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*by*

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# A Method of Estimating the Stock of Capital in Northern Ireland Manufacturing Industry; Limitations and Application

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C. W. JEFFERSON*

In Northern Ireland the Government has, since 1953, offered grants to encourage capital expenditure in manufacturing industry. The rates of grant have been, until recently, considerably higher than anywhere else in the United Kingdom and have been the main part of a programme of financial assistance to industry which attempts to increase employment by attracting new firms or helping existing firms to expand. An assessment of how the stock of capital in the various sectors of manufacturing industry has been expanding and how the pattern of growth has been affected by the capital subsidies may have important lessons for future employment policy.

The concept of capital stock, either net or gross, is far from straightforward and its estimation, even with the best possible data, leaves much to be desired. In Northern Ireland the problem is intensified by the absence of data on capital expenditure before 1949. To the author's knowledge no estimates of capital stock for Northern Ireland have yet been published. This paper attempts to estimate the order of magnitude of the stock of capital in the manufacturing sectors and to test these estimates for their sensitivity according to variations in the assumptions made. The pattern of growth in the various sectors is considered to discover the implications for future policy.

**The Concept of Capital Stock**

Capital stock at any point in time is comprised of investments from past years. The sum of these capital expenditures less the value of assets retired at constant prices, over the estimated lengths of life of the assets is normally termed "Gross Capital Stock". This concept is not always of practical use unless we have some idea about the amounts of these investments which have been used to maintain existing capacity, the age of the assets themselves, the intensity at which they have been used and the extent to which they have become obsolete. A measure of "Capital Consumption" is an attempt to place a value on this erosion of gross capital stock. Subtracting accrued capital consumption from gross capital stock gives us a measure of the "productive" value of capital which is termed "Net Capital Stock".

This measure differs from the accountants' book value of assets which is comprised of depreciated historic costs summed at original prices. Rates of depreciation tend to be conservative so that the book value of assets often becomes zero long before the asset is retired. This accounting figure does not provide the economist with a usable value of capital stock. The concepts of capital stock of interest to economists are associated with the assessment of productive capacity and with the stock of expected future services. The gross figure is probably closer to the former and the net figure to the latter though the precise meaning of either depends to a large extent on the sophistication of the treatment used to change the price basis of the various years' capital expenditures.

The approach used below to estimate net capital stock is based on the perpetual inventory method. This is a method of estimating gross capital stock and capital consumption from previous years' gross capital expenditures. It was first applied to data for the United Kingdom by Philip Redfern in a paper entitled "Net

*C. W. Jefferson, of the Department of Economics, The Queen's University, Belfast, was associated with The Economic and Social Research Institute during the Summer 1968. The paper has been accepted for publication by the Institute. The author is responsible for the contents of the paper including the views expressed therein.

Investment in Fixed Assets in the United Kingdom, 1938-1953".[1] Redfern's estimates were revised and modified in the light of further discussion and published in a paper by Geoffrey Dean entitled "The Stock of Fixed Capital in the United Kingdom in 1961".[2] The official estimates of gross capital stock and capital consumption which were first published in the 1964 National Income and Expenditure Blue Book are in fact Dean's figures.

The main alternative to the perpetual inventory method is the capital census approach. This direct method of measurement was attempted on a sample basis for the United Kingdom by Tibor Barna.[3] He obtained fire insurance valuations from the sample firms and after necessary adjustments took them as equivalent to replacement cost new. From the replacement cost figures capital per employee was calculated and the estimates for industry groups obtained by grossing up over the total number of employees. Replacement cost new may be regarded as the same as gross capital stock. This approach can provide a much needed check to the perpetual inventory results.

The perpetual inventory method adopts the accounting practice of speading the value of an asset over a pre-determined life, thereby implying that in buying a capital asset one is acquiring a store of productive capacity which is consumed over a period of years and is completely exhausted at the end of its expected productive life. The "straight-line" method of depreciation assumes assets render their services in equal amounts throughout their expected lives, (e.g. one-thirtieth of the original cost of the asset per year if its expected life is 30 years). This is the method of depreciation used here and also in Dean's and Redfern's papers. Annual capital consumption is the sum of the individual depreciations of all assets in a year.

Clearly this straight-line method is better suited to some assets than to others. It can be argued that an asset, if properly maintained, retains its full value in the productive process throughout its productive life until it is scrapped and its value goes directly to zero. This, however, takes no account of the expected future services or the qualitative aspects of capital assets. The ageing of assets and gradual obsolescence will substantially determine the value of an asset. Clearly, with the ageing of an asset its efficiency is likely to decline and costs of maintenance are likely to increase. Even more important, in a period of rapid technological change, if new assets are produced at the same real cost as the old ones but have a greater productive capacity, the value of the old machine must be lowered. Price indices constructed for a particular type of machinery may be sophisticated enough to incorporate technological change but general indices of capital do not incorporate these qualitative refinements. Consequently the measure of gross capital stock normally calculated is too high to represent capacity and net capital stock lies somewhere between productive capacity and the stock of expected future services.

The method used by Redfern and Dean cannot be applied in a straightforward manner to Northern Ireland. Whereas they were able to estimate or obtain estimates of gross capital expenditure back over the assumed length of life of the assets, figures on capital expenditure or their estimates in Northern Ireland are not available before 1949. Such figures as there are in the early Censuses of Production provide little useful evidence concerning gross capital expenditure. Ordinarily one would not consider a knowledge of 16 years capital expenditure sufficient to estimate capital stock, but using the perpetual inventory method in association with an assumption regarding capital output ratios, estimates of net capital stock have been attempted. The assumption is that the capital output ratio[4] in Northern Ireland industry groups changed to the same extent as that in the corresponding United Kingdom industries during the years 1949-1964. It is also implied that the rates of capital utilization changed to the same extent over the period. The reasonableness of these assumptions and the effects on the estimates of altering them will be discussed below.

**Gross Capital Expenditure**

Estimates of the capital stock of (a) buildings, and (b) plant and machinery for the various sectors[5] of Manufacturing industry have been calculated. Figures of gross capital expenditure were not immediately available in the form required so it was necessary to calculate them using the Census of Production capital expenditure figures, along with other figures provided by the Ministry of Commerce.

The figures of capital expenditure shown in the

[1] *Journal of the Royal Statistical Society*, Series A (General) Vol.118, Part 2, 1955.

[2] *Journal of the Royal Statistical Society*, Series A (General) Vol.127, Part 3, 1964.

[3] *Journal of the Royal Statistical Society*, Series A (General) Vol.120 Part. 1, 1957.

[4] The capital output ratio is defined here as net stock of capital divided by the value of net output at constant prices.

[5] The sectors of the Manufacturing industry were classified according to the report on the Census of Production of Northern Ireland 1963 (H.M.S.O., Belfast).

Census of Production relate to expenditure in the calendar year of those firms employing an average of 25 or more employees. The total cost of plant and machinery, vehicles and new building is shown irrespective of the amount of any contributions or grants payable by the Northern Ireland Government. Capital expenditure by firms not in production or any which has taken place before the calendar year to which the firm's first census relates, is not included in the census figures. Government expenditure on advance factory construction is also excluded.

The figures for gross investment used here were obtained in the following manner. The Census figures were firstly grossed up to estimate the "all firms" figures using employment percentages[6] and to these figures were added the capital expenditure of firms prior to the commencement of production.[7] Figures of the cost of advance factories were included and classified according to dates of occupation. Thus the cost of a factory completed in the year x and first occupied in the year (x+1) by a particular firm would be included with the figure of gross investment in the year (x+1) for the sector to which the firm belonged. This produces fluctuations in the gross investment series. However, it seems reasonable to include the total cost of a factory in the gross investment figure for an industry when that factory has been brought into use rather than the year-by-year cost of the factory before the factory has been allocated to any particular industry. The figure for Total Manufacturing arrived at in this manner, if aggregated over a three or four year period, is equivalent to that in the Northern Ireland *Digest of Statistics*, if similarly aggregated, the differences in the figures being that the Digest figure is an overall figure for buildings and plant and machinery; also the overall figure of Government factory construction for all Manufacturing industry is a yearly figure of the value of work done. The calculated figures of gross investment at current prices are shown in the Appendix in Table 1. The exceptional increase in the figures for buildings between 1956 and 1957 is due mainly to the completion and establishment of one particularly large factory complex in the Engineering industry. The figures were deflated to 1958 prices using the indices shown in Table 2 in the Appendix.[8]

[6]Less than 6 per cent of all employment in the manufacturing sector is not covered by the Census of Production.

[7]The "all firms" percentage adjustment figures, the figures of capital expenditure of firms prior to the commencement of production and the figures of costs and dates of occupation of Government financed advance factories, were all kindly supplied by the Ministry of Commerce.

[8]The price index numbers were supplied by the Statistics Division of the Board of Trade.

