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A STATISTICAL STUDY OF INDIVIDUAL IRISH MANUFACTURING INDUSTRIES

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This paper owes its inception to our coming across a very useful table in ISB (1977). This table showed, for each of the eleven years 1963-1973, index numbers of gross volume of production in each of the 45 manufacturing industries, according to the CIP classification then used but which has since been changed to the common list (NACE) used in the EEC. The years 1963-1973 are very suitable for industrial analysis (i) as starting some years after the industrial upsurge began (ca.1960), fairly uniformly good years, in fact; (ii) 1973 almost coinciding with the disastrous rise in oil prices and the increase in interest rates* to usurious levels; (iii) 1973 is the last year for which R.N. Vaughan's (1980) estimates of capital stock are available for almost all the 45 industries, one of the main reasons for our embarkation on this elaborate exercise. After 1973 there have been two recessions, one of 1975-1976 and the present one, from which there is little sign of an ending, qualifying it for its duration and severity, for the description "depression". It might be regarded as a continuation of K.A. Kennedy's (1969) paper, relating like this to individual manufacturing industries but for the years 1953-1967, i.e. bridging the start of the industrial upsurge and concentrating on the growth of labour productivity. Kennedy's variables and methodology differ from ours, in particular in his concentration on earnings, unit costs and prices, absent from the present paper, entirely devoted to entitites at constant prices.

Except for our giving at the end a short account of other recent work in this general field (but in which few papers dealt with particular industries, as Kennedy's does) this paper is non-economic. In fact we shall not object to its being regarded as aggressively statistical.

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* The Central Bank Exchequer Bills Interest Rate was as follows:

	December 1971	December 1972	December 1973	December 1974
Per cent	4.58	7.98	12.67	11.19

Source: Central Bank Annual Reports.

Tables here are at an advanced computational stage; we hope they will be regarded as useful for economic analysis. We confine our text to propounding problems suggested by the statistics, to methodology, to obvious inferences from the statistics and to some value judgements, with or without query marks. Our main findings are drawn together in a Conclusions section at the end. We do not include the basic tables we prepared but we shall be glad to supply copies of these to other researchers.

The work involved in preparing these from original sources was very onerous and time-consuming. Subsequent work was easy, for it was all done by computer programmed by our colleagues B.J. Whelan and D. Cummins to whom we are grateful. This experience with the preparation of basic tables prompts some general remarks. We have found the voluminous Data Bank 1980 of CBI very useful for other studies, with many data extending back for several years but no fixed data bank can possibly supply all the statistics required for a particular enterprise. We have found CSO very helpful in compiling single tables - in the present case CIP statistics of value of fuel used in each of the 45 industries in each year 1963-1973 - but they can scarcely be expected to produce all the tabular data required for a whole special research.

Would it be possible for CSO to put almost all the statistics it produces into the data bank of a computer and retrieve what is required to the exact specifications of the researcher? A fee could be charged for this valuable service: it would not be large and it would save a vast amount of tedium for the researcher. Simple calculations (percentages, averages etc) might be included, but these are easy when the basic data are available. Elsewhere we have suggested the use of respondents' computers (instead of traditional forms) for speeding up the compilation of statistics, especially CIP.

Basic data tables are as follows: All values are at constant prices, usually 1969, for E.W. Henry has estimates of profit for each of the 45 CIP industries for that year. All data relate in principle to each of the 45 industries for each of the years 1963-1973; a few data are missing for various reasons. We give very brief descriptions of industries, in the tables relying mainly on numbers, for textual convenience. Full descriptions are given in the ISB annual reports. The basic tables are:-

1. Volume of added value found as 1969 value adjusted proportionately as the index of gross production.

2. Number employed (average of single figure each month in year)

3. Net capital stock adjusted from Vaughan's 1958 basis for constant price to 1969.

4. Expected added value found for each year as:-
   No. employed x average pay 1969+
   net capital stock x profit per £ net capital stock in 1969.

5. Fuel purchased, designed proportionately as a proxy for net capital stock in use.

6. Exports in 1964 and 1969 as percentage of gross output of each industry.

7. Number unemployed as percentage of labour force.

To repeat, these basic tables are not reproduced here. Following are some notes on the concepts mentioned.

Added value. This is the sum of employee pay and profit. The assumption is implicit that added value at constant prices is exactly proportional to gross output. This assumption is dubious since volume of input of materials and services may be moving differently from volume of gross output. Unfortunately no estimates are available for volume inputs, so we are precluded from measurement of material productivity, amongst other productivities. The so-called double deflation method of estimating volume of added value (Geary, 1944) was invented in Ireland (and now much used in other countries) but not yet used here.

The statistical dubiety of our procedure does not matter much since most of our findings would apply if the figures were correctly described as proportional to volume of gross output.

Net capital stock. As Henry George pointed out in Progress and Poverty (1879) there are many definitions of capital. He was unable to accept any by economists up to his time, though he stated that Adam Smith's came nearest to being right, as we are finding these days with many of his concepts, after the intellectual turmoil of the intervening years. Unfortunately Henry George wrote unaware of the appearance of Das Kapital (1867) perhaps because the latter was first published in German, the first English edition appearing in 1887. R.N. Vaughan (1980) has two separate sets of estimates, both compiled by the "perpetual inventory" method, termed "gross" and "net", valued at current and constant (1958) prices. The net series at constant prices which we use can be regarded as depreciated and approximated to the value of the stock if sold. In the aggregate for all manufacturing industries the gross figure at constant prices increased by 8.1 per cent a year, between 1963 and 1973, the net by 8.8 per cent. If the increase from the net concept is the greater, the modification from using the gross would scarcely affect the emphatic results quoted later.

Profit. Statistics of profits are elusive. The estimates we use were derived from CSO 1969 Input-Output Table (92 sectors). With the cooperation of the Revenue Commissioners, CSO obtained profit and depreciation for each of the ten customary manufacturing groups (Food, Drink, Tobacco, Textiles etc.) Within each group, profit and depreciation were subdivided proportionately to the CIP Remainder of Net Output (i.e. remainder after deduction of employee pay).

Fuel. The CSO table was at current prices. As no wholesale price index was available, the deflator used to derive the constant price series was the Consumer Price Index for Fuel and Light.

Exports. It is extremely difficult to relate these to production since different classifications are used for CIP products and exports. We have recommended elsewhere that quantities exported should obtained in future CIPs. Our estimates of exports as percentage of gross output were simple averages derived by E.W. Henry from the 1964 and 1969 input-output tables. These two years were deemed to represent the eleven years 1963-1973.

We would recommend to CSO the general principle of using the same classifications of persons or things for all purposes; we write with full knowledge of the difficulties. Perhaps this uniformity could be attained at some level of aggregation.

Unemployed. Numbers were obtained from the CSO publication The Trend of Employment and Unemployment and the annual average for 1963-1973 derived. These were added, industry by industry, to the average number employed to yield the average annual labour force. The percentages used were 100 x average no. unemployed ÷ average labour force, so calculated.

