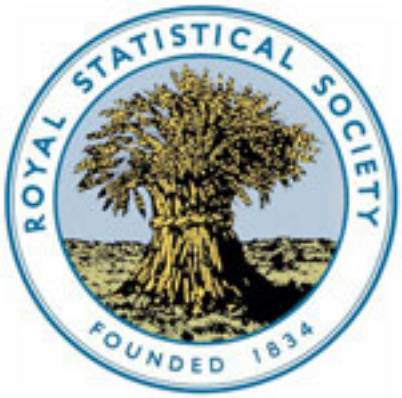


Vol. 118.] [Part II

Journal of the Royal Statistical Society

SERIES A (GENERAL)

PART II, 1955.

NET INVESTMENT IN FIXED ASSETS IN THE UNITED KINGDOM, 1938–1953

By PHILIP REDFERN

[Read before the ROYAL STATISTICAL SOCIETY, January 19th, 1955, the PRESIDENT, Lord PIERCY, C.B.E., in the Chair]

Introduction

1. Since the war, there has been increasing recognition of the need for further study subject of investment in fixed capital—in particular the need for further statistical analysis a result a considerably greater amount of information on the country's gross investment in fixed assets (that is expenditure on additions to, and renewals of, buildings, vehicles and machinery) has been collected than was available before the war. This has enabled an assessment to be made of the gross amount of resources being devoted to investment in fixed assets in the country as a whole and in each industry. But the figures so far available have been lacking in one very important respect. There have been no satisfactory estimates to indicate how much of this gross investment expenditure has been required to make good the wearing out of previously-existing fixed assets; and how much has been left over to provide for *net* additions to the country's stock of fixed capital assets. Consequently it has not been possible to measure the net rate of growth of domestic capital and the relative rates of growth in each industry.

2. The aim of this paper is therefore to present such a division of the gross investment statistics, and to derive estimates of the rate of growth of domestic capital. I have taken as a starting point the official estimates of gross investment (or "gross domestic fixed capital formation") published in August, 1954 in the *Blue Book*, "National Income and Expenditure, 1946–1953"—which I subsequently refer to as the "*Blue Book*, 1954"—and have attempted to produce estimates of net investment, or "net domestic fixed capital formation", of comparable scope and with similar classifications. These estimates cover the years 1938, and 1948 to 1953. The calculations also yield tentative estimates of the gross replacement value of domestic fixed capital at three points of time—the end of the years 1938, 1947 and 1952, and corresponding estimates of the *net* value of domestic fixed capital (i.e. the gross replacement value written down to allow for accrued depreciation).*

Arrangement of the Paper

3. The first part of the paper (paragraphs 4 to 14) sets out the problem and indicates the general lines of the solution here adopted. There follows a discussion of some important problems, some theoretical and some practical, which arise in applying this solution (paragraphs 15 to 29). More detail on the scope of the estimates given in this paper and on the methods actually employed in the calculation appears in paragraphs 30 to 40. The main results are embodied in Tables 1 to 8, with some supplementary information in Tables 9 to 13, and some of the principal conclusions to be derived are mentioned in paragraphs 41 onwards.

* The methods adopted in this paper are similar to those employed by R. W. Goldsmith in the United States in his study "A Perpetual Inventory of National Wealth". (*Studies in Income and Wealth*, Vol. 14, published by the National Bureau of Economic Research, New York, 1951.)

I. *The Problem and the Solution Proposed*

4. There is general agreement among economists that the national income should be measured after a deduction has been made from total output of goods and services to represent the capital resources "used up" in the process of production. The national income should thus be measured after deducting provision for maintaining capital intact, and a corresponding deduction should be made in measuring one element of final expenditure, namely fixed capital formation. I have no intention of adding in this paper to the considerable literature on the general principles of measuring capital consumption. It is, however, necessary to admit at once that there is probably no perfect statistical solution to the problem posed by the economists; there can only be approximations and arbitrary conventions. This paper attempts to express in figures one possible approach to a solution.

5. There are various ways in which capital consumption might in principle be measured. It might, for example, be assumed that an asset, if properly maintained, retained its full value until it was ultimately scrapped; capital consumption would then be represented simply by the assets going out of use and net investment would represent the difference between new assets installed and existing assets scrapped. This assumption clearly has an element of truth in it and it is in fact the basis of the accounting system wherein *renewals* of fixed assets are charged to operating account. But the method has major drawbacks. Firstly *net* investment would take no account of the ageing of an existing asset which was not scrapped. The assumption would thus ignore what has been described as the "two dimensional" nature of capital: the essence of a productive asset is that it continues to render services over a long period; its value is related not only to the service it renders in a given year, but also to the number of years over which it can be expected to remain productive. A second disadvantage of ignoring the ageing of assets is that it would imply a level of net profit and of national income fluctuating erratically according to the incidence of the scrapping of assets.

