Productivity, Earnings and the Composition of Labour: Irish Manufacturing Industries, 1953-1966

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In a paper read recently to the Statistical and Social Inquiry Society of Ireland by one of the present authors,[1] differences in the growth of labour productivity in Irish manufacturing industries over the period 1953 to 1966 were examined. It was found, amongst other things, that movements in output were highly correlated with movements both in labour input and in labour productivity; that there was only a small dispersion among industries in the movements of average labour earnings; and that movements in earnings were not highly correlated with movements in productivity. For the purposes of that paper the measure of labour input was simply numbers employed corrected for changes in hours worked. This paper examines the effect upon the findings when allowance is made, in measuring changes in labour input, for certain changes in the composition of the workforce in the period 1953–1966.

It is highly unlikely that over a period of thirteen years the labour input mix in each industry would remain unchanged. There are likely to be changes in the age, sex and skill composition of the workforce over time. Given that each of these categories of workers has a different contribution to output and a different earnings level, changes in the composition of the workforce will involve changes in labour input and will partly account for changes in output per man-hour and in earnings per man-hour.

Changes in the Shares of Different Categories of Labour in Manufacturing as a Whole

Data in the *Census of Industrial Production* (CIP) enable us to go some of the way toward assessing the importance of changes in the composition of labour input. The CIP divides the numbers engaged in each industry in a pay week in October

1. Kieran A. Kennedy, Growth of Labour Productivity in Irish Manufacturing Industry 1953–1967, *Journal of the Statistical and Social Inquiry Society of Ireland*, 1968-69 (forthcoming). Referred to hereafter for convenience as Kennedy (*JSSISI*).

into salaried workers and wage-earners,[2] and sub-divides each of these two categories into four classes (i) males under 18 years of age, (ii) males aged 18 and over, (iii) females under 18 years, and (iv) females aged 18 and over. There are very few salaried workers under 18 years of age and for simplicity such workers may be included in the corresponding 18 years and over class. Table 1 gives a breakdown of total persons engaged in Manufacturing as a whole in 1953 and in 1966 distinguished into six classes of workers, and Table 2 shows the percentage change from 1953 to 1966 in different classes.

TABLE 1: *Persons Engaged in Total Manufacturing in 1953 and in 1966 Divided into Various Classes of Workers*

	1953		1966	
	Numbers	*% of Total*	*Numbers*	*% of Total*
Salaried Workers:				
Males	14,417	10·1	19,991	11·4
Females	7,191	5·0	10,973	6·3
Wage-earners:				
Males under 18 years	6,675	4·7	7,593	4·3
Males 18 years and over	68,587	48·0	85,695	49·1
Females under 18 years	11,338	7·9	12,369	7·1
Females 18 years and over	34,715	24·3	38,027	21·8
Total Persons Engaged	142,923	100	174,648	100

Source: CIP reports. The figure for persons engaged in each industry as given in the CIP is made up of salaried workers at mid-October and the average number of wage-earners at twelve dates during the year. The age-sex breakdown of wage-earners is available only in respect of wage-earners engaged in a pay week in October. The breakdown of the annual figure for wage-earners given above was calculated using for each industry the proportions available for October.

2. Salaried workers comprise proprietors working in the business, and managerial, administrative, clerical etc. staff. Wage-earners comprise factory workers, packers, store-keepers etc.

TABLE 2: *Percentage Changes in Various Classes of Workers in Total Manufacturing, 1953–1966*

	%
Salaried Workers:	
Males	38·7
Females	52·6
Total Salaried Workers	43·3
Wage-earners	
Males under 18 years	13·8
Males 18 years and over	24·9
Females under 18 years	9·1
Females 18 years and over	9·5
Total Wage-earners	18·4
Total Persons Engaged	22·2
of which	
Total Males (Salaried and Wage-earners)	26·3
Total Females (Salaried and Wage-earners)	15·3

Source: Based on data in Table 1.

Salaried workers increased much more rapidly than wage-earners, and their share in total persons engaged rose from 15·1 per cent in 1953 to 17·7 per cent in 1966. Female salaried workers increased somewhat more rapidly than male salaried workers, but both salaried classes increased more rapidly than wage-earners.

