# STATISTICAL AND SOCIAL INQUIRY SOCIETY OF IRELAND

# Estimation of Capital Stock in Irish Industry, 1953-1968

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## INTRODUCTION

This paper is confined to discussion of methods of estimating Capital Stock, with a review of numerical results already available and a summary of new results calculated by the writer. Illustrations of the uses to which capital stock data may be put are not considered. Section 1 gives Professor Nevin's figures for the years 1950-59 and also the writer's reworking of them and their extension to 1968. Section 2 considers unsatisfactory aspects of the methods used by Nevin, looks at some alternative methods and definitions of capital stock and gives the writer's approach to a new set of results for the period 1953 to 1968. Section 3 discusses these latter results.

The appendices attached to this paper give results for 12 sub-groups of Transportable Goods industries and a further group, called Selected Construction. Detailed deflated Fixed Asset Purchases net of Sales, with derived End-of-Year Equivalent-New Capital Stock results and Associated Gross Output, Employment and Price Indices, are available[1] for individual Census of Production industries for the period 1953-1968 for those industries having data published in the annual reports of the Census of Industrial Production (see Table 10, December 1970 *Irish Statistical Bulletin* for a listing). The detailed Fixed Asset Purchases can be used to calculate capital stock for any CIP industry one chooses, according to whatever method of depreciation is deemed appropriate to the intended use of the capital stock results.

[1] "Estimated levels of Capital Stock in Irish industry 1953-1968" by E. W. Henry and S. Scott. A memorandum available on request from the Economic and Social Research Institute, Dublin.

## SECTION 1: CAPITAL STOCK OF MANUFACTURING, 1950-1959, By NEVIN, UPDATED TO 1968

### Nevin's Capital Stock of Manufacturing 1947-59

Professor Nevin's results were published [1] in November 1963. His investigations were confined to Manufacturing industries, shown under 10 sub-groups corresponding approximately to the 10 manufacturing sub-groups of the same names listed in the 1964 17-sector Input-Output Table [2]. In order to produce capital stock figures at 1958 prices for each of the 10 sub-sectors he used five basic sets of data:

(a) Balance-Sheet values of Total Fixed Assets held by a sample of manufacturing establishments at the end of 1958;

(b) Some basis for grossing up the latter results so as to estimate the Balance-Sheet values for all establishments engaged in manufacturing;

(c) Some indication of the amount of Buildings and the amount of Plant rented, but not owned, by manufacturing firms, such assets being additional to those shown in the balance-sheet results;

(d) Annual Price Indices, to be used for setting all his calculations at 1958 average prices;

(e) Census of Industrial Production (CIP) annual data on purchases and sales of new and second-hand (used) capital assets, with National Accounts estimates of overall manufacturing gross fixed capital formation, so that omissions, due to CIP non-response, could be allowed for.

The Balance-Sheet results for end-of-1958 came from a Central Statistics Office voluntary inquiry, of which the outcome was published [3] in a paper read to this Society in May 1963. Besides the actual balance sheet values there was further information obtained in the inquiry, on valuations of assets for insurance purposes. Nevin took the latter as "likely to approach written-down replacement values at current prices" (page 2 of [1]). He first of all used the available insurance valuations to produce estimates of the written-down replacement values of the stock of (1) Buildings, Land and "Other" Fixed Assets, (2) Plant and Vehicles, for the respondents to the CSO inquiry. He next grossed up the latter, via CIP Remainder of Net Output, to give written-down replacement values (end-of-1958) of Owned Assets for all CIP respondents. Using 1949 data, the most recent available for Renting of Buildings and Plant, he took 1949 Buildings as ten times the cost of their rent and expressed such value of rented buildings as a percentage of 1949 Balance-Sheet valuations, returned for that year in the CIP. He then applied these 1949 percentages to the estimated owned buildings, end-of-1958, of all CIP 1958 respondents. For rented plant he used similar methods, again based on 1949 data, but confined the plant rented to the Boot and Shoe industry. These estimated Rented Assets

are additional to the Owned Assets. Thus, at this stage he had, for each of the ten sub-groups of Manufacturing, estimates of the written-down replacement values of the stock of Buildings etc. and of Plant etc. (for end-of-1958 and at 1958 prices) for the 1958 CIP respondents, without allowance for non-respondents but including both owned and rented fixed capital assets.

**Capital Formation versus Depreciation**

He grouped the annual CIP data on purchases and sales (described below in Section 2) into net purchases (purchases less sales) of two groups of assets (a) Buildings, Land and "Other", (b) Plant, Machinery and Vehicles; and deflated each kind by CSO published capital goods' deflators. Types (a) and (b) will be referred to elsewhere in this section as Buildings and Plant, for brevity. The National Accounts data on Gross Fixed Capital Formation (GFCF), after deduction of GFCF by CIP respondents, gave the apparent GFCF by CIP non-respondents: he distributed the latter among the ten sub-groups, having deflated it, in proportion to the known CIP amounts of GFCF for Buildings and for Plant, with an estimate included for the new Oil Refinery for 1958 as follows: £1·5 million for Plant and £1·3 million for Buildings. The data available to him evidently were for each year of the period 1946-59, consisting of CIP and National Accounts figures.

"Given a realistic valuation of the capital stock at a particular moment of time, and reliable totals for gross investment in the assets concerned for the years preceding that date, however, it must follow that there can be only one average life of assets which makes these two sets of data consistent with one another". (page 7 of [1]). His Appendix A shows estimates of GFCF in Manufacturing for the years 1926-1947 and his derived Average Working Lives in years, are as follows:

| Sector | Buildings | Plant |
|---|---|---|
| Food ... ... ... ... | 91 | 23 |
| Drink and Tobacco ... ... | 99 | 15 |
| Textiles ... ... ... ... | 208 | 63 |
| Clothing ... ... ... ... | 67 | 13 |
| Wood ... ... ... ... | 92 | 24 |
| Paper ... ... ... ... | 125 | 36 |
| Chemicals ... ... ... | 92 | 33 |
| Minerals ... ... ... ... | 126 | 31 |
| Metals ... ... ... ... | 89 | 61 |
| Other Manufacturing ... ... | 74 | 62 |

The reciprocal of the Average Life gives the Depreciation annual rate. for assumed *Linear* Depreciation.

**Calculation of Capital Stock**

It might make the picture clearer to first of all give and explain Nevin's formula for derivation of the Average Life figures shown above, before going on to quote his formulae for calculation of Capital Stock.

Let $k_i$ be the GFCF (Purchases less Sales) of Plant in a sector, in year i, at 1958 prices. Consider only the case where $k_i$ is known for all relevant years, as this is sufficient both to derive the formula and define the Capital Stock at the end of year t. Let m be the Average Working Life of the Plant, to be found. Let $K_t$ be the Net Capital Stock at the end of year t. Both the $K_t$ and the $k_i$ are for CIP respondent establishments, without inclusion of either CIP non-respondents or rented assets, i.e. all the figures are specified. $K_t$ is the Net Stock, after removal of linear depreciation, which operates at an annual rate of 1/m. The fraction 1/m is also applied to $k_i$ put in place during the year i, so that a full year's depreciation is applied to the GFCF occurring during a year. The Net Capital Stock at end of year t is set equal to the cumulated depreciated year-by-year GFCF amounts, in order to find m:

$$K_t=(1-1/m)\,k_t+(1-2/m)\,k_{t-1}+\ldots+\frac{[1-(m-1)]\,k_{t-m+2}}{m}$$

(See page 7 of [1]).

This can be rewritten:

$$m=\frac{[k_t+2k_{t-1}+3\,k_{t-2}+\ldots+(m-1)\,k_{t-m+2}]}{[\sum_{i=t}^{t-m+2} k_i-K_t]}$$

and can be solved by adding terms to numerator and denominator until a satisfactory integer value of m is approximated. It is clear that one must start with enough terms to make the denominator positive and that from there on the numerator grows more rapidly than the denominator. Nevin gives no numerical illustration, but it is fairly obvious where one stops, if the m on the left-hand side of the formula is initially much smaller than the fraction on the right and the fraction converges downwards towards it in succeeding steps.

A numerical illustration of this convergent behaviour appears in Appendix 5.

It is now clear that the Capital Stock as calculated is End-of-Year Written-down linearly depreciated value, at 1958 prices. To go from the end of year (t−1) to the end of year t, one adds on the GFCF for year t, at 1958 prices, and then removes a fraction, 1/m, of the aggregate amount. By averaging the end-year values, mid-year values are obtained. By using the GFCF figures for non-respondents as well as respondents i.e. the full National Accounts totals and then finally adding on rented assets, an estimate for the full capital stock available is obtained. A brief description of the author's reworking of Nevin's results and comparisons of the two sets of figures for end-of-year 1958 appears in Appendix 6.

Dr. K. A. Kennedy provides updated estimates of Capital Stock and reworked Nevin figures, for the period 1946-1966, in Appendix Table 4 of [5]. Only a single aggregate stock figure is shown for each year for each ten sub-sectors of Manufacturing. He used Nevin's methods and definition of written-down but with revisions of Average Life figures used by Nevin for certain sub-sectors, thus providing improved capital stock estimates for 1946-1959.

## SECTION 2: COMMENTARY ON THE NEVIN RESULTS; THE WRITER'S ALTERNATIVE APPROACH

The first part of this section comments on the Nevin results; the second part gives a possible alternative approach, which yielded the results in Section 3 following.

### Commentary on the Nevin Results

Professor Nevin's results were the pioneering work in Ireland in the field of research into Capital Stock and should be given due credit on that account. The creators of pioneer works all too often suffer the ingratitude of later workers, who proceed to list the defects of the earlier works and then, with relatively less effort, produce improved versions. In the criticisms and the results quoted below, it is of relevance that this writer, as employed at the Central Statistics Office, found it possible to carry back the post-1953 industrial lists to 1945 for some industries and 1950 for others.