Statistical processes. We submitted our raw data to the computer for the customary statistical procedures, percentages per annum, regressions, averages, standard deviations, correlation coefficients etc. applied uniformly to entities (employment, output etc) at constant prices during the eleven years 1963-1973, in a few cases with data missing. For

[Table 1]

rate per cent per annum the formula was always $100\ b_i/\bar{y}_i$, i the industry, b_i its simple OLS regression coefficient on time. This method is more accurate than the more usual one of basing the estimate on first and last years only. The computer also provided the standard deviation of the b_i, indicating the few values probably not different from zero, asterisked on Table 1.

The outstanding showing of Table 1, and perhaps of this whole paper is the fantastic range of values of every entity, even at a time usually regarded as of uniform growth. The employment effect of the variations in percentage changes in output and employment in Table 1 are shown in Tables 2 and 3:

[Table 2]
[Table 3]

Table 1: Percentage increase per annum in various entities and average percentage per annum in exports and unemployment.

Manufacturing Industry		Percentage increase per annum					Annual average percentage rates	
		Gross Output	Employment	Net capital stock	Fuel	Expected Output	Unemployment	Exports
		1	2	3	4	5	6	7
1.	Bacon	3.38	3.97	7.78	3.24	1.72	6.0	50.3
2.	Slaughtering	7.09	5.65	11.85	6.87	7.40	1.9	33.3
3.	Butter	8.31	4.86	10.90	7.03	5.93	5.2	55.3
4.	Canning	7.36	1.00*	8.58	6.19	2.25	16.7	17.9
5.	Grain milling	3.01	-0.78	3.70	1.80	0.24*	5.3	3.9
6.	Bread	1.42	-0.03*	3.31	-2.03*	0.40	5.6	3.6
7.	Sugar	2.38	-2.82	0.00*	-4.89	-1.95	12.1	8.0
8.	Chocolate	3.39	-0.76	3.89	2.13	0.99	9.1	22.3
9.	Margarine	3.45	4.44	12.05	2.86	4.26	5.4	n.a.
10.	Misc. food	11.07	7.00	9.90	9.73	7.40	1.9	n.a.
11.	Distilling	5.97	n.u.	4.70	-2.29	n.c.	5.2	28.0
12.	Malting	5.16	n.u.	9.36	-1.10*	n.c	5.2	28.0
13.	Brewing	3.40	-0.16*	4.40	2.95	1.18	5.2	28.0
14.	Aerated	10.68	3.75	9.98	4.95	5.40	3.3	28.0
15.	Tobacco	1.63	0.00*	8.90	5.43	4.36	3.4	8.9
16.	Woollens	5.50	0.04*	7.22	2.27	1.30*	6.7	25.2
17.	Linen	0.37*	-4.21	3.64	-1.76*	-2.50	8.7	29.8
18.	Jute	10.01	1.60	16.31	10.08	4.84	4.1	36.5
19.	Hosiery	11.71	3.16	9.24	8.05	4.01	3.8	36.1
20.	Boot & Shoe	-0.07*	-1.85	6.06	2.27	-1.05	9.1	38.8
21.	Men & Boys	2.97	0.21*	5.32	2.71	0.57*	5.9	29.4
22.	Shirtmaking	2.37	2.84	8.83	6.95	3.25	8.1	29.4
23.	Womens & Girls	4.10	0.69*	8.14	4.43	0.85*	5.9	29.4
24.	Misc. clothing	2.54	-3.04	10.73	0.60	-2.21	5.9	29.4
25.	Made-up textiles	9.11	4.46	9.82	15.55	5.36	4.1	33.9
26.	Wood (ex.furniture)	5.45	1.33	8.37	7.07	1.78	7.8	17.4
27.	Furniture	1.66	0.27*	7.75	6.22	0.50*	6.9	17.4
28.	Paper	7.35	1.34	4.50	2.00	2.00	4.1	22.0
29.	Printing	3.49	1.79	5.12	5.46	2.37	4.2	11.6
30.	Fellmongery	1.75	-1.73	3.65	-0.63*	-0.76	5.7	n.a.
31.	Leather	0.51*	-1.32*	1.95	1.38	-1.02*	5.7	n.a.
32.	Fertiliser	7.62	3.86	9.42	12.69	6.49	6.1	1.3
33.	Oils	5.32	-0.17*	4.22	3.72	1.80	1.7	30.4
34.	Chemicals	13.98	7.71	20.12	19.69	16.88	5.5	30.4
35.	Soap	2.85	0.26*	3.36	-0.45*	2.34	7.5	30.4
36.	Glass	7.56	5.62	16.03	4.90	8.54	3.8	27.7
37.	Clay, cement	9.16	4.81	10.97	5.46	6.94	3.2	13.2
38.	Metals	7.37	3.97	11.28	7.80	6.10	3.5	22.1
39.	Mach. (ex electric)	3.59	4.69	9.33	7.99	6.77	18.7	76.2
40.	Electric mach.	6.13	5.02	9.79	4.82	6.81	5.3	44.7
41.	Ships	3.70	5.40	8.57	4.01	6.15	5.3	59.2
42.	Rail	-2.45	-1.40	n.a.	-4.87	n.a.	5.2	n.a.
43.	Vehicles (mech)	2.62	3.02	4.50	5.81	3.42	7.0	1.2
44.	Vehicles (non-mech)	2.31	1.41	9.30	6.52	2.31	7.0	n.a.
45.	Miscellaneous	9.90	6.43	10.82	4.26	7.86	6.7	11.9
	Simple average	5.05	1.91	8.04	4.40	3.36	6.1	26.8

Basic sources:- ISB (1977) and other issues; R.N. Vaughan (1980); TEU, various issues; E.W. Henry, manuscript tables.

Notes: In columns 1-5 all percentages calculated as $100\, b_i / \bar{y}_i$, b_i being the regression coefficient for measure y_i on t, $\bar{y}_i$ being mean of y_i in 1963-1973. Asterisks denote b_i's insignificant at NHP = 0.05. Most are small and negative.
In columns 6-7, classifications of industry were more generalized than for the other columns, necessitating repetition of figures for some industrues; columns mainly needed for calculations of Table 5.

Table 2: Number and percentage of employees classified according to industrial percentage increase per annum in output

Per cent increase per annum	Number of industries	Average Employment 000	%
Under 1	4	12.25	6.52
1 - 2	4	17.72	9.43
2 - 3	7	20.13	10.71
3 - 4	8	34.33	18.26
4 - 5	1	8.10	4.31
5 - 6	5	13.33	7.09
6 - 7	1	9.20	4.90
7 - 8	6	29.90	15.91
8 - 9	1	6.32	3.36
9 - 10	2	6.14	3.27
10 or over	6	30.52	16.24
Total	45	187.94	100.-

Basic sources: Table 1 and ISB, various issues.

Table 3: Number and percentage of employees classified according to industrial percentage increase per annum in employment .