**Assumed Length of Life of Assets**

Lengths of life of assets have chosen to be comparable with the official figures. In the Appendix of Dean's paper the distribution of plant and machinery in the United Kingdom according to assumed length of life by industry is shown.[9] The weighted average length of life for Manufacturing and Construction excluding Textiles is just over 30 years and the individual orders are in the vicinity of 30 years. In this study, in the absence of a detailed knowledge of the composition of these assets, the assumed average length of life for all plant and machinery is 30 years. An average life of 80 years has been assumed for buildings. This is the figure used by Dean. It is worth mentioning that using the straight-line perpetual inventory method, errors in estimating the length of life of assets may not greatly affect the estimates of total capital consumption in a given year. If the length of life is underestimated then capital consumption for each asset will be over-stated each year but since the asset will drop out of the gross capital stock sooner the error will be compensated for, to some extent, by the fact that total capital consumption will be based on too few assets.

**The Method**

*General*

The net stock of capital in 1964 can be subdivided into two distinct groups. Firstly, the remainder of the stock of capital which existed in 1949 and had been purchased prior to 1949. This 'pre 1949' stock of capital will have gradually diminished over the years till in 1964 it will be considerably smaller than it was in 1949. Secondly, the gross investment which has taken place from 1949 to 1964 is considered separately from the 'pre 1949' stock of capital. Net investment is calculated from gross investment in these years as if the 'pre 1949' stock of capital did not exist. The net stock of 'since 1949' capital (in isolation)

TABLE 1: CALCULATION OF THE 'SINCE 1949' NET CAPITAL STOCK

£ MILLION

| Year | Gross Investment During Year | Gross Capital Stock at End of Year | Capital Consumption i.e. 1/30th of G.C.S. | Net Investment | Net Stock of Capital 'Since 1949' |
|---|---|---|---|---|---|
| 1949 | 30 | 30 | 1 | 29 | 29 |
| 1950 | 30 | 60 | 2 | 28 | 57 |
| 1951 | 30 | 90 | 3 | 27 | 84 |

[9]Geoffrey Dean, *op. cit.*, Appendix to Section 2, Table 1.

can be obtained by summing up individual years' net investments. Thus if gross investment in machinery during 1949–1951 is, for example, £30 million each year, capital consumption will be one-thirtieth of gross capital stock so that in 1951 capital consumption will be £3 million and net investment will be £28 million. It can best be shown in Table 1.

Thus the total net stock of capital in 1964 comprises the remainder of the 'pre 1949' net capital stock and the 'since 1949' net capital stock considered in isolation. In symbols it can be written as:

$$K_{1964} = K'_p + K'_s \qquad (1)$$

The 'since 1949' net stock of capital existing in 1964, $K'_s$ can be calculated, as shown above, from the gross investment data for 1949 to 1964. The remainder of the 'pre 1949' stock of capital in 1964 can be written as:

$$K'_p = f.K'_{1949} \qquad (2)$$

Where $K'_{1949}$ is the net stock of 'pre 1949' capital existing at the end of 1949 and f represents the fraction of $K'_{1949}$ remaining in 1964. It is necessary to estimate $K'_p$ through f and $K'_{1949}$. The assumption mentioned above, that the capital output ratio for Northern Ireland changed by the same proportion as that for the United Kingdom, can be employed to obtain $K'_{1949}$, using a value for f which can reasonably be assumed to lie within certain percentage limits discussed below. The changes in the capital output ratios for the United Kingdom were calculated using the Index of Industrial Production[10] as a measure of net output and figures for the net stock of capital were arrived at from the figures of gross capital stock given in the National Income and Expenditure Blue Book in conjunction with an extrapolation of Dean's figures of capital consumption.[11] Table 3 in the Appendix shows the calculated figures. In Northern Ireland the index of Industrial Production for Northern Ireland[12] was used as the measure of output.

The total net stock of capital at the end of 1949 is equal to the net stock of 'pre 1949' capital plus net investment in 1949, where net investment is calculated as in Table 1 above; in symbols:

$$K_{1949} = K'_{1949} + NI'_{1949} \qquad (3)$$

The relationship for Northern Ireland can then be expressed as:

$$\frac{\text{Total Net Stock of Capital in 1964}}{\text{Net Output in 1964}} \Big/ \frac{\text{Total Net Stock of Capital in 1949}}{\text{Net Output in 1949}} = C$$

Where C is the ratio of the average capital output ratio in 1964 to 1949 calculated for the United Kingdom (1949 taken as unity). Rewriting in the symbols used above:

$$\frac{f.K'_{1949} + K'_s}{Q_{1964}} \Big/ \frac{K'_{1949} + NI'_{1949}}{Q_{1949}} = C \qquad (4)$$

In equation 4, $K'_s$, $NI'_{1949}$, $Q_{1949}$, $Q_{1964}$ and C are all known. The only two unknowns are f and $K'_{1949}$. If we can arrive at a value for f then we can obtain $K'_{1949}$ from this equation. With an assumed value of f and the calculated $K'_{1949}$ we can reduce the net stock of 'pre 1949' capital year-by-year up to 1964. If these figures are added to the 'since 1949' net stock of capital this will give the estimated total net stock of capital for the years 1949 to 1964.

*Particular*

In an attempt to avoid some of the bias inherent in the relationship between two individual years, i.e. 1949 and 1964, averages of the two four-year periods 1949-1952 and 1961-1964 were used. This should eliminate the possibility of peculiar movements in a particular year and establish a better trend relationship. In principle, Equation 4 is unaltered. In it, each reference to the years 1949 and 1964 can be simply taken as referring to the averages of the two four-year periods. The equation, adapted for the four-year periods, is shown in the explanation of Table 4 in the Appendix.

In order to arrive at a value for f, the operation

[10]Source: *Monthly Digest of Statistics, Annual Abstract of Statistics.*

[11]Table IV, Appendix to Section III of Dean's paper contains estimates of capital consumption for the manufacturing orders for buildings and plant and machinery. These yearly figures were extrapolated backwards over the assumed average length of life of the assets and estimates of accrued capital consumption were obtained for the years under consideration. By deducting these figures of accrued capital consumption from the figures of gross capital stock, estimates of net capital stock were obtained.

[12]Source: *Digest of Statistics,* Northern Ireland, (H.M.S.O., Belfast).

of the perpetual inventory method needs to be considered. Looking firstly at buildings, the amount of capital consumption taking place is assumed to be one-eightieth of the gross capital stock in any particular year. We do not know the gross capital stock in any year but we can, within certain broad limits derive a relationship between gross capital stock and net capital stock. The net stock of capital (buildings) will depend on the pattern of gross investment over the previous 80 years. Given a fixed amount of total gross investment over an eighty-year period, net capital stock will be low or high depending on whether the greater part of that gross investment took place in the early or later years. Various series of gross investment were used in order to calculate relationships of net to gross investment and some of these are shown in Table 2.

TABLE 2: NET CAPITAL STOCK OF BUILDINGS EXPRESSED AS A PERCENTAGE OF GROSS STOCK

| Assumption | Proportionate Gross Investment at Constant Prices | | | | 1949 Net Stock as a Percentage of Gross Stock |
|---|---|---|---|---|---|
| | 1869-88 | 1889-1908 | 1909-28 | 1929-48 | |
| A | 1 | 1 | 1 | 1 | 49.4 |
| B | 1 | 1 | 2 | 2 | 56.7 |
| C | 1 | 1 | 3 | 3 | 61.9 |
| D | 1 | 1 | 5 | 5 | 66.0 |
| E | 1 | 1 | 10 | 10 | 69.8 |
| F | 1 | 2 | 3 | 4 | 61.2 |

The percentages in the last column were calculated on the assumption that gross investment was constant each year throughout the periods at the stated values. Capital consumption was taken to be one-eightieth per annum. Thus if gross investment in the latter 40 years was twice as high as in the first 40 years then the net stock of buildings in 1949 will be 56.7 per cent of gross stock. Similar calculations were made for plant and machinery using one-thirtieth as the rate of capital consumption. They show similar variation of roughly between 50 per cent and 70 per cent.