### The 1958 Balance-sheet Levels Unsatisfactory

Even if balance-sheet (or insurance) valuations were available for the full set of 1958 CIP respondents this writer doubts their consistency. It is not know whether they are written-down original values, or written-down values at 1958 replacement cost, or a mixture of the two, or an even less satisfactory mixture of written-down and un-depreciated values. The grossing-factors used by Nevin range from 1·04 to 3·52 (Table B of [1]) and it is debatable whether Remainder of Net Output should be used for these grossing factors. The CIP industries (old listing) had available balance-sheet values, via the CIP, for each year 1945-1950; if somehow Average Life figures could have been derived and the Capital Stock built up from, say, 1945, using known GFCF totals, alternative estimates for 1947-59 would be available and one would be starting from a relatively small initial stock, which is being more and more reduced in importance, by depreciation, rather than ending with a 1958 set of levels, which are questionable.

The "written-down replacement value at current prices" which Nevin was hoping to achieve, is an accountants' book-valuation which is not

particularly useful, for some applications of the results. According to this approach, if a machine is being depreciated over eight years, it is valued as half a new machine at the end of its fourth year. This valuation is realistic, if one were replacing it by an identical machine having half its useful life remaining; it is also realistic for a large population of such machines, with values of remaining life, and new replacements, tending to smooth out the results, over the years. For any exercises on expansion of capital stock, however, via purchases of mostly new equipment, the capital stock figures estimated by the above method are too small, because every one of them is more or less depreciated i.e. every GFCF entry is depreciated for a full year's use even before being added to the previous aggregate and the figures give current replacement cost rather than current productive capacity. For some applications, at least, one would prefer to have the initial or new-cost figures, as a measure of capacity, which might be up to 80 per cent of the initial capacity, even at the end of the useful life.

**The Components of Each Kind of Stock too Heterogenous**

The stock referred to as Buildings contains Buildings, Land and Other Fixed Assets. Buildings have a long life, under reasonable care and maintenance. Land has an indefinite life and so should have Nil depreciation; the Other Fixed Assets might be taken to have a life similar to plant and machinery. They are likely to contain furniture, office machines, containers of the cask and crate type and so on. Thus these three kinds have rather different depreciation rates.

The stock termed Plant includes motor cars, lorries/dumpers/excavators etc. and plant and machinery generally. Each of these three kinds might reasonably be treated separately, as having a fairly short, a longer and a much longer average life. In summary, a case can be made for separately calculating six kinds of Capital Stock, rather than two, because of differences in average life and possibly more essential or less essential relation with productive capacity.

**The Average Life Values for Plant Appear Excessive**

The calculated average life values for Plant/Vehicles are in excess of 60 years for Textiles, Metals, etc. and Other Manufacturing, and the writer considers that since the plant itself must therefore average out at an even higher length (because the vehicles included undoubtedly have a life-span below 10 years) the implicit plant life is far too long. Even the Paper, Chemicals and Minerals figures, in excess of 30 years, for Plant and Vehicles combined, may be too high. For plant and machinery one might expect that 30 years or less is fairly typical, with technological change giving improved performance of new machines, and thus encouraging scrapping of machines which are operable, but increasingly obsolescent. One can generalise vaguely and one can be frequently wrong. Edwin Kuh, in Table 11.1 of [4], quotes the following figures, in years:

| | | | | | |
|---|---|---|---|---|---|
| Beverages | 19·1 | Paper | 24·2 | Primary Metals | 26·4 |
| Food | 19·7 | Printing | 25·2 | Fabricated Metals | 20·3 |
| Tobacco | 27·9 | Chemicals | 20·0 | Mach. (ex. Electr.) | 18·0 |
| Textiles | 23·9 | Petroleum | 13·5 | Electrical Machin. | 15·6 |
| Apparel | 14·3 | Rubber | 20·7 | Transport (ex Motor Veh.) | 24·7 |
| Lumber | 9·3 | Leather | 19·2 | Motor Vehicles | 20·0 |
| Furniture | 19·1 | Stone | 21·6 | Scientific Instr. | 18·9 |

Total 18·4

They are the "Life of Assets" given by the reciprocal of the Depreciation Rate, which "was computed by taking the average of depreciation plus amortisation for 1949 and 1950 and dividing it by the average gross property for the year" (page 321). So the above figures include Buildings, which will bring the average life up; on the other hand, the average life derived from accountants' depreciation plus amortisation may be too low, if the accountants write off the machinery completely too quickly i.e. if their depreciation rate is higher than the actual physical depreciation. In any case, one might argue from the above that as a general rule the life of plant and machinery should be in the under-30 range rather than higher.

A possible explanation for very high Average Life figures obtained by Nevin is as follows. If his end-of-1958 grossed-up total seriously over-estimated the actual Capital Stock (Nevin definition) because of bad data, then he would need both to go back far in time and also to depreciate mildly (i.e. allocate a long Average Life) in order to find enough cumulated net investment to reach his control level, far larger than the actual.

**An Alternative Approach: Equivalent-New Capital Stock**

The system can be set out as follows:

(1) Value all purchases and sales of Fixed Assets at constant prices (1958, here).

(2) Treat separately each of the following six kinds of Asset (a) Passenger Vehicles, (b) Work Vehicles, (c) Plant and Machinery, (d) Buildings, (e) Land, (f) Other Fixed Assets.

(3) Find a reliable starting value for each of the six kinds of Capital Stock (1945 where possible, 1950 otherwise), and estimate its level at 1958 prices.

(4) By means of the Nevin and Kuh results, consultations with C.S.O. personnel and direct advice from industrialists, estimate an Average Life for each kind of asset. Very large for Buildings and Land, some eight years for the two kinds of Vehicles, some 24 years for Other Fixed Assets, and, for Plant and Machinery, depending upon the industry. These Average Life figures are for *New* goods.

(5) Find the Equivalent-New values, from the available informed views, of the starting capital stock, by specifying that:

(a) The equivalent-new cost of the stock of Buildings is 1·5 times starting value (1958 prices) of (3) above.
(b) that of Land is the same as of (3) above;
(c) that of Other Fixed Assets is 2·0 times the value at (3) above, as also for Plant etc.;
(d) that of the two kinds of Vehicles is 1·8 times the value at (3) above.

(6) Use the same factors for inflating the quoted sales and purchases of Second-Hand Assets. All Sales are assumed to be of Second-Hand or Used Assets.

(7) Assume that Second-Hand Vehicles, Plant and Other Fixed Assets have a half-life remaining; they have been more or less doubled in value, for the purpose of the Stock cumulation; the compensating effect is to give them a half-life. The Land and Buildings are not affected as their life is taken to be very much greater than the 20 to 30 year span envisaged for most equipment.

(8) Use only the CIP purchases and sales data: this is assuming that the CIP figures for GFCF are reliable enough to be comparable with the Gross Output and Employment figures, all for CIP respondents. Omit any allowance for Rented Assets, because of lack of information.

(9) Build up the Equivalent-New Capital Stock, starting with 1945 for some industries and 1950 for others, using everywhere new or equivalent-new values, at 1958 prices, as follows:
(a) For Buildings and Land, the starting values are entered unchanged for the first year and all subsequent years, as positive amounts. All purchases are entered as positive amounts, and all sales as negative amounts, for the year in which they arise and all later years. Thus no depreciation is applied, in any way.
(b) For the other four kinds of assets, purchases of new goods are entered at full purchase value (1958 prices) for the year of purchase, then linearly depreciated to 80% of that initial purchase value, over their average live, and then totally omitted i.e. the last entry for the purchase of new work-vehicles appears as a positive entry having 80% of the initial entry, in the eighth year from its first appearance. Purchases of second-hand assets are positive entries which are gradually depreciated to 85 per cent of their initial new-equivalent entry value, the 85 per cent of the initial entry being the last entry and occurring in the last year of the half-life. Sales of (second-hand) assets have identical treatment, appearing as negative entries. The starting-values, new-equivalent, are also entered positive for each year of the half-life, and linearly depreciated to the 85 per cent level, for their last entry. The justification of the 80 or 85 per cent level for the last year is that the only assumed cause of reduction in capacity is the increased repair and maintenance time necessary to keep the lorry or machine operable. An inherent assumption

of this treatment is that each machine or vehicle is used evenly throughout its life-span; the average annual rate of use is uniform.

**The Meaning of the Equivalent-New Capital Stock**

The results are intended to show, for each of six kinds of capital stock, the amounts in use at a point of time in each year (by choice, mid-year) *at full new 1958 purchase prices.* for an industry or industry group. A machine, which was originally purchased new, is taken in its last year of use as equivalent to four-fifths of an identical new machine purchased new in that last year. Second-hand purchases and sales, usually small by comparison with new purchases, are treated as equivalent to new machines, but with only the half-life of a new machine and as being equivalent to 85% of a new machine, in the last year of their half-life. Thus depreciation is treated as a Step-Function process, which steadily decreases the purchase to 80 or 85 per cent of its initial usefulness, over the life of half-life and then immediately removes the remaining 80 or 85 per cent usefulness. If the data permitted distinction of pure scrapping from sale of Assets with realistic useful life remaining in them, the pure scrapping activity would have been ignored, as inherent in the depreciation final 80 or 85 per cent reduction. As it was, all sales were treated as having useful life remaining.

In common with Nevin's approach, the Equivalent-New approach makes no attempt to solve the ancient volume-index problem: how to allow for quality changes in the product mix within each of the six kinds of stock. The price deflators purport to reduce all entries to the 1958 price-level, but, at 1958 prices, the machine one buys for £1,000 in 1968 may be, and probably is, more productive than what was nominally a similar machine in 1950. For work-vehicles, the more recent models having hydraulic tipping-gears, removable containers for transfer to rail and sea carriers, are indeed more flexible and labour-saving than the earlier models. What this amounts to is that the price-deflator is not sufficient to give meaningful volume figures for the new purchases; some sort of productivity inflator would be also required, and such is not available. This would suggest that the capital stock figures for Work-Vehicles, Plant, Other Fixed Assets, may progressively undervalue the productivity of these assets, by reference to figures for the earlier years.

## SECTION 3: EQUIVALENT-NEW ESTIMATES

This section describes briefly how capital stock estimates were made by the author for each industry covered by the Census of Industrial Production. These Equivalent-New estimates are then compared, at group level, with the two sets of results already available, (those of Nevin and their re-calculation and up-dating).