Per cent increase per annum	Number of industries	Employees Average 000	%
< -2	3	6.54	3.50
-2/-1	4	10.35	5.54
-1/0	5	25.85	13.84
0/1	6	27.54	14.74
1/2	6	28.66	15.34
2/3	1	2.56	1.37
3/4	6	37.88	20.29
4/5	5	15.76	8.44
5/6	4	17.67	9.46
6/7	1	9.77	5.23
7/8	2	4.21	2.25
	43	186.81	100.-

We shall allow Tables 2 and 3 to speak for themselves except to state that considerable number of employees share in the different fortunes of the different industries. In this paper we are unconcerned about the kind of goods industries or firms make, only to note that all industries are similar in trying to provide pay, profit and employment, using capital for this purpose.

Table 1 raises a number of fundamental questions. To what extent is this country in the wrong industries? Change in time in industrial pattern is of the essence: are we too resistant to change, in technique, nature of goods produced etc, having regard especially to export potential, the country already so very much involved in exports? These are questions, in that we do not know the answers but we consider the questions should always be borne in mind in the hope of improvement. The questions reflect on the quality of management.

That almost everything can be exported nowadays is the answer to the plea that demands for goods differ widely. Clearly considerable investment in one technique to produce a cognate set of goods, with all the knowledge and skill of the producers, cannot be changed in the short term. But there must be considerable flexability in people and equipment to cope with change. To misquote Marie Antoinette: if you can't sell bread, make cakes.

Following are some relevant facts. In four periods from 1953 to 1976, in fact, 1953-60, 1960-1966, 1966-1973, 1973-1976, numbered respectively 1, 2, 3, 4, the annual average percentage increase in volume of output was calculated. With 44 industries as units the c.c.s between each consecutive interval were r (12) = .40, r (23) = .52, r (34) = .48, all significant at NHP = .01 (Geary, Dempsey (1979)). While these percentages are not large, there is a definite tendency for a high (low) percentage increase in output in one period to be followed by a high (low) increase in the next. That success is likely to persist should give entrepreneurs courage to change to better industries or products.

Variability in output between firms in the same industry is very great. From frequency distributions of net output per person employed, with firms as units, derived by T.P. Linehan (1962) from CIP manufacturing for 1958, R.C. Geary stated in the discussion of the paper that in each industry the effective range ratio, calculated from the frequency distributions, was about 4:1. This was the ratio of the 90th percentile net output per person to the 10th, when these figures are arrayed in ascending order of magnitude. This phenomenon, common to all industries, seemed at odds not only with classical economics but with common sense. How did the less efficient firms remain in business? Geary (who had found an effective range of about 3:1 for output per person on large samples of farms of given size) tried to find reasons for this phenomenon but without success. Questions included: to what extent were differences due to (i) product or products mix (ii) capital intensity, (iii) prices of products and materials, (iv) skills of staff and management, (v) industrial relations. There would, of course, be other causes, including persistance of good or bad results from year to year. As to the effect of product mix, Geary recalls being consulted soon after the last war by the late J.P. Beddy, then chairman of a commission on prices of bread, as to statistical inferences to be drawn from accountant's reports for some 40 bakeries related to a single product, plain bread. Of course the identity of the firms was concealed. A great variety of profit as per cent of output was revealed, for this product in which there was little scope for change in quality; so much so that one firm could have reduced the price of a 2-lb loaf by a penny, produced all the plain bread needed in Ireland and made a handsome profit. Of course this did not happen. Prices required to keep less competent firms in business yield windfall profit to more efficient firms, without the risks and the odium attaching to destructive competition.

We mention this problem of variability of return to suggest that it be reconsidered using modern data. To what extent are poor results due to poor management? Management consultants' reports often include recommendations to dismiss managers. We have in mind econometric and general economic inquiry, rather than for particular firms. Geary, Dempsey (1979) indicated how international trade statistics could be used to show what goods this country should be producing. There may be a case for reviving the Committee on Industrial Progress of 1968. The vast experience of IDA and CTT could also be drawn on.

The quality of Irish management seems to have received less attention than it deserves.* Early in the 1960s a visiting researcher in ESRI started work on this topic but did not finish it. At a seminar he stated that he had completed many interviews with firms and, as a result, had a table with firms arrayed in five categories according to quality of management, these categories defined objectively. He would put no firm in his best category. He remarked, however, that the second level of management was far better than the first; he expected improvement when this second level was promoted.

Managers are relatively few in number but they are very important since it is on their ability that employment and its conditions of most of the population depends. Probably most managers rise from the ranks of their firms. Here and abroad there are many third level educational courses for management. We would like to know something about their success. (At another seminar years ago in ESRI a lecturer amused those present, all graduates, by remarking that inquiry in England had shown that boards of directors with no graduates were more successful than boards with.)

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* In the 9 September 1982 issue of Business and Finance, Ronnie Hoffman surveys the prospects for the Irish Management Institute under its new director Brian Patterson, who "found himself in control of an organisation which was failing to align supply with demand, which was becoming something of an anachronism," Patterson said "There's a hell of a lot that business and managers can do that's not being done ... We've got to be a relevant, practical, authentic agency which helps managers to cope with their problems, and which does so in such a way that the managers learn from it ... We'll be doing fewer things here in the Institute and more out there in the workplace ... Our training is aimed at the long in tooth". All the management skills will continue to be taught. But a much greater emphasis will be placed on marketing skills. Patterson is determined that the Institute will henceforth work in far closer harmony with AnCO, IDA and CTT.

One imagines that it must be difficult to devise training courses for management ever likely to be regarded as essential, in the sense of those say for doctors and engineers.

It is suggested that statistical inquiries be undertaken to discover the main reasons for the vast differences in output of manufacturing concerns relative to employment.

The variability of every column in Table 1 scarcely justifies the row of simple averages; they are supplied for points of reference for interpretation of individual figures, e.g. are these above or below the average. The general increase in net capital stock is much greater than for output, in turn much greater than in employment. Increase in fuel, proxy for capital in use, is only half that for capital stock, indicating great economy in fuel use and or capital insufficiently used. The difference in percentages is so great that we must suspect the latter. The question stands; is capital used wastefully in Ireland? Amongst 43 industries, 12 showed declines in number employed and a further 8 showed no significant increase in number.

[Table 4]

The idea of the regressions on time t of added value and net capital stock at constant prices in Table 4 was to smooth away the year to year variability in 1963-1973 for the purpose of deriving the ICORs for the period as the quotients of the regression coefficients. The ACORs are also provided as the quotients of the means. The ACORs are indicative of capital intensity, hence different from ICOR which are dimensionless. The c.c. between the two is .54 with industries as units, highly significant, since, with 37 d.f., the NHP=.001 critical point is .51. In view of the vast increase in capitalisation and the possible wasteful use of capital in the period, this relationship seems important, to repeat, needing investigation. Employment for different ICORs is shown in Table 5.