The pattern of gross investment in buildings over the past 80 years will be different for each industry. Some useful evidence on it can be found as far back as 1907[13] but beyond this the information is very meagre.[14] However on the basis of such evidence as there is, it seems reasonable to assume for all industries that the total gross investment in the 40 years immediately prior to 1949 was not less than that in the 40 year period prior to 1909 even with the depression in the inter-war years, and that it was not more than 10 times as great. This being so, net capital stock in 1949 is between 50 per cent and 70 per cent of gross capital stock. It was decided to use the mid-value of 60 per cent and it will be shown later that in most cases the choice of any value between 50 per cent and 70 per cent does not greatly alter the overall estimates. Capital consumption of the 'pre 1949' stock of capital will occur at one-eightieth of the gross stock of 'pre 1949' capital per year. In 1949 it will be one-eightieth of the gross stock of capital in that year or since net stock is being taken as 60 per cent of gross stock it will be one-forty-eighth of net stock, i.e. $(\frac{1}{80} \times \frac{100}{60} = \frac{1}{48})$. This gross stock of 'pre 1949' capital will reduce each year from 1949 to 1964 but there is no way of telling by how much. However, since the length of life of buildings is 80 years, it will not have fallen very greatly during the 16 years from 1949 to 1964. Bearing this in mind capital consumption of the 'pre 1949' stock of capital was taken for all the years 1949 to 1964 as equal to that in 1949. This should not greatly affect the estimates. Thus in the year 1950 f in Equation 5 in the explanation to Table 4 in the Appendix will equal $(1 - \frac{1}{48})$ i.e. $\frac{47}{48}$ and in 1964 it will equal $(1 - \frac{15}{48})$ i.e. $\frac{33}{48}$ of the net stock of 'pre 1949' buildings existing at the end of 1949.

This approach cannot be simply applied to plant and machinery because the assumed length of life being 30 years, gross stock of 'pre 1949' capital will be much smaller in 1964 than in 1949. If the above procedure of reducing the net 'pre 1949' stock by one-eighteenth per year i.e. $(\frac{1}{30} \times \frac{100}{60})$ were applied, then it would be reduced to almost zero by 1964. This would clearly be an overestimate of the capital consumption. In order to avoid this, capital consumption was calculated as above for the first 8 years and then calculated on the assumption that the gross stock of 'pre 1949' capital was reduced to half for the remainder of the period. On this basis, f for plant and machinery in 1950 will be $(1 - \frac{1}{18})$ i.e. $\frac{17}{18}$ and in 1964 will be $(1 - \frac{23}{36})$ i.e. $\frac{13}{36}$. The old stock will be about two-thirds exhausted by 1964. This situation would occur if gross investment in the 30 years preceding 1949 had been in the later years about twice that in the earlier years. This method overestimates capital consumption in the mid-1950's and consequently underestimates total net capital stock in those years. This could be overcome by a reducing balance system wherein the gross 'pre 1949' stock of capital in 1949 reduces in the form of a geometric progression. However,

[13]1907 Census of Production for the United Kingdom of Great Britain and Ireland, H.M.S.O.

[14]Succeeding censuses provide information which enables estimates of expenditure on buildings to be made for industries in particular years in the 1920's and 1930's.

it was decided for the sake of simplicity to keep to the straight-line method described above.

The assumption that the capital output ratios in Northern Ireland changed to the same extent as the comparable United Kingdom groups cannot be wholly justified. For example, the composition of the trades within the corresponding industrial groups may differ. Secondly, the capital output ratio used here, i.e. net capital stock divided by net output, can be altered by a rapid expansion in an industry. A new factory with the same output as a similar old one will have a higher net capital output ratio so that with a rapid expansion net capital stock will increase proportionately more than output even though the technology has remained unaltered. However, in most cases similar movements in the groups as a whole will tend to occur. Some groups will be growing rapidly others declining and others experiencing rapid technical change. The figures of capital expenditure in both countries show similar patterns.

The consequences of altering the assumptions were considered and the estimates recalculated using different assumptions. The results of these alterations and the reasonableness of the assumptions are discussed below.

**The Results and Their Significance**

The actual computations for buildings in the Food, Drink and Tobacco sector are shown in the Appendix in Table 4 and the explanation following. Consideration of this should help in understanding the method. Estimates of the net stock of capital in Northern Ireland Manufacturing industry are shown in Table 3.

It is obvious that these figures can only be regarded as estimating broad orders of magnitude. Their worth clearly depends on the validity of the assumptions made in their calculation and the extent to which errors in these assumptions affect the final figures. Table 5 in the Appendix sets out percentage alterations in the estimates when the assumptions are varied. The recalculations were made firstly with the net stock of capital in 1949 taken as 50 per cent of the gross stock and then as 70 per cent of gross stock. These represent the extreme limits as shown in Table 2. The figures of net capital stock were again calculated varying the U.K. value for the change in the capital output ratios by 10 per cent in either direction. How realistic is it to allow a 10 per cent variation in the value of C? The C value for buildings with the exception of Leather, Clothing and Other Manufacturing does not vary much from 1.00. In most cases the C value for buildings is closer to 1.00 than for plant and machinery. This suggests a fairly stable relationship between output and the amount of buildings needed for its production. With this constancy in the relationship, a 10 per cent variation in either direction would seem to be reasonable to allow for a discrepancy between N.I. and U.K. The C values for plant and machinery as might be expected, vary more than those for buildings and consequently there may be more discrepancy between N.I. and U.K. The figure of 10 per cent was used and the percentage variations in the 1964 estimates are sufficiently small to permit further discrepancy without seriously damaging the estimates.

The variation in the estimates of Total Manufacturing shows an unduly pessimistic picture. It shows the variations as if the assumptions for all the individual orders varied in the same direction by the amounts at the head of each column. Clearly this is unrealistic. Some will tend to vary in one direction and some the other, so that the resulting accumulated discrepancies are likely to cancel out to a large extent. Looking firstly at plant and machinery we see that the changed assumption of the ratio of net to gross stock in 1949 affects the estimates for 1949 and 1964 equally, while the changes in C affect the estimates for 1949 much more than those for 1964. In 1964 greater variation is caused by the (net to gross stock) assumption than by the changes in C. The best results, i.e. those with the least variation, are Mineral Products and Other Manufacturing though most fare tolerably well.

The estimates for buildings are not as good as those for plant and machinery. The changes in the (net to gross stock) assumption affect the estimates less than changes in the C value. In fact the estimates of buildings are less affected by changes in the (net to gross stock) assumption than the estimates of plant and machinery. Changes in the value of C have a much more harmful effect particularly in 1949. The variation in Timber and Furniture, Clothing and Textiles is so large as to make the use of estimates in these individual industries very suspect. The apparent constancy in the relationship between output and buildings to some extent helps to support the poorer overall results. Again Mineral Products and Other Manufacturing show up particularly well.

Why should the method produce better results for some industries than others and why should the estimates of plant and machinery react differently to changes in the two assumptions from the estimates of buildings? The industries which fare best are those in which the total net

TABLE 3: NET STOCK OF CAPITAL IN NORTHERN IRELAND MANUFACTURING INDUSTRY
£ MILLION AT 1958 PRICES

| | Buildings | | | | | | Plant and Machinery | | | | | | Total | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1949 | 1960 | 1961 | 1962 | 1963 | 1964 | 1949 | 1960 | 1961 | 1962 | 1963 | 1964 | 1949 | 1960 | 1961 | 1962 | 1963 | 1964 |
| Food, Drink & Tobacco | 10·2 | 19·7 | 20·4 | 20·9 | 21·3 | 22·7 | 10·7 | 21·1 | 22·2 | 23·8 | 24·9 | 27·4 | 20·9 | 40·8 | 42·6 | 44·7 | 46·2 | 50·1 |
| Mineral Products | 1·1 | 2·6 | 2·8 | 3·1 | 3·1 | 3·2 | 1·8 | 4·9 | 5·4 | 5·7 | 6·0 | 6·2 | 2·9 | 7·5 | 8·2 | 8·8 | 9·1 | 9·4 |
| Timber & Furniture | 3·2 | 3·4 | 3·3 | 3·4 | 3·8 | 4·1 | 0·9 | 1·3 | 1·3 | 1·5 | 1·6 | 1·8 | 4·1 | 4·7 | 4·6 | 4·9 | 5·4 | 5·9 |
| Engineering | 29·0 | 37·8 | 39·0 | 40·0 | 40·4 | 41·9 | 50·8 | 46·6 | 49·0 | 51·4 | 54·6 | 57·1 | 79·8 | 84·4 | 88·0 | 91·4 | 95·0 | 99·0 |
| Clothing | 7·2 | 8·2 | 8·6 | 8·8 | 9·1 | 9·7 | 3·7 | 3·9 | 4·1 | 4·2 | 4·4 | 4·7 | 10·9 | 12·1 | 12·7 | 13·0 | 13·5 | 14·4 |
| Paper, Printing & Publishing | 1·0 | 1·5 | 1·6 | 1·6 | 1·9 | 2·0 | 3·3 | 3·8 | 4·0 | 4·2 | 4·6 | 4·9 | 4·3 | 5·3 | 5·6 | 5·8 | 6·5 | 6·9 |
| Textiles | 30·1 | 36·0 | 35·8 | 36·9 | 37·1 | 37·5 | 41·0 | 48·2 | 48·2 | 50·1 | 52·4 | 56·5 | 71·1 | 84·2 | 84·0 | 87·0 | 89·5 | 94·0 |
| Other Manufacturing | 2·1 | 7·5 | 8·4 | 10·1 | 14·4 | 17·7 | 2·7 | 10·2 | 11·1 | 14·8 | 17·4 | 20·8 | 4·8 | 17·7 | 19·5 | 24·9 | 31·8 | 38·5 |
| *Total Manufacturing | 84·0 | 116·7 | 119·9 | 124·8 | 131·0 | 138·9 | 114·9 | 140·0 | 145·3 | 155·7 | 166·0 | 179·4 | 198·9 | 256·7 | 265·2 | 280·5 | 297·0 | 318·3 |

*The figures for Total Manufacturing were obtained by summing the figures for individual orders.

stock of capital in 1964 comprises a high proportion of 'since 1949' capital, in other words those industries with high capital growth rates in the post-1949 years. Those industries with a slow rate of capital growth show up badly.