**Industry List**

The CIP industries distinguished in the post-1953 Census had a separate treatment given to each, with the following adjustments: CIP 9 was sub-divided between Flour Milling and Animal Feeding Stuffs including Other Milling; CIP 52, Other Manufacturing, was sub-divided; CIP 54 had only one part used, namely 54 (A), Construction activities of Local Authority Employees; CIP 48, Rail Vehicle Assembly and Repair, and CIP 56, repair work on the Railway's permanent way, were omitted. Thus some 62 productive sectors were treated separately, consisting of four for Mining and Peat Processing, 51 for Manufacturing, 3 for New and Repair Construction 3 for Electricity, Gas and Water and 1 for Laundries, Dry Cleaning etc.

For the period 1945-1952 inclusive the old, and less detailed, CIP list applied. Some of the old industries, being identical with the new ones, had the required results available without any search beyond the CIP summary. Some 16 of them, however, required sub-division and some re-aggregation, and the basic data were not available for earlier than 1950.

**GFCF and Starting Stock Extraction**

In summary, the GFCF data were extracted for some 62 sectors for each year of the period 1953-68, for as many as possible for the period 1946-52, and for the rest, only for the years 1951-1952. Starting stock values, given by the old CIP, were taken for end-of-1945, where possible; otherwise, for the end of 1950. The old CIP had obtained end-of-year balance-sheet values, for each year of 1945-1950, for (a) Buildings and Land (b) Plant, Machinery and Vehicles.

The full list of GFCF purchases/sales was taken as that appearing in the CIP for 1963 and later years and had 15 entries, 10 for purchases and 5 for sales: Purchases of (1) New Passenger Vehicles, (2) same, Used, (3) New Other Vehicles, (4) Same, Used, (5) New Plant etc. (6) Same, Used, (7) New Buildings, (8) Same, Used, (9) Land, (10) Other Fixed Assets; Sales of (11) Passenger Vehicles, (12) Other Vehicles, (13) Plant etc., (14) Buildings and Land, (15) Other Fixed Assets. The entry (5) includes Plant installed by the firm's own employees and the entry (7) includes Construction work on buildings, roads etc. done by the firm's own employees.

The GFCF data were first extracted in the detail in which they appeared on the CIP summary forms with certain entries for the earlier years being more aggregated than as required by the 1963 list. These aggregate items (mainly vehicles) were then distributed, via *Estimation*, among the New and Used headings, by reference to the observable proportions for later years. Possible errors, arising from such estimated distributions, are not considered to be serious.

The year 1963, however, is the first year for which purchases of Other Fixed Assets explicitly appear and so this item has dubious Capital Stock results. The purchase was taken as zero for years prior to 1963. Sales of

Land are implicitly taken as zero since the CIP gave Land and Buildings as a single item and this has been treated as pure Buildings. Thus the Capital Stock of Land as such may be excessive, although the starting stock was usually taken to be zero.

For most sectors, the starting stock of Plant and Vehicles was allocated between (1) Plant, (2) Work Vehicles, (3) Passenger Vehicles, in rough proportion to subsequent purchases of these items; generally the Plant had three-quarters, or more, of the starting value. Again, for most sectors the starting value for Buildings and Land was taken as Buildings, with Land and Other Fixed Assets left at zero level. These starting values, before sub-division, were CIP results for 1945 or 1950, end of year, and were "Written-Down or Balance-Sheet Values". It is assumed that all the CIP respondents made an entry for them i.e. that they are usable, without grossing.

**Deflators Used. to give GFCF and Starting Stock at 1958 Prices**

Before the Starting Stock and GFCF data could be used, it was necessary to value them consistently at 1958 prices. There were four deflator series, each based on unity for 1958: (a) Vehicles, (b) Plant, (c) Buildings, (d) Land. The Plant deflator was applied to the Other Fixed Assets. The four deflators are listed in Appendix 1, with notes on sources; they are for the years 1945-1968.

**The Average Life Values Used**

Buildings and Land were taken as having an infinite life, for the calculations under discussion. Both kinds of Vehicles were taken to have 8 years as the life for new goods. For the Plant and Machinery, the values used were to some extent a compromise between the Nevin and Kuh figures quoted above and to some extent derived from suggestions by CSO colleagues. The details are shown in Appendix 2. A figure of 24 years was taken everywhere for Other Fixed Assets, all purchases being assumed New. Thus the Average Life figures are considered the best available, without recourse to industrial personnel by means of survey methods. The Plant and Machinery is fairly diverse for many industries and one would have to obtain from a firm (a) the relative importance of several kinds of plant, measured as proportions of the total purchase cost (at actual prices or specified constant prices); (b) the expected useful life of each kind. One could then derive a weighted average useful life for the firm or establishment and combine firms within an industry by some further weighting process, to give an Average Life for the aggregate. Such a survey might be considered worthwhile if confined to large establishments and if likely to have a successful response.

**The Computing of Equivalent-New Capital Stock**

Without a computer, the volume of calculation for 62 separate sectors and for 23 or 18 years would have been formidable. The author produced

a Fortran programme which gave results for the following six kinds of stock in each sector: (1) Passenger Vehicles, (2) Work Vehicles, (3) Plant and Machinery, (4) Buildings, (5) Land, (6) Other Fixed Assets. As stated above, the results for the last two are doubtful because of lack of data.

The data length was either 23 years (1945-1967), or 18 years (1950-1967). The programme processed any desired number of industries of one specified data length, in a single run. When 1968 Asset data became available the 1968 Capital Stock estimates were made separately.

**Selected Results**

Appendix 3 shows results aggregated into 13 sectors, namely, 2 for Mining, 10 for Manufacturing, 1 for selected Construction. Aggregate capital stock is shown as the total, which is the sum of the values for all six kinds, and two sub-totals, one for Plant and Vehicles and one for Buildings, Land and Other Fixed Assets. These two sub-totals correspond to those for the calculations via Nevin's method. A further two sub-Aggregates are shown, one for Plant and one for Buildings.

**Comparison with Earlier Results**

Appendix 4 gives mid-year Capital Stock estimates for each year 1953-1968, for the Equivalent-New and the reworked Written-Down types. Nevin's original totals are also shown, for 1953-59. The author's two sets of results have Buildings and Plant shown, as well as the Total, for each of the 10 Manufacturing sub-sectors and for the Manufacturing aggregate. For all sectors except Clothing, the equivalent-new levels, both for Buildings and Plant, are considerably below the levels obtained by the Nevin method, for 1953; they catch up on the Nevin levels (and in a few cases exceed them) by 1968.

**Types of Depreciation Function**

The Nevin method uses the factor $(1-t/m)$ to give end-of-year value of the capital asset, where m is the Average Life and t the number of years since the beginning of the year in which the asset was purchased. The Equivalent-New method uses the factor $(1-\lambda(t-1)/m)$, for year t of the m years and then the factor 0·0 for year $(m+1)$ and subsequent years, $\lambda$ being about 0.2. For the purpose of estimating Capacity it is possible that curvilinear functions of t might be more appropriate, for some machines or for certain industries. Forms such as $(1-kt^2)$ or $(1-ae^{kt/m})$ might be more precise than those used for the numerical results given above, if one had the data from which to calculate the parameters, by fitting the functions. The Equivalent-New method, as stated in part (9) of the description of that method, assumes that apart from extra time for repairs towards the end of its life, the machine is used evenly over its useful life, the length of the latter being m years, regardless of fluctuations in intensity of use. as measuring the useful life of some typical machine rather than a fixed period of time; thus machine (A) used twice as intensively, on average,

as machine (B), would be scrapped at the point of time which was only half-way through the useful life of (B). Even here one is assuming a linear relationship between length of life and cumulative output. In any event, the use of the simplifying assumption of linear depreciation, with the associated fixed length of Average Life, is mainly or wholly due to lack of information which would make more precise treatment possible.

**General Conclusion**

The two sets of figures which cover the 16 years 1953-68 provide alternatives, each of which is consistent and could be used with data on Output, Employment and implicit price indices to calculate production functions at constant or at current prices. The writer believes that better Capital Stock figures are to be obtained by a survey which would give improved estimates of Average Life, rather than seek Stock data directly; by using known figures for purchases and sales of assets, combined with known price indices, and a specified Depreciation function, one obtains reliable and consistent results and one can define the Capital Stock by choice.

Mr. C. W. Jefferson, in [6], has valuable and interesting suggestions arising from his pilot survey of a direct approach to firms.