The rise in the share of salaried workers in total engaged in manufacturing industries has been noted in the case of other countries in the course of development.[3] Table 3 gives details over a longer period showing the trend in the salaried share in Irish manufacturing, with roughly comparable figures for UK manufacturing.

3. See, for example, Solomon Fabricant, *Employment in Manufacturing*, 1899–1939 (New York: National Bureau of Economic Research, 1942), and Seymour Melman, *Dynamic Factors in Industrial Productivity* (Oxford: Basil Blackwell, 1956). The latter work examines at some length the causes of the rise in the "administrative overhead" and concludes that it was largely due to expansion of the scope of management functions and the enlargement of managerial controls in such areas as purchasing and stocks, cost control, labour relations, planning and organisation, etc.

TABLE 3: *Share of Salaried Workers in Total Employment in Manufacturing in Ireland and the United Kingdom in Various Years*

Ireland		United Kingdom	
Year	*Salaried Employment Share*	*Year*	*Salaried Employment Share*
	%		%
1912	10·9	1907	7·9
1926	15·8	1924	11·8
1931	16·6	1930	12·1
1936	15·6	1935	13·1
1946	14·8	1948[1]	16·6
1953	15·1	1954	18·5
1966	17·7	1968[1]	26·2

[1]Figures for these years relate to Great Britain.

Source: Irish figures from CIP reports. The 1912 figure is derived from the table on page xxi of the 1926 CIP report. UK figures for 1907–1948 taken from Seymour Melman, *Dynamic Factors in Industrial Productivity* (Oxford: Basil Blackwell, 1956), p. 73; the 1954 figure is derived from the British *Census of Production for 1954*; and the 1968 figure is from *Employment and Productivity Gazette*, January, 1969. The UK figures above comprise proprietors and administrative, technical and clerical workers, and are reasonably comparable in coverage with the Irish figures.

Unlike the UK figures, the rise in the salaried employment share in Irish manufacturing has not been steady. The rapid transformation of industry in the period 1931 to 1936 was accompanied by a fall in the share in manufacturing as a whole. Examination of the individual industry figures for this period, however, reveals that the overall fall was due as much to relatively rapid growth of employment in industries with a relatively low salaried employment share as to a fall in the share *within* industries. In fact, in about half of the individual industries the salaried share rose in this period, and the mean of the individual industry shares fell only from 17·6 per cent in 1931 to 17·1 per cent in 1936. The overall salaried share in Irish manufacturing continued to decline from 1936 to 1946; there was a slight rise from 1946 to 1953; and, as already stated, there was a significant rise from 1953 to 1966.

Among wage-earners over the period 1953–1966, males aged 18 and over grew considerably faster than any of the other three classes of wage-earners. Female wage-earners increased least of all and the share of total female wage-earners in total persons engaged fell from 32·2 per cent in 1953, to 28·9 per cent in 1966.

The differences in the rates of change in labour input of the various classes could be offset or increased by differential rates of change in average hours worked. Unfortunately, no data are available for average hours worked by salaried workers, but data are available for a pay week in October in each year on weekly hours

worked by each of the four classes of wage-earners. Table 4 compares the percentage changes in total man-hours worked by each of the four classes of wage-earners with the percentage changes in numbers of such workers.

TABLE 4: *Percentage Changes in Numbers Engaged and Total Man-hours in each of Four Classes of Wage-Earners, 1953–1966*

Wage-Earners	(1) *Numbers*	(2) *Total Man-hours*
	%	%
Males under 18 years	13·8	12·4
Males 18 years and over	24·9	22·3
Females under 18 years	9·1	7·0
Females 18 years and over	9·5	2·5

Source: Column (1) as in Table 2. Column (2) is based on numbers engaged adjusted for average hours of each class in a pay week in October.

As is clear from Table 4, the relatively slow growth of female wage-earners (especially adult females) is accentuated when account is taken of changes in average hours.

The relatively rapid overall growth in salaried workers and the relatively slow overall growth in female wage-earners could conceivably arise due to a faster rate of growth of employment in the industries with a relatively high proportion of salaried workers and a relatively low proportion of female wage-earners, even if there were no changes in the composition of workers within individual industries. In fact, however, as we shall show, there have been sizeable changes in the composition of workers within individual industries.

