Growth of Labour Productivity in Irish Manufacturing 1953-1967[1]

By KIERAN A KENNEDY

(*Read before the Society on 18 April, 1969*)

The main concern of this paper is with longer term differences among individual manufacturing industries in the growth of labour productivity and how such differences are associated with relative movements in output, labour earnings, unit costs and prices Certain relationships between the movements of these variables in Irish manufacturing industries will be examined and the results compared with similar work by other authors using data for other countries Particular emphasis will be laid on the strong positive association between the growth rates of productivity and output – what has now become known as the "Verdoorn Law" – and a brief explanation of this relationship is offered in the final section of the paper The starting point of the analysis is 1953 because from that year on consistent data are available for the relevant variables for forty-four individual manufacturing industries The terminal year is the latest year for which the data are available

Before going on to the individual industries, however, it may be helpful to examine briefly the overall rates of change in output and productivity as revealed by the data for total manufacturing and for ten groups of industries.

1 CHANGES IN OUTPUT AND LABOUR PRODUCTIVITY IN TOTAL MANUFACTURING AND IN TEN GROUPS

Total Manufacturing

From 1953 to 1967, the volume of output in manufacturing as a whole grew at an average annual rate of 4 7 per cent, employment grew by 1 5 per cent per annum, and output per head by 3 1 per cent per annum If allowance is made for changes in average hours, the average growth rate of labour productivity is somewhat higher at 3 4 per cent per annum

The growth rate of output from 1953 to 1967 is rather less than the growth rate of output over the whole of the post-war period, 1946 to 1967 However, the post-war period is by no means a homogeneous period and, in Table 1, I have divided it into three sub-periods, 1946-50, 1950-60 and 1960-67 While the volume of output in manufacturing as a whole had by 1946 recovered to the highest pre-war level, many individual industries were still well below pre-war levels The very rapid rates of growth of output and labour productivity in the years 1946 to 1950 must be seen as recovery from the effects of the war there was a release of pent-up demand, capital goods and materials not available for so long were becoming

[1] I gratefully acknowledge the help of my research assistant, Mr Brendan Dowling, who compiled most of the data on which this paper is based

available again, and there was a back-log of technological opportunities for application The growth rate of output tapered off in 1951 and in 1952 there was a fall in output Following recovery in 1953 output grew relatively slowly in 1954 and 1955 This was followed by a prolonged depression in 1956 and 1957 and although there was some recovery in 1958 the 1955 level was surpassed, in the case of output, only in 1959 and, in the case of employment, only in 1960

TABLE 1

AVERAGE ANNUAL PERCENTAGE RATES OF GROWTH IN IRISH MANUFACTURING

Period	Volume of Output	Employment	Output per Head
1946-50	10 8	5 4	5 1
1950-60	3 1	1 0	2 1
1960-67	6 2	2 2	3 9
1946-67	5 5	2 3	3 1

SOURCE Annual *Census of Industrial Production* (C I P) Reports and *Quarterly Industrial Production Inquiry* (Q I P), published in the *Irish Statistical Bulletin*, various issues Prior to 1953, indexes of production and employment in transportable goods industries were used, and were linked at 1953 with the manufacturing indexes

It will be seen from Table 1 that the growth rate of output achieved so far in the 1960s is twice as high as that achieved in the 1950s, while the growth rate of labour productivity is just less than twice as high [2]

Comparisons with other countries

Table 2 gives, *inter alia*, the growth rates of output, total man-hours (i e employment corrected for changes in average weekly hours), and output per man-hour in manufacturing industry in several countries covering, in general, the period 1953 to 1967 The countries are ranked in terms of output growth

[2] When allowance is made for changes in average weekly hours, the growth rate of labour productivity is just over twice as great in the 1960s as in the 1950s (4 3 per cent per annum as against 2 1 per cent per annum)

TABLE 2

AVERAGE ANNUAL PERCENTAGE RATES OF GROWTH IN TOTAL MANUFACTURING IN VARIOUS COUNTRIES, 1953-1967

Countries (ranked by output growth)	Volume or Output	Total Man-hours	Output per Man-hour	Average Hourly Earnings	Unit Wage Cost
1 Japan	14 0	5 3[3]	8 2[3]	8 1[3]	0 0
2 Israel[1,2]	10 0	5 2[3]	4 6[3]	10 3[3]	5 4
3 Italy	8 3	2 1	6 1	6 9	0 8
4 West Germany[2]	7 3	2 3	4 9	8 0	3 0
5 Austria[2]	6 9	1 8	5 0	7 2	2 1
6 France	6 7	0 8	5 9	7 4	1 4
7 Finland	6 3	0 7	5 6	7 0	1 3
8 Netherlands	6 0	1 0[3]	5 0[3]	8 3	3 1
9 Norway	5 4	1 0[3]	4 3[3]	6 9	2 5
10 Belgium	5 1	1 0[3]	4 1[3]	5 5[3]	1 3
11 **Ireland**	**4 7**	**1 3**	**3 4**	**6 4**	**2 9**
12 Canada	4 6	1 4	3 2	3 9[4]	0 7
13 United States	3 9	0 8	3 1	3 4	0 3
14 United Kingdom[2]	3 5	0 6	2 9	6 2	3 2

[1] Starting year 1955
[2] End year 1966, since output declined in 1967
[3] Data relate to employment, output per head and earnings per head, respectively
[4] Data relate to 1953-66

SOURCES C I P and Q I P for Ireland For other countries, United Nations, *Monthly Bulletin of Statistics*, various issues Data on weekly earnings for the United Kingdom taken from *The British Economy Key Statistics* 1900-1966 (London and Cambridge Economic Service) and corrected for changes in weekly hours Prior to 1960, the growth rates of employment in both Italy and Canada were considerably lower, for no obvious substantial reason, on the basis of U N sources than on the basis of O E C D sources (i e *General Statistics*) A compromise was adopted here by taking the simple average of the average annual growth rates of employment over the whole period derived from the two sources and allowing for changes in average hours

As may be seen from Table 2, the Irish performance over the period 1953 to 1967 does not compare favourably with that of most of the other countries Out of the fourteen countries in the table, Ireland ranks eleventh in regard to both output growth and productivity growth A radically different picture, in regard to output growth in particular, emerges from Table 3 which shows, *inter alia*, the growth rates of manufacturing output, employment and productivity in various countries from 1960 to 1967 The countries are again ranked by output growth and four additional countries are added which were not included in Table 2 due to lack of data

Among the eighteen countries in Table 3, Ireland ranks seventh in terms of output growth and twelfth in terms of productivity growth In

relation to the fourteen countries in Table 2, Ireland's output rank has improved in the more recent period from eleventh to fifth, and the productivity rank from eleventh to ninth [3] This improved performance is all the more remarkable in view of the fact that the United Kingdom, which provides our main export market, has the lowest rank for output growth in Table 3 as well as in Table 2

TABLE 3

AVERAGE ANNUAL PERCENTAGE RATES OF GROWTH IN TOTAL MANUFACTURING IN VARIOUS COUNTRIES, 1960-1967

Countries (ranked by output growth)	Volume of Output	Total Man-hours	Output per Man-hour	Average Hourly Earnings	Unit Wage Cost
1 Japan	13 2	4 2[3]	8 6[3]	10 6[3]	1 8
2 Israel[1]	11 4	5 8[3]	5 2[3]	12 3[3]	6 7
3 Spain	11 4	4 4[3]	6 7[3]	n a	n a
4 Greece[2]	8 4	2 2[3]	6 1[3]	8 9[3]	2 6
5 Italy	7 7	1 3	6 3	9 1	2 6
6 Canada	6 5	2 9	3 5	4 0[4]	0 5
7 **Ireland**	**6 2**	**1 8**	**4 3**	**8 0**	**3 5**
8 Sweden	6 1	0 0[3]	6 1[3]	7 1	0 9
9 Finland	5 8	0 1	5 7	8 4	2 6
10 United States	5 7	2 4	3 2	3 3	0 1
11 Norway	5 6	0 5	5 1	7 3	2 1
12 Netherlands	5 4	−0 6	6 0	9 8	3 6
13 France	5 3	0 3	5 0	7 1	2 0
14 West Germany[1]	5 1	0 5	4 6	9 1	4 3
15 Belgium	5 0	1 4[3]	3 5[3]	7 7[3]	4 1
16 Switzerland	4 6	1 0	3 6	7 5	3 8
17 Austria[1]	4 2	0 2	4 0	8 4	4 2
18 United Kingdom[1]	2 9	−0 4	3 3	6 6	3 2

n a means not available

[1] End year 1966 since output declined in 1967

[2] Data relate to 1961-67

[3] Data relate to employment, output per head and earnings per head, respectively

[4] Data relate to 1960-66

[3] The fact that Ireland's productivity rank improved less than the output rank may be due to the fact that we are still catching up on the relatively low productivity growth in 1965 and 1966 This is borne out by the very high productivity growth in relation to output growth evident in the figures so far available for 1968, covering the first three quarters

SOURCES C I P and Q I P for Ireland For most other countries data taken from United Nations, *Monthly Bulletin of Statistics*, various issues Data on volume of output for Greece, Spain, Sweden and Switzerland from O E C D , *Industrial Production Historical Statistics* 1957-1966 Data on weekly earnings for the United Kingdom taken from *The British Economy Key Statistics* 1900-1966. *op cit* , and corrected for changes in weekly hours

It would take me too far afield in the present paper to enter into a cross section analysis of the country data, but it may be of interest to comment briefly on the associations between certain variables in Tables 2 and 3, which include, as well as the figures on output and labour productivity, data on changes in average hourly earnings and unit wage cost Table 4 gives the rank correlation coefficient (Spearman's rho) between a number of the variables the figures not in brackets are based on the data in Table 2 (1953-1967), while the figures in brackets are based on the data in Table 3 (1960-1967)

TABLE 4

COEFFICIENTS OF RANK CORRELATION (RHO) BETWEEN CERTAIN VARIABLES IN TABLES 2 AND 3[1]

	Volume of Output	Total Man-hours	Output per Man-hour	Average Hourly Earnings	Unit Wage Cost
Volume of Output		0 73 (0 70)	0 85 (0 68)	0 80 (0 39)	−0 02 (−0 36)
Total Man-hours	0 73 (0 70)		0 39 (0 13)	0 48 (0 16)	
Output per Man-hour	0 85 (0 68)	0 39 (0 13)		0 68 (0 68)	−0 24 (−0 10)
Average Hourly Earnings	0 80 (0 39)	0 48 (0 16)	0 68 (0 68)		0 42 (0 56)
Unit Wage Cost	—0 02 (−0 36)		—0 24 (−0 10)	0 42 (0 56)	

[1] Figures not in brackets relate to the data in Table 2 (1953-1967) and are based on fourteen observations for each correlation coefficient Figures in brackets relate to Table 3 (1960-1967) and are based on eighteen observations for all coefficients except those involving hourly earnings and unit wage cost, only seventeen observations being available for the latter two variables

Significance of rank correlation coefficients

N	0 05 Level	0 01 Level
14	0 54	0 72
17	0 49	0 64
18	0 48	0 63

It emerges clearly from Table 4 that, in so far as manufacturing industry is concerned, countries with the highest rates of growth of output also tend to achieve the highest rates of growth of both labour input *and* labour productivity The coefficient of rank correlation between the growth rates

of output and productivity is 0 85 for the data in Table 2 and 0 68 for the data in Table 3, both coefficients being significant at the 1 per cent level The Verdoorn Law regarding the longer-term relationship between the growth rates of output and productivity is explained later on, and in this paper I will concentrate mainly on Verdoorn's Law in relation to different industries in the same country For the record, however, the Verdoorn coefficient (i e the coefficient of the output growth rate in the regression of the productivity growth rate on the output growth rate) is given in Euqations (1) and (2) for the data in Tables 2 and 3, respectively,

$$P^* = 1\ 71 + 0\ 457Q \qquad (0\ 075) \qquad r = 0\ 87 \tag{1}$$

$$P^* = 2\ 41 + 0\ 394Q \qquad (0\ 088) \qquad r = 0\ 74 \tag{2}$$

where P*, Q are the average annual growth rates of output per man-hour and of output, respectively [4]

It will also be noticed in Table 4 that countries with the most rapid rates of growth of output tended to have the fastest rates of increase in average hourly earnings For the fourteen countries over the period 1953-1967 the rank correlation coefficient is 0 80, significant at the 1 per cent level, but in the more recent, shorter period and with inclusion of three additional countries the correlation coefficient (0 39), though positive, is not significant at the 5 per cent level The productivity growth rates are positively and significantly correlated with the growth rates of average hourly earnings in both periods moreover, as is obvious from Tables 2 and 3, there is considerable variation among countries in the growth rates of average earnings We shall see later that neither of these two findings is replicated for data relating to different industries within a country

Most surprising of all, perhaps, is the fact that there is scarcely any negative correlation at all over the longer period, and in neither period any *significant* negative correlation, between the growth rates of output and unit wage cost If the extreme case of Israel, which from many points of view may be regarded as exceptional, is excluded, the rank correlation coefficient for the more recent period becomes significant at the 5 per cent level, but the correlation for the longer period remains negligible It would be rash, on the basis of these figures alone, to jump to the conclusion that relative reductions in unit wage cost are not important for achieving growth before any such conclusion could be justified it would be necessary also to take into account movements in unit wage cost in other sectors, degree of foreign trade dependence and so on Moreover, changes in Ireland's unit labour cost relative to the United Kingdom are probably much more important to growth here than changes relative to other countries in general Nevertheless, I feel that the relation between changes in unit labour cost and growth is more complex than is generally supposed and needs to be worked out more thoroughly