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APPENDIX I

PRICE DEFLATORS USED FOR EQUIVALENT — NEW CAPITAL STOCK CALCULATIONS

| Year | Passenger Vehicles and Work-vehicles | Plant, Machin. and other Fixed Assets | Buildings | Land | 1945–53 "Metal" 1953–68 "Imported" Producer Cap. Goods | 1945–53 "Capital" 1953–68 'Transported Cap. for Industry' | Average of (5) and (6) |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1945 | 0·7053 | 0·5711 | 0·450 | 0·61 | 0·6776 | 0·6234 | 0·6505 |
| 1946 | 0·6862 | 0·5865 | 0·556 | 0·64 | 0·6748 | 0·6613 | 0·6680 |
| 1947 | 0·7586 | 0·6515 | 0·648 | 0·67 | 0·7486 | 0·7356 | 0·7421 |
| 1948 | 0·7399 | 0·7145 | 0·703 | 0·70 | 0·8297 | 0·7979 | 0·8138 |
| 1949 | 0·7376 | 0·7170 | 0·706 | 0·73 | 0·8311 | 0·8023 | 0·8167 |
| 1950 | 0·7514 | 0·7345 | 0·732 | 0·76 | 0·8412 | 0·8319 | 0·8366 |
| 1951 | 0·8427 | 0·8104 | 0·785 | 0·79 | 0·9544 | 0·8918 | 0·9231 |
| 1952 | 0·9030 | 0·8978 | 0·873 | 0·82 | 1·0540 | 0·9912 | 1·0226 |
| 1953 | 0·9114 | 0·8780 | 0·8811 | 0·85 | 1·0 | 1·0 | 1·0 |
| 1954 | 0·8955 | 0·8802 | 0·8626 | 0·88 | 1·009 | 0·996 | 1·0025 |
| 1955 | 0·8861 | 0·9188 | 0·8837 | 0·91 | 1·050 | 1·043 | 1·0465 |
| 1956 | 0·9731 | 0·9587 | 0·9401 | 0·94 | 1·096 | 1·088 | 1·0920 |
| 1957 | 0·9794 | 0·9934 | 0·9824 | 0·97 | 1·138 | 1·125 | 1·1315 |
| 1958 | 1·0 | 1·0 | 1·0 | 1·0 | 1·149 | 1·129 | 1·1390 |
| 1959 | 0·9918 | 1·0044 | 0·9806 | 1·00 | 1·115 | 1·133 | 1·1440 |
| 1960 | 1·0027 | 1·0114 | 1·0088 | 1·05 | 1·163 | 1·141 | 1·1520 |
| 1961 | 1·0892 | 1·0356 | 1·0493 | 1·25 | 1·194 | 1·165 | 1·1795 |
| 1962 | 1·1479 | 1·0544 | 1·1048 | 1·50 | 1·220 | 1·182 | 1·2010 |
| 1963 | 1·1746 | 1·0601 | 1·1145 | 1·75 | 1·222 | 1·193 | 1·2075 |
| 1964 | 1·2196 | 1·0961 | 1·2000 | 2·00 | 1·264 | 1·233 | 1·2485 |
| 1965 | 1·2804 | 1·1155 | 1·2361 | 2·25 | 1·289 | 1·252 | 1·2705 |
| 1966 | 1·3459 | 1·1440 | 1·2916 | 2·50 | 1·326 | 1·280 | 1·3030 |
| 1967 | 1·4577 | 1·1664 | 1·3400 | 2·75 | 1·354 | 1·303 | 1·3285 |
| 1968 | 1·4628 | 1·2261 | 1·3965 | 3·64 | 1·409 | 1·384 | 1·3965 |

Notes: Series (1) is the implied price deflator obtained by the ratio CIP 49 (Motor Vehicles, Land and Road) Value Index based on 1958/CIP 49 Volume Index based on 1958; the Volume Index is obtained by a "Fisher Ideal" formula.
Series (3) is the Wholesale Price Index for Building and Construction shown as a sub-sector of "Capital Goods" Indices, rebased on 1958. See Table 339, "Statistical Abstract of Ireland 1967", for some of the basic series.
Series (4) is taken from CSO National Accounts work-files for 1958-68, and is estimated by this writer for the earlier years, via an assumed change, annual of 3 per cent.
Series (2) is the simple average of the series (5) and (6) above, rebased on 1958. Series (5) for 1945–53 is the old Wholesale Price Index for "Metal and Manufactures" and for 1953–68 is the Wholesale Price Index for "Imported Producer Capital Goods". Series (6) for 1945–53 is the Wholesale Price Index for "Capital Equipment" and for 1953–68 is the Wholesale Price Index for "Transportable Capital Goods for Use in Industry". See here also Table 339 of "Statistical Abstract',.

APPENDIX 2

AVERAGE LIFE OF PLANT/MACHINERY USED IN EQUIVALENT—NEW CAPITAL STOCK CALCULATIONS, WITH NEVIN AND KUH FIGURES

| CIP Industry or Group | Average Life (Years) | | |
|---|---|---|---|
| | Equiv. New | Nevin | Kuh |
| 1. Coal | 25 | | |
| 2. Stone | 25 | | |
| 3. Miscellaneous | 25 | | |
| 4. Peat | 25 | | |
| MINING | | | |
| 5. Bacon | 23 | | |
| 6. Slaught. | 23 | | |
| 7. Milk | 23 | | |
| 8. Veg. Cann. | 23 | | |
| 9a. Flour | 23 | | |
| 9b. Animal Feed | 23 | | |
| 10. Bread | 23 | | |
| 11. Sugar | 23 | | |
| 12. Chocolate | 23 | | |
| 13. Fish | 23 | | |
| 14. Margarine | 23 | | |
| 15. Other Food | 23 | | |
| FOOD | | 23 | 20 |
| 16. Distill. | 15 | | 19 |
| 17. Malt. | 15 | | |
| 18. Brew. | 15 | | |
| 19. Soft Drinks | 15 | | |
| 20. Tobacco | 15 | | 28 |
| DRINK/TOBACCO | | 15 | |
| 21. Woollen | 40 | | |
| 22. Cotton | 40 | | |
| 23. Jute | 40 | | |
| 30. Made-up | 40 | | |
| TEXTILES | | 63 | 24 |
| 24. Hosiery | 40 | | 14 |
| 25. Shoes | 20 | | |
| 26. Men's | 15 | | |
| 27. Shirts | 13 | | |
| 28. Women's | 13 | | |
| 29. Miscellaneous | 15 | | |
| 35. Tanning | 40 | | 19 |
| 36. Leather | 25 | | |
| CLOTHING | | 13 | |
| 31. Wood | 24 | | 9 |
| 32. Furniture | 30 | | 19 |
| 51. Brushes | 30 | | |
| WOOD | | 24 | |
| 33. Paper | 30 | | 24 |
| 34. Printing | 30 | | 25 |
| PAPER | | 36 | |
| 37. Fertilisers | 30 | | |
| 38. Paints | 40 | | |
| 39. Chemicals | 40 | | |
| 40. Soap | 40 | | |
| CHEMICALS | | 33 | 20 |
| 41. Pottery | 25 | | 22 |
| 42. Clay | 25 | | |
| 43. Cement | 25 | | |
| CLAY | | 31 | |
| 44. Metal | 30 | | 20 |
| 45. Non-E.M. | 40 | | 18 |
| 46. Elec. Mach. | 40 | | 16 |
| 47. Ships | 30 | | 25 |
| 49. Motor Vehicles | 30 | | 20 |
| 50. Other Vehicles | 30 | | 25 |
| METAL | | 61 | |
| 52a. Petrol | 50 | | 14 |
| 52b. Rubber | 40 | | 21 |
| 52c. Plastics | 40 | | |
| 52d. Rest | 40 | | |
| OTHER MAN. | | 62 | |
| 53. Construct. | 25 | | |
| 54a. Local Auth. | 25 | | |
| 55. Docks | 25 | | |
| SELECTED CONSTRUCT. | | | |

APPENDIX 3

EQUIVALENT-NEW CAPITAL STOCK MID-YEAR ESTIMATES AT 1958 PRICES (£000). SOLID FUEL (COAL AND PEAT-PROCESSING)

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 3,702 | 2,230 | 1,472 | 2,069 | 1,270 |
| 1954 | 4,475 | 2,931 | 1,544 | 2,826 | 1,325 |
| 1955 | 5,660 | 3,978 | 1,682 | 3,911 | 1,441 |
| 1956 | 6,473 | 4,652 | 1,821 | 4,556 | 1,563 |
| 1957 | 6,957 | 5,038 | 1,919 | 4,927 | 1,643 |
| 1958 | 7,748 | 5,538 | 2,210 | 5,412 | 1,917 |
| 1959 | 9,243 | 6,014 | 3,229 | 5,889 | 2,918 |
| 1960 | 10,772 | 6,420 | 4,352 | 6,298 | 4,023 |
| 1961 | 11,872 | 6,767 | 5,105 | 6,632 | 4,762 |
| 1962 | 12,829 | 7,170 | 5,659 | 7,023 | 5,304 |
| 1963 | 13,139 | 7,100 | 6,039 | 6,955 | 5,671 |
| 1964 | 13,434 | 6,813 | 6,621 | 6,681 | 6,235 |
| 1965 | 14,047 | 6,925 | 7,122 | 6,808 | 6,725 |
| 1966 | 14,396 | 7,039 | 7,357 | 6,933 | 6,955 |
| 1967 | 14,635 | 7,111 | 7,524 | 7,015 | 7,118 |
| 1968 | 14,793 | 7,112 | 7,681 | 7,021 | 7,273 |

OTHER MINING

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 3,626 | 2,715 | 911 | 1,987 | 869 |
| 1954 | 3,740 | 2,764 | 976 | 2,187 | 915 |
| 1955 | 3,971 | 2,915 | 1,056 | 2,462 | 962 |
| 1956 | 4,610 | 3,413 | 1,197 | 2,835 | 1,078 |
| 1957 | 5,186 | 3,787 | 1,399 | 3,093 | 1,258 |
| 1958 | 6,334 | 4,653 | 1,681 | 3,809 | 1,516 |
| 1959 | 7,298 | 5,431 | 1,867 | 4,523 | 1,687 |
| 1960 | 7,530 | 5,632 | 1,898 | 4,756 | 1,700 |
| 1961 | 8,065 | 6,060 | 2,005 | 5,115 | 1,750 |
| 1962 | 8,790 | 6,604 | 2,186 | 5,645 | 1,865 |
| 1963 | 8,621 | 6,367 | 2,254 | 5,475 | 1,828 |
| 1964 | 8,814 | 6,111 | 2,703 | 5,211 | 2,119 |
| 1965 | 11,656 | 8,022 | 3,634 | 6,950 | 2,840 |
| 1966 | 14,528 | 10,163 | 4,365 | 8,992 | 3,410 |
| 1967 | 16,719 | 11,604 | 5,115 | 10,431 | 4,117 |
| 1968 | 18,611 | 12,914 | 5,697 | 11,621 | 4,631 |

**Appendix 3 (Continued) Equivalent-New Mid-Year Capital Stock (£000)**

FOOD

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 39,175 | 19,781 | 19,394 | 16,823 | 19,226 |
| 1954 | 41,424 | 21,223 | 20,201 | 18,421 | 20,014 |
| 1955 | 43,638 | 22,505 | 21,133 | 19,877 | 20,922 |
| 1956 | 46,256 | 24,203 | 22,053 | 21,452 | 21,821 |
| 1957 | 47,102 | 24,064 | 23,038 | 20,995 | 22,764 |
| 1958 | 47,634 | 23,665 | 23,969 | 20,375 | 23,641 |
| 1959 | 49,960 | 25,248 | 24,712 | 21,788 | 24,343 |
| 1960 | 52,566 | 26,945 | 25,621 | 23,321 | 25,214 |
| 1961 | 55,829 | 29,109 | 26,720 | 25,269 | 26,266 |
| 1962 | 58,436 | 30,232 | 28,204 | 26,104 | 27,702 |
| 1963 | 62,527 | 32,396 | 30,131 | 28,040 | 29,579 |
| 1964 | 68,787 | 36,765 | 32,022 | 32,200 | 31,390 |
| 1965 | 74,763 | 49,747 | 34,016 | 36,016 | 33,273 |
| 1966 | 81,603 | 45,127 | 36,476 | 40,297 | 35,610 |
| 1967 | 88,928 | 49,768 | 39,160 | 44,893 | 38,199 |
| 1968 | 96,879 | 54,953 | 41,926 | 49,868 | 40,717 |