The important difference between buildings and plant and machinery lies in their different lengths of life. The sixteen years from 1949 to 1964 will have exhausted a much higher proportion of the 'pre 1949' plant and machinery than the 'pre 1949' buildings. Because of this, changes in C will cause greater variation in buildings where the pre-1949 stock existing in 1964 is proportionately greater than in plant and machinery. Why should changes in the (net to gross stock) assumption affect buildings less than plant and machinery? The value of f is affected to a greater extent in plant and machinery by a change in this assumption than in buildings, thus causing greater variation in plant and machinery.

The implication that the rates of capital utilisation varied throughout the period to the same extent in comparable sectors in Northern Ireland and the United Kingdom needs to be considered. A study of employment figures suggested little need for concern in most sectors. Engineering and Textiles are the exceptions. Employment in Engineering in the years 1961-64 fell more than 10 per cent below the level of the preceding years. This suggests a fall in the rate of capital utilisation and it is not accompanied by a similar movement in the United Kingdom. Thus the C value for the United Kingdom is likely to be lower than for Northern Ireland; but by how much? It is likely that a fall in employment will be accompanied by a smaller drop in output. Businessmen will first cut back on the least productive processes and equipment. Thus if the existing stock of capital were utilized output should be higher but probably by less than 10 per cent. This is equivalent to saying that the C value for Northern Ireland should be higher than that for the United Kingdom by somewhat less than 10 per cent. The estimates for Engineering in Northern Ireland should probably be at the lower end of the range of variation shown in Table 5 in the Appendix. The numbers employed in the Textile industry have been falling throughout the period. This has been due to the decline in the Linen industry. It has been accompanied by a growth in the non-linen sector and a considerable process of rationalisation in the industry as a whole. In the absence of a comparable United Kingdom figure to use for guidance the value of C was taken as 1.00 for both buildings and plant and machinery. This is probably on the low side and so overestimates the stock of capital in Textiles but there is no way of telling by how much.

Table 6 in the Appendix shows estimates of capital consumption for plant and machinery and buildings. They are obtained by totalling the figures for the old stock of capital and the new stock. These estimates can easily be carried forward but the capital consumption of the stock of old buildings would need readjusting to allow for the reducing gross capital stock of 'pre 1949' buildings.

**Application**

One of the reasons for computing estimates of capital stock was to determine whether any pattern of growth could be distinguished and to see if any implications for employment policy can be drawn from it.

Looking at the indices of net capital stock for Northern Ireland shown in Table 4 the sectors with the greatest increase in capital stock are Other Manufacturing, Mineral Products and Food, Drink and Tobacco, the phenomenal increase in Other Manufacturing being almost entirely in Chemicals. Engineering, Clothing and Textiles are the sectors with the slowest rates of growth. In the United Kingdom, Chemicals, Bricks, Pottery, Glass etc., Food, Drink and Tobacco and Iron and Steel show the greatest increases but none of these are as high as the comparable sectors in Northern Ireland.

TABLE 4: INDICES OF TOTAL NET CAPITAL STOCK 1959 AND 1964
1949=100

| Northern Ireland | 1959 | 1964 | United Kingdom | 1959 | 1964 |
|---|---|---|---|---|---|
| Food, Drink & Tobacco | 182.1 | 239.3 | Food, Drink & Tobacco | 141.0 | 171.9 |
| Mineral Products | 234.1 | 330.1 | Bricks, Pottery, Glass, etc. | 140.3 | 189.7 |
| Timber & Furniture | 111.1 | 142.6 | Timber & Furniture | 140.0 | 159.1 |
| Engineering | 102.4 | 123.6 | Metal-using Industries | 133.8 | 138.6 |
| Clothing | 109.9 | 132.9 | Leather, Clothing and Other Manufacturing | 96.5 | 101.5 |
| Paper, Printing & Publishing | 114.9 | 162.0 | Paper, Printing & Publishing | 120.1 | 136.0 |
| Textiles | 117.5 | 132.1 | Iron & Steel | 137.8 | 172.4 |
| Other Manufacturing | 296.8 | 806.9 | Chemicals & Allied Industries | 198.2 | 228.5 |
| Total Manufacturing | 128.5 | 159.9 | Total Manufacturing Excluding Textiles | 140.2 | 157.3 |

The rate of increase in net stock in Total Manufacturing in Northern Ireland is much greater from 1959 onwards than in earlier years.

TABLE 5: NET CAPITAL STOCK PER EMPLOYEE AT 1958 PRICES

£ thousand

| Northern Ireland | 1949 | 1959 | 1964 | United Kingdom | 1949 | 1959 | 1964 |
|---|---|---|---|---|---|---|---|
| Food, Drink and Tobacco | 1·0 | 1·5 | 1·8 | Food, Drink and Tobacco | 1·2 | 1·4 | 1·7 |
| Mineral Products | 0·8 | 1·8 | 2·4 | Bricks, Pottery, Glass, etc. | 0·9 | 1·2 | 1·5 |
| Timber and Furniture | 0·7 | 1·0 | 1·3 | Timber and Furniture | 0·4 | 0·6 | 0·6 |
| Engineering | 1·7 | 1·6 | 2·1 | Metal-using Industries | 1·1 | 1·2 | 1·2 |
| Clothing | 0·4 | 0·5 | 0·6 | Leather, Clothing and Other Manufacturing | 0·6 | 0·6 | 0·6 |
| Paper, Printing and Publishing | 0·7 | 0·9 | 1·1 | Paper, Printing and Publishing | 1·4 | 1·4 | 1·5 |
| Textiles | 0·9 | 1·4 | 1·8 | Iron and Steel | 2·0 | 2·8 | 3·2 |
| Other Manufacturing | — | 2·7 | 4·4 | Chemicals and Allied Industries | 2·3 | 3·9 | 4·5 |
| Total Manufacturing | 1·06 | 1·42 | 1·80 | Total Manufacturing excluding textiles | 1·15 | 1·36 | 1·50 |

*Source:* Labour figures—Northern Ireland *Digest of Statistics* and Ministry of Commerce, *Monthly Digest of Statistics and Annual Abstract of Statistics*. Capital figures—United Kingdom, estimated from Dean, *op. cit.*, as described above.

In the United Kingdom as a whole this is not the case. This growth can at least partly be attributed to the increased expenditure on capital grants in the late 'fifties and 'sixties and to the greatly expanded programme of Government financed factory construction.

One question which requires answering for purposes of policy-making is whether there is a connection between the capital intensity[15] of an industry and the rate of expansion of that industry in Northern Ireland. Table 5 shows the net stock of capital per employee in Northern Ireland and the United Kingdom.

The actual content of any industrial sector may differ between Northern Ireland and the United Kingdom and this will account for some of the differences in the figures. The overall picture is that during the period under consideration the individual sectors of Manufacturing industry have become more capital intensive. Both sets of figures are broadly similar except for the Engineering and Mineral Products sectors. The higher figures for Mineral Products in Northern Ireland are probably accounted for by the growth of highly capital intensive trades such as cement-making compared with the less capital intensive trades such as pottery ceramics, or slate in Britain. The United Kingdom Engineering figure looks low compared with the other sectors so the ratios of gross capital stock per employee were calculated and the Engineering figures bore a similar relationship to the other sectors as net capital stock per employee. The Northern Ireland figure for 1964 is inflated by unemployment in the industry. The 1959 figure, though it is likely to be on the high side because of the probable overestimate of capital stock mentioned above, gives a more representative figure. It is likely that a higher proportion of employment in the Engineering industry in Northern Ireland is in heavy engineering than in the United Kingdom.