[4] These results are similar to those obtained by Kaldor (1966) for total manufacturing in twelve countries over the period 1953/54 to 1963/64 Full references to the work of authors mentioned in the text or in the footnotes are given at the end of the paper

Productivity change in total manufacturing due to inter-industry shifts

Productivity may rise (fall) in total manufacturing even if there were no change in productivity in any individual industry provided that the industries with relatively high levels of productivity increased (reduced) their share in total manufacturing employment The inter-industry shift component, as it is known, is most notable in the case of the shift of workers out of low productivity agricultural production into relatively high productivity industrial production It is of interest to see how much, if any, of the rise in productivity in Irish manufacturing as a whole from 1953 to 1967 can be accounted for by inter-industry shifts in employment shares among individual manufacturing industries A little algebra is helpful in showing how the inter-industry component can be measured and the symbols used are as follows

- X, X_i, level of output in total manufacturing and in the ith industry respectively,
- L, L_i, level of employment in total manufacturing and in the ith industry, respectively,
- P, P_i, level of productivity in total manufacturing and in the ith industry, respectively, where productivity is defined as output per head,
- w_i, share of ith industry in total manufacturing employment,
- v_i, share of ith industry in total manufacturing output

Superscripts 0 and 1 relate to the beginning and end years, respectively.

$$P = \frac{X}{L}$$

$$= \Sigma \frac{X_i}{L_i} \frac{L_i}{L}$$

$$= \Sigma w_i P_i$$

The change in productivity in manufacturing as a whole between the beginning and end years (ΔP) can be broken down as follows

$$\Delta P = \Sigma w_i^{\circ} \Delta P_i + \Sigma P_i^{\circ} \Delta w_i + \Sigma \Delta P_i \Delta w_i$$

Dividing by P°, we get

$$\frac{\Delta P}{P^{\circ}} = \frac{\Sigma w_i^{\circ} \Delta P_i}{P^{\circ}} + \frac{\Sigma P_i^{\circ} \Delta w_i}{P^{\circ}} + \frac{\Sigma \Delta P_i \Delta w_i}{P^{\circ}}$$

The percentage change in productivity in manufacturing as a whole has now been divided into three components The first, usually called the *intra-industry* component, represents the change in productivity in total manufacturing (as a proportion of productivity in manufacturing in the first year) that would arise as a result of the actual productivity changes in the individual industries on the assumption of unchanged employment shares The second component, the *inter-industry* component, represents the change in productivity in total manufacturing that would arise as a

result of the actual changes in employment shares on the assumption of unchanged productivity in every individual industry The third component, which may be called the *interrelations* component, shows the residual effect of combined changes in productivity and in employment shares

To simplify the calculations, it can readily be shown that the intra-industry and inter-industry components may be re-written as follows

$$\text{Intra-industry component} \quad \frac{\Sigma w_1^{\circ}\,\Delta P_1}{P^{\circ}} = \Sigma v_1^{\circ}\frac{\Delta P_1}{P_1^{\circ}}$$

$$\text{Inter-industry component} \quad \frac{\Sigma P_1^{\circ}\,\Delta w_1}{P^{\circ}} = \frac{\Sigma v_1^{\circ}\dfrac{L_1^1}{L_1^{\circ}}}{\dfrac{L^1}{L^{\circ}}} - 1$$

In words, the intra-industry component may be calculated by weighting the percentage changes in productivity in the individual industries by their respective shares in output in the first year The inter-industry component may be calculated by dividing the unweighted employment index for total manufacturing into a weighted employment index, using the industry output shares in the first year as weights, and subtracting unity The interrelations component can then simply be measured residually

The size of the inter-industry component will vary depending on the size of the breakdown of total manufacturing into individual industries In making the calculations, the results of which are presented in Table 5, I have used the 44 individual industries which are considered in the next section The output weights used were the net output shares in 1953 and productivity growth is measured as the change in volume of output per head

TABLE 5

PRODUCTIVITY CHANGE IN IRISH MANUFACTURING AS A WHOLE, 1953-1967, DIVIDED INTO INTRA-INDUSTRY, INTER-INDUSTRY AND INTERRELATIONS COMPONENTS

	%
Intra-industry component	49 6
Inter-industry component	1 0
Interrelations component	3 3
Total productivity change	53 9

As is clear from Table 5, scarcely any of the rise in productivity was due to the inter-industry effect, and this indicates that, on balance, there was only a slight tendency for industries with high *levels* of productivity to have

TABLE 7

AVERAGE ANNUAL PERCENTAGE RATES OF GROWTH OF VOLUME OF OUTPUT, LABOUR PRODUCTIVITY, UNIT COSTS, PRICES, ETC., IN IRISH MANUFACTURING INDUSTRIES, 1953-1966

Industries (ranked by output growth)	(1) Volume of Output	(2) Employment	(3) Output per Head	(4) Total Man-hours	(5) Output per Man-hour	(6) Salaries and Wages per head	(7) Salaries and Wages per Man-hour	(8) Unit Labour Cost	(9) Unit Gross Margin Cost	(10) Unit Materials Cost	(11) Unit Net Price	(12) Unit Gross Price	(13) Unit Gross Price (incl. certain duties)
1. Electrical machinery	15.2	9.3	5.4	9.3	5.3	5.8	5.7	0.4	5.5	0.4	2.9	1.4	1.4
2. Chemicals, drugs	13.1	5.3	7.4	5.3	7.4	6.3	6.3	-1.0	4.7	2.2	2.9	2.6	2.6
3. Micellaneous manufacturing	11.7	4.7	6.7	4.3	7.1	6.8	7.2	0.1	4.8	5.4	2.5	4.2	4.2
4. Fertilizers	11.0	5.6	5.1	5.1	5.6	5.3	5.7	0.1	4.5	1.0	2.2	1.3	1.3
5. Metal trades	8.9	4.0	4.8	3.7	5.0	6.5	6.8	1.7	2.0	2.3	1.8	2.1	2.1
6. Non-electrical machinery	8.5	3.9	4.4	3.4	4.9	5.5	6.0	1.0	7.1	4.3	3.5	3.9	3.9
7. Slaughtering, meat preparation	7.9	6.2	1.6	6.5	1.3	6.6	6.4	5.0	-0.6	2.4	3.9	2.6	2.6
8. Linen, cotton	7.8	2.4	5.3	1.6	6.1	7.7	8.5	2.3	-0.2	-0.7	1.1	0.0	0.0
9. Structural clay and cement	7.8	3.2	4.4	2.8	4.9	6.3	6.8	1.8	4.0	0.7	3.0	1.8	1.8
10. Made-up textiles	7.5	3.2	4.2	3.0	4.4	5.5	5.7	1.2	1.9	1.4	1.5	1.5	1.5
11. Miscellaneous food (incl. fish)	6.9	8.0	-1.1	7.7	-0.8	5.0	5.3	6.2	6.1	0.8	6.1	2.2	2.2
12. Jute, canvas, miscellaneous textiles	6.6	2.4	4.0	2.0	4.4	6.6	7.0	2.5	0.8	1.1	1.5	1.2	1.2
13. Hosiery	6.4	1.3	5.1	0.9	5.4	6.0	6.4	0.9	-0.7	-0.4	0.6	0.0	0.0
14. Glass, glassware, pottery	6.2	2.8	3.3	2.5	3.6	6.7	7.0	3.3	8.1	0.9	5.0	3.5	3.5
15. Paper	6.0	1.6	4.3	1.4	4.5	6.7	6.9	2.3	1.3	0.8	1.8	1.2	1.2
16. Assembly of mechanical road vehicles	5.4	3.3	2.0	2.8	2.5	5.2	5.7	3.1	3.8	2.9	3.4	3.0	3.0
17. Clothing: women's and girls'	5.2	1.0	4.2	0.8	4.4	5.8	6.0	1.5	4.8	0.7	2.8	1.6	1.6
18. Mineral waters	5.1	0.3	4.8	0.2	5.0	5.8	5.9	1.0	4.2	1.3	2.8	2.3	2.3
19. Ship and boat building	4.7	4.8	-0.1	4.6	0.1	5.4	5.6	5.5	16.6	8.1	8.1	8.1	8.1
20. Butter, cheese, edible milk products	4.5	2.1	2.4	1.8	2.7	5.9	6.2	3.5	0.8	0.0	1.9	0.3	0.3
21. Leather manufactures	4.3	2.4	1.9	1.8	2.4	6.5	7.1	4.6	8.5	3.3	6.1	4.6	4.6
22. Clothing: shirtmaking	4.2	1.3	2.9	1.0	3.2	5.1	5.5	2.2	4.4	2.8	3.1	2.9	2.9
23. Woollen and worsted	4.2	1.6	2.5	1.1	3.0	5.9	6.4	3.3	3.3	-0.9	3.3	0.4	0.4
24. Oils, paints, inks, polishes	3.8	1.5	2.3	1.3	2.5	5.2	5.4	2.9	4.7	-0.1	4.0	1.0	1.0
25. Printing, publishing	3.6	0.8	2.8	1.2	2.4	6.4	6.0	3.6	4.5	2.7	3.9	3.5	3.5
26. Boot and Shoe	3.3	-0.4	3.7	-0.7	4.0	5.2	5.5	1.5	3.7	-0.9	2.3	0.6	0.6
27. Clothing: miscellaneous	2.7	0.5	2.2	0.3	2.4	6.2	6.5	4.0	-0.1	1.5	2.5	2.0	2.0
28. Wood, cork	2.6	-1.6	4.3	-1.9	4.6	5.8	6.1	1.4	5.5	-0.7	2.7	0.5	0.5
29. Furniture, brushes and brooms	2.6	-0.2	2.8	-0.3	2.9	5.4	5.5	2.5	2.1	2.3	2.4	2.3	2.3
30. Soap, detergents, candles	2.5	0.7	1.8	0.3	2.2	6.4	6.7	4.4	2.8	1.5	3.7	2.2	2.2
31. Assembly of non-road vehicles	2.5	4.2	-1.6	4.5	-1.9	7.6	7.3	9.4	0.8	2.1	7.7	4.7	4.7
32. Fellmongery, tanning	2.3	0.0	2.3	-0.2	2.5	6.1	6.3	3.8	2.4	1.4	3.1	1.8	1.8
33. Bacon	2.2	2.1	0.1	1.7	0.5	5.1	5.5	5.0	0.5	0.2	2.7	0.5	0.5
34. Canned fruit and vegetables, jams etc.	2.0	2.6	-0.6	2.5	-0.5	5.7	5.8	6.3	2.9	2.0	4.4	2.8	2.8
35. Margarine	1.9	-0.9	2.9	-0.7	2.7	6.0	5.8	3.0	4.4	-0.2	4.0	0.8	0.8
36. Grain milling, animal feeding stuffs	1.8	-0.2	2.0	-0.3	2.1	5.8	5.9	3.8	5.0	0.9	4.5	1.4	1.4
37. Malting	1.7	-1.8	3.5	-1.4	3.1	6.2	5.8	2.6	2.1	-1.6	2.4	-0.3	-0.3
38. Brewing	1.1	0.6	0.5	0.8	0.3	6.5	6.3	5.9	4.8	-1.8	5.2	2.6	3.3
39. Distilling	0.9	-0.8	1.6	-1.5	2.4	4.4	5.2	2.8	11.5	-1.8	6.7	2.3	3.2
40. Sugar, cocoa, sugar confectionery	0.2	-0.6	0.7	-1.4	1.5	5.8	6.6	5.0	3.6	-0.4	4.3	0.9	0.9
41. Bread, biscuits, flour confectionery	0.1	-0.7	0.7	-0.8	0.9	5.9	6.0	5.1	3.7	3.4	4.5	3.9	3.9
42. Clothing: men's and boys'	-0.6	-1.0	0.5	-1.3	0.7	5.3	5.5	4.8	6.7	3.1	5.4	4.1	4.1
43. Tobacco	-1.5	-1.6	0.1	-2.0	0.5	6.8	7.3	6.7	6.7	4.5	6.7	5.25	5.35
44. Railroad equipment	-5.0	-3.5	-2.6	-4.1	-2.0	5.0	5.7	7.8	13.0	2.0	8.0	6.0	6.0
Total Manufacturing	4.4	1.6	2.8	1.3	3.1	6.0	6.2	3.1	3.9	0.9	3.5	1.7	1.5

SOURCE: C.I.P. Reports.

NOTES TO TABLE 7

Col. 2: "Persons engaged" as defined in the C.I.P.

Col. 4: Employment adjusted for changes in average weekly hours worked by wage-earners in a week in October. For the Malting industry the average of the hours worked in a week in each quarter in 1953 and 1966 was used.

Col. 6: Derived by dividing index of annual salaries, wages and earnings by index of employment and calculating the average annual growth rate.

Col. 7: Index of annual salaries, wages and earnings divided by index of total man-hours.