[Table 5]

Table 4: OLS regression constants for added value and net capital stock at constant (1969) prices on time (t), mean values, incremental and average capital/output ratios, manufacturing industries, 1963-1973

Manufacturing Industry	Added Value		Net Capital Stock		Mean Ratio		Capital Output Ratio	
	Constant	Coefficient of t	Constant	Coefficient of t	Added Value	Net Capital Stock	Incremental ICOR	Average ACOR
1. Bacon	3.702	0.156	5.931	0.866	4.638	11.127	5.55	2.40
2. Slaughtering	2.401	0.296	2.354	0.966	4.178	8.151	3.26	1.95
3. Butter	3.770	0.626	10.025	3.142	7.525	28.883	5.02	3.83
4. Canning	1.884	0.248	5.048	0.892	3.374	10.400	3.60	3.08
5. Grain milling	4.493	0.165	15.180	0.721	5.484	19.506	4.37	3.56
6. Bread	8.240	0.128	18.825	0.778	9.014	23.493	6.08	2.61
7. Sugar	2.895	0.081	8.897	0	3.378	8.897	n.c.	2.63
8. Chocolate	3.329	0.141	11.702	0.594	4.175	15,266	4.21	3.66
9. Margarine	0.379	0.165	1.018	0.440	1.369	3.652	2.64	2.67
10. Misc. food	0.316	0.104	1.595	0.389	0.941	3.929	3.74	4.18
11. Distilling	0.264	0.0246	3.083	0.202	0.412	4.295	8.21	10.42
12. Malting	0.590	0.0440	1.510	0.324	0.854	3.460	7.39	4.05
13. Brewing	8.425	0.359	27.151	1.625	10.580	36.906	4.53	3.49
14. Aerated	0.691	0.217	2.455	0.610	1.992	6.115	2.81	3.07
15. Tobacco	4.835	0.088	4.122	0.787	5.361	8.844	8.94	1.65
16. Woollens	4.257	0.349	8.331	1.045	6.354	14.475	2.99	2.28
17. Linen	3.534	0.014	7.157	0.333	3.618	9.155	n.c.	2.53
18. Jute	1.714	0.430	0.270	2.134	4.291	13.080	4.97	3.05
19. Hosiery	1.909	0.752	6.649	1.378	6.423	14.917	1.83	2.32
20. Boot and Shoe	4.425	0.003	3.403	0.324	4.228	5.347	n.c.	1.26
21. Men's and Boys'	2.674	0.968	2.139	0.167	3.253	3.141	0.17	0.97
22. Shirtmaking	1.066	0.294	0.644	0.121	1.242	1.370	0.41	1.10
23. Women's and Girls'	3.460	0.188	2.328	0.370	4.588	4.548	1.97	0.99
24. Misc. clothing	0.540	0.0162	0.596	0.018	0.637	1.676	n.c.	2.63
25. Madeup textiles	0.279	0.056	0.414	0.099	0.616	1.008	1.77	1.64
26. Wood (excl. furniture)	1.935	0.156	4.224	0.711	2.874	8.490	4.56	2.95
27. Furniture	2.907	0.0537	2.007	0.291	3.228	3.753	0.54	1.16
28. Paper	3.384	0.445	11.449	0.705	6.054	15.679	1.58	2.59
29. Printing	9.910	0.437	12.718	0.939	12.534	18.352	2.15	1.46
30. Fellmongery	1.567	0.0307	2.890	0.135	1.751	3.700	4.40	2.11
31. Leather	0.564	0.00298	0.950	0.021	0.581	1.076	n.c.	1.85
32. Fertiliser	2.580	0.362	8.949	1.936	4.750	20.559	5.35	4.33
33. Oils	1.671	0.131	3.329	0.188	2.455	4.457	1.44	1.82
34. Chemicals	1.100	0.953	-2.518	2.452	6.815	12.188	2.57	1.79
35. Soap	2.105	0.0724	1.829	0.077	2.539	2.291	1.06	0.90
36. Glass	2.491	0.544	0.350	1.481	4.559	9,237	4.31	2.03
37. Clay, Cement	3.481	0.707	11.230	3.603	7.727	32.849	5.10	4.25
38. Metals	7.724	1.020	10.538	3.681	13.846	32.624	3.61	2.36
39. Mach. (excl. electric)	3.624	0.166	3.136	0.665	4.618	7.126	4.01	1.54
40. Elect. Mach.	6.693	0.649	6.615	1.571	10.587	16.041	2.42	1.52
41. Ships	1.732	0.032	2.470	0.436	2.226	5.086	5.32	2.28
42. Rail	2.697	0.058	n.a.	n.a.	2.351	n.a.	n.a.	n.a.
43. Vehicles (mech.)	8.833	0.274	10.294	0.634	10.482	14.098	2.31	1.34
44. Vehicles (non-mech.)	2.002	0.0538	1.377	0.290	2.325	3.117	5.39	1.34
45. Miscellaneous	4.633	1.129	15.157	4.673	11.407	44.018	4.22	3.86

n.c. = not calculated as meaninglessly great.

Table 5. Average number and percentage employed in industries, classified by size of ICOR

ICOR	Number of industries	Employment 000	Employment %
< 1	3	11.89	6.7
1 – 2	6	24.40	13.7
2 – 3	7	41.51	23.4
3 – 4	5	29.77	16.7
4 – 5	8	30.63	17.2
5 – 6	6	21.26	12.0
6 or over	4	18.29	10.3
Total (data available)	39	177.75	100.

Productivity of various kinds is the quotient of volume output by each entity at constant prices. Per cent per annum changes during 1963-1973 for each industry are shown in Table 6, derived from Table 1 in the manner indicated in the Note. The factor figures are derived from

[Table 6]

the quotient of actual by expected output at constant prices, expected output being that from labour and net capital stock valued at 1969 prices. (As percentage changes are involved the year of valuation matters little). The factor productivity column reveals the well known residual productivity phenomenon, i.e. the productivity after full allowance has been made for the contribution of labour and capital. This property, much discussed in the literature, has never been satisfactorily proved. One explanation, in our view a plausible one, is that new capital stock, in replacement of old or additional, nearly always incorporates improvements, not necessarily recognised in price. There are but 10 (out of 42) exceptions to the rule of residual productivity in Table 4.

One might expect residual productivity to be related to quantum of capital. (This is not the tentative thesis of the last paragraph which has to do with quality of capital). The c.c. is -.23, not significant at NHP = .1, the minus sign being due to net capital stock being included in both variables with negative effect. Residual productivity is not due to quantity of capital but, to repeat, it may be due to its quality. As already noted, the huge increase in net capital stock has had the effect of making capital productivity annual average percentage change negative except in 8 cases.

[Table 7]

Great attention having been paid to the Cobb-Douglas so-called production functions in the literature, we provide the data in linear logarithmic form in Table 7. We do so conventionally but without conviction. First we are doubtful about the direction of causation. Causation implies a decision to produce a product or product mix in certain quantity using given technique, implying employment in given numbers and types and capital of

Table 6: Productivities per cent per annum of labour, capital, factor, fuel manufacturing industries, 1963-1973.