Net capital stock per employee in Total Manufacturing in Northern Ireland increased at a faster rate than in the United Kingdom as a whole even though the respective net capital stocks increased at about the same rate. In Northern Ireland the figure rises from £1.06 thousand in 1949 to £1.80 thousand in 1964 and in the United Kingdom from £1.15 thousand to £1.50 thousand. One reason for this is that while the number of employees in Manufacturing excluding textiles in the United Kingdom rose from 6,651 thousand to 8,040 thousand the number of employees in Total Manufacturing in Northern Ireland fell from 188 thousand to 176 thousand. This decline in numbers can be mainly attributed to the decline in two of Northern Ireland's largest industries, Linen and Shipbuilding. Employment in Textiles over the period fell from 79.8 thousand to 53.4 thousand, employment in Shipbuilding and Marine Engineering falling from 23.8 thousand to 12.1 thousand. It was pointed out above that the net capital stock value of a new asset will be higher than that of a similar older one since, in the computation the new one will have depreciated less than the older one. A rapid growth of capital formation will increase net capital per head in an industry and since the growth of capital expenditure has been much higher in the later years in Northern Ireland this will raise the Northern Ireland figure relative to the United Kingdom. A further reason for the greater increase in Northern Ireland is the higher growth rates in the capital intensive sectors. This may also be relevant in both countries at the individual sector level where the more capital intensive trades may have grown faster than the less capital intensive. In most sectors in both countries

[15]The capital intensity of an industry is taken to be the net capital stock per employee.

labour saving changes in technology will have occurred. Altering the combination of factors in this way will obviously raise the net capital stock per employee ratio. Unfortunately there is no way of separating the effect of the individual causes.

Excluding Engineering and Textiles the most capital intensive sectors in Northern Ireland are Other Manufacturing, Mineral Products and Food, Drink and Tobacco. Both Engineering and Textiles are complicated sectors which would require subdivision before meaningful conclusions could be drawn. These two sectors aside, it is the three most capital intensive industries in 1964 which have had the highest capital growth rates. Similarly in the United Kingdom where the four industries with the fastest capital growth rates have been the most capital intensive.[16]

The growth of an industry implies of course more than just the growth of its capital stock. Table 7 in the Appendix shows indices of net output and numbers employed in manufacturing industries. The pattern of growth is again repeated. Omitting the sub-section Engineering excluding shipbuilding and air-craft, the same three capital intensive industries, Other Manufacturing, Mineral Products and Food, Drink and Tobacco come first, second and fourth in the growth of output and first, third and second in the growth of numbers employed.

In using the estimates of capital stock to consider the contribution of capital to output there is a problem of circularity. In the method of estimation output has been used to estimate capital and while account is taken of changes in the capital output ratio the difficulty is not overcome. Bearing this limitation in mind productivity indices were calculated to see if the pattern of growth of productivity was significant. Calculating changes in labour productivity is a matter of relating the change in output to the change in labour input. All factor productivity indices, however, involve weighting the labour and capital inputs appropriately before relating to changes in output. Nevin[17] in his paper discusses this problem and uses the annual charges of labour and capital as weights. Labour was weighted by the total wage and salary bill in a particular year and the annual charge for capital was taken as the average rate of depreciation plus a pure rate of interest, taken as the average rate of interest on long term Government bonds over the period. In this study the total wage bill for 1958 is used to weight labour input and 10 per cent of capital stock used as the capital input figure.[18] Dividing the index of production by the indices of (a) labour input and (b) all factor input gives the productivity indices. The computed indices are shown in Table 6.

TABLE 6: PRODUCTIVITY INDICES, 1959 AND 1964
1949=100

| | Labour | | All Factors | |
|---|---|---|---|---|
| | 1959 | 1964 | 1959 | 1964 |
| Food, Drink and Tobacco | 134 | 133 | 124 | 117 |
| Mineral Products | 187 | 294 | 163 | 238 |
| Timber and Furniture | 107 | 150 | 101 | 134 |
| Engineering | 121 | 143 | 122 | 135 |
| Clothing | 136 | 164 | 134 | 158 |
| Paper, Printing and Publishing | 150 | 187 | 146 | 116 |
| Textiles | 157 | 200 | 139 | 165 |
| Other Manufacturing | 148 | 292 | 72 | 187 |
| Total Manufacturing | 145 | 186 | 133 | 159 |

As might be expected the labour productivity index is higher in most cases than the corresponding all factor index.[19] The all factor productivity index gives a more useful picture of changes in productivity.[20] The interpretation of even the simplest productivity index is a difficult and complex task for behind changes in productivity lie some or all of the forces of change in economic life. Changes in productivity usually suggest technological change; such as improvements in capital equipment, higher levels of labour training and skills, better organisation. A change in the quality of final output, a change in the level of profit, and many other qualitative changes will also affect productivity. Further, the assumption in the estimates that the capital output ratio changed to the same extent as that in the United Kingdom automatically brings in changes in productivity. Without attemp-

[16]A comparison of net capital stock per employee was attempted with the Republic of Ireland for 1949 and 1959 using estimates of capital stock from Edward Nevin's paper "The Capital Stock of Irish Industry", Paper No. 19, The Economic Research Institute, November 1963. Nevin's figures proved to be on the high side compared with the Northern Ireland and United Kingdom figures above. This was due partly to the inclusion of vehicles in his estimates and probably in part to his taking insurance valuations as equivalent to the written down values of assets at current prices. No discernible relationship between growth of capital stock and capital per employee could be distinguished up to 1959, the most recent year in his estimates.

[17]Nevin, *op. cit.* The labour input index was weighted with the total wages bill in 1953 and the capital input index by 10.3 per cent of the average capital stock over the period 1947 to 1949.

[18]Small variations in the weights chosen have little effect on the productivity indices.

[19]In Nevin's study for the year 1959 with 1947 as base he finds little difference in all manufacturing between the two indices. Individual sectors diverge considerably with, in some cases, the all factors index being much higher than the labour index.

[20]The very low figure for the Other Manufacturing all factor index in 1959 is probably due to the establishment of large factories in 1958 and 1959 which were operating at less than full capacity in 1959.

ting to enumerate all possible causes it is sufficient for the purposes of this paper to state the obvious; that increases in productivity are to be desired.

Table 6 shows that Mineral Products and Other Manufacturing have increased most over the period. They are followed by Textiles and Clothing. The high figure for Textiles is due to the rationalization which has taken place in the industry. A shift from linen to synthetic fibres has been accompanied by a fall off in the numbers employed and a change to more capital intensive processes. It is rather surprising that Clothing should have a high increase in productivity. It may be due to improved quality of the final product and the consequent higher selling price. From these results, growth of productivity is not closely related to capital intensity or the growth of capital stock except in the case of Mineral Products and Other Manufacturing. Increases in productivity come about through change in an industry but this change may accompany growth or decline or some alteration in the final product or other reasons.

**Lessons for Policy**

The growth rates in the capital intensive sectors in Northern Ireland are considerably higher than the comparable sectors in the United Kingdom. This suggests that some special reason exists which encourages their expansion. Financial aid to industry in Northern Ireland is given mainly as grants or loans towards expenditure on fixed capital and it is given on a scale considerably higher than any other part of the United Kingdom. Aid is given on this higher scale in an attempt to offset the disadvantages due to the remoteness of Northern Ireland. New establishments and expanding firms receive most benefit under the Industries Development Acts[21]. For the most part, this assistance takes the form of grants and loans towards capital expenditure and also renting Government built factories at favourable rentals. A firm can only attract assistance under these Acts if there is a clear prospect of increased employment. Under the Capital Grants to Industry Acts the Ministry of Commerce made fixed percentage payments towards capital expenditure at a lower rate on average than the assistance given under the Industrial Development Acts.[22] This form of assistance was an alternative to that above and it did not require that there must be an increase in employment. Other assistance is given in the form of a subsidy on fuel, grants towards employing industrial consultants and partial rating relief.

Capital subsidies would appear to benefit capital intensive industries most and they may encourage fastest growth in these sectors. Do capital subsidies actually have this effect and if so, is it desirable to encourage this pattern of growth when the immediate problem is the employment of surplus labour? These sectors employ relatively little labour so that the cost of increasing direct employment in capital intensive industries appears to be highest. Economic theory tells us that in static conditions one should subsidise labour in order to encourage its use so that a subsidy on labour, as suggested and discussed in the Hall Report[23] might offer a cheaper method of mopping up surplus labour which would yield quicker results.[24] It can also be argued that any help in reducing costs will serve to increase employment and prevent redundancies. But this type of assistance is essentially short term in character; it merely helps to alleviate the problems caused by the existing industrial structure and makes no attempt to improve it. Aid to industry, if it is to achieve its main objective must provide the necessary stimulus for the development of a healthy vigorous industrial sector. There must be diversification from the declining industries to the newer growth industries. The short term problem of increasing employment and preventing redundancies cannot be dismissed, especially with the higher level of unemployment existing in Northern Ireland, but it must take second place to the long term objectives. Theoretically at least the two aims may well be conflicting for by maintaining declining firms in existence with short term measures, resources are tied up which, if freed, could be available for the expansion of the growth industries.

The crucial question for policy is what form of assistance will fulfil the long term objective and still provide short term relief. Subsidies on capital have much to commend them. The bulk of a firm's capital expenditure takes place on its establishment or when the firm is expanding, replacement expenditure is usually of much smaller magnitude. Firms will only invest in capital assets when they foresee successful futures in front of them. Firms in declining industries may invest to diversify but they have no incentive

[21]Industries Development Acts (Northern Ireland) 1945-1966.