Col. 8: Index of annual salaries, wages and earnings divided by index of volume of output.

Col. 9: Index of value of remainder of net output divided by index of volume of output.

Col. 10: Index of value of materials, fuel, containers, etc., divided by index of volume of output. Customs duties on tobacco were excluded from the value of materials for the Tobacco industry and for total manufacturing.

Col. 11: Index of value of net output divided by index of volume of output. As explained in the text, this represents an accurate estimate of the true implicit net output price only on the basis of a rather restrictive assumption.

Col. 12: Index of value of gross output divided by index of volume of output. Duties on tobacco were excluded from the value of gross output for that industry and for total manufacturing. See Appendix 2 regarding the inappropriateness of the estimate of the change in the unit gross price for *total manufacturing*..

Col. 13: Index of value of gross output, including the customs duties on the Tobacco industry and the excise duties on Brewing and Distilling, divided by index of volume of output. The final sentence of the notes to column 12 applies here also.

above-average increases in employment In particular, the falling share in total employment of the drink and tobacco industries – industries with a much higher than average level of net output per head – was an important factor in diminishing the size of the productivity increase that might otherwise arise in this way [5]

Growth of output and productivity in ten Irish manufacturing groups

The Central Statistics Office divide manufacturing into ten broad groups and Table 6 gives the growth rates of output, employment and output per head in these ten groups over the period 1953 to 1967, the groups being ranked by output growth

TABLE 6

AVERAGE ANNUAL PERCENTAGE RATES OF GROWTH IN TEN IRISH MANUFACTURING GROUPS, 1953-1967

Groups (ranked by output growth)	Volume of Output	Employment	Output per head
1 Other manufacturing	10 0	3 6	6 2
2 Chemicals	9 6	3 8	5 6
3 Clay products, glass, cement, etc	7 6	3 0	4 4
4 Metals, engineering	7 3	3 5	3 6
5 Textiles	5 5	2 0	3 5
6 Paper, printing	4 8	1 0	3 8
7 Clothing, footwear	3 1	0 1	3 0
8 Food	2 4	0 8	1 6
9 Wood and furniture	2 3	−1 0	3 4
10 Drink, tobacco	1 1	−0 1	1 2
Total Manufacturing	4 7	1 5	3 1

SOURCE C I P reports and Q I P

Table 6 reveals that there are considerable differences among the groups in the movements of all three variables Five groups (i e Other Manufacturing, Chemicals, Clay Products, etc , Metals and Textiles), each of which at least doubled its output from 1953 to 1967, had growth rates of output well above the rate for total manufacturing On the other hand, there were four groups (i e Clothing, Food, Wood and Drink and Tobacco), with growth rates of output well below the rate for total manufacturing The remaining group (i e Paper) had a growth rate of output almost identical with that for total manufacturing

It will also be noticed from Table 6 that the five groups with rapid output growth all had growth rates of employment *and* labour productivity above the corresponding rates for total manufacturing, while the four slowly-growing groups all had (with the exception of the Wood and Furniture group) growth rates of employment and productivity below the

[5] I have shown elsewhere (Kennedy (1968)) that an important factor in explaining the low productivity growth in Irish industry in the pre-war period as the productivity-reducing nature of the inter-industry shifts due in particular to the large fall in the share of the Brewing industry in total employment

corresponding rates for total manufacturing Thus groups with the highest rates of growth of output tend to achieve also the highest rates of growth of both employment and labour productivity The coefficient of correlation (r) between the output growth rates and the employment growth rates is 0 94 and that between the output growth rates and the productivity growth rates is 0 91, both coefficients being significant at the 1 per cent level [6]

A strong positive association between the *long term* growth rates of output and productivity – in manufacturing industries in particular, but also in certain other industries – has been observed by numerous writers in data relating to a number of countries and to different time periods [7] Verdoorn, writing as long ago as 1949, was one of the first to draw attention to this association and he went further than most writers by advancing the bold hypothesis that the elasticity of labour productivity with respect to output (i e the regression coefficient of the logarithm of the output index, when the logarithm of the productivity index is regressed on the logarithm of the output index) is stable Specifically, Verdoorn concluded from an examination of long term historical series for total industrial production and for individual industries in a number of countries that the average value of the elasticity of labour productivity with respect to output was about 0 45 and that the extreme lower and upper limits of the elasticity were, respectively, 0 41 and 0 57 Putting the matter more simply, the "Verdoorn Law" states that, over the longer term, the growth rates of labour productivity and output will be highly and positively correlated, and that a one percentage point increase in the output growth rate will be accompanied by slightly less than an 0 5 percentage point increase in the growth rate of labour productivity and slightly more than an 0 5 percentage point increase in the employment growth rate

To test the Verdoorn hypothesis for the Irish data in Table 6, the growth rates of labour productivity and employment have been separately regressed on the growth rate of output The results are given in Equations (3) and (4), the standard errors of the regression coefficients being given in brackets

$$P = \underset{(0\ 074)}{1\ 24 + 0\ 445Q} \qquad r = 0\ 91 \tag{3}$$

$$L = \underset{(0\ 066)}{-1\ 12 + 0\ 520Q} \qquad r = 0\ 94 \tag{4}$$

where Q, L and P are the average annual growth rates of output, employ-

[6] The possibility that the correlation between changes in output and productivity might be spurious, for a number of possible reasons, has been fully explored by Salter (1960), and decisively rejected by him, *op cit*, pp 109-113 See also the discussion by Geary and Pratschke (1968), pp 13-14, in regard to the correlation of changes in output and unit price

[7] *Vide* Kaldor (1966), Kendrick (1961), Lomax (1959), Lomax (1964), Maddison (1955), Nicholson and Gupta (1960), Reddaway and Smith (1960), Reddaway (1966), Salter (1960) and Verdoorn (1949) A review of the empirical literature on the subject is given in Kennedy (1968)

ment and productivity respectively

These regressions suggest that, apart from an average annual increase in labour productivity of a little over 1 per cent per annum even if there were no change in output, every one percentage point addition to the growth rate of output is accompanied by just under a one-half percentage point increase in the growth rate of productivity (or just over a one-half percentage point increase in the growth rate of employment) The regression coefficients, which are highly significant, are very close to the figures mentioned by Verdoorn In the final section of this paper I shall briefly discuss the explanation of this relationship when the data relating to the individual industries have been examined Here I wish only to emphasise that my concern is with the longer term association and not with the positive association that may exist between short-term cyclical movements in output and productivity The causes of the latter phenomenon lie in such matters as changes in the degree of utilisation of capacity and of overhead labour, short term lags in employment changes behind output changes, and so on Such factors can play only an insignificant role in explaining the longer term relationship

Dividing the period 1953-1967 at 1960, the regression equations, corresponding to (3), for the two sub-periods 1953-60 and 1960-67 are given in Equations (3a) and (3b), respectively

$$P=1\ 39+0\ 445Q \qquad (0\ 099) \qquad r=0\ 85 \tag{3a}$$

$$P=0\ 82+0\ 478Q \qquad (0\ 097) \qquad r=0\ 87 \tag{3b}$$

where Q, P are the average annual rates of growth of volume of output and labour productivity, respectively

The stability of the regression coefficient in the two sub-periods, that differ in many ways, is noteworthy [8]

2 CHANGES IN OUTPUT, PRODUCTIVITY, UNIT COSTS AND PRICES IN INDIVIDUAL IRISH MANUFACTURING INDUSTRIES

Table 7 gives data on the average annual rates of growth of volume of output, labour input, labour productivity, average earnings, unit costs and unit prices from 1953 to 1966 for manufacturing industry divided into forty four individual industries based on the data in the Census of Industrial Production Definitions of certain variables, the meaning of which may not be clear, are given in notes to the table The year 1966 has

[8] The smaller intercept in the second sub-period may seem surprising but it is mainly explained by changes in average weekly hours There was practically no change in average weekly hours in total manufacturing in the first sub-period as against a fall of 0 45 per cent per annum in the second sub-period As will be seen later in the case of the individual industries, the difference between the output per head and output per man-hour measures of productivity would affect mainly the intercept since there is a broad similarity in the movements of average hours in most groups

been chosen here as the terminal year because it is the latest year for which all the relevant data is available It is not, however, an entirely suitable year since output was temporarily depressed in several industries I have, therefore, set out in Appendix Table A as much of the corresponding data as is available for the period 1953-1967 To avoid excessive duplication in commenting on the results of the analysis, I shall confine myself in the text mainly to discussing the 1953-1966 data, but the same analysis has been carried out for the 1953-1967 data and the results summarised in Appendix I It can readily be seen by comparing the results for 1953-1967 in Appendix I with those for 1953-1966 in the text that the difference in the terminal year makes no material difference to the analysis, as is to be expected in a longer term analysis of the type in question here

As is clear from Table 7 there is a great variety of experience among the different industries In regard to output growth, five industries had increases of the order of 9 per cent per annum or more – involving at least a three-fold rise in output over the period as a whole – while six industries had declines in output or increases of less than 1 per cent per annum Seven industries recorded increases in labour productivity, measured by output per man-hour, of more than 5 per cent per annum while ten industries had falls in productivity or increases of less than 1 per cent per annum Table 8 sets out the mean, standard deviation and coefficient of variation for each variable in Table 7 relating to the 44 industries

The variable with the highest mean rate of growth is average labour earnings per man-hour (6 21 per cent per annum) while the variable with the smallest mean rise is unit materials cost (1 39 per cent per annum) All variables show considerable variation among industries, as measured by the coefficient of variation, with the outstanding exception of average labour earnings – whether measured per employee or per man-hour – and labour input shows the most variation [9]

The small degree of variation among industries in the movements of average labour earnings, which has been noted also in United Kingdom and United States data by Salter (1960) and in United Kingdom data by Reddaway (1966), calls for some comments First, even the small variation that appears in the data can almost certainly be explained more by changes in the composition of workers *within* industries rather than by differences

[9] The large variation in labour input appears to contrast with the results in Salter (1960) who found that employment showed far less variation than output for twenty-eight British industries over the period 1924 to 1950 However, Salter was using the values of the indexes in 1950, to base 1924=100, rather than average annual growth rates The relative size of the coefficients of variation for two different sets of data will vary depending on whether the coefficients are calculated by reference to the average annual growth rate or to the percentage change over the whole period Moreover, the use of index values as compared with the percentage change over the period, while it does not affect the standard deviations, will raise the mean of the variable with the lower mean rate of change (in this case, employment) relative to the mean of the variable with the higher mean rate of change (in this case, output) and will thus lower the coefficient of variation for the variable with the lower mean rate of change relative to that of the variable with the higher mean rate of change If the ceofficient of variation were calculated here for output and employment on the same basis as in Salter (i e using the values of the index in 1966 to base 1953=100,) the coefficients for output and employment are, respectively, 55 3 per cent and 37 9 per cent

TABLE 8

MEAN, STANDARD DEVIATION AND COEFFICIENT OF VARIATION FOR VARIABLES RELATING TO 44 INDUSTRIES IN TABLE 7

Variable	Mean	Standard Deviation	Coefficient of Variation
			%
1 Volume of Output	4 52	3 92	86 7
2 Employment	1 83	2 63	143 7
3 Output per head	2 62	2 17	82 8
4 Total Man-hours	1 59	2 67	168 4
5 Output per Man-hour	2 87	2 20	76 6
6 Salaries and Wages per Head	5 95	0 67	11 3
7 Salaries and Wages per Man-hour	6 21	0 66	10 7
8 Unit Labour Cost	3 29	2 16	65 7
9 Unit Gross Margin Cost	4 24	3 43	80 9
10 Unit Materials Cost	1 39	1 96	141 0
11 Unit Net Price	3 70	1 82	49 2
12 Unit Gross Price (excl duty)	2 31	1 72	74 5
13 Unit Gross Price (incl duty)	2 35	1 74	74 0

among industries in rates of increase of remuneration for a given composition of workers For example, the Linen industry had the highest rate of increase in salaries and wages per head but examination of the age-sex breakdown of workers in the industry reveals that this was mainly due to a big rise in the share in total employment of male wage-earners aged 18 years and over, who are relatively highly-paid, at the expense of female wage-earners and of wage-earners under 18 years, both of which are relatively lowly-paid classes The details are given in Table 9

TABLE 9

PERCENTAGE SHARE OF DIFFERENT CLASSES OF WORKERS IN TOTAL EMPLOYMENT IN THE LINEN, ETC INDUSTRY

	1953			1966		
	Males	Females	Total	Males	Females	Total
Salaried	5 4	2 5	7 9	6 0	5 0	11 0
Wage-earners						
18 years and over	36 2	30 1	66 3	53 6	23 1	76 7
Under 18 years	9 8	16 0	25 8	5 9	6 5	12 4
Total	51 4	48 6	100 0	65 5	34 6	100 0

Second, the small variation among industries in the movements of average labour earnings compared with the variation in productivity movements, combined with the fact that, as we shall see later, there is no significant correlation between the growth rates of average earnings and productivity, means that industries with above-average increases in productivity tend to achieve roughly an equi-proportionate relative fall in unit labour cost