	Manufacturing Industry	Labour	Capital	Factor	Fuel
1.	Bacon	-0.59	-4.40	1.66	0.14
2.	Slaughtering	1.44	-4.76	-0.31	0.22
3.	Butter	3.35	-2.59	2.38	1.28
4.	Canning	6.36	-1.22	5.11	1.17
5.	Grain milling	3.79	-0.69	2.77	1.21
6.	Bread	1.45	-1.89	1.02	3.46
7.	Sugar	5.20	2.38	4.33	7.27
8.	Chocolate	4.15	-0.50	2.40	1.26
9.	Margarine	-0.99	-8.60	-0.81	0.59
10.	Misc. food	4.07	1.17	3.67	1.34
11.	Distilling	n.c.	1.27	n.c.	8.26
12.	Malting	n.c.	-4.20	n.c.	6.26
13.	Brewing	3.56	-1.10	2.22	0.45
14.	Aerated	7.13	0.90	5.48	5.93
15.	Tobacco	1.63	-7.27	-2.73	-3.80
16.	Woollens	5.46	-1.72	4.20	3.23
17.	Linen	4.58	-3.27	2.87	2.13
18.	Jute	8.41	-6.30	5.17	-0.07
19.	Hosiery	8.55	4.47	7.70	3.66
20.	Boot & Shoe	1.78	-6.13	0.98	-2.34
21.	Men & Boys	2.76	-2.35	2.40	0.26
22.	Shirtmaking	-0.47	-6.46	-0.88	-4.58
23.	Womens & Girls	3.41	-4.04	3.25	-0.33
24.	Misc. clothing	5.58	1.47	4.75	1.94
25.	Madeup textiles	4.65	-0.71	3.75	-6.44
26.	Wood (ex. furniture)	4.12	-2.92	3.67	-1.82
27.	Furniture	1.39	-6.09	1.16	-4.56
28.	Paper	6.01	2.85	5.35	5.35
29.	Printing	1.70	-1.63	1.12	-1.97
30.	Fellmongery	3.48	-1.90	2.51	2.38
31.	Leather	1.83	-1.44	1.53	-0.87
32.	Fertiliser	3.76	-1.80	1.13	-5.07
33.	Oils	5.49	-1.10	3.52	1.82
34.	Chemicals	6.27	-6.14	-2.90	-5.71
35.	Soap	2.59	-0.51	0.51	3.30
36.	Glass	1.94	-8.47	-0.98	2.66
37.	Clay, cement	4.35	-1.81	2.22	4.30
38.	Metals	3.40	-3.91	1.27	-0.43
39.	Mach (ex electric)	-1.10	-5.74	-3.18	-4.40
40.	Electric mach.	1.11	-3.66	-0.68	1.31
41.	Ships	-1.75	-4.87	-2.45	-0.51
42.	Rail	-1.05	n.a.	n.a.	2.42
43.	Vehicles (mech)	-1.00	-1.88	-0.80	-3.19
44.	Vehicles (non-mech)	0.90	-6.99	0.00	-4.21
45.	Miscellaneous	3.47	-0.72	2.04	5.64

Source: Table 1

Note: r being the average rate of increase per cent per annum in added value at constant prices and r' the corresponding rate for any factor, the productivity for that factor $100\left[(1 + r/100)/(1 + r'/100) - 1\right]$, taken as (r-r'). For factor productivity See text.

Table 7: Cobb-Douglas functions: log added value (LY) regressed on log labour (LL) and log net capital stock (LK); correlation coefficients and regression functions.

Manufacturing Industry	Correlation coefficients			Regression coefficients		Regression functions		
	LY, LL	LY, LK	LL, LK	LL	LK	R	F	γ (tau)
1. Bacon	.53*	.93	.53*	0.28*	0.40	.93	25	4
2. Slaughtering	.99	.90	.92	1.42	-0.06*	.99	159	6
3. Butter	.98	.99	.99	-0.45*	0.93	.99	369	4
4. Canning	.60	.98	.51*	0.42*	0.79	.99	149	4
5. Grain milling	-.52*	.78	-.58*	-0.31*	0.49	.78	6	3+
6. Bread	-.05*	.94	-.20*	0.36*	0.42	.95	36	3+
7. Sugar	-.55*	-.19*	.09*	-0.47*	0.57*	.57	2*	6
8. Chocolate	-.72	.97	-.74	0.02*	0.86	.97	70	6
9. Margarine	.90	.84	.89	0.61	0.17*	.91	19	6
10. Misc. food	.97	.98	.94	0.71	0.62	.99	265	6
13. Brewing	-.33*	.94	-.18*	-0.51	0.70	.95	41	6
14. Aerated	.97	.99	.93	0.98	0.71	1.00	771	6
15. Tobacco	-.21*	.62	.05*	-0.64	0.16	.67	3*	4
16. Woollens	.24*	.97	.06*	0.45	0.77	.99	148	6
17. Linen	.10*	.07*	-.89	0.47*	0.56*	.38	1*	7
18. Jute	.90	.97	.80	1.70	0.42	.99	207	4
19. Hosiery	.87	.99	.87	0.09*	1.24	.99	341	2+
20. Boot and Shoe	.51*	-.02*	-.77	0.89	0.26	.77	6	5
21. Men's and Boys'	.40*	.89	.28*	0.47*	0.51	.90	17	3+
22. Shirtmaking	.85	.89	.94	0.13	0.23*	.89	16	4
23. Women's and Girls'	.26*	.69	.50*	-0.31*	0.50	.70	4*	7
24. Misc. clothing	-.05*	.77	.59*	0.34*	1.22	.83	9	6
25. Madeup textiles	.90	.97	.86	0.46*	0.67	.98	97	5
26. Wood (excl. furniture)	.77	.98	.83	-0.56*	0.73	.98	95	4
27. Furniture	.50*	.89	.40*	0.45*	0.21	.90	17	5
28. Paper	.95	.95	.85	2.45	0.89	.99	140	4
29. Printing	.97	.94	.86	1.12	0.29	.99	163	6
30. Fellmongery	-.49*	.74	-.86	0.67*	0.73	.79	6	2+
31. Leather	-.09*	-.21*	-.14*	-0.12*	-0.17*	.24	0*	4
32. Fertiliser	.89	.89	.99	-0.01*	0.57*	.89	16	4
33. Oils	-.31*	.96	-.21*	-0.66	1.23	.97	67	6
34. Chemicals	.94	.84	.93	2.57	-0.26	.95	39	3+
35. Soap	.15*	.63	.22*	0.02*	0.55	.63	3*	4
36. Glass	.95	.98	.97	-0.08*	0.47	.98	112	7
37. Clay, Cement	.99	.93	.94	2.14	-0.09*	.99	277	5
38. Metals	.92	.91	.97	1.36	0.14*	.92	23	4
39. Mach.(excl. electric)	.97	.96	.95	0.44	0.17*	.98	87	6
40. Elect. Mach.	.99	.94	.97	1.46	-0.10*	.98	96	4
41. Ships	.93	.83	.97	1.63	-0.60	.97	59	5
43. Vehicles (mech.)	.83	.71	.96	2.20	-0.89*	.90	17	5
44. Vehicles (non-mech.)	.67	.86	.76	0.04*	0.21	.86	12	6
45. Miscellaneous	.98	.98	.99	0.61*	0.56*	.98	87	3+

* Not significant at NHP = .05

+ Residual autoregression regarded as significant; one-sided NHP = .055 for 3 or fewer.

