "the d_iT ". Finally, Leslie and Wise also used unemployment as a variable to allow for the effects of labour hoarding. This proved totally useless in the Irish case and no further mention of it is made. The coefficients of the equation were estimated by the standard method of Ordinary Least Squares. There do not appear to be any violations of the assumptions on which the method is based. The 'Shazam' software package was used. This makes it relatively easy to handle the large quantities of data involved.

The Data

The data needed for the study were obtained as follows:

- (1) Gross output at constant prices: From the "Index numbers of the volume of production" in the Irish Statistical Abstract (ISA).
- (2) Numbers employed: "Industrial Production" in ISA.
- (3) Average weekly hours worked: From "Hourly wage rates and hours worked" in the Census of Industrial Production (CIP). The four quarters were averaged.
- (4) Materials used at constant prices: These could only be calculated for the 23 industries for which physical quantities of materials were available in the CIP. These quantities were multiplied by the 1953 prices. "Other materials" were deflated by the "wholesale price index of materials for use in industry". Fuel was deflated by a specially prepared index.

The appropriate industrial categories were initiated in 1956 so this dictated the first year of the sample. It was necessary to stop the series in 1971 because quantities of materials used were not reported afterwards.

The Results

The results of the statistical investigations are presented in Table 2. Each line represents the outcome of a single regression; that is, a calculation by ordinary least squares of the coefficients of the equation:

$$Q = f(M, N, H, K, \text{Dummy variables})$$

Definitions of the variables are given at the foot of the table. The various regressions differ only in the dummy variables which are included. As mentioned above, the coefficients shown in the table are elasticities. For example, in line 1 the coefficient of M is 0.664. This indicates that a 1% increase in materials used would lead to an increase of 0.664% in gross output. Similarly, an increase of 1% in numbers employed (N) would lead to an increase of 0.236% in gross output.

These elasticities are only estimates. The figures shown in brackets underneath are standard errors of these estimates and indicate how reliable they are. Under standard assumptions we can say, with a 95% probability of being correct, that the true value of the coefficient will be contained in the range given by two standard errors on either side of the estimate. For example, in line 1 we could say that the true value of the coefficient of M should be somewhere in the range $0.664 \pm (2 \times 0.013)$, that is, between 0.690 and 0.638. Naturally, the smaller the standard error, the better. Finally, the value of R^2 given at the end of the line indicates the overall goodness-of-fit. In other words, it provides a measure of the extent to which variations in Q are 'explained' by variations in the other variables. The bigger R^2 is, the better.

Table 2: *Regression Coefficients*

Line	M	N	H	K	R ²
1	0.664 (0.013)	0.236 (0.017)	0.594 (0.205)	0.171 (0.014)	0.962
2	0.589 (0.088)	0.629 (0.128)	-0.344 (0.313)	-0.426 (0.852)	0.987
3	0.673 (0.014)	0.290 (0.019)	-0.266 (0.222)	0.104 (0.013)	0.984
4.	0.570 (0.070)	0.408 (0.097)	0.437 (1.457)	-0.119 (0.063)	0.984
5.	0.692 (0.014)	0.200 (0.018)	0.691 (0.209)	0.172 (0.014)	0.973

Figures in brackets are standard errors.

(M = Materials used at constant 1953 prices.

N = Numbers employed.

H = Hours worked per person per week.

K = Capital stock at constant 1953 prices.

In all cases the dependent variable is Q = gross output at constant 1953 prices).

We can now examine the results of the various regressions. In *Line 1* of Table 2, Q is expressed as a function of M, N, H and K only; no dummy variables are included. On the whole, the results are quite good. All the standard errors are sufficiently small to enable us to say that the coefficients are significantly different from zero with at least 99% confidence. However, in view of the results obtained by Leslie and Wise, it is necessary to see whether the inclusion of dummy variables might improve the results.

Line 2 shows the results of a regression where Q was expressed as a function of M, N, H, K, a full set of d_i variables (which allow for different levels of efficiency in each industry) and a full set of d_iT variables (which allow for different rates of technical change in each industry). The results are quite poor. Two of the coefficients (those of H and K) have standard errors which are so big that the coefficients cannot be said to differ from zero at any reasonable level of probability. Further-

more, the coefficient of H is negative (indicating that more would be produced in all industries if people worked shorter hours) and this is difficult to accept. An examination of the coefficients of the dummies in the regression (which are too numerous to include here) shows that most of them do not differ significantly from zero, so that the poor results are probably caused by the inclusion of a large number of unnecessary variables in the regression.

Accordingly, *Line 3* shows the results of a regression where only those dummies whose coefficients were significant at the 90% level¹ included. This produces a considerable improvement because all the standard errors of the coefficients are reduced, but the results are still suspect because the coefficient of H has a negative sign.

This negative coefficient of H requires some investigation. It is quite persistent and emerges when any of the dummy variables were included. Since it is hard to believe that more is produced in all industries when people work shorter hours and all other factors are held constant, we must look for another explanation. It seems most probable that the reduction in hours is associated with some other change which leads to an increase in output. One possibility is that decreases in H were negotiated as part of more extensive arrangements which also included reorganisation of the production process and a more efficient use of labour — in short 'rationalisation'. If this were strong enough, it could well conceal the true relationship between Q and H . It is, however, unlikely that this effect would hold in all, or even most, industries. If the industries in which the effect is significant could be discovered and if its influence could be removed, then one might obtain a more satisfactory estimate of the coefficient linking Q to H .