DRINK AND TOBACCO

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 16,610 | 6,741 | 9,869 | 6,134 | 9,733 |
| 1954 | 16,477 | 6,565 | 9,912 | 5,902 | 9,767 |
| 1955 | 18,694 | 8,028 | 10,666 | 7,298 | 10,516 |
| 1956 | 20,100 | 9,190 | 10,910 | 8,436 | 10,756 |
| 1957 | 21,187 | 10,077 | 11,110 | 9,339 | 10,952 |
| 1958 | 22,205 | 10,928 | 11,277 | 10,199 | 11,115 |
| 1959 | 23,162 | 11,711 | 11,451 | 11,003 | 11,288 |
| 1960 | 24,436 | 12,687 | 11,749 | 11,985 | 11,579 |
| 1961 | 26,120 | 14,045 | 12,075 | 13,301 | 11,894 |
| 1962 | 28,012 | 15,451 | 12,561 | 14,698 | 12,369 |
| 1963 | 29,988 | 16,641 | 13,347 | 15,854 | 13,003 |
| 1964 | 31,977 | 17,441 | 14,536 | 16,518 | 13,786 |
| 1965 | 33,883 | 18,131 | 15,752 | 17,051 | 14,667 |
| 1966 | 35,878 | 19,393 | 16,485 | 18,142 | 15,347 |
| 1967 | 38,468 | 21,069 | 17,399 | 19,691 | 16,291 |
| 1968 | 40,121 | 21,956 | 18,165 | 20,521 | 17,095 |

**Appendix 3 (Continued) Equivalent-New Mid-Year Capital Stock (£000)**

TEXTILES, EXCEPT HOSIERY

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 9,720 | 5,594 | 4,126 | 5,236 | 4,075 |
| 1954 | 10,319 | 6,002 | 4,317 | 5,760 | 4,261 |
| 1955 | 10,921 | 6,366 | 4,555 | 6,222 | 4,492 |
| 1956 | 11,588 | 6,845 | 4,743 | 6,665 | 4,677 |
| 1957 | 12,268 | 7,364 | 4,904 | 7,164 | 4,836 |
| 1958 | 13,004 | 7,908 | 5,096 | 7,688 | 5,025 |
| 1959 | 13,808 | 8,494 | 5,314 | 8,266 | 5,239 |
| 1960 | 15,029 | 9,429 | 5,600 | 9,185 | 5,515 |
| 1961 | 16,315 | 10,416 | 5,899 | 10,134 | 5,807 |
| 1962 | 17,564 | 11,271 | 6,293 | 10,965 | 6,198 |
| 1963 | 19,032 | 12,296 | 6,736 | 11,987 | 6,637 |
| 1964 | 20,549 | 13,435 | 7,114 | 13,126 | 7,008 |
| 1965 | 21,359 | 13,977 | 7,382 | 13,654 | 7,269 |
| 1966 | 22,145 | 14,488 | 7,657 | 14,129 | 7,536 |
| 1967 | 24,080 | 15,872 | 8,208 | 15,471 | 8,075 |
| 1968 | 26,377 | 17,612 | 8,765 | 17,179 | 8,667 |

CLOTHING, HOSIERY, SHOES, LEATHER

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 10,463 | 4,993 | 5,470 | 4,494 | 5,392 |
| 1954 | 10,968 | 5,292 | 5,676 | 4,760 | 5,594 |
| 1955 | 11,441 | 5,582 | 5,859 | 5,050 | 5,776 |
| 1956 | 11,858 | 5,826 | 6,032 | 5,307 | 5,947 |
| 1957 | 12,334 | 6,159 | 6,175 | 5,670 | 6,089 |
| 1958 | 12,824 | 6,465 | 6,359 | 5,988 | 6,269 |
| 1959 | 13,367 | 6,853 | 6,514 | 6,350 | 6,419 |
| 1960 | 14,164 | 7,402 | 6,762 | 6,872 | 6,657 |
| 1961 | 15,255 | 8,159 | 7,096 | 7,619 | 6,980 |
| 1962 | 16,550 | 9,096 | 7,454 | 8,547 | 7,327 |
| 1963 | 17,790 | 9,919 | 7,871 | 9,341 | 7,722 |
| 1964 | 19,186 | 10,843 | 8,343 | 10,226 | 8,158 |
| 1965 | 20,555 | 11,614 | 8,941 | 10,970 | 8,712 |
| 1966 | 21,680 | 12,201 | 9,479 | 11,525 | 9,213 |
| 1967 | 23,213 | 13,055 | 10,158 | 12,371 | 9,841 |
| 1968 | 25,401 | 14,238 | 11,163 | 13,512 | 10,751 |

**Appendix 3 (Continued) Equivalent-New Mid-Year Capital Stock (£000)**

WOOD, FURNITURE, BRUSHES

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 3,640 | 1,516 | 2,124 | 1,168 | 2,107 |
| 1954 | 3,830 | 1,662 | 2,168 | 1,250 | 2,151 |
| 1955 | 4,070 | 1,836 | 2,234 | 1,381 | 2,215 |
| 1956 | 4,289 | 1,966 | 2,323 | 1,501 | 2,301 |
| 1957 | 4,253 | 1,848 | 2,405 | 1,382 | 2,378 |
| 1958 | 4,187 | 1,723 | 2,464 | 1,256 | 2,433 |
| 1959 | 4,313 | 1,795 | 2,518 | 1,313 | 2,485 |
| 1960 | 4,496 | 1,884 | 2,612 | 1,378 | 2,578 |
| 1961 | 4,727 | 2,025 | 2,702 | 1,496 | 2,665 |
| 1962 | 5,290 | 2,407 | 2,883 | 1,871 | 2,840 |
| 1963 | 5,993 | 2,836 | 3,157 | 2,289 | 3,109 |
| 1964 | 6,603 | 3,221 | 3,382 | 2,634 | 3,335 |
| 1965 | 7,152 | 3,570 | 3,582 | 2,950 | 3,532 |
| 1966 | 7,513 | 3,781 | 3,732 | 3,155 | 3,675 |
| 1967 | 7,769 | 3,957 | 3,812 | 3,336 | 3,747 |
| 1968 | 8,339 | 4,290 | 4,049 | 3,643 | 3,917 |

PAPER AND PRINTING

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 11,000 | 6,219 | 4,781 | 5,950 | 4,705 |
| 1954 | 12,002 | 6,941 | 5,061 | 6,625 | 4,979 |
| 1955 | 12,950 | 7,651 | 5,299 | 7,311 | 5,216 |
| 1956 | 13,810 | 8,340 | 5,470 | 7,994 | 5,381 |
| 1957 | 14,645 | 9,046 | 5,599 | 8,707 | 5,504 |
| 1958 | 15,289 | 9,617 | 5,672 | 9,282 | 5,576 |
| 1959 | 15,702 | 9,927 | 5,775 | 9,565 | 5,676 |
| 1960 | 15,122 | 9,180 | 5,942 | 8,776 | 5,838 |
| 1961 | 15,032 | 8,825 | 6,207 | 8,381 | 6,099 |
| 1962 | 16,355 | 9,826 | 6,529 | 9,359 | 6,419 |
| 1963 | 17,657 | 10,736 | 6,921 | 10,244 | 6,809 |
| 1964 | 19,227 | 11,903 | 7,324 | 11,376 | 7,202 |
| 1965 | 20,956 | 13,255 | 7,701 | 12,696 | 7,545 |
| 1966 | 22,510 | 14,395 | 8,115 | 13,798 | 7,923 |
| 1967 | 24,054 | 15,485 | 8,569 | 14,870 | 8,350 |
| 1968 | 26,044 | 16,930 | 9,114 | 16,266 | 8,837 |

**Appendix 3 (Continued) Equivalent-New Mid-Year Capital Stock (£000)**

CHEMICALS

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 5,809 | 2,607 | 3,202 | 2,351 | 3,166 |
| 1954 | 6,189 | 2,881 | 3,308 | 2,593 | 3,268 |
| 1955 | 6,703 | 3,193 | 3,510 | 2,879 | 3,445 |
| 1956 | 7,212 | 3,499 | 3,713 | 3,166 | 3,618 |
| 1957 | 7,891 | 3,874 | 4,017 | 3,525 | 3,917 |
| 1958 | 8,516 | 4,175 | 4,341 | 3,816 | 4,240 |
| 1959 | 9,034 | 4,477 | 4,557 | 4,094 | 4,455 |
| 1960 | 9,951 | 4,979 | 4,972 | 4,556 | 4,858 |
| 1961 | 11,664 | 5,861 | 5,803 | 5,382 | 5,677 |
| 1962 | 13,456 | 6,867 | 6,589 | 6,314 | 6,462 |
| 1963 | 14,535 | 7,505 | 7,030 | 6,932 | 6,900 |
| 1964 | 15,296 | 7,959 | 7,337 | 7,374 | 7,199 |
| 1965 | 15,979 | 8,336 | 7,643 | 7,694 | 7,497 |
| 1966 | 20,211 | 11,559 | 8,652 | 10,875 | 8,492 |
| 1967 | 25,579 | 15,644 | 9,935 | 14,917 | 9,744 |
| 1968 | 28,114 | 17,529 | 10,585 | 16,716 | 10,347 |