Thirdly, the small variation in earnings increases is of considerable interest in the context of the discussion on incomes policy There are two extreme, exemplified to some extent in the N I E C *Report on the Economic Situation*, is that changes in all categories of average earnings should, apart from special categories such as "lowly-paid" workers, be related to the growth of national productivity The implication of this view is that differences among industries or firms in the growth of labour productivity would result in differential changes in unit labour cost and would make for differences in price changes The other extreme view is that earnings increases in each industry or even in each firm should be related to productivity growth in the industry or in the firm

To date, the actual situation has conformed most closely to the first of these viewpoints – though the size of the increase has been higher than many economists would consider desirable, given the growth of national productivity Speaking for myself, I regard the first view-point as the most desirable general approach to incomes policy I shall argue later that differences among industries in the growth of labour productivity are, in the main, *not* due to differential changes among industries in the quality of workers or the intensity of their effort – nor for that matter, can differences in productivity changes be substantially explained by differences in the growth of the volume of capital per worker If this is so, then it seems more desirable, both on economic grounds and on grounds of equity, that the greater part of relative increases in productivity should be passed on in relative price reductions to the benefit of the community as a whole If efficient firms, with relative productivity increases, were to pass on all or most of the relative increase in the form of relative earnings increases, they would be hampered from increasing output by lowering their price relative to other firms in the industry It is sometimes argued that differential changes in average earnings are necessary to secure mobility However, the degree to which mobility is influenced by *differential changes* in average earnings can easily be exaggerated [10] Mobility depends much more on differences in earnings *levels*, and the size of differential changes in earnings necessary to alter relative earnings levels substantially would generally be far greater than are normally envisaged in the discussion of the general approach to incomes policy Moreover, mobility can be fostered in many other ways besides earnings differences All of this is not to reject completely the idea of "productivity barganing" – there may in many cases be a strong practical case for such as an inducement to raising productivity by, for example, securing the elimination of restrictive practices – or to deny that certain categories of workers ought to receive relative increases Rather the view advanced here is that as a general rule – subject to many exceptions in particular cases – relative increases in labour productivity that are not due to increased skill or effort by workers or to increased capital per worker should be passed on to the community in the

[10] *Vide* the OECD study, *Wages and Labour Mobility*, which concluded, following an exhaustive examination of the evidence, that in general little importance can be attached to changing wage differentials in re-allocating labour

form of relative price reductions rather than in the form of higher relative earnings per unit of labour or of capital

The growth rates of several of the variables in Table 7 are associated with each other in a manner which is of considerable interest for economic analysis Table 10 sets out correlation coefficients (r) between related variables The correlation coefficients are based on forty-three of the forty-four industries in Table 7, the Shipbuilding industry having been excluded for reasons explained later In what follows the more important relationships between the variables are discussed

Changes in Output, Labour Input and Labour Productivity

Two measures of labour input were given in Table 7 – one based on employment and the other on total man-hours – together with two corresponding measures of labour productivity and average labour earnings It will be seen from Table 10 that the two measures are very highly correlated for all three variables and, as the mean values and the dispersion of the two measures are also not substantially different from each other, I shall from now on deal with the three variables as measured in relation to man-hours

The strong positive correlation between the growth rates of output and productivity, already pointed out in the case of the data for different countries and for the ten Irish manufacturing groups, is again evident in the data for the individual industries The growth rates of productivity and of total man-hours have been separately regressed on the output growth rate and the results are given in Equations (5) and (6)

$$P^* = \underset{(0\ 059)}{1\ 01 + 0\ 411Q} \qquad r = 0\ 73 \qquad (5)^{11}$$

$$L^* = \underset{(0\ 059)}{-0\ 96 + 0\ 565Q} \qquad r = 0\ 83 \qquad (6)$$

where Q, L* and P* are the average annual growth rates of volume of output, total man-hours and output per man-hour, respectively

The coefficients of output in Equations (5) and (6) are again close to the figures suggested by Verdoorn [12]

It is always useful to look at the largest deviations from any relation-

[11] The regression equation for the alternative measure of the growth of labour productivity – output per head – on the growth rate of output is as follows

$$P = \underset{(0\ 057)}{0\ 74 + 0\ 415Q} \qquad r = 0\ 75$$

Most of the difference between the two productivity measures shows up in the intercept leaving the regression coefficient virtually unaffected

[12] It may be noted that Verdoorn used in his regressions the logarithms of the indexes rather than average annual growth rates, and the latter give a slightly lower regression coefficient If logs were used in Equations (5) and (6), then since the logs of the indexes of labour input and labour productivity would add up exactly to the log of the output index for each industry, the sum of the two intercept terms would be zero and the sum of the regression coefficients would be exactly unity The average annual growth rates of labour input and labour productivity do not add up exactly to the average annual growth rate of output, and hence the sum of the regression coefficient is slightly less than unity (i e 0 976) Using logarithmic data in Equation (5) would give a regression coefficient slightly greater than 0 4

TABLE 10

COEFFICIENTS OF CORRELATION (r) BETWEEN CERTAIN VARIABLES IN TABLE 7[1]

	(1) Volume of Output	(2) Employment	(3) Output per Head	(4) Total Man-hours	(5) Output per Man-hour	(6) Salaries and Wages per Head	(7) Salaries and Wages per hour	(8) Unit Labour Cost	(9) Unit Gross Margin Cost	(10) Unit Materials Cost	(11) Unit Net Price	(12) Unit Gross Price	(13) Unit Gross Price (incl duty)
1 Volume of Output		0 85	0 76	0 84	0 75	0 21	0 19	–0 70	–0 26	0 11	–0 54	–0 23	–0 26
2 Employment	0 85		0 31	0 995		0 16							
3 Output per Head	0 76	0 31			0 991	0 20		–0 95	–0 23	–0 04	–0 76	–0 41	–0 42
4 Total Man-hours	0 84	0 995			0 27		0 09						
5 Output per Man-hour	0 75		0 991	0 27			0 23	–0 95	–0 19	–0 04	–0 75	–0 41	–0 42
6 Salaries and Wages per Head	0 21	0 16	0 20				0 90	0 11					
7 Salaries and Wages per Man-hour	0 19			0 09	0 23	0 90		0 07					
8 Unit Labour Cost	–0 70		–0 95		–0 95	0 11	0 07		0 11	0 09	0 75	0 45	0 46
9 Unit Gross Margin Cost	–0 26		–0 23		–0 19			0 11		0 14	0 67	0 55	0 59
10 Unit Materials Cost	0 11		–0 04		–0 04			0 09	0 14		0 20	0 76	0 71
11 Unit Net Price	–0 54		–0 76		–0 75			0 75	0 67	0 20		0 71	0 74
12 Unit Gross Price	–0 23		–0 41		–0 41			0 45	0 55	0 76	0 71		0 994
13 Unit Gross Price (incl duty)	–0 26		–0 42		–0 42			0 46	0 59	0 71	0 74	0 994	

[1] Based on 43 industries, Shipbuilding being excluded For n=43, the value of the correlation coefficient (r) that is significant at the 0 05 level is 0 30 at the 0 01 level, 0 39

ship In the Shipbuilding industry (No 19 in Table 7) there was practically no change in productivity despite a relatively rapid rate of growth of output The explanation is that there could not, in fact, be any change in productivity in this industry since the volume of output is measured in terms of man-hours! That such a measure of output seriously underestimates the true rise in volume of output in this industry is even more strongly suggested by the unit cost (especially unit gross margin cost) and unit price data, which as may be seen from Table 7 are so substantially above those of all other industries that they are clearly implausible I would confidently suggest that the true rate of growth of output in this industry is at least twice as great as that shown in Table 7 An even larger deviant case in Miscellaneous Food (including Fish)(No 11) where despite a rapid rate of growth of output, productivity fell I understand from the Central Statistics Office that the data for this industry are very unreliable Another large deviant industry is Assembly of Non-Road Vehicles (No 31) This industry is dominated by the output of the Aer Lingus workshop, the volume index for which is derived by deflating the value of output by an earnings index, a method which again almost certainly understates seriously the true rise in output and productivity in the industry It is surely a measure of the strength of the Verdoorn relationship if it can be used to establish errors in the data! It is only fair to add, however, that there are three other industries where the method of measuring the volume of output is by no means ideal and which do not show up as large deviations from the regression line these are Printing (No 25), Furniture (No 29) and Railroad Equipment (No 44) where the volume index is based on materials and labour input [13] Moreover, there are also three other industries which deviate substantially from the regression line due, so far as I know, to reasons other than errors in the data these are Slaughtering and Meat Preparation (No 7) ,Wood and Cork (No 23) and Canned Fruit and Vegetables (No 34)

While one hesitates to drop observations which do not fit in with one's hypothesis, there are good grounds for doing so when there are strong, objective reasons – independent of the hypothesis under examination – for believing that the data for these observations are inappropriate Such objective reasons exist for omitting several of the industries mentioned in the previous paragraph, in which case the correlation between the growth of output and productivity would be greater [14] I have omitted only the Shipbuilding industry, not just because it does not fit well on the regression

[13] It can, however, be argued that, as a measure of volume of gross output, the volume index for these three industries is less unsuitable than when the volume index is based on labour input alone The reason is that in most industries the volume of materials per unit of output almost certainly varies less than labour input per unit of output so that the growth of materials volume is generally closer to the growth of volume of output than is the growth of labour input This is clearly evident from the data in Geary and Forecast (1955)

[14] If the three industries where the data are most suspect – Miscellaneous Food (including Fish), Shipbuilding and Assembly of Non-Road Vehicles – were omitted the correlation between the growth rates of output and procuctivity would rise from 0 73 to 0 84 and the regression coefficient of output would be 0 417 as compared with 0 411 in Equation (5)

line of Equation (5) but because the measure of volume of output totally excludes any productivity change and because the resulting unit cost data are such that they might seriously distort any correlations with the unit cost data The correlation coefficients in Table 10 and the regression equations that follow are, therefore, based on forty-three observations In fact, the exclusion of Shipbuilding makes little difference except in the case of those correlations that involve unit gross margin cost and unit materials cost, and any large difference is noted in footnotes to the text Regression Equations (5) and (6), with Shipbuilding excluded, are as follows

$$P^* = 1\ 07 + 0\ 413Q \qquad (0\ 057) \quad r = 0\ 75 \tag{7}$$

$$L^* = -1\ 03 + 0\ 563Q \qquad (0\ 057) \quad r = 0\ 84 \tag{8}$$

It will be noted from Table 10 that there is a small positive correlation (0 31), just significant at the 5 per cent level, between the growth rates of employment and output per head This suggests that, contrary to the commonly-expressed fears that rapid productivity growth means reduced employment, there is in fact some tendency – at least among manufacturing industries – for the industries with above-average increases in productivity to have above-average increases in employment Salter (1960) noted the same result in his United Kingdom data It should be emphasised, however, that this finding in no way detracts from the need to provide redundancy and retraining schemes clearly it is no consolation to the individual worker displaced by technological progress to be told that his own experience is contrary to the general tendency for employment to rise with increased productivity Moreover, even though there may be a general tendency for overall employment to rise in industries with rapid productivity growth, particular categories of workers may be made redundant as a result of technical progress

Changes in Output, Productivity and Average Labour Earnings

It has already been pointed out that differences among industries in the growth of average labour earnings are small and, as may be seen from Table 10, there is only a small, non-significant positive correlation between the growth rates of productivity and average labour earnings The regression equation of the earnings growth rate on the productivity growth rate is as follows

$$W^* = 6\ 02 + 0\ 069P^* \qquad (0\ 046) \quad r = 0\ 23 \tag{9}$$

where W* and P* are the average annual growth rates of salaries and wages per man-hour and output per man-hour, respectively

Neither is there any evidence that industries with rapid rates of growth of output or of labour input have, over the longer run, bid up relative earnings in order to attract more labour, as may be seen from Equation (10) and (11)

$$W^* = 6\ 07 + 0\ 032Q \quad (0\ 026) \quad r = 0\ 19 \tag{10}$$

$$W^* = 6\ 18 + 0\ 024L^* \quad (0\ 039) \quad r = 0\ 09 \tag{11}$$

where W*, Q and L* are the average annual growth rates of salaries and wages per man-hour, volume of output and total man-hours, respectively

In all three Equations (9), (10) and (11), the intercept term is close to the mean rise in average earnings and the regression coefficients are small and non-significant

Changes in Output, Productivity and Unit Labour Cost

Since changes in average labour earnings show little variation among industries and are uncorrelated with changes in labour productivity, it is only to be expected that changes in productivity would show a high negative correlation with changes in unit labour cost, since the index of unit labour cost is simply the index of average earnings divided by the index productivity This is in fact so, the correlation coefficient being −0 95 Moreover, industries that achieve relative increases in productivity tend to achieve almost equi-proportionate relative reductions in unit labour cost as may be seen from Equation (12)

$$C_L = 6\ 00 - 0\ 942P^* \quad (0\ 046) \quad r = -0\ 95 \tag{12}$$

where C_L, P* are the average annual growth rates of unit labour cost and output per man-hour, respectively

In Equation (12), the intercept is not far short of the mean rise in average earnings and the regression coefficient of productivity is not significantly different from unity

As might also be expected, industries with relatively rapid output growth also tend to achieve relative reductions in unit labour cost The regression equation is as follows

$$C_L = 4\ 96 - 0\ 382Q \quad (0\ 060) \quad r = -0\ 70 \tag{13}$$

where C_L, Q are the average annual growth rates of unit labour cost and output, respectively