Note

Industries 11, 12 and 42 omitted, 11 and 12 because employment figures are dubious and 42 because net capital stock figures are missing.

given kinds and amounts. It is therefore more natural to regard labour and capital as functions of output of a particular kind than the other way about. Also the Cobb-Douglas implies substitutability (typically a unit elasticity of substitution) between labour and capital which must be true to only a very limited extent, and then only for a very large product-mix, change in capital/labour mix being due to product mix. And, in fact, Cobb-Douglas has been used mainly for national industrial aggregates. These have shown remarkably a tendency towards uniform results, lending prestige to this approach. If b_1 and b_2 are the coefficients of LL and LK, these results unforced often had $b_1 + b_2$ nearly unity, i.e. true to scale, often also with $b_1 \sim 0.75$ and $b_2 \sim 0.25$*

Often a time t term is introduced into the log form and termed "technology". This is unjustified. Usually in time series the variables are highly correlated and each with t itself. We here state three basic results of statistical theory and practice which crucially affect regression results and their interpretation. (a) From the Frisch-Waugh theorem the b_1 and b_2 in any regression having a time term t are exactly those which would be found on regression of the residues of the variables after allowing for t. (See, for example, Leser (1966) page 32.) Thus an improved formulation of the equation would be to regress the depvar on t and then use with b_1 and b_2 the residues of LL and LK after removal of the effects of regression of LL and LK on t. (b) In a correlated system of independent (explanatory) variables the individual regression coefficients are meaningless, except in the trivial case of statistically independent indvars (Geary, 1963). (c) In such a correlated system, small changes in indvars can cause large changes in coefficients (Leser, 1966, page 27).

The reason why most of the correlation coefficients are large in the first three columns of Table 7 (many in the .90s) is because in the short 11 year period most of the variables were rising in value. Most of the negative values were significantly different from zero. The (LY, LK) relationships were very much higher than the other two in LL, because LY and LK were rising steeply in 1963-1973. Half the regression coefficients of LL were not significantly different from zero; by the tests of F (or R) and r, most of the regression lines were good fits - but the time-period was short, so that the γ - test was insensitive.

The overwhelming impression is the variability of the coefficient system, not one of which conforms to the ideal system outlined above.

* To quote P. Douglas (1948) "The fact that on the basis of fairly wide studies there is an appreciable degree of uniformity, and that the sum of the exponents approximates to unity, fairly clearly suggests that there are laws of production which can be approximated by inductive studies and that we are at least approaching them." The actual function derived was $O^1 = 1.01\ K^{0.25}\ L^{0.75}$.

This is a routine exercise in OLS regression which gives little economic information.

Exactly the same operations were carried out by computer as in Table 7, but with fuel taking the place of net capital stock K, a proxy for capital in use. Table 8 compares the results. These were far

[Table 8]

better for net capital stock, for which bad relationships were less numerous (except one case) and good relationships more numerous.

Figures in the previous large tables may have given the impression of chaos. Table 9 shows that this is not the case. Eight of the c.c.s are high, over .60, two involving employment are much lower but significant at NHP = .05, to be expected because of the very much lower percentage increases for employment. The high c.c.s for expected output are somewhat artificial since this variable was constructed from employment and net capital stock.

[Table 9]

The low relationships for rates of unemployment and exports will come as a surprise. To a certain extent these may be due to statistical faults. The export figures are based on those of two years only of the eleven and concordance of production and export statistics was difficult; notoriously there has been a marked time lag for adjustment for description of last industry on UI books. Still, if the relationships were really strong they would be expected to transcend statistical faults. At any rate that familiar minor claim may be made: "the signs are right." The unemployment paradox may be partly due to successful industries attracting large labour pools, of people who get some work. The poor showing of the export industries requires investigation, having regard to the economic virtue attaching to this sector of the economy.

The computer programmes used by our advisors provided thousands of correlation coefficients, unplanned for by us. These consisted of c.c.s between every pair of basic values for the 45 (or slightly fewer)

Table 8. Comparison of results for K as net capital stock and as fuel

	K as net cap stock	K as fuel
Bad relationship (values insignificant at NHP = .05)		
Correlation coefficients	Number	
LY, LL	Identical at	17
LY, LK	4	11
LL, LK	15	8
Regression coefficients		
LL	17	25
LK	12	15
Regression functions		
R } F	5	8
Residual significance Υ	7	7
Good Relationship		
Correlation coefficients $\geq .95$		
LY, LL	Identical at	10
LY, LK	15	11
LL, LK	9	8
Regression coefficients $t \geq 3$		
LL	12	10
LK	20	14
Regression functions		
R, $\geq .95$	22	16
F ≥ 37	20	15
$\Upsilon \geq 6$	15	11

Table 9. Correlation coefficients between annual average rates of increase of five variables and average annual rates for unemployment and exports.

	1	2	3	4	5	6
1 Output						
2 Employment	.43					
3 Net capital stock	.67	.44				
4 Fuel	.67	.62	.71			
5 Expected output	.68	.78	.75	.79		
6 Unemployment	-.29	-.12*	-.22*	-.12*	-.18*	
7 Exports	.07*	.17*	.26*	.13*	.18*	.19*

* Not significant at NHP = .05

Note

All data relate to period 1963-1973. Units are 45 individual industries, sometimes a few missing through lack of data. See Table 1 for description of variables.

industries for each entity (output, employment etc.). Confronted with this prodigality we wondered how it would be put to use: it will be available to other researchers with better imaginations than ours.

Each c.c. was derived from 11 pairs of observations. Very many of the c.c.s were large (over .90) but with so few pairs this was obviously due mainly to the relationship of each of the pair to time t. But could there be relationships when allowance was made for t, upstream industries affected by change in downstream demand, sympathetic short term movements generally, like those of the stock exchange?

To test this, random samples of 20 industries were picked by number from the 45 and paired arbitrarily, the process continuing until we had 10 pairs each with c.c. from the output series, exceeding .60, this being the NHP = .05 level for 9 d.f. Our object was the partial c.c. between each of the ten random pairs with t constant, r (ij;t) in fact. This necessitated the calculation of r (it) and r (jt) for application of the well known partial formula. Following were the results:-

Table 10. Value of r (ij;t) for 10 random pairs from the output series.

i,j	r (ij;t)
3, 16	-.42
12, 16	-.14
18, 33	-.04
23, 26	-.38
16, 37	-.69
16, 29	.69
11, 35	-.40
5, 7	-.42
14, 26	.19
9, 34	-.22

For 8 d.f. the formal NHP = .05 point is .63 which does not mean that the pairs (16, 37) and (16, 29) above are significant, for this might occur with series of random numbers if these were numerous enough; formal NHP does not apply; we are in the domain of order significance. Anyway, industries numbered 16, 29, 37 are briefly described as woollens, printing and clay, cement, between which there could be no relationship. Elimination of the time element leaves no relationship between the variables.