CLAY, CEMENT, GLASS/POTTERY

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 6,775 | 3,767 | 3,008 | 3,035 | 2,946 |
| 1954 | 7,662 | 4,400 | 3,262 | 3,913 | 3,189 |
| 1955 | 8,315 | 4,784 | 3,531 | 4,526 | 3,439 |
| 1956 | 8,927 | 5,151 | 3,776 | 4,854 | 3,651 |
| 1957 | 9,517 | 5,534 | 3,983 | 5,192 | 3,818 |
| 1958 | 10,011 | 5,843 | 4,168 | 5,455 | 3,983 |
| 1959 | 10,339 | 6,051 | 4,288 | 5,615 | 4,091 |
| 1960 | 10,627 | 6,223 | 4,404 | 5,761 | 4,196 |
| 1961 | 11,516 | 6,921 | 4,595 | 6,431 | 4,377 |
| 1962 | 12,634 | 7,784 | 4,850 | 7,299 | 4,617 |
| 1963 | 13,177 | 8,018 | 5,159 | 7,538 | 4,903 |
| 1964 | 15,470 | 9,755 | 5,715 | 9,214 | 5,384 |
| 1965 | 18,942 | 12,599 | 6,343 | 12,007 | 5,932 |
| 1966 | 21,604 | 14,630 | 6,974 | 13,974 | 6,511 |
| 1967 | 24,229 | 16,473 | 7,756 | 15,739 | 7,332 |
| 1968 | 26,347 | 17,909 | 8,438 | 17,089 | 7,836 |

**Appendix 3 (Continued) Equivalent-New Mid-Year Capital Stock (£000)**

METAL, ENGINEERING, VEHICLES

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 14,552 | 7,445 | 7,107 | 6,839 | 6,945 |
| 1954 | 15,394 | 7,854 | 7,540 | 7,359 | 7,363 |
| 1955 | 16,459 | 8,315 | 8,144 | 7,912 | 7,959 |
| 1956 | 17,600 | 8,953 | 8,647 | 8,474 | 8,449 |
| 1957 | 18,253 | 9,349 | 8,904 | 8,867 | 8,698 |
| 1958 | 18,823 | 9,719 | 9,104 | 9,245 | 8,895 |
| 1959 | 19,830 | 10,434 | 9,396 | 9,928 | 9,190 |
| 1960 | 20,662 | 10,518 | 10,144 | 9,970 | 9,887 |
| 1961 | 22,188 | 11,020 | 11,168 | 10,365 | 10,865 |
| 1962 | 25,417 | 13,121 | 12,296 | 12,351 | 11,979 |
| 1963 | 30,101 | 16,701 | 13,400 | 15,857 | 13,086 |
| 1964 | 34,759 | 20,123 | 14,636 | 19,210 | 14,281 |
| 1965 | 38,367 | 22,267 | 16,100 | 21,303 | 15,654 |
| 1966 | 42,014 | 24,664 | 17,350 | 23,666 | 16,840 |
| 1967 | 45,101 | 26,573 | 18,528 | 25,556 | 17,940 |
| 1968 | 48,168 | 28,409 | 19,759 | 27,311 | 19,036 |

OTHER MANUFACTURING

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 3,352 | 1,548 | 1,804 | 1,301 | 1,781 |
| 1954 | 3,536 | 1,638 | 1,898 | 1,478 | 1,874 |
| 1955 | 3,746 | 1,747 | 1,999 | 1,663 | 1,945 |
| 1956 | 4,101 | 1,957 | 2,144 | 1,854 | 2,060 |
| 1957 | 4,417 | 2,156 | 2,261 | 2,039 | 2,177 |
| 1958 | 6,069 | 3,195 | 2,964 | 2,972 | 2,880 |
| 1959 | 8,030 | 4,295 | 3,735 | 4,144 | 3,650 |
| 1960 | 8,728 | 4,780 | 3,948 | 4,607 | 3,862 |
| 1961 | 9,451 | 5,213 | 4,238 | 5,011 | 4,148 |
| 1962 | 10,647 | 5,956 | 4,691 | 5,717 | 4,592 |
| 1963 | 12,050 | 6,915 | 5,135 | 6,644 | 5,027 |
| 1964 | 13,626 | 8,032 | 5,594 | 7,717 | 5,469 |
| 1965 | 15,735 | 9,531 | 6,204 | 9,163 | 6,060 |
| 1966 | 17,794 | 11,015 | 6,779 | 10,607 | 6,618 |
| 1967 | 19,450 | 12,194 | 7,256 | 11,766 | 7,065 |
| 1968 | 21,508 | 13,713 | 7,795 | 13,253 | 7,546 |

**Appendix 3 (Continued) Equivalent-New Mid-Year Capital Stock (£000)**

SELECTED CONSTRUCTION

| Year | Total | Plant and Vehicles | Buildings, Land and Other | Plant | Buildings |
|---|---|---|---|---|---|
| 1953 | 14,544 | 5,662 | 8,882 | 4,407 | 7,092 |
| 1954 | 16,317 | 6,686 | 9,631 | 5,079 | 7,435 |
| 1955 | 17,689 | 7,594 | 10,095 | 5,752 | 7,669 |
| 1956 | 18,471 | 8,064 | 10,407 | 6,143 | 7,911 |
| 1957 | 19,218 | 8,227 | 10,991 | 6,334 | 8,448 |
| 1958 | 19,629 | 7,920 | 11,709 | 6,015 | 9,117 |
| 1959 | 20,206 | 7,868 | 12,338 | 5,896 | 9,678 |
| 1960 | 21,086 | 8,219 | 12,867 | 6,204 | 10,109 |
| 1961 | 21,979 | 8,547 | 13,432 | 6,459 | 10,572 |
| 1962 | 23,276 | 9,049 | 14,227 | 6,966 | 11,267 |
| 1963 | 25,143 | 9,870 | 15,273 | 7,758 | 12,165 |
| 1964 | 27,799 | 11,117 | 16,682 | 8,771 | 13,341 |
| 1965 | 30,750 | 12,472 | 18,278 | 9,836 | 14,693 |
| 1966 | 33,466 | 13,588 | 19,878 | 10,810 | 16,169 |
| 1967 | 36,674 | 14,528 | 22,146 | 11,716 | 18,305 |
| 1968 | 41,423 | 15,738 | 25,685 | 12,806 | 21,605 |

## APPENDIX 4

### MANUFACTURING MID-YEAR CAPITAL STOCK (£ MILLION AT 1958 PRICES)

(1) Equivalent-new ,excluding CIP Non-Respondents and Rented Asset.
(2) Written down, using Nevin's methods, including CIP Non-Respondents, but excluding Rented Assets.
(3) Nevin's original results, including CIP Non-Respondents and Rented Assets.

| | | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **FOOD** | | | | | | | | | | | | | | | | | |
| Buildings | (1) | 19·39 | 20·20 | 21·13 | 22·05 | 23·04 | 23·97 | 24·71 | 25·62 | 26·72 | 28·20 | 30·13 | 32·02 | 34·02 | 36·48 | 39·16 | 41·93 |
| | (2) | 29·22 | 29·56 | 30·07 | 30·60 | 31·16 | 31·56 | 31·76 | 32·09 | 32·59 | 32·98 | 33·24 | 34·94 | 36·15 | 37·82 | 39·74 | 41·77 |
| Plant | (1) | 19·78 | 21·22 | 22·51 | 24·20 | 24·06 | 23·66 | 25·25 | 26·95 | 29·11 | 30·23 | 32·40 | 36·77 | 40·75 | 45·13 | 49·77 | 54·95 |
| | (2) | 28·40 | 28·93 | 29·33 | 29·88 | 30·51 | 30·84 | 30·94 | 31·14 | 31·47 | 32·93 | 35·55 | 39·21 | 41·89 | 44·57 | 46·86 | 49·41 |
| TOTAL | (1) | 39·17 | 41·42 | 43·64 | 45·26 | 47·10 | 47·63 | 49·96 | 52·57 | 55·83 | 58·44 | 62·53 | 68·79 | 74·76 | 81·60 | 88·93 | 96·88 |
| | (2) | 57·62 | 58·49 | 59·40 | 60·48 | 61·67 | 62·40 | 62·70 | 62·23 | 64·06 | 65·91 | 68·79 | 74·17 | 78·04 | 82·39 | 86·60 | 91·18 |
| | (3) | 57·6 | 58·5 | 59·5 | 60·6 | 61·8 | 62·6 | 62·9 | — | — | — | — | — | — | — | — | — |
| **DRINK/TOBACCO** | | | | | | | | | | | | | | | | | |
| Buildings | (1) | 9·87 | 9·91 | 10·67 | 10·91 | 11·11 | 11·28 | 11·45 | 11·75 | 12·07 | 12·56 | 13·35 | 14·54 | 15·75 | 16·49 | 17·40 | 18·16 |
| | (2) | 20·54 | 20·54 | 20·66 | 20·57 | 20·41 | 20·20 | 20·27 | 20·45 | 20·39 | 20·49 | 20·79 | 21·19 | 21·64 | 21·97 | 22·50 | 22·81 |
| Plant | (1) | 6·74 | 6·57 | 8·03 | 9·19 | 10·09 | 10·93 | 11·71 | 12·69 | 14·05 | 15·45 | 16·64 | 17·44 | 18·13 | 19·39 | 21·07 | 21·96 |
| | (2) | 8·89 | 9·67 | 10·59 | 11·17 | 11·28 | 11·25 | 11·15 | 11·28 | 11·83 | 12·69 | 13·56 | 14·20 | 15·01 | 15·93 | 16·53 | 16·56 |
| TOTAL | (1) | 16·61 | 16·48 | 18·69 | 20·10 | 21·19 | 22·21 | 23·16 | 24·44 | 26·12 | 28·01 | 29·99 | 31·98 | 33·88 | 35·88 | 38·47 | 40·12 |
| | (2) | 29·43 | 30·21 | 31·25 | 31·74 | 31·69 | 31·45 | 31·42 | 31·73 | 32·22 | 33·18 | 34·35 | 35·39 | 36·65 | 37·90 | 39·03 | 39·37 |
| | (3) | 29·4 | 30·1 | 31·1 | 31·5 | 31·4 | 31·2 | 29·8 | — | — | — | — | — | — | — | — | — |
| **TEXTILES (Ex. HOSIERY)** | | | | | | | | | | | | | | | | | |
| Buildings | (1) | 4·13 | 4·32 | 4·55 | 4·74 | 4·90 | 5·10 | 5·31 | 5·60 | 5·90 | 6·29 | 6·74 | 7·11 | 7·38 | 7·66 | 8·21 | 8·77 |
| | (2) | 11·39 | 11·51 | 11·70 | 11·83 | 11·91 | 12·02 | 12·17 | 11·38 | 12·57 | 12·91 | 13·21 | 13·45 | 13·60 | 13·76 | 14·19 | 14·68 |
| Plant | (1) | 5·59 | 6·00 | 6·37 | 6·85 | 7·36 | 7·91 | 8·49 | 9·43 | 10·42 | 11·27 | 12·30 | 13·44 | 13·98 | 14·49 | 15·87 | 17·61 |
| | (2) | 17·25 | 17·45 | 17·58 | 17·71 | 17·84 | 17·97 | 18·16 | 18·80 | 19·52 | 20·22 | 21·08 | 21·89 | 22·82 | 23·60 | 24·44 | 25·62 |
| TOTAL | (1) | 9·72 | 10·32 | 10·92 | 11·59 | 12·27 | 13·00 | 13·81 | 15·03 | 16·32 | 17·56 | 19·03 | 20·55 | 21·36 | 22·15 | 24·08 | 26·38 |
| | (2) | 28·64 | 28·96 | 29·28 | 29·54 | 29·75 | 29·99 | 30·33 | 33·18 | 32·09 | 33·13 | 34·29 | 35·34 | 36·42 | 37·36 | 38·63 | 40·30 |
| | (3) | 28·9 | 29·3 | 29·6 | 29·9 | 30·1 | 30·4 | 30·7 | — | — | — | — | — | — | — | — | — |
| **CLOTHING ETC.** | | | | | | | | | | | | | | | | | |
| Buildings | (1) | 5·47 | 5·68 | 5·86 | 6·03 | 6·18 | 6·36 | 6·51 | 6·76 | 7·10 | 7·45 | 7·87 | 8·34 | 8·94 | 9·48 | 10·16 | 11·16 |
| | (2) | 5·26 | 5·36 | 5·46 | 5·55 | 5·58 | 5·63 | 5·66 | 5·75 | 5·91 | 6·10 | 6·32 | 6·56 | 6·94 | 7·30 | 7·80 | 8·59 |
| Plant | (1) | 4·99 | 5·29 | 5·58 | 5·83 | 6·16 | 6·47 | 6·85 | 7·40 | 8·16 | 9·10 | 9·92 | 10·84 | 11·61 | 12·20 | 13·06 | 14·24 |
| | (2) | 4·21 | 4·36 | 4·44 | 4·46 | 4·41 | 4·28 | 4·20 | 4·32 | 4·70 | 5·36 | 6·00 | 6·56 | 7·30 | 7·80 | 8·18 | 8·82 |
| TOTAL | (1) | 10·46 | 10·97 | 11·44 | 11·86 | 12·33 | 12·83 | 13·37 | 14·16 | 15·26 | 16·55 | 17·79 | 19·19 | 20·55 | 21·68 | 23·21 | 25 40 |
| | (2) | 9·47 | 9·72 | 9·90 | 10·01 | 9·99 | 9·91 | 9·86 | 10·07 | 10·61 | 11·46 | 12·32 | 13·12 | 14·24 | 15·10 | 15·98 | 17·41 |
| | (3) | 12·4 | 12·6 | 12·8 | 12·9 | 12·8 | 12·7 | 12·6 | — | — | — | — | — | — | — | — | — |
| **WOOD ETC.** | | | | | | | | | | | | | | | | | |
| Buildings | (1) | 2·12 | 2·17 | 2·23 | 2·32 | 2·41 | 2·46 | 2·52 | 2·61 | 2·70 | 2·88 | 3·16 | 3·38 | 3·58 | 3·73 | 3·81 | 4·05 |
| | (2) | 3·26 | 3·25 | 3·28 | 3·34 | 3·36 | 3·36 | 3·35 | 3·38 | 3·40 | 3·51 | 3·71 | 3·87 | 3·99 | 4·07 | 4·08 | 4·26 |
| Plant | (1) | 1·52 | 1·66 | 1·84 | 1·97 | 1·85 | 1·72 | 1·80 | 1·88 | 2·03 | 2·41 | 2·84 | 3·22 | 3·57 | 3·78 | 3·96 | 4·29 |
| | (2) | 2·64 | 2·65 | 2·69 | 2·72 | 2·68 | 2·61 | 2·58 | 2·61 | 2·68 | 3·02 | 3·41 | 3·72 | 4·04 | 4·16 | 4·19 | 4·37 |
| TOTAL | (1) | 3·64 | 3·83 | 4·07 | 4·29 | 4·25 | 4·19 | 4·31 | 4·50 | 4·73 | 5·29 | 5·99 | 6·60 | 7·15 | 7·51 | 7·77 | 8·34 |
| | (2) | 5·90 | 5·90 | 5·97 | 6·06 | 6·04 | 5·97 | 5·93 | 5·99 | 6·08 | 6·53 | 7·12 | 7·59 | 8·03 | 8·23 | 8·27 | 8·63 |
| | (3) | 6·5 | 6·5 | 6·6 | 6·7 | 6·7 | 6·6 | 6·6 | — | — | — | — | — | — | — | — | — |
| **PAPER ETC.** | | | | | | | | | | | | | | | | | |
| Buildings | (1) | 4·78 | 5·06 | 5·30 | 5·47 | 5·60 | 5·67 | 5·77 | 5·94 | 6·21 | 6·53 | 6·92 | 7·32 | 7·70 | 8·12 | 8·57 | 9·11 |
| | (2) | 10·24 | 10·38 | 10·47 | 10·52 | 10·52 | 10·45 | 10·41 | 10·43 | 10·52 | 10·69 | 10·91 | 11·12 | 11·29 | 11·51 | 11·78 | 12·14 |
| Plant | (1) | 6·22 | 6·94 | 7·65 | 8·34 | 9·05 | 9·62 | 9·93 | 9·18 | 8·83 | 9·83 | 10·74 | 11·90 | 13·26 | 14·40 | 15·48 | 16·93 |

## APPENDIX 5

## NUMERICAL EXAMPLE: FINDING m, AVERAGE LIFE, BY ITERATION

Let m=10, so that 1/m=0·1 and suppose that the following scheme sets out for 10 years: $k_t$ the gross investment in year t, at constant prices; $K_t$, the capital stock at end of year t, (the capital stock at the beginning of year 1 being assumed nil); and the detail of the depreciated values which aggregate to form each $K_t$.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| kt | 10 | 20 | 10 | 30 | 20 | 40 | 30 | 50 | 30 | 20 |
| Depreciated values at end of year | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | | 18 | 16 | 14 | 12 | 10 | 8 | 6 | 4 | 2 |
| | | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
| | | | | 27 | 24 | 21 | 18 | 15 | 12 | 9 |
| | | | | | 18 | 16 | 14 | 12 | 10 | 8 |
| | | | | | | 36 | 32 | 28 | 24 | 20 |
| | | | | | | | 27 | 24 | 21 | 18 |
| | | | | | | | | 45 | 40 | 35 |
| | | | | | | | | | 27 | 24 |
| | | | | | | | | | | 18 |
| $K_t$ | 9 | 26 | 32 | 55 | 66 | 93 | 107 | 136 | 142 | 136 |

Now, for correct choice of value of m,

$$m=\frac{[k_t+2k_{t-1}+3k_{t-2}+\ldots+(m-1)k_{t-m+2}]}{[\sum_{i=t}^{t-m+2} k_i-K_t]}$$

Using $K_{10}=136$, given in all trials, find m.

For m=5 and t=10: t−m+2=7: $\sum_{i=10}^{7} k_i=130$

$\sum_{i=10}^{7} k_i-K_{10}=130-136$ negative, so denominator negative.

For m=6, t=10; t−m+2=6; $\sum_{i=10}^{6} k_i=170$; Denom.=34

Numerator $k_{10}+2k_9+\ldots+5k_6=550$; Fraction on right≃16.

For m=8, t=10: t−m+2=4; $\sum_{i=10}^{4} k_i=220$; Denom.=84

Numerator=880; Fraction≃10·5

For m=9, t=10: Denominator=94; Numerator=960; Fraction≃10·2
For m=10, t=10: Denom.=114; Numerator=1,140; Fraction=10·0
For m=11, t=10; Denom.=124; Numerator=1,240; Fraction=10·0

Thus the integer chosen, on the left, and the resulting fraction, on the right, apparently converge upon the correct value of m.

## APPENDIX 6

# RE-WORKING OF NEVIN'S RESULTS AND COMPARISONS FOR END-OF-1958

*The re-working of Nevin's results and Up-dating*

Nevin's Appendix F gives Mid-Year Capital Stock for each of the ten sub-groups of Manufacturing, at 1958 prices. Buildings and Plant are not shown separately. The writer re-worked the figures, using Nevin's methods and average working lives, and updated the figures to 1968.