Changes in Productivity and Other Unit Costs

Price per unit output is affected not only by changes in unit labour cost but also by changes in other unit costs The other unit costs are distinguished here into two categories – unit materials cost and unit gross margin cost The change in materials cost per unit of output is calculated by dividing the index of value of materials by the index of volume of output

Changes in unit gross margin cost were derived by dividing the index of value of "remainder of net output", as it is called in the C I P Reports, by the index of volume of output It should be noted that the "remainder of net output" includes, as well as gross profit (including depreciation), certain other expenses of production such as printing, postage, advertising, rent, rates, etc [15]

As may be seen from Table 10 there is practically no correlation between changes in labour productivity and unit materials cost or between changes in unit labour cost and unit materials cost This finding is interesting because if differences among industries in the growth of labour productivity (as measured by volume of gross output per labour unit) were accounted for by differential changes in materials volume per unit of output, there would tend to be a strong positive correlation between the growth of productivity and unit materials cost,[16] unless relative increases in the quantity of materials per unit of output were systematically offset by relative reductions in materials price In fact more direct and compelling evidence is available which suggests that differences in the growth of labour productivity cannot be explained by differences in the growth of materials volume per unit of output In the data on volume of net output and volume of net output per head in Geary and Forecast (1955), relating to Irish industries, and in Blyth and Hamer (1965), relating to New Zealand industries, there is as much variation among industries in the growth of volume of net output per head as in the growth of volume of gross output per head, and changes in volume of net output per head are as highly correlated with changes in volume of net output as are changes in volume of gross output per head with changes in volume of gross output For United States data, Kendrick (1961) found a significant *negative* correlation between changes in productivity and in volume of materials per unit of output

In Table 10 it will be seen that changes in unit gross margin cost are negatively correlated with changes in productivity and positively correlated with changes in unit labour cost [17] Though the correlation coefficients are not significant they are of the opposite sign to what one would expect if differences in the growth of labour productivity were explained by differential changes in capital in such circumstances one would expect relative unit labour cost and relative unit capital cost to be moving in

[15] Thus the relative rate of growth of unit gross margin cost can be regarded as an indicator of the relative rate of growth of profit per unit of output only on the basis of certain restrictive, and probably unrealistic, assumptions involving the relative rate of growth of other expenses per unit of output and the share of these other expenses in the remainder of net output Moreover, profit per unit of output may vary among industries because of differential changes either in capital per unit of output or in the rate of profit per unit of capital

[16] In fact, in the United States and United Kingdom data there was a high *negative* correlation between changes in productivity and unit materials cost *Vide* Salter (1960), Kendrick (1961) and Reddaway (1966)

[17] There is also a positive, though non-significant, correlation between changes in unit materials cost and unit gross margin cost This is the correlation coefficient that is by far the most seriously affected by the exclusion of the Shipbuilding industry The exclusion of this industry lowers the correlation from 0 38 to 0 14

opposite directions This evidence in itself is not very compelling, however, because of the qualifications attached earlier to the interpretation of changes in unit gross margin cost Much more firm evidence on this subject is provided in the studies that give data on changes in the volume of capital [18] Broadly, these studies show that there is no general evidence of a strong positive correlation between changes in labour productivity and in the volume of capital per labour unit, that changes in output per unit of combined labour and capital input vary nearly as much among industries as do changes in labour productivity, and that these two productivity measures are very highly correlated Similar conclusions follow in the case of Ireland on the basis of the capital stock data in Nevin (1963) relating to the ten manufacturing groups [19]

It is important, however, to stress that these conclusions about the role of changes in capital are subject to the qualification that the measures of change in the volume of capital are such that improvements in the productive efficiency of new capital goods as a result of technological progress are counted, not as a rise in capital input but, as a rise in productivity in the industry using the capital goods This treatment of capital input is analogous to the treatment of labour input – in both cases productivity is measured in relation to inputs of base-period efficiency But if there are substantial improvements in the quality of capital goods over time as a result of technological progress and more particularly, from the viewpoint of the present analysis, if there are substantial *differential* rates of improvement in the capital goods used by different industries, then new investment – whether net investment or replacement – may play an important role as a carrier of technological progress Even more interesting is the possibility, mentioned later, that the rate at which technological knowledge, affecting new capital goods for use in an industry, is discovered may depend on the rate of investment in the industry

Changes in Output, Productivity and Prices

Three unit price variables are included in Table 7 The first, the unit net price, is derived by dividing the index of value of net output by the index of volume of output It should be noted that this price indicator is equiva-

[18] *Vide* Reddaway and Smith (1960), Kendrick (1961) and Nicholson (1966)

[19] These conclusions are not clear from Nevin's paper due to a slip in the paper In Column 5, Table 5, page 9, *op cit*, Nevin gives what purports to be an index of the productivity of all factors (i e of labour and capital combined) In fact, as examination of his data will show, it is clearly an index of total factor input, not total factor *productivity* The regression of the two measures of productivity growth (i e labour productivity and total factor productivity) on output growth based on Nevin's data for 1947-1959, and using the corrent measure of total factor productivity, gives these results

$$P_L = 0\,46 + 0\,513Q \qquad r = 0\,87$$
$$(0\,104)$$

$$P_{LK} \quad 0\,29 + 0\,514Q \qquad r = 0\,93$$
$$(0\,069)$$

where Q, P_L, P_{LK} are the average annual rates of growth of output, labour productivity and total factor productivity, respectively

lent to the true implicit price of net output in the individual industries and in total manufacturing *only* if the volume indexes for the individual industries, which are gross output volume indexes, change in the same proportion as a net output volume index for the individual industries The unit gross price (excluding duty) is derived by dividing the index of value of gross output (excluding duties on certain industries) by the index of volume of output, while the unit gross price (including duty) is derived by dividing the index of value of gross output (including duties on certain industries) by the index of volume of output The two gross price indicators are the same for all industries except Distilling, Brewing and Tobacco These three industries were treated specially both because the duties are large and because the rate of duty has changed substantially This also holds true of Miscellaneous Manufacturing, which includes the oil refinery, but for reasons given in Appendix 2 no attempt was made to include the duties in this industry For the generality of *individual* industries the unit gross price derived in this way is a true implicit price of gross output This is not so in the case of the unit gross price for total manufacturing, as is suggested by the absurd result in Table 7 which shows a larger rise in the unit gross price (excluding duty) for total manufacturing than in the unit gross price (including duty) even though the price rise in the industries concerned was above-average and the duties involved a still larger price increase This matter is dealt with in Appendix 2

In view of what has already been said about the associations between changes in productivity and the various categories of unit cost, it is not surprising to find significant negative correlations between changes in productivity and in the unit price indicators, since unit price is a weighted sum of the unit costs The negative correlation between the growth rates of productivity and unit net price, −0 75, is considerably larger than the correlation between the growth rates of productivity and unit gross price, −0 41 This is not surprising since materials form such a large proportion of gross output in most industries, and there was only a negligible negative correlation between changes in labour productivity and unit materials cost [20] The regression of the growth rate of unit gross price (excluding duty) on the productivity growth rate is as follows

$$G = 3\,00 - 0\,280P^* \qquad (0\,098) \qquad r = -0\,41 \tag{14}$$

where G, P* are the average annual rates of growth of unit gross price and output per man-hour, respectively

The coefficient of the productivity variable suggests that an additional one percentage point increase in productivity is associated with a reduction in relative price of a little less than one-third of one percentage point Given that the mean share of labour cost in value of gross output in the

[20] It may be noted that in the United Kingdom and United States data where there was a high and significant negative correlation between changes in productivity and unit materials cost, the negative correlation between changes in productivity and unit gross price was far higher than in the Irish data *Vide* Salter (1960) and Kendrick (1961)

forty-three industries was 22 per cent, the relative reduction in price associated with a relative rise in labour productivity is larger than would be expected if relative increases in labour productivity involved a relative fall only in unit labour cost Though it would be unwise to lay too much stress on this, in view of the size of the standard error of the regression coefficient, it does lend some support to the view that relative reductions in unit labour cost, due to relative increases in labour productivity, have not been systematically offset by relative increases in other unit costs

The correlation between the growth rates of output and unit gross price (excluding duty) is only −0 23, not significant at the 5 per cent level With the duties included in respect of the three industries already mentioned the correlation coefficient rises to −0 26, but is still not significant Given the small size of this correlation coefficient, it would be hard to account, in any substantial way, for the differences in rates of growth of output among industries in terms of relative price changes, a point which is of considerable importance in interpreting the causes of the association between the growth rates of output and productivity

To sum up the findings in this section, the Irish data confirmed the widely established association between the longer term growth rates of output and labour productivity As in the case of manufacturing industries in other countries, differences in the movements of average labour earnings are small compared to, and are not significantly correlated with, differences in labour productivity movements Thus industries with relative productivity increases tend to achieve equi-propotionate relative reductions in unit labour cost Moreover, relative reductions in unit labour cost are not systematically offset by relative increases in other unit costs in fact there is some tendency, more pronounced in other countries than in Ireland, for all categories of unit cost to fall relatively in industries with relative increases in labour productivity This, together with independent evidence on changes in unit materials volume and in volume of capital per labour unit, suggests that differential changes in labour productivity cannot be accounted for by offsetting differential changes in the quantities of other factors Because of the high proportion of value of materials in value of gross output in most Irish industries and the fact that there is only a negligible negative correlation between changes in productivity and unit materials cost, there is a comparatively low, though significant, negative correlation between changes in productivity and unit (gross) price, while there is only a small, non-significant, negative correlation between changes in output and unit (gross) price

3. CAUSES OF THE ASSOCIATION BETWEEN THE GROWTH OF OUTPUT AND PRODUCTIVITY

I hope to deal fully in a forthcoming book with, *inter alia*, the causes of the high positive correlation between the longer term rates of growth of output and productivity among manufacturing industries I can here give only a brief resume of the argument

Most writers who have discussed the association recognise that in principle the causation may operate in either direction For example, a

relatively rapid rate of productivity growth due, for example, to "exogenous technological progress would involve a lower relative price increase and, possibly, a higher relative output increase On the other hand, a relatively rapid rate of growth of output, due, for example, to high income elasticity of demand, might raise productivity growth for a number of reasons, such as the realisation of economies of scale Although it must be recognised that high rates of growth of productivity and output are likely to reinforce each other, it is argued here that the main stimulus arises from forces generated by the growth of output

In explaining the association, it is convenient to consider first the possible causes of differences in productivity growth rates It must be emphasised that we are dealing with differences among industries labour productivity may rise in all industries due to a number of factors common to all industries (such as an all-round rise in the quality of labour) and this is reflected in the intercept of the regression equation which shows that, in Irish industries over the period 1953-1966, productivity would tend to rise by a little over 1 per cent per annum even if there were no change in output

Differential changes in labour productivity may, in principle, be due to differences in the growth of the quantity of other factors per labour unit, differential changes in the quality of labour, differential changes in the quality of other factors and differential changes in the efficiency with which production is organised It has already been argued, on the basis of the evidence, that differences among industries in the growth of labour productivity cannot be satisfactorily explained by differential changes in quantities of other factors per labour unit It is also extremely unlikely that differential rates of improvement in the quality of labour could be an important explanatory factor Salter (1960) rejected such an explanation for the following reasons first, it is difficult to imagine that the quality of labour or the intensity of its effort could change at such very different rates among industries as to account for the large differences in rates of growth of productivity, second, if there were such large differential changes in the quality of labour, then since labour earnings rose at much the same rate in all industries, the large (hypothetical) relative increases in quality of labour would not have been compensated by higher earnings and we should be forced to conclude that the labour market was radically more imperfect than it is normally conceived to be, and, thirdly, the hyposthesis cannot by itself explain why, as was the case in Salter's data, industries with relative increases in labour productivity tended to achieve reductions in all categories of unit cost

Differential changes in the quality or productive efficiency of other factors of production are in the main due to differential rates of technological advance affecting such inputs, while differential changes in the efficiency with which the factors are organised are due mainly either to technological progress[21] or the realisation of static economies of scale, the

[21] Differential changes in the efficiency of management are here included under technological progress because differences in the quality of management affecting productive efficiency show up, to a large extent, in differences in the ability to develop and apply new knowledge

latter being available frequently because of earlier technological advances There can be little doubt that a satisfactory general explanation of differences in productivity growth rates rests mainly on differences in the rate of application and discovery of new technological knowledge The interesting question then arises – and it is of great importance to our understanding of the determinants of technological progress and, therefore, of economic growth - whether differences in productivity growth would be correlated with differences in output growth if technological change were exogenous By "exogenous" technological progress here is meant new knowledge that is developed and applied independently of the growth of output in the industry