[22]Capital Grants to Industry Acts (Northern Ireland) 1954-1966. These Acts have been replaced by the Industrial Investment (General Assistance) Act (Northern Ireland) 1966.

[23]Report of the Joint Working Party on the Economy of Northern Ireland Cmnd.1835, H.M.S.O., London.

[24]Northern Ireland as well as the Development Districts in the United Kingdom now has a labour subsidy in the form of the Regional Employment Premium which was introduced in September 1967. It is a *per capita* payment made to manufacturing firms.

to invest in their present occupation. In Northern Ireland subsidies on capital are selective in two ways: firstly, only firms which are investing in fixed capital receive benefit and secondly, firms which are expanding or new firms obtain greater benefit than firms which are only replacing their assets and not increasing their employment. Thus the fastest growing industries benefit most from capital subsidies and this benefit is further increased when the fastest growing industries are capital intensive as they are in Northern Ireland and in the United Kingdom. The criticism that capital subsidies attract capital intensive firms may be true in Northern Ireland but its truth is due to the coincidence that the fastest growing industries in the United Kingdom as in most countries are capital intensive. If the fastest growing were labour intensive then it is they which would respond best to the capital subsidies. If all other things were equal the attraction would obviously be strongest for capital intensive firms, but all other things are seldom equal.

In a situation where technology is changing to more capital intensive methods the static economic theory would no longer apply. Subsidising capital should help to promote change to the newer techniques. Assistance given regardless of the prospect of increases in employment is particularly important in this respect for encouraging businessmen to adjust their methods of production to keep pace with technological progress. A further advantage of a capital subsidy is that it is convenient to administer. Grants are usually given in a single payment or a few payments on a proportion of the approved capital expenditure. Advance factories are built prior to requirements and then rented at favourable rentals in the normal manner.

The short term objective of preventing redundancies is not well catered for by subsidies on capital expenditure. Assistance given as a subsidy on fuel, industrial advice grants and partial rating relief offer some help in this direction.

Clearly a subsidy on labour or a general subsidy on costs could be tailored so that new firms or expanding firms would receive most benefit. For example, a subsidy could be devised for increases in employment with a lower rate for maintaining existing numbers. However it would be inferior to a capital subsidy in several ways: the administration of such a subsidy scheme is fraught with difficulties. Not only would the subsidy for maintaining existing numbers provide no incentive to improve methods it would be a disincentive to changing to new labour saving techniques. While it would still benefit the fast growing capital intensive industries most, the amount of the benefit and therefore the strength of the inducement would be proportionately less. It would probably be much more effective in achieving the short term objectives but they are of secondary importance to the long term objective of improving the industrial structure and this is better catered for with a capital subsidy. The Hall Committee after considerable discussion[25] reached a majority conclusion that neither a subsidy for increases in employment nor for existing employment were practicable substitutes for subsidies on capital.

In trying to attract industry to Northern Ireland the Government must try to attract growth industries. In a sense these should be the easiest to attract since they will require new sites for expansion. Further, since these industries are growing most rapidly the firms should continue to grow after their establishment and provide further expansion of employment. The figures for the growth of output[26] and capital in the United Kingdom suggest that Chemicals, Bricks, Pottery, Glass etc., Paper, Printing and Publishing and Engineering and Allied Industries[27] may be this type. The first three are fairly capital intensive. Food, Drink and Tobacco has also been growing quite fast and is capital intensive. They should respond well to grants towards capital expenditure.

Although Government assistance has been successful in attracting new firms to Northern Ireland and encouraging expansion of existing firms the total numbers employed in manufacturing as a whole have not increased over the period under consideration. This is due to the decline in the two large industries Linen and Shipbuilding discussed above. What the All Industry figures do not tell is the change in the industrial structure. Table 7 in the Appendix shows indices of numbers employed by industry and these show the fastest growth in Other Manufacturing re Chemicals, Engineering excluding shipbuilding and aircraft, Food, Drink and Tobacco and alternate products. Bearing in mind the size of the declining industries and the extent of the decline the progress in restructuring and diversifying industry must be regarded as a considerable success. The greater part of this change has taken place in the latter part of the period and must be attributed at least

[25]Hall Report *op. cit.* para. 108-121.

[26]The index of Industrial Production taken from the *Monthly Digest of Statistics* 1949=100, shows for the year 1964, Chemicals and Allied Industries 270, Paper, Printing and Publishing 207, Engineering and Allied Industries 191, Bricks, Pottery, Glass etc. 172, Food, Drink and Tobacco 144 and Total Manufacturing 186.

[27]Growth in employment in the subsector Engineering excluding shipbuilding and aircraft in Northern Ireland has been second only to that in "Other Manufacturing".

partly to the policy of subsidising capital at a higher rate than elsewhere in the United Kingdom.

A high rate of growth in an industry will generate considerable secondary employment especially in the non-manufacturing sectors. In Northern Ireland there has been considerable growth in employment in the service type of industries, as can be seen in Table 7.

TABLE 7: TRENDS IN EMPLOYMENT IN NORTHERN IRELAND, 1959-1964

Thousands

| Sector | June 1959 | June 1964 | Actual | Percentage |
|---|---|---|---|---|
| Manufacturing | 179·2 | 176·3 | —2·9 | — 1·6 |
| Construction | 38·1 | 42·3 | 4·2 | 11·0 |
| Distribution | 85·6 | 88·4 | 2·8 | 3·3 |
| Services | 80·8 | 98·9 | 18·1 | 22·4 |
| Agriculture | 14·0 | 11·5 | —2·5 | —17·9 |
| Public administration and public services | 38·9 | 42·5 | 3·6 | 9·3 |
| Other | 3·2 | 3·8 | 0·6 | 18·7 |
| Total number of employees | 439·8 | 463·7 | 23·9 | 5·4 |

*Source:* Northern Ireland *Digest of Statistics*

This cannot be attributed solely to the growth in manufacturing output. It is merely due to the increasing level of social services, the trend to urbanization and a rising level of income. However by establishing growing industries in the manufacturing sector further expansion in secondary employment will develop.

In trying to assess the cost of creating employment in Northern Ireland it is not sufficient to consider only immediate primary employment. The expected growth potential of firms, the likely secondary employment generated and the effects on the competitive efficiency of firms and on the general structure of industry must all be taken into consideration. Long term objectives must clearly take precedence over short term expediency.

## Conclusion

The method used here for estimating the net stock of capital can clearly be brought up to date as information on capital expenditure in successive years becomes available. With more data available the estimates will clearly improve. Estimates of the net stock of plant and machinery will become particularly accurate in a few years since the stock of 'pre 1949' plant and machinery will be a decreasing proportion of the total net stock. The estimates for buildings will improve with time but it will take much longer to reach the same standards of accuracy. In this paper broad assumptions have been used for all industries but estimates for individual industries could be improved by using narrower and more precise assumptions based on information from the early Censuses of Production or trade publications. The present writer found some useful evidence in the early Censuses but decided to make the same broad assumptions for all industries for the sake of consistency in this paper.

The method in principle consists of using the information available to obtain figures for part of the capital stock and estimating that other part for which data is not available. It is particularly effective for industries which are growing at a fast rate such as Other Manufacturing where a large proportion of capital stock in the latter years is made up of investments for which data is available. It gives better estimates for plant and machinery than for buildings. The estimates can only be regarded as indicating broad orders of magnitude but their consistency coupled with the accuracy of the fast growing sectors offers a useful guide to the pattern of growth of capital in the manufacturing sector in Northern Ireland.

The pattern of growth of capital stock is of considerable interest in evaluating the effects of subsidising capital in Northern Ireland Manufacturing industry. Broadly speaking the highest rates of growth have been experienced by the capital intensive sectors. It seems reasonable to attribute this at least partly to the subsidies on capital although what is more important is that these industries are also growing fastest in the United Kingdom as a whole. Subsidising capital may appear to be an expensive method of increasing employment, however, practical consideration of the long term objectives of assistance to industry clearly favours subsidies on capital. In the long term subsidies on capital should improve the industrial structure in Manufacturing industry as a whole and assist the individual firm to adjust to more modern methods of production. In an economy such as Northern Ireland a general subsidy on costs or a subsidy on labour are essentially short term measures to expand employment and prevent redundancies. They provide little or no incentive to modernise methods of production or strengthen the structure of industry. If Manufacturing industry in Northern Ireland is to be assisted to become structurally up-to-date, with efficient and competitive firms then it is principally by subsidising capital that it will be achieved.