Changes in the Composition of Labour in Individual Manufacturing Industries

In order to quantify and compare changes in the composition of workers within industries, it is helpful to compile a new index of labour input. The method used, in compiling the index is described in the Appendix to this paper, but, in effect the method involves, for each industry, weighting the changes in man-hours worked in each of the different classes of workers by the earnings of that class in the base year (1953 in this case). Since the CIP does not give separate data on the earnings of male and female salaried workers these two classes had to be combined: moreover, in the absence of data on average hours worked by salaried workers, changes in average hours worked by wage-earners in each industry were used in estimating changes in man-hours worked by salaried workers in the same industry.

This index of weighted man-hours, when divided by the index of man-hours unweighted, shows, subject to an important assumption, the change in volume of labour input due to changes in the composition of the workforce between

the five classes distinguished.[4] The underlying assumption is that differences in labour input among the different classes of workers are reflected in differences in average earnings. The actual position is unlikely to correspond precisely to this assumption, since factors other than the relative contribution to output are likely to affect relative earnings levels. Yet it is to be expected, for example, that the average contribution to output of an adult wage-earner is greater than that of a juvenile wage-earner, and it seems more satisfactory to take account of this difference using relative earnings as a measure than not to take account of it at all.

Table 5 shows, *inter alia*, for each of the forty-four industries comprising total manufacturing, the average annual rates of growth from 1953 to 1966 in two measures of labour input, i.e. man-hours unweighted and weighted man-hours. The table also gives corresponding measures of the change in labour productivity and average labour earnings. The change in output per weighted man-hour measures the rise in labour productivity when account is taken, in measuring labour input, of changes in the composition of workers; or putting the matter another way, it attempts to measure what the change in output per man-hour would have been if there were no changes in the composition of workers. Thus the amount by which the actual rate of growth of output per man-hour exceeds (or falls short of)[5] the rate of change in output per weighted man-hour gives a measure of the rise (or fall)in productivity due to changes in the composition of workers. As in the case of labour input, the accuracy of the measure depends on the validity of the assumption that differences in the average contribution to output among the different classes of workers are equal, or proportional, to differences in average earnings.

It may be noted that the interpretation of the changes in earnings per weighted man-hour (Column 7 of Table 5) is not subject to the same qualification that attaches to the interpretation of changes in weighted man-hours or changes in output per weighted man-hour. Since the index of salaries and wages per weighted man-hour was derived by dividing the index of total salaries and wages by the index of weighted man-hours, it is equivalent to an index derived by weighting changes in average earnings in each class of workers by the share of each class of

4. It might seem more appropriate to call this the change in the *quality* of labour due to changes in the composition of the workforce, since the effect is due to changes in the mix of workers who are presumed to be of different quality (as indicated by their relative earnings). However, in the parallel case of goods, economists generally regard a change in the mix of goods of different quality (as indicated by relative prices) as a volume change, and apply the term quality change only to changes in the quality of individual goods or the introduction of a new-quality good. At all events, it should be noted that we are not seeking here to measure quality changes that may have taken place in each of the different classes of workers, due, for example, to better health, education, etc.

5. We mean here the excess (or deficiency) in a multiplicative rather than an arithmetic sense. In other words, the difference between the average annual growth rates of output per man-hour (r) and output per weighted man-hour (k) is given by $\frac{100\,(r-k)}{100+k}$, rather than by $(r-k)$, though in practice the two are roughly the same.