If new technological knowledge were developed and applied independently of the growth of output, then the emergence of a strong positive correlation between the growth rates of productivity and output would depend mainly on whether relative productivity changes resulted in relative price changes *and* on whether relative price changes induced substantial relative output changes The evidence already mentioned for Ireland shows that there is indeed a significant negative correlation between the growth rates of productivity and unit (gross) price, but it is not a high correlation Moreover, the regression of price changes on productivity changes suggested that a relative rise in labour productivity of one percentage point was accompanied by a relative fall in price of only one-third of one percentage point Furthermore, the small, non-significant correlation between the growth rates of output and unit price would suggest that only a small part of the variation among industries in output growth could be explained by relative price changes In the face of this evidence, it would be difficult to maintain that the high positive association between the growth rates of output and productivity could be explained by differential price movements resulting from exogenously-determined relative productivity changes This conclusion is surely not as surprising as it might seem at first sight Relative price changes among firms in the same industry are undoubtedly important in explaining differential output movements among such firms, but it is hardly to be expected, in view of the variety of other influences determining the demand for the output of different manufacturing industries, that relative price changes among manufacturing industries, resulting from relative productivity changes, can exert a dominant role in explaining the differences in the rates of growth of output of the industries

It might be thought that in a country so open to world trade as Ireland relative price changes among industries would lead to large relative output changes through export expansion or import substitution However, when we are talking about relative prices in the context of export expansion or import substitution, the relative price comparison that matters is that between the price of domestically-produced products and the price of the same products abroad, and not, as is relevant here, the relation between the price of different domestically-produced manufactured products Thus, for example, the price of an Irish industry may fall relative to the price of other Irish manufacturing industries but this may not lead to relatively rapid expansion of exports in that industry, or indeed to any export

expansion at all, since the price of comparable products abroad may either be falling more rapidly or still be substantially lower in absolute terms If the causation had to work solely or even mainly from productivity growth to output growth via relative prices among manufacturing industries, then the association between the growth of output and productivity would almost certainly be weak some industries would achieve rapid rates of growth of output (e g because of high income elasticity of demand) without necessarily having any productivity increase, while on the other hand some industries with high rates of growth of productivity would have low output growth (e g because their materials prices rose substantially)

It would seem that in order to explain the association satisfactorily we must accept that technological progress is not exogenously determined, or not solely so, and that differences among industries in the rate of application and discovery of new knowledge depend in large measure on differences in rates of growth of output There are a number of ways in which rapid output growth may facilitate the application of new technological knowledge rapidly-growing industries may attract better managers who apply new techniques more quickly and to a greater degree, relatively rapid output growth is likely to induce a relatively high rate of gross investment thereby involving relatively greater additions of new – and, therefore, technologically-improved – capacity, the uncertainty that attaches to innovation (i e the initial application of a new technique) is likely to be less, and workers may be more amenable to the introduction of new techniques since the resulting productivity advance is less likely to involve a fall in employment than in industries where output is stagnant or growing slowly Moreover firms in rapidly-growing industries may be able to realise static internal economies of scale, many of which are created by earlier technological advances

While the application of existing technological knowledge and the realisation of those economies of scale that are already available would possibly result in a positive association between the growth rates of output and productivity, it is extremely unlikely that the association would be so strong in different countries unless the discovery of new technological knowledge were induced by the growth of output [22] The reason is that if the rate at which new knowledge for use in an industry – affecting either its inputs or its methods of production – were determined independently of the growth of output in the industry, then there would be no assurance that new knowledge would be developed any more rapidly for the rapidly-growing industries than for the slowly-growing industries in fact, in that case, many slowly-growing industries might have a relatively fast rate of advance in technological knowledge and, even though they applied a smaller proportion of the new knowledge, they might still achieve relatively rapid productivity advance

[22] However, technological progress, even if exogenous, may affect output growth directly (i e other than by lowering relative prices) by its impact on consumer tastes This is undoubtedly important, especially in the case of new consumer goods and the materials used therein, but it can hardly be sufficiently general to provide in itself a fully satisfactory explanation Besides, new consumer goods are often developed as a response to expectations about future demand

A brief reference is appropriate here to two modern works which argue that the rate of technological progress affecting production methods and inputs is, in fact, largely demand-determined Arrow (1962) argued that advances in technological knowledge, which are termed learning, are a function of experience In so far as technological progress affecting new capital goods is concerned, Arrow would argue that experience can be measured by the volume of such capital goods previously produced Schmookler (1966) argued, and supported his argument with some compelling evidence, that invention is essentially an economic activity, and that the amount of inventive activity that will be devoted, for example, to improving the capital goods for use in an industry will depend on the demand for these capital goods The implications of the arguments of both of these writers is that, in the case of a particular type of capital goods, the level of technology is a function of the total amount of such goods ever produced (i e cumulative gross investment from the beginning) and that the rate of change in technology depends on the rate of change in cumulative gross investment Thus both of these writers link the discovery of new knowledge with a dynamic interpretation of changes in scale, the emphasis being on technological responses to the rate of change in scale rather than the effect of achieving a given level of scale In both of the theories the relevant scale variable is the rate of change in cumulative gross investment, but it is to be expected that, over a given, reasonably-long period, differences among industries in the rate of change in that scale variable would be closely related to, and substantially determined by, differences in the rate of change in output

Finally, I would like to raise the question why in the Irish data, as in the case of a number of studies for other countries, relative productivity seems to advance in approximately a square root relationship with relative increases in output, as indicated by the regression results showing that an additional one percentage point in the growth rate of output tends to be accompanied by somewhat less than a one-half percentage point addition to the productivity growth rate This is a much more difficult question to answer and I can only indicate a few suggestive points from the empirical literature One such point is that engineers operate with an "0 6 rule" in relation to various types of equipment, such as containers, pipe-lines, etc , where cost is a function of surface area but capacity is a function of volume [23] This rule states that the increase in capital cost is proportional, not to the increase in capacity but, to the increase in capacity raised to the 0 6 power, or, in other words, the rate of reduction in capital cost per unit of output is related to the rate of increase in capacity by a coefficient of 0 4 It can also be shown that optimum safety allowances to provide against random variations in the holding of stocks, spare parts, cash balances etc , vary proportionally with the square root of output [24] However, these two factors do not directly throw light on the relation between the growth of labour productivity and output, and in any event they would not go far, in themselves, to explaining the association

[23] Balassa (1962), p 121-122
[24] Whitin and Peston (1954)

A more suggestive possibility is the evidence on the learning curve Arrow (1962) stated that in the airframe industry in the United States it has been found that the amount of labour input per airframe of a given type is a decreasing function of the number of airframes of the same type previously produced The relationship is a cube root relationship – the number of man-hours required for the Nth airframe is proportional to $N^{-\frac{1}{3}}$ and has been so firmly established that, according to Arrow, it "has become basic in the production and cost planning of the United States Air Force" It will be noted that the learning curve here relates the rate of growth of productivity, not to the rate of growth of output but, to the rate of growth of cumulative output, and that the coefficient of one-third is considerably less than that suggested by Verdoorn A similar learning curve was established by Hirsch (1952) who examined changes over time in the output and direct labour input of one of the largest machine tool firms in the United States Hirsch found that the elasticity of labour productivity with respect to cumulative output for seven machine tools, which differed in their function, size, etc , was about 0 30 and that there was considerable stability in the value of the elasticity for the different products Of even greater interest, perhaps, in the Irish context, since much of our industry relies on assembly of imported materials that have already received basic processing, is Hirsch's finding that the rate of learning was considerably higher in assembly operations than in machining operations in the assembly operations relating to the different products, the mean elasticity was 0 41 as against 0 20 for the machining operations These results, as I said, are only suggestive If in fact the elasticity of productivity with respect to output is generally as precise as Verdoorn postulated, then much further research is necessary to establish the underlying reasons for the size and stability of the relationship

REFERENCES

Arrow, K J (1962) "The Economic Implications of Learning by Doing", *Review of Economic Studies*, June 1962

Balassa, Bela (1962) *The Theory of Economic Integration* (London Allen and Unwin, 1962)

Blyth, C A , and Hamer, P (1965) "Output, Employment and Productivity Growth in New Zealand Manufacturing Industries", *Productivity Measurement Review*, No 41 (May 1965)

Geary, R C , and Forecast, K G (1955) "The Use of Census of Industrial Production Material for the Estimation of Productivity", *Review of the International Statistical Institute*, Vol 23, No 1-3, 1955

Geary, R C , and Pratschke, J L (1968) "Some Aspects of Price Inflation in Ireland" (Dublin The Economic and Social Research Institute, Paper No 40, January 1968)

Hirsch, W Z (1952) "Manufacturing Progress Functions", *Review of Economics and Statistics*, May 1952

Kaldor, Nicholas (1966) "Causes of the Slow Rate of Economic Growth of the United Kingdom", an Inaugural Lecture (Cambridge Cambridge University Press, 1966)

Kendrick, John W (1961) *Productivity Trends in the United States* (Princeton Princeton University Press, 1961)

Kennedy, Kieran A , (1968) *Labour Productivity in Irish Industry*, Unpublished Doctoral Dissertation for Harvard University (February 1968)

Lomax, K S (1959) "Production and Productivity Movements in the United Kingdom since 1900", *Journal of the Royal Statistical Society*, Series A, Part 2, 1959

Lomax, K S (1964) "Growth of Productivity in the United Kingdom", *Productivity Measurement Review*, August 1964

Maddison, A (1955) "Output, Employment and Productivity in British Manufacturing in the Last Half Century", *Bulletin of the Oxford University Institute of Statistics*, November 1955

Nevin, Edward (1963) "The Capital Stock of Irish Industry" (Dublin The Economic Research Institute, Paper No 17, November 1963)

Nicholson, R J (1966) "Capital Stock, Employment and Output in British Industry 1948-1964", *Yorkshire Bulletin of Economic and Social Research*, November 1966

Nicholson, R J , and Gupta, S (1960) "Output and Productivity Changes in British Manufacturing Industry 1948-1954 A Study from Census of Production Data", *Journal of the Royal Statistical Society*, Series A, Part 4, 1960

Reddaway, W B (1966) "The Post-War Scene", an Addendum to Second Edition of Salter (1960)

Reddaway, W B , and Smith, A D , (1960) "Progress in British Manufacturing Industries in the Period 1948-1954", *Economic Journal*, March 1960

Salter, W E G (1960) *Productivity and Technical Change*, First Edition (Cambridge Cambridge University Press, 1960)

Schmookler, Jacob (1966) *Invention and Economic Growth* (Cambridge, Mass Harvard University Press, 1966)

Whitin, T M , and Peston, M H (1954) "Random Variations, Risks and Returns to Scale", *Quarterly Journal of Economics*, May 1954

Verdoorn, P J (1949) "Fattori che Regolano lo Sviluppo della Produttivita del Lavoro", *L'Industria*, 1, 1949

APPENDIX 1

CHANGES IN OUTPUT, PRODUCTIVITY AND UNIT WAGE COST IN INDIVIDUAL INDUSTRIES, 1953-1967

Appendix Table A gives data for the period 1953-1967, corresponding to that given in Table 7 for the period 1953-1966, for as much of the data as are available to date for 1967 Appendix Table B, which corresponds to Table 8 in the text, gives the mean, standard deviation and coefficient of variation for the variables in Appendix Table A Appendix Table C, which corresponds to Table 10 in the text, gives correlation coefficients between related variables based on 43 industries in Appendix Table A, excluding the Shipbuilding industry

The regression equations for 1953-1967, corresponding to those given in the text for 1953-1966, are set out below The equations are given the same number as the corresponding equations in the text, with the addition of the letter A The symbols used are the same as those in the text but it should be noted that the average earnings data here relate to wage-earners only, whereas in the text they relate to wage-earners and salaried workers As a result the derived data on labour cost here are unit wage cost data, rather than unit labour cost data as in the text, and it should also be noted that the data here are not a strictly accurate measure of unit wage cost since the labour input and labour productivity data include both wage-earners and salaried workers

$$P^* = 1\,02 + \underset{(0\,057)}{0\,440}Q \qquad r = 0\,77 \tag{5A}$$

$$L^* = -0\,96 + \underset{(0\,057)}{0\,534}Q \qquad r = 0\,82 \tag{6A}$$

$$P^* = 1\,10 + \underset{(0\,055)}{0\,437}Q \qquad r = 0\,78 \tag{7A}$$

$$L^* = -1\,04 + \underset{(0\,056)}{0\,537}Q \qquad r = 0\,83 \tag{8A}$$

$$W^* = 6\,27 + \underset{(0\,042)}{0\,040}P^* \qquad r = 0\,15 \tag{9A}$$

$$W^* = 6\,19 + \underset{(0\,023)}{0\,046}Q \qquad r = 0\,30 \tag{10A}$$

$$W^* = 6\,29 + \underset{(0\,035)}{0\,076}L^* \qquad r = 0\,32 \tag{11A}$$

$$C_L = 6\,24 - \underset{(0\,043)}{0\,965}P^* \qquad r = -0\,96 \tag{12A}$$

$$C_L = 5\,03 - \underset{(0\,064)}{0\,391}Q \qquad r = -0\,69 \tag{13A}$$

APPENDIX TABLE A

AVERAGE ANNUAL PERCENTAGE RATES OF GROWTH OF VOLUME OF OUTPUT LABOUR PRODUCTIVITY AVERAGE EARNINGS AND UNIT LABOUR COST IN IRISH MANUFACTURING 1953 1967