# Appendix

TABLE 1: GROSS FIXED INVESTMENT AT CURRENT PRICES BY INDUSTRY GROUP

£ thousand

| | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Plant and Machinery* | | | | | | | | | | | | | | | | |
| Food, Drink and Tobacco | 849 | 874 | 695 | 909 | 814 | 1,052 | 1,427 | 1,541 | 1,897 | 2,901 | 2,888 | 2,409 | 2,212 | 2,790 | 2,529 | 4,249 |
| Mineral Products | 231 | 147 | 118 | 208 | 891 | 593 | 328 | 292 | 266 | 369 | 433 | 810 | 714 | 679 | 616 | 550 |
| Timber and Furniture | 83 | 59 | 81 | 53 | 59 | 75 | 55 | 59 | 73 | 51 | 255 | 103 | 113 | 251 | 204 | 292 |
| Engineering | 739 | 703 | 762 | 882 | 1,047 | 995 | 2,002 | 2,585 | 4,297 | 3,825 | 3,093 | 4,580 | 5,100 | 5,265 | 6,566 | 6,178 |
| Clothing | 194 | 169 | 201 | 84 | 115 | 204 | 206 | 222 | 241 | 211 | 251 | 400 | 426 | 388 | 476 | 620 |
| Paper, Printing and Publishing | 162 | 165 | 206 | 180 | 116 | 305 | 192 | 211 | 167 | 220 | 268 | 402 | 471 | 449 | 653 | 618 |
| Textiles | 3,301 | 4,117 | 2,714 | 2,195 | 1,842 | 1,959 | 2,122 | 2,447 | 1,959 | 4,511 | 4,632 | 2,531 | 2,584 | 4,810 | 5,483 | 7,791 |
| Other Manufacturing | 98 | 122 | 169 | 158 | 152 | 195 | 286 | 554 | 313 | 1,932 | 4,092 | 1,720 | 1,447 | 4,501 | 3,593 | 4,701 |
| Total Manufacturing | 5,813 | 6,265 | 5,081 | 4,779 | 5,055 | 5,428 | 6,768 | 8,090 | 9,458 | 14,263 | 15,262 | 13,098 | 13,260 | 19,347 | 20,524 | 24,384 |
| *Buildings* | | | | | | | | | | | | | | | | |
| Food, Drink and Tobacco | 428 | 408 | 441 | 389 | 426 | 622 | 778 | 667 | 773 | 3,370 | 2,280 | 1,659 | 1,028 | 961 | 903 | 2,002 |
| Mineral Products | 154 | 51 | 47 | 45 | 363 | 386 | 138 | 142 | 52 | 82 | 78 | 306 | 233 | 371 | 95 | 151 |
| Timber and Furniture | 77 | 97 | 87 | 22 | 89 | 30 | 57 | 29 | 75 | 40 | 176 | 123 | 51 | 188 | 512 | 368 |
| Engineering | 862 | 516 | 516 | 609 | 524 | 344 | 818 | 948 | 6,324 | 1,362 | 1,890 | 1,360 | 2,094 | 1,889 | 1,323 | 2,658 |
| Clothing | 336 | 600 | 464 | 45 | 84 | 69 | 290 | 134 | 145 | 230 | 212 | 89 | 598 | 416 | 565 | 868 |
| Paper, Printing and Publishing | 6 | 14 | 127 | 58 | 39 | 32 | 73 | 22 | 20 | 75 | 39 | 202 | 114 | 60 | 274 | 250 |
| Textiles | 1,445 | 1,351 | 119 | 570 | 445 | 811 | 376 | 361 | 1,649 | 1,165 | 2,970 | 1,199 | 610 | 2,054 | 1,026 | 1,466 |
| Other Manufacturing | 46 | 93 | 18 | 43 | 39 | 98 | 217 | 237 | 186 | 1,894 | 811 | 2,389 | 1,003 | 1,962 | 4,823 | 3,963 |
| Total Manufacturing | 3,405 | 3,193 | 2,851 | 3,572 | 2,009 | 2,373 | 2,755 | 2,570 | 9,268 | 8,248 | 8,607 | 7,313 | 5,712 | 7,914 | 9,656 | 12,009 |

*Source*: Northern Ireland Census of Production, Ministry of Commerce. See text for details.

TABLE 2: PRICE INDEX NUMBERS OF PLANT AND MACHINERY AND BUILDINGS FOR THE UNITED KINGDOM, 1958=100

| | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant and Machinery | 66·7 | 68·7 | 73·9 | 81·7 | 84·5 | 84·6 | 88·7 | 93·8 | 97·3 | 100·0 | 100·4 | 101·5 | 105·0 | 106·7 | 108·5 | 111·2 |
| Buildings | 68·0 | 68·0 | 76·4 | 83·8 | 84·3 | 84·1 | 89·6 | 93·1 | 97·2 | 100·0 | 98·3 | 102·6 | 99·7 | 104·6 | 108·1 | 110·7 |

*Source*: Statistics Division, Board of Trade.

TABLE 3: CAPITAL/OUTPUT RATIOS IN THE U.K., IN 1961-1964 WITH 1949-1952 AS UNITY

(C)

| | Food, Drink and Tobacco | Bricks, Pottery, Glass, Cement etc. | Timber and Furniture | Other Metals, Engineering and Allied Industries | Leather, Clothing and Other Manufacturing | Paper, Printing & Publishing | Chemicals and Allied Industries | Textiles* |
|---|---|---|---|---|---|---|---|---|
| Plant and Machinery | 1·18 | 1·20 | 1·45 | ·85 | ·77 | ·71 | ·99 | 1·0 |
| Buildings | 1·10 | 1·05 | ·96 | 1·04 | ·75 | ·85 | ·91 | 1·0 |

*No estimates of the stock of capital in Textiles in 1961-64 could be obtained and consequently there are no calculated figures for the changes in the average capital/output ratios. In order to obtain estimates of capital stock for Total Manufacturing, rough estimates of the capital stock in Textiles were made with a value of C taken as 1·0 for both buildings and plant and machinery.

The United Kingdom figure for Chemicals and Allied Trades was taken as the figure for Northern Ireland Other Manufacturing since about 90 per cent of the gross investment in this sector has been in Chemicals and Allied Trades. The figure for Bricks, Pottery, Glass, Cement etc. was used for Mineral Products. The figures of gross capital stock in Timber and Furniture were supplied by the Central Statistical Office in advance of their intended publication in the 1967 Blue Book.

TABLE 4: CALCULATION OF THE NET CAPITAL STOCK OF BUILDINGS IN FOOD, DRINK AND TOBACCO £ thousand

| Year | (1) Gross Investment at Current Prices | (2) Gross Investment at 1958 Prices | (3) Gross Stock of Buildings 'Since 1949' | (4) Capital Consumption (Col. 3÷80) | (5) Net Investment 'Since 1949' (Col. 2−Col. 4) | (6) Net Capital Stock of Buildings 'Since 1949' | (7) Net Stock of 'Pre 1949' Buildings at 1958 Prices | (8) Total Net Stock of Buildings at 1958 Prices (Col. 6+Col. 7) |
|---|---|---|---|---|---|---|---|---|
| 1949 | 428 | 629 | 629 | 8 | 621 | 621 | 9,589 | 10,210 |
| 1950 | 408 | 600 | 1,229 | 15 | 585 | 1,206 | 9,389 | 10,595 |
| 1951 | 441 | 577 | 1,806 | 23 | 544 | 1,750 | 9,189 | 10,939 |
| 1952 | 389 | 464 | 2,270 | 28 | 436 | 2,186 | 8,989 | 11,175 |
| 1953 | 426 | 505 | 2,775 | 35 | 470 | 2,656 | 8,789 | 11,445 |
| 1954 | 622 | 740 | 3,515 | 44 | 696 | 3,352 | 8,589 | 11,941 |
| 1955 | 778 | 868 | 4,383 | 55 | 813 | 4,165 | 8,389 | 12,554 |
| 1956 | 667 | 716 | 5,099 | 64 | 652 | 4,817 | 8,189 | 13,006 |
| 1957 | 773 | 795 | 5,894 | 74 | 721 | 5,538 | 7,989 | 13,527 |
| 1958 | 3,370 | 3,370 | 9,264 | 115 | 3,155 | 8,693 | 7,789 | 16,482 |
| 1959 | 2,280 | 2,319 | 11,583 | 145 | 2,174 | 10,867 | 7,589 | 18,456 |
| 1960 | 1,659 | 1,617 | 13,200 | 165 | 1,452 | 12,319 | 7,389 | 19,708 |
| 1961 | 1,028 | 1,031 | 14,231 | 178 | 853 | 13,172 | 7,189 | 20,361 |
| 1962 | 961 | 919 | 15,150 | 189 | 730 | 13,902 | 6,989 | 20,891 |
| 1963 | 903 | 835 | 15,985 | 200 | 635 | 14,537 | 6,789 | 21,326 |
| 1964 | 2,022 | 1,808 | 17,793 | 222 | 1,586 | 16,123 | 6,589 | 22,712 |