To test this theory, the d_iT dummy variables were removed and replaced by a new set called the d_iH . The purpose of these latter was to allow changes in H to have different effects in the various industries. When they are included, the normal effect of changes in H over the whole of industry is given by the coefficient of H and amount by which the effect varies from the 'normal' in a particular industry is given by the coefficient of its individual d_iH . *Line 4* shows the results of a regression where Q is expressed as a function of M , N , H , K , the d_i and a full set of d_iH . This line is of no very great significance, as its main purpose is to identify those industries where the d_iH have coefficients which are statistically significant. However, the results are encouraging because the coefficient of H has become positive. Five of the d_iH coefficients are significant at, or above, the 90% level and these are included in the next regression.

Line 5 gives the results of a regression where Q is expressed as a function of M , N , H , K , the d_i and the five d_iH which are found to be significant in Line 4. These results are quite good. All the coefficients have the expected positive sign and are statistically significant at more than the 99% level. The results in Line 5 are, in fact, very like those in Line 1. This is interesting, because it shows that there is a substantial difference between the English and the Irish cases. In the former, the inclusion of dummy variables caused a big change in the results and in particular to the coefficients of N and H . In the Irish case, the most satisfactory set of dummies makes little changes in these coefficients. It also indicates that the coefficients are reasonably robust, because they are not changed by the inclusion of additional variables.

The main point of interest is, of course, the difference between the coefficients of N and H . This difference is very great and it can be shown that we can reject the hypothesis that they are equal with more than 99% probability. The general indication is that hours worked per person per week (H) are more productive than numbers of people employed (N). Suppose, for example, that a 'worksharing' scheme was proposed whereby the hours worked per week by industrial employees (H) were reduced by 10% and the labour force (N) was increased by 10%. We will also assume that the hourly wage rate is not increased so that each worker takes a pay-cut of 10%. Bearing in mind that the coefficients are elasticities, we can see from Line 5 that the reduction in output caused by the decrease in H would be 6.91% (i.e. $10\% \times 0.691$) and the increase in output caused by the increase in N would be 2% (i.e. $10\% \times 0.200$). There would thus be a reduction in output of 4.9% even though the wage-bill would remain the same. Extra labour and/or capital would have to be employed to maintain the level of output and the cost per unit of output would rise. In short, the indications are that 'worksharing' in industry in general would make Irish industrial goods less competitive. This accords well with commonsense. With a given size of plant, it is usually easier to produce additional output by having the existing work-force work longer hours rather than by employing additional workers.

It will be recalled that five industries were found where the coefficients of d_iH were significantly different from zero. The industries with their coefficients are as shown in Columns 1 and 2 of Table 3.

These are the only d_iH coefficients which were statistically significant at the 90% level or above. As hypothesised above, all these coefficients are negative. Presumably, this is because the reductions in hours worked per week in these industries were accompanied by reorganisation which

Table 3: *Coefficients of d_tH from Table 2 Line 5*

<i>Column 1</i>	<i>Column 2</i>	<i>Column 3</i>
Industry	Coefficient	Total H Coefficient
Hosiery	-0.504	0.187
Clothing (women and girls)	-0.994	-0.303
Paper and Paper Products	-0.505	0.186
Glass and Glassware	-0.160	0.531
Structural Clay and Cement	-0.442	0.249

brought about increased efficiency. In the case of these industries the total coefficient of H is the algebraic sum of the general figure shown in Table 2 Line 5 (0.691) and the appropriate figure in Table 3 Column 1. These total coefficients are shown in Column 3 of Table 3. We would interpret the negative figure for clothing (women and girls) as indicating that the increase in efficiency was so great that the reduction in hours was accompanied by an increase in output. In the case of the first three of these industries the total coefficient of H is less than that of N in Line 5 of Table 2. This enables us to say that a work-sharing scheme of the type outlined above would not raise costs in these three industries provided that it was accompanied by an increase in efficiency as great as that which took place in the period 1956-71. The likelihood of this can only be judged by those who are familiar with conditions in the industries in question.

Summary and Conclusions

The purpose of this study is to discover whether numbers employed in Irish industry (N) are a good substitute for hours worked per person per week (H). To do this a Cobb-Douglas production function was applied to pooled time-series and cross-section data by ordinary least squares, the main interest being centred on the coefficients of N and H. Several sets of dummies were used to increase the precision of the estimation. The data cover 23 industries, this being the maximum for which information was available. Estimates of materials used in industries were prepared by the author. The period involved was 1956-1971 partly because of data constraints but also because this is the only period in which a major change in H took place.

The results are statistically much better than those that could be

obtained from either cross-section or time-series data alone. They indicate strongly that N is not a good substitute for H and that, in the period in question, there would have been a loss of industrial efficiency if extra jobs had been created by reducing the working week and increasing the numbers employed. Since the study covers the only period in recent history in which there was a substantial reduction in hours worked per week, it must cast considerable doubt on the practicability of "work-sharing" as a general means of solving the problem of industrial unemployment.

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Note

1. If a coefficient is significant at the 90% level, this means that we can say that it is not equal to zero and have a 90% probability of being correct.