Industries (ranked by output growth)	(1) Volume of Output	(2) Employment	(3) Output per Head	(4) Total Man hours	(5) Output per Man hour	(6) Average Weekly Earnings	(7) Average Hourly Earnings	(8) Unit Wage Cost
1 Electrical machinery	14 8	8 6	5 7	8 3	6 1	6 0	6 4	0 3
2 Chemicals drugs	14 5	5 4	8 7	5 2	8 8	6 6	6 8	-1 9
3 Miscellaneous manufacturing	12 3	4 8	7 1	4 4	7 6	6 3	6 8	-0 7
4 Fertilizers	11 8	5 5	6 0	5 5	6 0	7 0	7 0	1 0
5 Slaughtering meat preparation	10 3	7 8	2 4	7 6	2 5	6 0	6 2	3 6
6 Metal trades	8 5	3 6	4 8	3 6	4 7	6 3	6 3	1 5
7 Structural clay and cement	8 4	3 4	4 8	3 0	5 2	6 4	6 8	1 5
8 Made up textiles	7 9	3 2	4 6	2 9	4 9	6 4	6 8	1 7
9 Linen cotton	7 7	2 2	5 5	1 5	6 1	7 6	8 3	2 1
10 Non electrical machinery	7 3	3 5	3 7	2 9	4 3	5 2	5 8	1 5
11 Paper	7 1	1 7	5 4	1 3	5 7	6 8	7 1	1 3
12 Jute canvas miscellaneous textiles	6 9	2 4	4 5	1 9	5 0	6 8	7 3	2 3
13 Hosiery	6 9	1 6	5 2	1 3	5 6	5 9	6 4	0 7
14 Miscellaneous food (including fish)	6 6	7 9	-1 2	7 6	-0 9	6 3	6 7	7 6
15 Glass glassware pottery	6 4	2 5	3 9	2 3	4 1	6 5	6 8	2 6
16 Clothing Women's and girls	5 6	1 2	4 3	0 8	4 8	5 7	6 2	1 3
17 Butter, cheese, edible milk products	5 4	2 1	3 2	1 9	3 4	6 2	6 4	2 8
18 Mineral waters	5 3	0 4	4 9	0 6	4 7	6 4	6 1	1 4
19 Assembly of mechanical road vehicles	4 7	3 0	1 6	2 4	2 2	5 6	6 2	4 0
20 Woollen and worsted	4 6	1 9	2 7	1 5	3 1	6 4	6 8	3 7
21 Oils paints inks, polishes	4 1	1 2	2 9	0 9	3 2	5 7	6 0	2 7
22 Ship and boat building	3 8	4 1	-0 2	3 8	0 0	5 4	5 7	5 7
23 Clothing Shirtmaking	3 7	1 0	2 7	0 6	3 0	5 5	5 9	2 8
24 Leather manufacturers	3 6	2 5	1 1	2 2	1 4	6 8	7 2	5 7
25 Printing, publishing	3 4	0 7	2 8	1 0	2 4	6 8	6 4	3 9
26 Clothing miscellaneous	3 1	0 6	2 5	0 2	2 9	5 9	6 3	3 3
27 Malting	3 1	-1 4	4 6	-0 8	3 9	6 3	5 7	1 7
28 Boot and Shoe	2 9	-0 8	3 7	-1 0	3 9	4 9	5 2	1 2
29 Wood, cork	2 5	-1 9	4 5	-2 3	4 9	5 2	5 6	0 7
30 Canned fruit and vegetables, jams etc	2 4	2 3	0 1	2 0	0 4	6 1	6 4	6 0
31 Assembly of non-road vehicles	2 3	3 8	-1 5	4 0	-1 7	7 6	7 4	9 2
32 Fellmongery tanning	2 2	-0 4	2 6	-0 6	2 8	5 8	6 0	3 1
33 Furniture, brushes and brooms	2 1	0 0	2 1	-0 2	2 3	5 4	5 6	3 2
34 Margarine	1 9	0 1	1 8	0 0	1 9	5 2	5 2	3 3

APPENDIX TABLE A—continued

Industries (ranked by output growth)	(1) Volume of Output	(2) Employment	(3) Output per Head	(4) Total Man hours	(5) Output per Man hour	(6) Average Weekly Earnings	(7) Average Hourly Earnings	(8) Unit Wage Cost
35 Bacon	1 8	1 5	0 3	1 2	0 7	5 1	5 4	4 8
36 Grain milling, animal feeding stuffs	1 6	–0 3	1 9	–0 4	2 0	5 9	6 0	4 0
37 Soap, detergents, candles	1 5	0 6	0 9	0 4	1 1	6 5	6 7	5 5
38 Brewing	1 2	0 8	0 4	1 0	0 2	6 9	6 7	6 5
39 Distilling	0 8	–1 2	2 0	–2 2	3 0	5 4	6 4	3 3
40 Sugar, cocoa, sugar confectionery	0 5	–0 5	1 0	–1 2	1 8	6 1	6 9	5 1
41 Clothing Men's and boys	0 1	–0 9	1 1	–1 0	1 1	5 4	5 4	4 3
42 Bread, biscuits, flour confectionery	0 0	–0 8	0 8	–1 1	1 1	5 9	6 1	5 0
43 Tobacco	–0 9	–1 2	0 4	–1 3	0 5	7 0	7 1	6 6
44 Railroad equipment	–5 4	–3 6	–2 0	–4 3	–1 2	5 5	6 3	7 6
Total Manufacturing	4 7	1 5	3 1	1 3	3 4	6 1	6 4	2 9

SOURCE C I P Reports and Quarterly Industrial Production Inquiry

Notes to Appendix Table A

Col 2[1] "Persons engaged" as defined in the C I P

Col 4[1] Employment adjusted for changes in average weekly hours worked by wage earners Average weekly hours worked in a week in October were used for 1953 for all industries except Malting, where the average of the weekly hours in a week in each quarter was used The 1967 figures on average hours for all industries are averages of the data for a week in each quarter

Col 6[1] Derived by dividing the index of average weekly earnings of wage earners by index of employment The 1953 data on earnings relate to week in October, while the 1967 figures are averages based on a week in each quarter

Col 7[1] Index of average weekly earnings adjusted for changes in average weekly hours

Col 8[1] Index of weekly earnings divided by index of volume of output per head or, equally, index of hourly earnings divided by index of volume of output per man-hour

Appendix Table B

MEAN, STANDARD DEVIATION AND COEFFICIENT OF VARIATION FOR VARIABLES RELATING TO 44 INDUSTRIES IN APPENDIX TABLE A

Variable	Mean	Standard Deviation	Coefficient of Variation
			%
1 Volume of Output	4 67	4 04	86 5
2 Employment	1 79	2 61	145 8
3 Output per Head	2 82	2 30	81 6
4 Total Man-hours	1 53	2 63	171 9
5 Output per Man-hour	3 08	2 32	75 3
6 Average Weekly Earnings	6 11	0 64	10 5
7 Average Hourly Earnings	6 38	0 62	9 7
8 Unit Wage Cost	3 25	2 31	71 1

APPENDIX TABLE C

COEFFICIENTS OF CORRELATION (r) BETWEEN CERTAIN VARIABLES IN APPENDIX TABLE A[1]

	(1) Volume of Output	(2) Employment	(3) Output per Head	(4) Total Man-hours	(5) Output per Man-hour	(6) Average Weekly Earnings	(7) Average Hourly Earnings	(8) Unit Wage Cost
(1) Volume of Output		0 84	0 78	0 83	0 78	0 30	0 30	−0 69
(2) Employment	0 84		0 31	0 994		0 34		
(3) Output per Head	0 78	0 31			0 992	0 14		−0 96
(4) Total Man-hours	0 83	0 994	0 14		0 30		0 32	
(5) Output per Man-hour	0 78		0 992	0 30			0 15	−0 96
(6) Average Weekly Earnings	0 30	0 34					0 88	0 14
(7) Average Hourly Earnings	0 30			0 32	0 15	0 88		0 13
(8) Unit Wage Cost	−0 69		−0 96		−0 96	0 14	0 13	

[1] Based on 43 industries, Shipbuilding being excluded For n=43, the value of the correlation coefficient (r) that is significant at the 0 05 level is 0 30, at the 0 01 level, 0 39

APPENDIX TABLE D

VOLUME AND IMPLICIT GROSS PRICE INDEXES FOR TOTAL MANUFACTURING IN 1966 (TO BASE 1953=100)

Index of value of gross output (excluding certain duties)	219 1
Index of value of gross output (including certain duties)	213 9
Based on gross output weights excluding duty	
Volume index	171 9
Implied price index	127 4
Based on gross output weights including duty	
Volume index	161 6
Implied price	132 4
Based on net output weights	
Volume	175 1
Implied gross price (excluding duty)	125 1
Implied gross price (including duty	122 2

APPENDIX 2

THE IMPLICIT GROSS OUTPUT PRICE IN TOTAL MANUFACTURING

An interesting statistical point arises in Table 7 as regards the implicit price of gross output for total manufacturing The unit gross price in the Brewing, Distilling and Tobacco industries, even when the duties in the beginning and end years are omitted, increased more than average and, when account is taken of the duties, the price rise was greater still Yet when the duties that applied to these products are included in value of gross output in total manufacturing the implicit price derived by dividing the value index by the volume index rose less when the duties are included than when the duties are excluded Clearly this is an absurd result [1]

The difficulty arises essentially because in calculating the volume index for total manufacturing the volume indexes of the individual industries are weighted by the net output shares of the individual industries To measure the change in unit gross price for total manufacturing the volume index must be based on the *gross* output shares of the individual industries Moreover, if we wish to measure the change in the gross output price excluding and including duties, it is necessary to calculate two gross output volume indexes – one based on gross output shares when the duties are excluded from the individual industries and from total manufacturing and the other based on gross output shares when the duties are included in the individual industries and in total manufacturing The correct implicit

[1] Even if the price *change* in the three industries were the same whether duties were excluded or included, the price rise in total manufacturing should still be greater when the duties are included than when they are excluded if, as was the case, the rise in price (excluding duty) in the three industries was above average The reason is that, when the duties are included, a larger weight is being given to an above-average price increase

gross price excluding duty can then be calculated by dividing the index of value of gross output (excluding duty) by the first volume index [2] The correct implicit gross price including duty can be calculated by dividing the index of value of gross output (including duty) by the second volume index

Volume indexes and implicit price indexes, excluding and including the duties on certain industries, have been calculated, on the basis outlined in the previous paragraph, for the gross output of total manufacturing and are included in Appendix Table D These indexes are direct-link Fisher indexes, using the gross output weights of the beginning and end years For comparative purposes the Fisher direct-link volume index, derived by weighting the volume indexes of the individual industries by *net* output shares, is also given in Appendix Table D together with the implicit prices that result from dividing this index into (a) the value index of total gross output excluding certain duties, and (b) the value index of total gross output including certain duties The latter volume index differs in principle from the C S O volume index which is a chain-link Fisher index In practice the difference here is slight the direct-link volume index, based on net output weights, was 175 1 in 1966 (to base 1953=100) as against 175 5 for the C S O volume index

As may be seen from Appendix Table D, the unit gross price (exclusive of duty), when correctly calculated on the basis of gross output weights, rises more than the unit gross price derived on the basis of net output weights Moreover, the unit gross price (including duty), when correctly calculated, rises more than the unit gross price (excluding duty), as it ought to give the facts in this instance

For the generality of individual industries the implied price index, derived by dividing the index of value of gross output by the index of volume, is a true unit price of gross output since the volume indexes for most industries are based on gross output weights An important exception is Miscellaneous Manufacturing (including the oil refinery), where the method of calculating the volume index appears to result in a substantial overstatement in the implicit gross price It will be noted from Table 7 that this industry had a very high rise in unit gross price, especially in the light of the rapid rates of growth of output and productivity in the industry and given that the duties on oil are *not* included in the figures Examination of the annual data for this industry shows that almost all of the price increase between 1953 and 1966 took place in one year, 1959, the year in which the oil refinery first came into full production In that year the implicit gross output price rose by an incredible 64 per cent The explanation probably lies in the fact that, according to McCarthy,[3] the volume index for this industry is derived by combining the separate volume indexes for petroleum, rubber, matches and all other products included in this industry on the

[2] An alternative procedure, which will give an identical result is Fisher indexes are used for price as well as volume, is to weight the implicit price indexes in the individual industries by the shares in total value of *gross* output

[3] M D McCarthy, "Ireland Productivity Measurement at Industry Branch Level", in O E C D , *Productivity Measurement*, Vol III, (Paris 1966)

basis of *net* output weights, and since petroleum refining in Ireland, even with the duties excluded, involves a very low ratio of net output to gross output this means that the rise in volume of output in the industry, at least in the first year in which the oil refinery was included, was undoubtedly a great deal less on the basis of net output weights than if gross output weights were used Hence, use of the published volume index for this industry to measure the unit gross price probably involves a serious overstatement of the true rise in unit gross price In the circumstances, no attempt was made to include the duties in respect of oil

DISCUSSION

Dr W Brosnan Congratulations are due to Dr Kennedy on a paper which makes a most valuable contribution to our knowledge of Irish industry Not only are new facts presented, but further evidence is provided to back up that already available from other sources

Dr Kennedy clearly demonstrates that countries with the highest rates of growth of output also tend to achieve the highest rates of growth of labour input, productivity and average hourly earnings Here is definite evidence that hard work and efficient management in manufacturing industry benefits the community as a whole In addition, there is the specific message for Ireland in the operation of the Verdoorn Law in this country Surprising, however, is the lack of a strong positive correlation between changes in labour productivity and in the volume of capital per labour unit, although Dr Kennedy does go some way towards explaining the point