Before embarking on this enterprize we made a reasonably close study of the recent literature on, or relating to, Irish manufacturing industry. It happens that this has received far more attention than any other sector of the economy, because the relevant statistics are more numerous, through CIP and the quarterly (now monthly) series. We did not expect to find close relationships between our work and these papers, because the latter dealt with specific problems, statistics used being selected for the particular purpose, while for us the statistics are of the essence, designed to raise the problems, rather than to answer them. We have propounded these problems throughout this paper. They are very general (even ranging outside statistics, e.g. quality of management) and statistical procedures. We think, however, that some very brief account of our study may be found interesting and useful to others.

The selected literature will be summarised under three themes: (i) the growth of real net output during 1963-1973 with related growth of exports and increasing productivity; (ii) the theoretical background of production functions; (iii) practical application of these theories to Irish data. The summaries are so brief as to be unfair to the authors. They are designed to show the areas they are in. Relationship to our results will be pointed out, where applicable, in square brackets.

(i) <u>The growth of Manufacturing output</u>

Kennedy and Dowling (1975) in their book <u>Economic Growth in Ireland, the Experience since 1947</u>, considered manufacturing in aggregate. They found that during 1961-1968 real net output grew at about 7 per cent per annum, but slowed down to 5 per cent for 1968-1972. Related employment grew at more than 2 per cent during the first period but slowed down to less than 1 per cent during the second period. Thus a slowing down of activity is apparent in the five years up to 1972. [Our Table 1 data for 1963-1973 show the simple average growth rate of gross output as 5.05 per cent per annum (assumed same as growth of net output) together with corresponding average growth rate of employment at 1.91 per cent per annum.]

Kennedy (1969) in his Statistical Society paper analysed longer-term differences among individual manufacturing industries in the growth of labour productivity. This latter was regressed on the growth rate of output. Results support the Verdoorn hypothesis that growth in productivity is positively associated with growth of output. Among possible contributing factors are mentioned exogenous technological progress, economic of scale, improved quality of labour, new and technologically improved capacity. [Our Table 6 results show a simple average growth rate of 3.07 per cent in labour productivity (as defined by us) versus our Table 3 simple average 5.05% growth rate of gross (and net) output. So we too find positive association between growth of labour productivity and growth of output.]

Farley (1972) considered explanatory hypotheses for Irish trade in manufactured goods in the mid-nineteen sixties. Among the main results were that aggregate 1964 exports were more labout-intensive than aggregate similar imports; they were also more capital-intensive. Aggregate export had a higher capital/labour ratio than aggregate similar imports. The results show Ireland as an exporter of goods dependent on unskilled labour and an importer of goods which incorporate skilled labour.

Farley (1981) examined outward-looking policies and the changing basis of Ireland's foreign trade. He used two tests to examine the changing factor content of Irish trade between the mid-1950s and the early 1970s. The results show that Ireland had a comparative advantage in primary goods over the period and developed advantages in labour-intensive manufactured goods. There was indication of the growing importance of electrical and mechanical skills and improvements in labour productivity in changing the basis of Irish trade.

(ii) The Theoretical background of production functions

Bridge (1971) in his textbook Applied Econometrics devoted chapter 6 to production functions. He concentrated on two main types of production function: (i) Cobb-Doughlas, (ii) CES, meaning constant electricity of substitution. Both functions express real value added as a function of capital and labour, with a possible time-trend exponential term to allow for technical progress. After reviewing a variety of numerical applications the author reaches fairly pessimistic conclusions: "These problems have been handled with considerable ingenuity, but it seems that little trust can be placed in the empirical results obtained. In none of the other fields we have reviewed has so little agreement occurred" (p. 395). [We have Cobb-Douglas functions expressed by the regression coefficients of Table 7. Because of the generally significant correlations between LL and LK, the explanatory (independent) variables, one must not expect their regression coefficients to show small variability; this has been pointed out on page 18 above. This aspect could explain widely varying coefficient values.]

Field and Grebenstein (1981) discussed more recent types of production function in their paper "Capital-energy substitution in U.S. manufacturing." These functions use as factors of production energy, labour, and one, or both, of fixed capital and materials used. To investigage substitution between capital and energy the authors apply a translog cost function to ten US 1971 manufacturing sectors. This cost function is one of constant returns to scale and is minimum unit production cost for four inputs, namely prices of physical capital, working capital, labour and energy. The authors conclude "There does seem to be a sufficiently strong pattern to warrant the conclusion that reproducible capital and energy are for the most part complements while working capital and energy are largely substitutes in production" (p. 211). [In the results summarised in Table 8 we use fuel as a substitute for fixed capital in use, with little success. By "substitute" we mean "in direct proportion to".]

(iii) Practical application of production function theory to Irish data

Five papers are summarised in what follows; except for Higgins (1981), there is exclusion of energy and materials used as factors of production.

Smyth and McMahon (1975) estimated short-run employment functions for the manufacturing sector, by using quarterly data 1959-1971 without seasonal adjustment. Besides total manufacturing, ten sub-groups (e.g. food) were analysed. They used the Cobb-Douglas production function having utilised capital and manhours of labour as explanatory variables, with a time-trend term for technical progress. Major assumptions were that output, capital stock and techniques of production are exogenous in the short-run. The model worked satisfactorily for total manufacturing and for six sub-groups. Results showed that the level of employment responds to output changes with a time lag, the speed of adjustment differing considerably from industry to industry.

Kirwan (1979) presented a recursive model of the short-run demand for workers and hours in Irish industry. Total manufacturing was treated in aggregate, with quarterly data for 1969-1977. The model consisted of two log-linear equations, one for numbers employed and one for total hours worked. The basic hypothesis to be tested was that the ratio of non-wage to standard wage costs exerts a negative influence on the numbers employed and a positive influence on the average levels of hours worked. Results suggest that hours adjust to accommodate short-term excess demand for employment and that non-wage costs of employment exert a significant negative effect on numbers employed.

Higgins (1981) considered four factor inputs (capital services, labour, material, fuel) in three sectors of the Irish food industry. The time period used was 1953-1973, with data mainly CIP annual and quarterly. In the paper the degree of substitution between capital services, labour, material and fuel was estimated for each of the three sectors, as well as the responsiveness of these inputs to price changes. A set of nine equations was estimated, based on partial derivatives of a translog cost function. Results showed that capital and labour are strong substitutes in production as are capital and fuel. Labour and fuel are complements. Labour and materials are weak substitutes. "In general it can be concluded that in none of the three sectors is the technology of production consistent with the commonly used Cobb-Douglas or CES production functions. Capital and labour are strong substitutes in all three industrial groups and the price elasticity of demand for labour in relatively large ... The effect of technical change on labour demand varies across the three sectors" (p. 263). [In our Table 7 analysis we find significant correlations between labour and capital for 2 of the 3 sectors involved (industries 1-3); our arguments therefore against the validity and stability of individual coefficients apply to 2 of the 3 industries being analysed.