TABLE 5: *Average Annual Rates of Change in Labour Productivity and Average Labour Earnings in Irish Manufacturing Industries, 1953–1966, for Different Measures of Labour Input*

Industries (ranked by output growth)	*Alternative Measures of Labour Input*			*Alternative Measures of Labour Productivity*		*Alternative Measures of Labour Earnings*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Volume of Output	*Man-hours*	*Weighted Man-hours*	*Output per Man-hour*	*Output per Weighted Man-hour*	*Salaries and Wages per Man-hour*	*Salaries and Wages per Weighted Man-hour*
	%	%	%	%	%	%	%
1. Electrical machinery	15·15	9·32	9·26	5·34	5·39	5·73	5·79
2. Chemicals, drugs	13·06	5·21	5·49	7·46	7·18	6·36	6·08
3. Miscellaneous manufacturing	11·72	4·32	4·83	7·09	6·57	7·15	6·64
4. Fertilisers	11·03	5·14	6·05	5·60	4·70	5·75	4·85
5. Metal trades (excl. machinery and transport equipment)	8·94	3·70	4·63	5·05	4·12	6·82	5·88
6. Non-electrical machinery	8·46	3·40	3·33	4·89	4·97	5·98	6·05
7. Slaughtering, meat preparation	7·90	6·48	6·67	1·33	1·15	6·39	6·20
8. Linen, cotton	7·81	1·64	2·87	6·06	4·80	8·46	7·17
9. Structural clay and cement	7·78	2·78	3·05	4·86	4·58	6·79	6·51
10. Made-up textiles	7·54	2·98	3·32	4·44	4·09	5·73	5·37
11. Miscellaneous food (incl. fish)	6·86	7·73	8·63	−0·81	−1·63	5·33	4·46
12. Jute, canvas, miscellaneous textiles	6·57	2·04	2·85	4·44	3·61	7·01	6·16
13. Hosiery	6·43	0·94	1·95	5·44	4·39	6·36	5·31
14. Glass, glassware, pottery	6·15	2·49	2·76	3·58	3·30	6·98	6·69
15. Paper	5·95	1·42	2·24	4·47	3·61	6·90	6·02
16. Assembly of mechanical road vehicles	5·43	2·81	2·76	2·55	2·60	5·74	5·79
17. Clothing: women's and girls'	5·23	0·78	0·80	4·42	4·39	6·00	5·97
18. Aerated and mineral waters	5·12	0·18	0·24	4·95	4·88	5·95	5·88
19. Ship and boat building	4·74	4·64	4·74	0·09	0·01	5·63	5·53
20. Butter, cheese, edible milk products	4·50	1·79	1·76	2·67	2·70	6·22	6·25
21. Leather manufactures	4·32	1·84	2·11	2·43	2·16	7·10	6·81
22. Clothing: Shirtmaking	4·24	0·97	0·43	3·23	3·79	5·49	6·05
23. Woollen and worsted	4·17	1·09	1·62	3·04	2·51	6·43	5·88
24. Oils, paints, inks, polishes	3·81	1·27	1·79	2·50	1·98	5·44	4·90
25. Printing, publishing	3·63	1·23	1·60	2·37	2·00	6·00	5·62
26. Boot and shoe	3·28	−0·67	−0·76	3·99	4·08	5·53	5·63
27. Clothing: miscellaneous	2·66	0·26	0·64	2·38	2·00	6·46	6·06
28. Manufactures of wood (except furniture)	2·62	−1·86	−2·07	4·56	4·78	6·05	6·28
29. Furniture, brushes and brooms	2·60	−0·30	−0·31	2·90	2·92	5·50	5·51
30. Soap, detergents, candles	2·54	0·34	0·43	2·19	2·09	6·74	6·63
31. Assembly of non-road vehicles	2·51	4·47	5·12	−1·88	−2·48	7·30	6·64
32. Fellmongery, tanning	2·28	−0·21	−0·11	2·50	2·39	6·34	6·23
33. Bacon	2·20	1·67	1·82	0·52	0·37	5·51	5·35
34. Canned fruit and vegetables, jams, etc.	2·01	2·51	3·15	−0·49	−1·10	5·81	5·15
35. Margarine	1·94	−0·71	−0·92	2·66	2·89	5·80	6·02
36. Grain milling, animal feeding stuffs	1·79	−0·27	−0·16	2·06	1·95	5·94	5·82
37. Malting	1·66	−1·41	−1·31	3·12	3·01	5·80	5·68
38. Brewing	1·14	0·79	1·05	0·35	0·08	6·28	6·00
39. Distilling	0·85	−1·48	−1·72	2·37	2·62	5·19	5·45
40. Sugar, cocoa, sugar confectionery	0·18	−1·35	−1·03	1·55	1·22	6·60	6·26
41. Bread, biscuit, flour confectionery	0·05	−0·80	−0·73	0·86	0·79	6·00	5·94
42. Clothing: men's and boys'	−0·60	−1·25	−1·30	0·66	0·71	5·54	5·59
43. Tobacco	−1·53	−2·02	−1·28	0·50	−0·26	7·28	6·47
44. Railroad equipment	−6·01	−4·13	−4·05	−1·96	−2·04	5·67	5·58
Mean	4·52	1·59	1·87	2·87	2·59	6·21	5·91
Standard Deviation	3·92	2·67	2·81	2·20	2·18	0·66	0·54
Coefficient of Variation (%)	86·7	168·4	150·1	76·6	84·2	10·7	9·1