EXPLANATION OF TABLE 4

Columns (1) to (6) can be calculated from the known data. The net stock of 'pre 1949' buildings existing in 1949 can be calculated using Equation 4 adapted to take four year averages:–

$$\frac{\sum_{61}^{64} \text{Total Net Stock of Buildings}}{\sum_{61}^{64} \text{Net Output}} \Big/ \frac{\sum_{49}^{52} \text{Total Net Stock of Buildings}}{\sum_{49}^{52} \text{Net Output}} = C$$

in symbols:

$$\frac{\sum_{i=61}^{64} (f_i.K'_{49}+K'_i)}{\sum_{i=61}^{64} Q_i} \Big/ \frac{\sum_{i=49}^{52} (f_i.K'_{49}+K'_i)}{\sum_{i=49}^{52} Q_i} = C \quad (5)$$

Where $K'_i$ represents the net stock of 'since 1949' buildings in year i, $K'_{49}$ is the net stock of 'pre 1949' buildings existing in 1949 and $f_i$ is the fraction of $K'_{49}$ remaining in the year i.

$$\sum_{i=49}^{52} (f_i.K'_{49}+K'_i) = (K'_{49}+621)+(\tfrac{47}{48}K'_{49}+1,206)$$
$$+ (\tfrac{46}{48}K'_{49}+1,750)+(\tfrac{45}{48}K'_{49}+2,186)$$
$$= 3\tfrac{42}{48}K'_{49}+5,763.$$

$$\sum_{i=61}^{64} (f_i(K'_{49})+K'_i) = 2\tfrac{42}{48}K'_{49}+57,734.$$

$$\sum_{i=49}^{52} Q_i=264, \qquad \sum_{i=61}^{64} Q_i=477, \qquad C=1.10.$$

$$\frac{2.875\,K'_{49}+57,734}{477} \Big/ \frac{3.875\,K'_{49}+5,763}{264} = 1.10.$$

$K'_{49}=9,589.$

The gross stock of 'pre 1949' buildings in 1949$=K'_{49} \times \frac{100}{60} = 15,982$. Capital consumption at $\frac{1}{80}$th per annum = 200.

TABLE 5: PERCENTAGE VARIATION IN THE ESTIMATES OF NET STOCK OF CAPITAL DUE TO ALTERATIONS IN ASSUMPTIONS

| | Net Stock of Capital in 1949 Taken as 50% of Gross Stock* | | Net Stock of Capital in 1949 Taken as 70% of Gross Stock* | | †Change in the Average Capital /Output Ratios Reduced by 10% | | †Change in the Average Capital /Output Ratios Increased by 10% | |
|---|---|---|---|---|---|---|---|---|
| | 1949 | 1964 | 1949 | 1964 | 1949 | 1964 | 1949 | 1964 |
| *Plant and Machinery* | | | | | | | | |
| Food, Drink and Tobacco | 95·5 | 95·2 | 103·8 | 103·9 | 117·0 | 102·5 | 86·7 | 98·1 |
| Mineral Products | 97·8 | 96·9 | 101·9 | 102·3 | 115·7 | 101·7 | 87·6 | 98·9 |
| Timber and Furniture | 93·7 | 94·1 | 105·6 | 105·1 | 119·1 | 103·2 | 85·7 | 97·4 |
| Engineering | 86·1 | 86·0 | 113·5 | 113·4 | 119·7 | 106·3 | 85·8 | 95·4 |
| Clothing | 88·1 | 88·8 | 111·3 | 110·7 | 121·8 | 105·7 | 84·4 | 95·6 |
| Paper, Printing and Publishing | 90·2 | 90·7 | 108·9 | 108·2 | 119·3 | 104·6 | 85·6 | 96·5 |
| Textiles | 88·5 | 89·8 | 110·9 | 109·4 | 122·5 | 105·9 | 83·7 | 95·7 |
| Other Manufacturing | 99·7 | 98·3 | 100·6 | 101·2 | 113·7 | 100·7 | 89·0 | 99·5 |
| Total Manufacturing | 88·2 | 90·4 | 111·5 | 109·0 | 120·5 | 104·8 | 85·1 | 96·5 |
| *Buildings* | | | | | | | | |
| Food, Drink and Tobacco | 96·7 | 96·5 | 102·5 | 102·7 | 118·4 | 105·4 | 85·1 | 95·4 |
| Mineral Products | 98·3 | 98·0 | 101·3 | 101·1 | 116·7 | 103·8 | 92·5 | 98·3 |
| Timber and Furniture | 88·1 | 96·7 | 112·4 | 110·6 | 150·0 | 127·2 | 75·4 | 86·4 |
| Engineering | 93·2 | 92·9 | 105·9 | 106·2 | 127·2 | 112·9 | 82·1 | 91·5 |
| Clothing | 89·5 | 88·5 | 109·8 | 108·4 | 141·2 | 121·0 | 76·1 | 87·9 |
| Paper, Printing and Publishing | 94·6 | 94·4 | 104·4 | 103·7 | 123·9 | 108·5 | 81·8 | 93·0 |
| Textiles | 90·0 | 90·3 | 108·7 | 108·7 | 141·1 | 122·7 | 76·8 | 87·1 |
| Other Manufacturing | 99·5 | 99·4 | 100·1 | 100·6 | 115·2 | 101·3 | 87·8 | 99·0 |
| Total Manufacturing | 92·0 | 93·4 | 107·0 | 105·8 | 133·1 | 113·9 | 79·9 | 91·5 |

*In the text net stock of capital in 1949 was taken as 60 per cent of gross stock.

†The C values used in the actual estimates were obtained by dividing the average capital/output ratio for 1961-1964 by that for 1949-1952. The estimates were recalculated an increase and a decrease of 10 per cent in the C figure.

TABLE 6: ESTIMATED CAPITAL CONSUMPTION AT 1958 PRICES

£ hundred thousand

| | 1949 | 1960 | 1961 | 1962 | 1963 | 1964 |
|---|---|---|---|---|---|---|
| *Plant and Machinery* | | | | | | |
| Food, Drink and Tobacco | 5·7 | 9·4 | 10·1 | 11·0 | 11·8 | 13·0 |
| Mineral Products | 0·9 | 2·2 | 2·4 | 2·6 | 2·8 | 3·0 |
| Timber and Furniture | 0·4 | 0·6 | 0·6 | 0·7 | 0·8 | 0·9 |
| Engineering | 28·0 | 23·0 | 24·6 | 26·2 | 28·2 | 30·1 |
| Clothing | 2·0 | 1·9 | 2·0 | 2·2 | 2·3 | 2·5 |
| Paper, Printing and Publishing | 1·8 | 1·8 | 2·0 | 2·1 | 2·3 | 2·5 |
| Textiles | 21·8 | 23·6 | 24·4 | 25·9 | 27·5 | 29·9 |
| Other Manufacturing | 1·5 | 4·1 | 4·5 | 5·9 | 7·0 | 8·4 |
| Total Manufacturing | 62·1 | 66·5 | 70·6 | 76·6 | 82·8 | 90·3 |
| *Buildings* | | | | | | |
| Food, Drink and Tobacco | 2·1 | 3·6 | 3·8 | 3·9 | 4·0 | 4·2 |
| Mineral Products | 0·2 | 0·4 | 0·5 | 0·5 | 0·5 | 0·6 |
| Timber and Furniture | 0·7 | 0·8 | 0·8 | 0·8 | 0·9 | 0·9 |
| Engineering | 5·9 | 8·0 | 8·2 | 8·5 | 8·6 | 8·9 |
| Clothing | 1·4 | 1·8 | 1·9 | 1·9 | 2·0 | 2·1 |
| Paper, Printing and Publishing | 0·2 | 0·3 | 0·3 | 0·3 | 0·4 | 0·4 |
| Textiles | 6·1 | 7·8 | 7·9 | 8·1 | 8·2 | 8·4 |
| Other Manufacturing | 0·4 | 1·2 | 1·3 | 1·6 | 2·1 | 2·6 |
| Total Manufacturing | 17·1 | 24·0 | 24·7 | 25·6 | 26·7 | 28·0 |

TABLE 7: INDICES OF NET OUTPUT AND NUMBERS EMPLOYED IN NORTHERN IRELAND MANUFACTURING INDUSTRIES, 1949=100

| | Net Output | | Numbers Employed | |
|---|---|---|---|---|
| | 1959 | 1964 | 1959 | 1964 |
| Food, Drink and Tobacco | 171 | 183 | 128 | 138 |
| Mineral Products | 193 | 326 | 103 | 111 |
| Timber and Furniture | 88 | 126 | 82 | 84 |
| Engineering | 134 | 142 | 111 | 89 |
| Engineering, excl. shipbuilding and aircraft | 207 | 315 | 145 | 186 |
| Clothing | 136 | 174 | 100 | 106 |
| Paper, Printing and Publishing | 143 | 200 | 95 | 107 |
| Textiles | 116 | 134 | 74 | 67 |
| Other Manufacturing | 154 | 846 | 177 | 290 |
| Total Manufacturing | 138 | 175 | 95 | 94 |

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