Boyle and Sloan (1982) examined the demand for labour and capital inputs in Irish manufacturing during 1953-1973. Factor-demand functions were estimated for two types of labour and capital, for 40 industries. A translog demand function expressed value added in terms of gross capital stock (Vaughan), wage earners, salaried workers. The authors conclude that the two labour types cannot be consistently aggregated because they show different elasticities of substitution with capital stock. In a majority of industries capital is more complementary with non-production than with production workers. "The elasticity of substitution between wage-earners and capital was generally less than one and greater than the corresponding elasticity between salaried-workers and capital" (p. 153).

Farley (1982) analysed the functional distribution of income in Ireland's manufacturing sector during 1956-1973. The estimates of distributive shares were based on a series for net value added, which was calculated from data including CIP, input-output tables and Vaughan's capital stock. The analysis was of a statistical kind and no explicit use was made of an econometric model. Six sub-sectors of manufacturing were used. Net value added was defined to be net profits (excluding implicit wages of self-employed) plus wages etc. (including implicit wages of self-employed). The author concludes "The profit share in total manufacturing over the period has increased ... The mean profit share was .244 and this also met preconceptions for the period. In the US, for example, there has been a working assumption of a 75/25 share distribution and these results are fully consistent with that" (p. 120).

Conclusions

The major inferences to be drawn from our analysis can be summarised under six headings, as follows:

1. There is a wide range of growth-rates of values of every entity, even at a time usually regarded as of uniform growth, via the showing of

Table 1. One may therefore ask the question: to what extent is this country in the wrong industries? As part of any answer one must take into account developments since 1973, thus not covered by our analysis. One such development is the increased concentration on exports, whereby by 1980 is it estimated that two-thirds of manufacturing employment was occupied in production for exports. We may conclude that in recent years the production process must be reasonably efficient, in being able to sell in export markets, for some two-thirds of manufacturing employment. But the question remains as to whether the given output and exports are in any sense optimal, within the constraints imposed by existing markets and trading conditions.

2. Poor results might be due to poor management. The quality of Irish management seems to have received less attention than it deserves. The new director of IMI says there is much room for improvement and that his Institute must become "a relevant, practical, authentic agency which helps managers to cope with their problems and which does so in such a way that managers learn from it." Managers are relatively few in number but they are very important since it is on their ability that employment and its conditions depend. We recommend that statistical inquiries be undertaken to discover the main reasons for the large differences in output per manyear, to the extent that these differences are not clearly understood.

Also requiring investigation is the vast range (4:1) in output per person in firms in any given industry. Is this due to managerial efficiency, product range, luck or what? We don't know and we should.

3. Net capital stock has increased much more rapidly than output, which in turn has increased more rapidly than employment. Because use of fuel has increased only half as fast as net capital stock, we surmise that capital stock may be insufficiently used. Because the 1962-1973 period had fuel plentiful and cheap, there is little likelihood that the relatively slow growth of fuel demand was due to increasing economy in fuel use. The question therefore arises: was capital stock being

used wastefully in Ireland during the 1962-1973 period? If so, does this also hold for the post - 1973 period? For these questions also, some statistical inquiries or sample surveys might be necessary. The fact that capital stock grew faster than employment means a lower labour/output ratio at the end of the period than at the beginning, with correspondingly reduced employment (actual or potential) per unit of output. This latter aspect of increased productivity of labour may not be receiving the attention it deserves, in any discussion of national policies of increasing employment.

4. There are admittedly some questions posed to which we do not have answers. We think however that getting such answers is outside the scope of our present paper. Three main questions emerge from our analysis:

(i) If the growth of the export market is the main determinant of our industrial expansion, what is the optimal product-mix we should be striving to achieve (in terms of GDP and/or employment) and what are the real-world constraints on such an achievement (IDA and Coras Trachtala experience)?

(ii) Within a given industry (e.g. bacon factories) what explains the considerable variation in output per manyear? We can readily think of four contributary factors; (a) the quality of the product (old sows versus prime porkers for export), (b) the scale of production, (c) machinery and equipment per manyear, probably related to (b), (d) management plus marketing ability, meaning that the early bird catches the early worm. Trouble is that we now have no information on these factors and therefore we are unable to answer our question on variation in output per manyear.

(iii) Within each industry, to have capital/output ratios at establishment level, probably over some years, so as to establish more and less efficient use of capital stock. Some of this kind of information of course emerges in a firm's annual report, which includes written down values of fixed assets. We feel sure that this approach could yield criteria as to wasteful or efficient use of fixed capital. Here again we do not have detailed information so as to answer the question.

In conclusion, we think that our questions require considerable research, before answers can be supplied.

5. We have used the Cobb-Douglas approach to estimate output of each of the 45 manufacturing industries as depending jointly upon capital stock and labour, so as to yield a capital coefficient and a labour coefficient. Because our analysis is statistical we have applied basic theorems or principles of statistics to the design of our model and abided by the rules, in interpreting our results. According to one basic principle, a time trend term t is not justified as an explanatory (independent) variable, if both explanatory variables are themselves high correlated with t and (therefore) with each other. So we have not introduced such a time term t into our formulae. A further basic principle is that in a correlated system of independent variables the individual regression coefficients are meaningless, unless the indvars are themselves statistically independent of one another. In such a correlated system small changes in indvars can cause large changes in coefficients.

Our Table 7 results verify the relevance and implications of the above-mentioned statistical principles. The third column shows generally a highly significant correlation between the explanatory variables LL and LK. The R column shows generally high efficiency of fit, R^2 expressing the proportion of the variance of the dependent variable explained by the regression formula, and 29 values of $R \geq 0.9$. But the coefficient of LL shows wide variability, even to the extent of taking on negative values; the same can be said of the LK coefficient. There is no suggestion in the results of a tendency of the LK coefficient to the value 0.25, nor of a tendency of the LL coefficient to the value 0.75, as has in fact occurred at the level of national aggregates. The overwhelming impression is the variability of the coefficient system; to the extent that changes in indvars can cause large changes in coefficients the coefficient values shown in Table 7 are to be regarded as arbitrary. Another way in which high variability of such coefficients shows itself is in their large 95% or 99% confidence intervals, via their standard errors; this approach has not been followed here.

6. The literature we have surveyed finds results generally in agreement with ours, where points of similarity occur. There are of couse basic differences of approach: each of the books or papers performing statistical or economic analysis of much the same Irish data puts it in an economic setting, sometimes in considerable detail e.g. quarterly or monthly time series, whereas our analysis is mainly statistical, without economic analysis, with proposals for further investigation. But our analysis in one way is more detailed than that of the quoted literature: we have analysed each of the 45 manufacturing industries, whereas the literature generally has treated aggregated or grouped industries to a greater or lesser extent. At the end of each summary of a paper we point out any similarity with our results, or indeed any disagreements. One basic disagreement must be faced: some of the papers surveyed treat individual coefficients in a correlated system as if the indvars were independent; we have argued at some length above that this approach is not in accord with some of the fundamental theory of statistics. We are convinced that the point we are making may contribute to improved methodology of coefficient estimation, in future.

7. We hope the large painfully wrought tables 1, 4, 6, 7 will propound the right questions about particular industries and help to supply the answers.

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