Source: Census of Industrial Production reports.
Explanatory Notes: Col. 2: "Persons engaged", as defined in the CIP, 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 in 1966 was used. *Col. 3:* Changes in man-hours worked by various categories of workers weighted by their earnings in 1953, as explained in the Appendix. *Col. 4:* Derived from col. (1) and col. (2). *Col. 5:* Derived from col. (1) and col. (3). *Col. 6:* Derived by dividing index of annual salaries and wages by index of man-hours. *Col. 7:* Derived by dividing index of annual salaries and wages by index of weighted man-hours.

workers in total man-hours.[6] The index of earnings per weighted man-hour, therefore, shows, without qualification (apart from the usual index number ambiguity),[7] the rise in average earnings for an unchanged mix of workers; and the excess (or deficiency) of the rate of growth of earnings per man-hour over the rate of growth of earnings per weighted man-hour shows the rise (or fall) in average earnings due to changes in the composition of labour.

The mean, standard deviation and coefficient of variation for each variable in Table 5 relating to the forty-four industries is given at the bottom of the Table. It may be seen that the mean value of changes in weighted man-hours is about 0·3 per cent per annum more than the mean value of the changes in man-hours and, therefore, the mean values of the changes in weighted productivity and weighted earnings are about 0·3 per cent per annum less than the corresponding mean values unweighted. This means that for the forty-four industries, on average, the shift towards relatively highly-paid workers was responsible for a rise in average earnings of about 0·3 per cent per annum, and for a rise in productivity of like amount (assuming, of course, that the relatively highly-paid workers were correspondingly relatively more productive). The effect was considerably greater in a number of the individual industries. In the Linen and Cotton industry, which had the highest rate of increase in earnings per man-hour, a substantial part (1·2 per cent per annum) of the above-average rise in earnings in the industry was due to shifts in the composition of workers towards more highly-paid classes. Other industries in which there were substantial increases in the quantity of labour input associated with changes in the mix of workers were Fertilisers (0·9 per cent per annum), Metal trades (0·9 per cent), Miscellaneous Food (0·8 per cent), Jute (0·8 per cent), Hosiery (1·0 per cent), Paper (0·8 per cent) and Tobacco (0·8 per cent). In thirty-three of the forty-four industries the growth of weighted man-hours exceeded the growth of man-hours, the chief reasons for this being the rise in the proportion of salaried workers, which applied in almost all industries, and the fall in the proportion of female wage-earners (especially those aged 18 and over), which applied in the great majority of industries.[8] It can be seen from Table 5 that in all industries in the Textiles group (i.e. Linen and Cotton, Made-up Textiles, Jute, Hosiery and Woollen and Worsted), the rate of change in weighted man-hours exceeds the rate of change in man-hours by more than average, and this was due mainly to a substantial decline in the proportion of female wage-earners (both under and over 18 years), whether measured in relation

6. Since the index of weighted man-hours here is a Laspeyres index (i.e. 1953 weights), the index of earnings per weighted man-hour is a Paasche index (i.e. 1966 weights).

7. The index number ambiguity is here not great, however: because of the tendency for average earnings in each of the different classes of workers to rise at much the same rate it makes little difference whether first-year or end-year weighting is used.