The paper also gives worthwhile comparisons on the progress of different Irish manufacturing industries In Table 7 it is shown that, amongst the top manufacturing performers as regards rate of growth between 1953 and 1967, were electrical machinery with 15 2 per cent, chemicals and drugs with 13 1 per cent, and metal trades with 8 9 per cent Amongst those with the lowest growth rates were the various branches of food, tobacco, clothing footwear, and wood products and furniture Not surprisingly, the manufacturing groups with the fastest rates of growth of output also tended to have the highest employment and productivity growth rates, while those with the lowest annual percentage rates of increase in output volume tended to have the smallest annual percentage rises in output per head and employment, and indeed even experienced employment decreases In this connection it is interesting to note that in the Third Programme for Economic and Social Development the metal trades, electrical machinery and chemicals are among the individual manufacturing industries in which the largest absolute increases in growth are expected to occur Similarly, the metal trades, electrical machinery and chemicals are included in the manufacturing industries in which the main employment increases are expected

The Irish experience as demonstrated by Dr Kennedy and the developments anticipated in the Third Programme seem to be in line with what has occurred in the rest of the world In "Problems of Industrialisation in

Developing Countries and their Implications for Ireland", a paper read before the Society on 10th November, 1967, Dr C F V Leser showed that, in the world as a whole, heavy industries are expanding more rapidly than light industries Dr Leser was using the United Nations definitions which include metals, chemicals and chemical products in the heavy industries, and food, tobacco, clothing, footwear and wood products and furniture in the light industries His calculations showed that between 1958 and 1966 in all countries the output of metal products increased by 87 per cent, while that of chemicals, petroleum and coal products rose by 98 per cent During the same years and for the same countries food, beverages and tobacco output increased by 38 per cent, clothing, footwear and made-up textiles by 43 per cent, and wood products and furniture by 64 per cent

Some reference should also be made to Tables 2 and 3 In Table 2, apart from the fact that Ireland's volume of output growth rate is fourth last in a table of fourteen countries, our unit wage costs grew by 2 9 per cent per annum, which is the fifth highest of those listed Even in Table 3, which covers the years 1960 to 1967, and as regards volume of output growth shows Ireland in better light at seventh place among eighteen countries, we come out at seventh place as regards average annual rates of increase in unit wage costs This surely is a trend which cannot be allowed to continue in the light of the increasing competition which is being experienced by Irish manufacturing industry

In conclusion, I am very pleased to propose the vote of thanks to Dr Kennedy for his paper

Mr L Leonard I am glad to second the vote of thanks to Dr Kennedy The mass of detail presented by our Census of Industrial Production is formidable, in his particular field of interest, Dr Kennedy has mined it and sifted it with considerable perseverance and insight Our thanks are, indeed, due to him for the care that he has brought to the task, for the light he throws on the relationships involved and for the measurements that he has made

I find very many of the points that he has made of interest, and would like to comment on just a few To some extent I share his surprise, expressed on p 130 of his paper, at the absence of any significant negative correlation between the growth rates of output and unit wage cost in the international context As he rightly points out, however, important factors here are those such as the relative importance of foreign trade for the countries concerned, barriers in the way of exports etc Even more relevant, perhaps, is the practice of differential pricing between markets practised by businessmen This can enable them to keep export prices competitive at the expense of domestic market prices Statistically, this practice appears to show up for a number of OECD countries in slower rates of growth of export price indices than of domestic price indices for manufactured goods, a development that has been remarked on by many economic commentators It also appears in Irish data Thus for the period 1954-1967, what may be regarded as the index of export prices of manufactured goods increased at an annual average rate of 1 4 per cent a year, while the corresponding domestic index

rose 3 0 per cent a year, i e more than twice as fast For 1960-1967, the figures are 1 7 per cent and 3 5 per cent, respectively

It would, I think, be quite wrong to infer from Dr Kennedy's paper that the growth of unit wage costs here are irrelevant as far as expanding output is concerned The proportion of our total output exported is already high, and is increasing Again, impediments to the free movement of goods between Ireland and the U K are disappearing, so that the scope for differential pricing is also being reduced To the extent, therefore, that price competitiveness is a factor at all in promoting export expansion, there is a strong reason why manufacturers here must be mindful of the rate of increase in their unit costs

Page 126 of the paper makes reference to the lack of evidence in the data examined that industries with rapid rates of growth of output or of labour input have bid up relative earnings in order to attract more labour This may be because of an assumption of homogeneity of labour underlying the analysis I think it is true that, in Irish conditions, rapidly expanding industries have to bid up the price of only a small proportion of total labour, representing skills in short supply, in order to attract their manpower requirements The cost of this relatively scarce labour would be only a small part of total labour costs for an industry, and changes in it would probably be quite insignificant for changes in the total Hence the lack of evidence of the kind referred to shown up by Dr Kennedy's equations

As regards the negative correlation, noted in the paper, between changes in unit gross margin costs and changes in productivity, and the positive correlation between changes in the former costs and changes in unit labour costs, the explanation here may also lie in business practices That is to say, the relationships may derive from the practice of manufacturers to fix their prices by adding a percentage margin to their costs Footnote 17 on page 132 would also seem to support this point of view The interesting thing, of course, if the view is correct, is the indication it gives that businessmen in adding on their percentage do so with regard to unit costs rather than overall costs

On the relationship between changes in labour productivity and the volume of capital employed per labour unit, wrong conclusions might easily be drawn from the evidence quoted in the paper I do not reject the results of the studies referred to, and it could well be that there is no general evidence of strong positive correlation between changes in labour productivity and in the volume of capital per labour unit in individual manufacturing activities This might result from changes in industrial structure, particularly those relating to successive stages in the manufacturing process In assembly industries, for instance, it might be that the productivity of workers in the final assembly stage is enhanced by improvements in the quality or finish of the components used which has resulted from increased capitalisation at some earlier stage of manufacturing outside the assembly industry It would, however, be very surprising if in highly integrated industries, or in industry as a whole, increased productivity were not correlated significantly with the volume of capital per

labour unit Further investigations of this interesting field would seem to be justified

I was also interested in the implications of the "Verdoorn Law" for certain calculations in the Third Programme Table 7 of the programme sets out expectations for the growth of industrial gross output and employment over the programme period 1969-1972 According to these, gross output is expected to increase at an annual average rate of 6 7 per cent a year, and employment is expected to rise to 318,000 in 1972 The implied productivity growth rate is nearly 4 1 per cent a year For the same data, Dr Kennedy's equation (3b) on page 000 gives a productivity growth rate of just over 4 0 per cent a year This striking coincidence of numbers may not silence all critics of the programme, but it will, I am sure, provide some comfort for its authors

Perhaps, a more interesting implication of the "law" lies in the field of economic management For many years there has existed a school of thought, especially in the U K , that if exports are to be increased, domestic demand should be curtailed so that capacity can be made available to produce the goods needed for exports This point of view has been vigorously opposed by others who contend that the increase in exports can only be achieved if there is a reduction in unit costs, and that the home market must be allowed to flourish so that this reduction will be effected through expanding output The "Verdoorn Law" lends support to the second school rather than the first, and emphasises once again the necessity in the strategy of growth of increased investment which will enable both home and export markets to be catered for

I think that it is obvious that I found Dr Kennedy's paper stimulating I am sure all his other listeners found it the same Again, we owe him our thanks

Mr C Mulvey May I begin by congratulating Dr Kennedy on an excellent paper As he himself suggested certain of his results are of great interest from the point of view of economic theory Traditional economic theory lacks a systematic analysis of the causes and effects of changes in labour productivity and indeed many of the assumptions which have seemed appropriate in a purely theoretical context have frequently been proved wrong in practice From the point of view of economic policy this analytical deficiency may have hampered the development of policies designed to encourage the rapid growth of productivity and the distribution of its benefits in a desirable way I am thinking primarily of incomes policy in this regard and I would like to make a few comments in relation to such a policy in the light of Dr Kennedy's findings

Dr Kennedy has demonstrated that there is no significant correlation in the long run between the growth rates of average earnings and productivity in the industries which he has examined and that there are small variations in the movements of average labour earnings compared with the variation in productivity movements among industries This is not surprising The strength of the criterion of comparability between the wages of similar workers in different industries in the wage determination

mechanism in Ireland virtually ensures that wage rates rise at the same rate throughout occupations The actual variations in the rate of growth of earnings which were found to exist possibly reflect variations in the earnings drift between industries, as well as difference in and changes in the structure of industrial labour forces A question of some importance in this regard, however, which was not of course within the scope of Dr Kennedy's study, is whether or not the pace of average earnings increase is set by those industries in which relatively high rates of increase in labour productivity have been recorded If this were so one would expect that unit labour costs in industries with rapid rates of growth in productivity to remain fairly stable while unit labour costs in those industries with relatively slow rates of growth in productivity would increase relatively rapidly Dr Kennedy's findings tend to confirm that this has been generally the case Clearly there are a number of other factors which will influence the average rate of change in earnings but it seems plausible to suggest that employers will generally be prepared to concede earnings increases to labour in rough proportion to the rate at which labour productivity has increased in a firm or an industry Hence trade union tactics in selecting the industries in which to establish key settlements would tend to lead them first to the point of least resistance, industries with relatively rapid productivity increase Having established one or a number of such key settlements the unions would then be in a strong position to coerce other employers into making similar concessions, irrespective of the rate of increase in productivity in the industry, by employing the highly persuasive argument of comparability A hypothesis of this kind would require an examination of the timing of wage settlements in different industries in relation to the rate of change in productivity in each industry, and would also require the inclusion of industries such as building and construction not within the scope of Dr Kennedy's present paper

Dr Kennedy's findings suggest that the relative rate of increase in price is negatively correlated with the rate of increase in productivity Hence the tendency for average earnings to rise at a uniform rate in manufacturing industry leads to differential rates of increase in prices and in this way in a sense some part of increased productivity is passed on to consumers in the form of relatively slow rates of increase in prices where relatively rapid increases in productivity have occured Hence as Dr Kennedy points out it is the size of the uniform increase in wages rather than the fact of its uniformity which is the real problem for incomes policy Further, Dr Kennedy rejects the view that changes in average wage differentials, presumably those determined by relative rates of change in labour productivity, are essential to secure adequate labour mobility Quite apart from the reasons given by Dr Kennedy for re,ecting this view the primary objection to it is surely that it carries no economic justification in theory or in practice unless differential changes in average earnings are related directly to changes in labour productivity arising out of some change in the quality of the labour force Hence the concept of a uniform incomes norm with specified exceptions relating to productivity change brought about by the direct action of the labour force

Finally may I again congratulate Dr Kennedy and express the hope that he continues to develop and extend this line of inquiry since it is of considerable importance that this neglected area of economic analysis concerning the growth of labour productivity, its determinants and its effects on the demand for labour urgently requires an empirical base on which to develop

Dr C E V Leser In the paper mentioned by the proposer of the vote of thanks, it was shown only that the Verdoorn Law holds in an international cross section comparison, but also that the deviations from the average relationship fall into a recognisable pattern Thus it would seem appropriate to supplement the demonstration of the general tendencies in Irish manufacturing by a study of the departures from the norm in individual industries There is some danger in accepting the Verdoorn Law too mechanically, as this might suggest that productivity cannot possibly be substantially raised unless output grows rapidly, and such considerations may provide justification for weakly founded policy decisions such as the introduction of a Selective Employment Tax

Having said this, I should like to associate myself with the thanks to the author and the appreciation of this most stimulating paper

Reply by Dr Kennedy

I should like to thank all speakers for their interesting comments which I found most stimulating Though I do not agree fully with a number of the points made, I shall confine myself to one point, namely, the doubts expressed by several speakers about the evidence in regard to the small role played by changes in the volume of capital per worker in explaining changes in output per worker Though this finding has emerged in numerous studies, it is not surprising that it should continue to be controversial since it appears to conflict with everyday experience which suggests that a great deal of technological progress that raises labour productivity is incorporated in new capital goods, The apparent conflict is largely resolved, however, when it is recalled that in most estimates of changes in the quantity of capital, new capital goods in *any* year are valued in terms of how much it would cost to produce them in a *given*, base year Thus, increases over time in the quality (or productive efficiency) of new capital goods show up mainly, not as a rise in capital input but, as a rise in output per unit of input (i e productivity) This is an acceptable analytical approach, just as it is acceptable to consider separately changes in the quantity of labour in terms of number of workers and changes in the quality of labour due, for example, to a general rise in educational levels But, as always, in assessing the implications of any finding – for example, in the present case, in considering the effect of new investment, whether "replacement" or "net", on labour productivity – the precise nature of the analytical conventions must be borne in mind

One might, of course, try to estimate changes in capital input by allowing for changes in the quality, as well as in the quantity, of new capital goods, but it is a matter of opinion whether or not it is possible to do so And

even if one does adopt this approach, one is still left with the question of what causes the quality of new capital goods to change, or in the context of my own paper, what causes differential changes among industries in the rate of quality improvement affecting their capital goods In other words, whatever measurement conventions are adopted, a satisfactory analysis cannot avoid dealing with the determinants of technological advance, even if only to the extent of labelling it exogenous