The writer worked forward from the end of 1946, using his interpretation of Nevin's starting-value formulae, whereas Nevin worked backward from the end of 1958, using a 1958 figure some £4·3 million higher than that shown in his Appendix Table B of CIP respondents, to allow for CIP non-respondents. The writer has omitted all Rented Assets from the new calculations and given end-of-year values, whereas Nevin's figures include the rented assets. For the fresh calculations, it was decided to omit rented assets because no data on even the rent was available after 1950 and because a factor 10 applied to the rent cost might be arbitrary. The following list shows the writer's end-of-1958 figures, Nevin's estimated end-of-1958 figures (for CIP respondents only, as he has no details of the extra 4·3) less the 1958 estimated rented Assets (Appendix Table B), and the difference. All figures are in 1958 £ million.

| | Buildings | | | Plant | | | Combined |
|---|---|---|---|---|---|---|---|
| Sector | New (A) | Nevin (B) | Differ. (A)–(B) | New (A) | Nevin (B) | Differ. (A)–(B) | Differ. (A)–(B) |
| Food | 31·6 | 31·3 | 0·3 | 30·8 | 28·6 | 2·2 | 2·5 |
| Drink/Tobacco | 20·1 | 19·6 | 0·5 | 11·2 | 10·1 | 1·1 | 1·6 |
| Textiles (ex. H) | 12·1 | 12·1 | 0·0 | 18·0 | 17·3 | 0·7 | 0·7 |
| Clothing etc. | 5·7 | 5·5 | 0·2 | 4·2 | 3·5 | 0·7 | 0·9 |
| Wood | 3·4 | 3·1 | 0·3 | 2·6 | 2·4 | 0·2 | 0·5 |
| Paper | 10·4 | 10·3 | 0·1 | 15·8 | 15·0 | 0·8 | 0·9 |
| Chemicals | 6·2 | 5·8 | 0·4 | 6·6 | 6·2 | 0·4 | 0·8 |
| Clay etc. | 6·1 | 6·1 | 0·0 | 7·4 | 6·5 | 0·9 | 0·9 |
| Metal | 10·6 | 10·5 | 0·1 | 14·5 | 8·8 | 5·7 | 5·8 |
| Other Man. | 6·1 | 4·5 | 1·6 | 11·8 | 5·3 | 6·5 | 8·1 |
| Total Man. | 112·3 | 108·8 | 3·5 | 122·9 | 103·7 | 19·2 | 22·7 |

After allowing for Nevin's extra £4·3 million, for non-respondents, the writer's estimates are in excess, by some £18·4 million, on Nevin's £216·8 million, some 9 per cent. Going back to end-of-1949, Nevin has £183·0, via averages of mid-1949 and mid-1950; this presumably includes £3.3 million for rented assets of both kinds, via a factor 10 applied to figures he quotes on pages 3 and 4 of his paper (for Shoes £67,000 plant rental, for

all manufacturing £264, 000 building rental). His level, therefore, for owned assets is £179·7 million, compared with this writer's level of £189·8 million, the latter being some £10 million higher, or some 6 per cent of Nevin's level. The writer's estimate for mid-1947 is £173·5 million, against Nevin's total of £165·7 million, reduced to some £163 million by exclusion of rented assets, so there is again an excess of some £10 million.

The 1958 comparison shows that most of the excess in the new calculation arises in Plant, for Metal and Other Manufacturing. One solution, to give complete agreement with Nevin's figures, is to scale down the new 1958 plant estimates by £18·4 million and make an equal reduction of the plant levels for all subsequent years. This same reduction might also be carried back to 1950, since in each year 1950-1959 the new figures (excluding rented assets) exceed Nevin's figures (including rented assets) by a surprisingly constant £5 to £6 million. Because of the extensive estimation involved, both for getting Nevin's 1958 control levels and his Average Live values, one's zeal for apparent precision should be curbed. The alternative solution is to accept the new figures, as being consistent, at least. With or without the suggested reduction of £18·4 million. they extend the data to 1968 and enable separate production function experiments to be applied to the two kinds of stock.

## DISCUSSION

*Mr. Jefferson,* I am very pleased to be invited here tonight to propose the vote of thanks to Mr. Henry especially since it gives me a chance to propound some of my own ideas on the measurement of capital stock. This paper brings out some of the difficulties involved in this problem area in official statistics. One can attempt to measure capital in a variety of different ways and it is of the utmost importance that the meaning of any particular measure should be understood and that it should be used in an appropriate way. More often than not researchers are only too glad to find any measure of capital available and they frequently accept one and use it without really exploring its meaning or its suitability.

On page 6 Mr. Henry discusses briefly the idea of the gross (undepreciated) measure of capital stock and the net or (written-down) measure and he decides (rightly in my opinion) that the gross concept is the better measure for capacity or quantity. In the paper he has attempted to calculate a gross capital series for Ireland. Both replacement cost new and written down replacement cost have different meanings and different uses. The gross concept (replacement cost new) is a more adequate measure for the quantity of capital or capacity since the productive ability of an asset is unlikely to be greatly affected by its age. The value of a capital asset on the other hand is likely to be greatly influenced by age and here the written down or depreciated measure is more appropriate. Certainly written down replacement cost is the best measure of the resale value of assets in a perfect market. The economists' definition of the value of capital is related to the flow of future returns; again the written down concept of capital is the one to be used for this.

Mr. Henry has modified his gross estimates to take account of the possibility of a reduction in productive ability through increasing repairs and maintenance. He uses linear depreciation from new to 80 per cent when scrapped. I would like to suggest that this adjustment may not be necessary or desirable. It may be that the pattern of repairs and maintenance is as follows: initially high though teething troubles—then low for most of the assets' life—then high immediately prior to and probably the cause of scrapping. Or perhaps a large piece of expenditure, say an engine mid-way through the asset's life.

Replacing parts can greatly alter the length of life of assets. An industrialist put it succintly by saying of an asset of 50 years' life expectancy "all that remains of the original unit is the plant number and the machine drawings". In the past income tax principles stated that where expenditure is on a new asset or an improvement it should be treated as capital expenditure. In all other cases it was to be treated as maintenance and charged to current account. In practice, the maintenance of plant and machinery often requires extensive replacement of parts and this may improve operating efficiency. The improvement is difficult to specify and there was a definite incentive in the form of the tax allowances for treating all as maintenance when possible. Tax allowances on capital expenditure were spread over a number of years where expenditure on maintenance was treated as a current cost, i.e., full allowance was given in that year.

Firms have tended to lump as much expenditure as possible under the maintenance heading—some treat expenditure on all small pieces of equipment as maintenance. This will mean that GFCF figures in general may tend to be understated and this would account for the tendency for perpetual inventory measures of gross capital stock levels in practice to be below replacement cost new values while theoretically one would expect the reverse.

As regards the figures for average length of life of assets given in page 15, I am not convinced of the worth of the Kuh figures which are based on Balance Sheet depreciation and amortization.

Mr. Henry points out that they may be too low if accountants write off assets too rapidly. Some work which I did a few years ago suggests that on average they tend to write off assets over a period of about a half to two-thirds of their expected lives. My own experience suggests that most assets normally termed plant and machinery tend to have lives of between 5-50 years depending on type of asset and industry.

An interesting result occurs when firms write down assets conservatively on historical cost. The figures for depreciation which they arrive at are usually of much the same size as what would have been obtained if they had written down on replacement cost using actual length of life. They thus arrive at an adequate deduction for replacement over time. A case of two wrongs making a right.

In discussing the gross fixed capital formation series on page 15 it appears that sales of fixed assets may be a problem. The figure on sales collected by the CIP is simply the second-hand or scrap price obtained for the assets—it does not indicate the reduction in the quantity or capacity

of the assets. To do that one would need to know the replacement cost new of the assets being scrapped.

I feel that there is a major problem area in this paper which can be seen from comments in pages 5 and 6. Henry in calculating an Equivalent New Series uses the Balance Sheet values for 1945 from the CIP.

Balance sheet values are usually at written down historical cost and as such would need to be grossed up on two counts in order to provide a base for the equivalent new series; firstly to obtain written down replacement cost, and secondly to convert written down replacement cost up to replacement cost new, i.e., Equivalent New.

Such rough estimates as I could attempt suggest that Mr. Henry's grossing up factors are on the low side since he is only taking account of the second factor in his calculation. The earlier discussion of balance sheet methods of depreciation might suggest a further factor of 1·5 to 2·0 to obtain an adequate base year figure.

This may explain Henry's low figures for the early years compared with Nevin's. Nevin's estimates are written down replacement cost and should of course be smaller than the gross or equivalent new series. The fact that Henry's figures for the earlier years are so much smaller than Nevin's gives rise to considerable concern. This is largely explained by inadequate grossing up of the balance sheet figures to obtain an appropriate base year figure.

With some amendment Mr. Henry's estimates could yield a useful series of the quantity of capital in Ireland.

They are a perpetual inventory type of series and the universal problem of a perpetual inventory series is how to handle changing technology. Because of this many statisticians regard the true measure of capacity as lying somewhere between gross and net capital stock. The practical approach is to use gross and obtain an index of productivity elsewhere.

The alternative to the perpetual inventory method is to obtain directly from firms estimates of the replacement costs of their assets. It is clearly more difficult to obtain than the gross stock calculated from GFCF but it is conceptually a more meaningful measure of the quantity or capacity of capital.

*Dr. Geary:* Mr. Henry's paper supplies statistics of which the need, for economic analysis in Ireland, can be described only as desperate. I infer from the paper that the estimates of capital are available in full CIP detail back to 1950 or 1945. I hope that these will be published.

The differences between the levels and trends of the totals (1) (Mr. Henry's) and (2) for manufacturing industry in Appendix 4 are, at first sight anyway, disconcerting. Dividing the 16-year period into two of eight years each we find the following percentage changes:

| Period | (1) | (2) |
|---|---|---|
| | % | % |
| 1953 to 1960-61 | +50 | +14 |
| 1960-61 to 1968 | +91 | +50 |

By reference to ICOR, i.e. taking per cent increases in quantum output during these periods into account as well, the Henry series (1) is the more plausible. But even the trend differences are formidable.

There are many concepts of tangible capital, all yielding different estimates and sometimes these differences are substantial. I recall a paper by Raymond Goldsmith giving some dozens of different estimates for U.S.A. It is obviously very necessary to define each series precisely before using figures. I personally am perfectly clear about the fundamental usefulness of three series, two at constant prices (like Mr. Henry's) and one at current prices:

(i) Value of tangible capital remaining installed, undepreciated at constant (say 1958) prices; this is the concept relevant to the study of factor productivity.

(ii) Depreciated value of tangible capital at (a) current and (b) constant prices.

Length of life and replacement cost do not enter into concept (i): each asset remaining in stock at relevant date is valued at constant prices by applying price index numbers to purchase price. Concept (ii) (at current prices) may be regarded as the "census" or "selling price".

The familiar problem of quality change is particularly acute in the capital context. We are still unsure whether repairs and maintenance should or should not be included in GFCF. These are matters well worthy of further research.

These estimates should now be taken over officially by CSO: they are too important for privateers. C. W. Jefferson (in ESRI Paper No. 60) has, by intensive pilot inquiry, shown the way and the light.