8. In industries generally, the salaried class has the highest average earnings, adult male wage-earners come next, average earnings of adult female wage-earners are considerably lower than for adult male wage-earners, and the earnings of juvenile wage-earners (male and female) are the lowest of all.

to total persons engaged or to total wage-earners. It is well known that the textile industries have suffered severe difficulties in recruiting sufficient female workers and have clearly been forced to substitute male labour. Curiously, no corresponding shift happened to any great extent in the clothing industries which have also had difficulties in recruiting female labour. Indeed, the Shirtmaking industry was the one with the largest decline in the quantity of labour input due to changes in composition and this arose from a substantial increase in the share in total employment of female wage-earners under 18 years (from 23·6 per cent to 35·4 per cent), which almost matched the fall in the share of adult female wage-earners (from 62·4 per cent to 49·5 per cent), leaving the proportion of total female wage-earners almost unchanged. In all industries in the Clothing group (excluding the Boot and Shoe industry), there has been a relatively rapid increase in employment of male wage-earners under 18 years but the numbers involved are still extremely small.

One might have expected that the greatest changes in the composition of workers would take place in the industries with the highest rates of change (positive or negative) in labour input on the grounds that the industries where employment was increasing most, or falling most, would be most likely to, and could most readily, effect changes in composition. In fact, however, this was so only to a slight extent: the rank correlation (rho) between changes in man-hours (ranked without regard to sign) and changes in labour input due to changes in composition[9] (also ranked without regard to sign) is 0·23, not significant at the 5 per cent level. However, the correlation might be stronger if a more detailed breakdown of the workforce were available, allowing, in particular, for changes in skilled, semi-skilled and unskilled workers. When the two variables are both ranked with regard to sign, the rank correlation is 0·36, significant at the 5 per cent level, indicating that there was a significant, though slight, tendency for the share of more highly-paid—and presumably more productive—workers to rise most in industries where labour input increased most.

It is of interest to enquire whether the dispersion of productivity changes is reduced when the effect of changes in the composition of labour is excluded from the measure of productivity change. In fact this is not so: as may be seen from Table 5, the standard deviation of the growth rates of output per weighted man-hour is almost identical with the standard deviation of the growth rates of output per man-hour; and, given the lower mean rise in output per weighted man-hour, the relative dispersion of the weighted productivity growth rates is somewhat greater than that of the unweighted productivity growth rates. This suggests that the variation in the productivity growth rates cannot be explained by changes in the composition of workers.[10]

9. That is, the difference between the rate of growth of weighted man-hours and the rate of growth of man-hours unweighted.

10. This is also suggested by the fact that the rank correlation coefficient between the changes in output per man-hour and changes in the quantity of labour input due to changes in the mix of workers is 0.05 which is totally insignificant.

On the other hand, the dispersion of movements in earnings is reduced, both absolutely and relatively, when the effect of changes in the composition of labour on earnings movements is excluded, though the difference is not significant at the 5 per cent level. Moreover, the rank correlation between changes in salaries and wages per man-hour and changes in the quantity of labour input due to changes in the composition of labour is 0·51, significant at the 1 per cent level. Thus, part of the already small variation in earnings movements among industries can be explained by changes in the composition of labour. The changes in the composition of labour distinguished here do not cover all the changes in composition: in particular it would be desirable to have information on relative changes in skilled, semi-skilled and unskilled wage-earners. If a more detailed breakdown of the various classes of workers was available for each industry and changes in their shares taken into account in measuring labour input, it is likely that the dispersion of movements in average earnings would be reduced still further. On the other hand, there is no doubt that substantial differences among industries in the growth of labour productivity would remain. It is clear, therefore, that if differences among industries in productivity movements were due, to any great extent, to differences in the rate at which the quality of labour, for a given composition of workers, improved, then such differential changes in quality cannot have been compensated much by differences in earnings movements.

Correlation coefficients (r) between related variables in Table 5 are set out in Table 6. The correlations are based on forty-three of the forty-four industries, the Shipbuilding industry being omitted.[11] The two measures of change in labour input are highly correlated and so also are the two measures of change in labour productivity. The strong positive correlations between the growth rates of output and labour input and between the growth rates of output and labour productivity were discussed in Kennedy (*JSSISI*), where labour input and labour productivity were measured in relation to man-hours unweighted. It is clear from Table 6 that the correlations remain much the same whichever of the two measures of labour input and labour productivity is used. The regressions of the two different measures of labour productivity growth on the growth of output are given in equations (1) and (2),

$$P = \underset{(0\cdot343)}{1\cdot072} + \underset{(0\cdot057)}{0\cdot413}Q \qquad r=0\cdot750 \qquad (1)$$

$$P^* = \underset{(0\cdot363)}{0\cdot905} + \underset{(0\cdot061)}{0\cdot387}Q \qquad r=0\cdot707 \qquad (2)$$

where Q, P, P^* represent the average annual rates of growth of volume of output, output per man-hour and output per weighted man-hour, respectively.

11. The reasons for excluding this industry were discussed in Kennedy (*JSSISI*).

TABLE 6: *Coefficients of Correlation (r) Between Certain Variables in Table 5*[1]

	(1) *Volume of Output*	(2) *Man-hours*	(3) *Weighted Man-hours*	(4) *Output per Man-hour*	(5) *Output per Weighted Man-hour*	(6) *Salaries and Wages per Man-hour*	(7) *Salaries and Wages per Weighted Man-hour*
(1) Volume of Output		0·84	0·83	0·75	0·71	0·19	0·05
(2) Man-hours	0·84		0·991	0·27		0·09	
(3) Weighted Man-hours	0·83	0·991			0·20		—0·10
(4) Output per Man-hour	0·75	0·27			0·984	0·23	
(5) Output per Weighted Man-hour	0·71		0·20	0·984			0·21
(6) Salaries and Wages per Man-hour	0·19	0·09		0·23			0·80
(7) Salaries and Wages per Weighted Man-hour	0·05		—0·10		0·21	0·80	

1. Based on 43 industries, Shipbuilding being omitted. 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.

The two equations are very similar and the size of the regression coefficient in both is close to the range postulated by Verdoorn.

The two measures of changes in average earnings are also highly correlated, though the correlation is considerably less than that between the two measures of changes in labour productivity. It was pointed out in Kennedy (*JSSISI*) that there was only a small, non-significant, positive correlation between changes in output per man-hour and earnings per man-hour, and as may be seen from Table 6 the correlation is reduced slightly when account is taken in the measure of labour input of changes in the composition of workers. A reduction in the correlation is to be expected, of course, since an increase in the proportion of more highly-paid workers involves a rise in output per man-hour as well as in earnings per man-hour compared with the corresponding measures using weighted man-hours, and likewise a fall in the proportion of more highly-paid workers involves a lower rise in output per man-hour and in earnings per man-hour.

The small non-significant positive correlation between changes in output and in earnings per man-hour practically disappears when the effect on earnings movements of changes in the composition of workers is excluded. Neither is there any significant correlation between changes in labour input and average earnings, regardless of whether or not allowance is made for changes in the composition of workers. Looking at the position of the two most important classes of wage-earners, adult males and adult females, there was no correlation in either case across industries between changes in man-hours and in earnings per man-hour.[12] It may be noted that in over two-thirds of the industries, hourly earnings of adult female wage-earners rose more than hourly earnings of adult male wage-earners, though the differences in general were not large. On the other hand, as already pointed out, adult male employment (and total man-hours) rose considerably more rapidly than adult female employment (and total man-hours) in most industries. Thus, in the majority of industries, relative changes in the earnings of adult male and female wage-earners moved in the opposite direction to relative changes in man-hours worked by adult male and female wage-earners. This broad tendency, however, did not hold systematically *across* industries: the rank correlation between changes in relative earnings and changes in relative man-hours worked was only −0·11, not significant at the 5 per cent level. In any event, as already mentioned, the difference in most industries between changes in average earnings of adult male and adult female wage-earners was small, and since there was some positive correlation across industries between the earnings movements of the two classes,[13] the variation in the movements of relative earnings of the two classes among industries was small.

12. The rank correlation between changes in man-hours and earnings per man-hour for adult male wage-earners was —0.17 and for adult females 0.04. Both of these correlations are based on 38 industries, 6 industries being excluded which had only a very small number of adult female wage-earners.

13. The rank correlation between changes in hourly earnings of adult male and adult female wage-earners for 38 industries was 0.38, significant at the 5 per cent level.

Total Manufacturing

For Manufacturing as a whole the average annual rate of change from 1953 to 1966 in man-hours unweighted was 1·32 per cent per annum. Allowance for changes in the composition of labour *between* industries can be made by weighting the changes in man-hours in each industry using the share of the industry's salaries and wages in total salaries and wages. This also gives a rate of 1·32 per cent per annum, so that changes in the composition of workers between industries had, on balance, no perceptible effect on the growth of total labour input. However, changes in the composition of workers *within* industries did have an appreciable, though not a large, effect on the growth of labour input; combining the rates of change in weighted man-hours in the individual industries on the basis of their share in total earnings gives an average annual rate of growth of labour input of 1·62 per cent. Thus, changes in the composition of labour within industries involved a rise in labour input of about one-third of one per cent per annum. Thus, of the total rise in output per man-hour of 3·1 per cent per annum and in earnings per man-hour of 6·2 per cent per annum, in both cases about one-third of one per cent per annum can be accounted for by changes in the composition of labour.

Conclusions

For manufacturing as a whole a small part of the rise in labour productivity and in average earnings from 1953–1966 can be explained by shifts in the composition of workers within industries. In some individual industries, however, changes in the composition of workers involved a sizeable change in labour input. In industries generally the share of salaried workers in the total has risen, and in the majority of industries there has been a fall—in several industries, a substantial fall—in the share of adult female wage-earners. Taking account of changes in the composition of labour in measuring labour input does not, however, affect earlier findings concerning the association between movements in output and productivity, the small variation in changes in average earnings, or the lack of significant correlation between movements in average earnings and movements in productivity, or in labour input or in output.

APPENDIX

The data on changes in weighted man-hours in Table 5 were derived as follows. Data are given in the *Census of Industrial Production* for a week in October each year on numbers of wage-earners in each industry distinguished into four categories (i) males under 18 years of age, (ii) males aged 18 and over, (iii) females under 18 years, and (iv) females aged 18 and over. Data are also given on average hours worked by each of these classes and their average hourly earnings in the same week. The total number of wage-earners in October differs slightly from the annual figure for total

wage-earners included in "persons engaged" in each industry, which is the average of wage-earners engaged in a week in each month of the year. The first step in the calculation was to divide the annual figure for total wage-earners in 1953 and 1966 into the four categories of wage-earners mentioned using the proportions available for October. The numbers so derived for the four categories of workers in each of the two years were then multiplied by the corresponding average weekly hours worked by each class in a week in October in the same year. The man-hours data for the four categories in each of the years were then multiplied by the corresponding average hourly earnings in each category in 1953. Summing the results for each year and dividing the 1953 total into the 1966 total gives an index of weighted man-hours worked by wage-earners.

For salaried workers, the number included in the annual figure of persons engaged is the October figure. This figure is divided on an age-sex basis as in the case of wage-earners, but the number of salaried workers under 18 years is so small in all industries that there would be little point in weighting them separately. Unfortunately, no data are available on average hours worked by salaried workers, nor is there any information on earnings of salaried workers other than the annual total of salaries. Changes in total salaried employment were here adjusted for changes in hours, as in the case of the index of man-hours unweighted, using the average figure for wage-earners as a whole. The index of total man-hours worked by salaried workers was then combined with the index of weighted man-hours worked by wage-earners, derived as explained in the previous paragraph, using as weights the annual totals for salaries and for wages and earnings in 1953. Had separate earnings data been available for male salaried workers and female salaried workers, it would have been desirable to weight separately changes in man-hours worked by these classes. However, since the weights for male and female salaried workers taken together were less than 25 per cent in most industries and since in fact there were not generally large differences in the rates of change in male salaried workers as compared with female salaried workers, the results would not be substantially different even if these two classes were separately weighted.

The data on output per weighted man-hour were derived by dividing the index of volume of output by the index of weighted man-hours. Likewise, the data on salaries and wages per weighted man-hour were derived by dividing the index of total salaries and wages by the index of weighted man-hours.