6. Alternatively, it might in theory be possible to find a measure of capital consumption based on the physical wear and tear of productive assets, together with some measure of rates of obsolescence. This might come closer to the economic significance of capital consumption. Some national income statisticians have attempted an approach to this by varying the level of depreciation in the national accounts in accordance with variations in the level of total output, the latter being taken to represent the intensity of usage of the asset. In our present state of knowledge there are inadequate data to apply these methods.

7. The solution in fact adopted in this paper is to accept the fundamental convention employed by accountants for estimating depreciation: this is that use of an asset may be regarded as being spread in some arbitrary way over a predetermined life. There is, of course, more than one way of spreading the use of an asset over time. The method adopted here is the "straight line" method under which the asset is assumed to depreciate by a constant amount each year (one-tenth of its cost if the asset is assumed to last 10 years). The most common alternative is the "reducing balance" system wherein the successive annual allowances are (except the last of the series) in the form of a geometric progression; the depreciation allowances get smaller as the age of the asset increases, being a constant *proportion* of the written down value at the beginning of each year. This is the basis of the method used in estimating depreciation allowances for tax purposes in the United Kingdom. These two alternative methods of spreading the use of an asset over time can give rise to considerable differences in the calculated depreciation. The choice between them must involve an element of arbitrariness, but I have chosen the straight line rule on the grounds that in a great number of cases the productive services rendered by an asset are likely to be more nearly constant over time than to reduce exponentially.

8. Although the fundamental accounting convention of spreading depreciation over a predetermined life (using the "straight line" method) is accepted here, the way in which it is applied has one major difference. The commercial accountant normally depreciates the original cost. It is unnecessary to enter here into the current controversy over the appropriateness, for commercial accountancy, of depreciating on the basis of original cost. The categorical statement may simply be made that, for the measurement of the national income and of net investment, depreciation at original cost is irrelevant. What one is seeking to determine is a measure of the use of capital expressed in the same prices as the other transactions recorded in the national accounts. For estimating the national income, product and expenditure in current prices, the object is to estimate

capital consumption in the current prices of each year. For estimating the national product and expenditure in terms of constant prices of the year X, the object is to estimate capital consumption in each year at the prices of year X.

Limitations and Qualifications

9. Before describing the methods and the results in more detail three warnings should be given. Firstly net investment is derived here from the change in the written-down value of assets, after correction for price changes. It cannot be too strongly emphasised that this will normally differ from a measure of changes in productive capacity, or in the "quantity" of assets in place. Thus the estimates of net investment here given take account not only of changes in the quantity of assets installed but also of changes in their unexpired lives—a "two dimensional" concept; whereas measures of productive capacity or quantity of assets in place are essentially one-dimensional. Moreover the estimates of net value of assets here given will normally differ from a measure of their income-earning capacity or their second-hand market value (in cases where a second-hand market exists). In conditions of stability second-hand market values must be related to the written-down replacement cost (which is the measure of net value here employed)*, but in the short run the two valuations may differ substantially.

10. In the second place it must be recognized that the nature of technical change makes it impossible to express in any accurate way the concept of "maintaining capital intact." A worn-out machine is rarely replaced by a precisely identical machine; it may be replaced by a more efficient machine, or, because some new process has been invented, the worn-out machine may not be replaced at all. The problem is to assess the quantitative relationship between new machines currently being installed and machines installed in the past; if a new machine embodies the same quantity of factors of production as an old machine, but has an output 50 per cent. greater than the old machine, is the new machine to be regarded as the equivalent of 1 old machine or 1·5 old machines?

11. This problem resolves itself into constructing a price index for each type of capital good: an attempt might be made to measure the changes in the price of goods embodying a constant quantity of factors of production or changes in the price of goods of constant productive capacity. Without embarking on a discussion of which approach is more appropriate, it is sufficient to state here that the choice is largely dictated by the available data. The price indices here employed tend to be of the former type, that is to measure the prices of goods embodying a constant quantity of factors of production. For instance the price index for plant and machinery has been derived mainly from changes in the average value per ton of particular descriptions of machinery as given in the Census of Production and export statistics. In consequence the figures of net investment appearing in this paper tend to omit increases in productive resources arising not from the increase in the number of assets in use but from an increase in their efficiency.

12. In the third place, even if the conventions and definitions used here be accepted, there is room for substantial errors in measurement arising in particular from three causes :

(i) The calculations involve the formulation of price indices for vehicles, machinery and buildings extending over long periods, and the data available for doing this are very incomplete. Some of the difficulties in constructing price indices for products whose character is continually changing have already been discussed in the preceding paragraph.

(ii) The calculations depend heavily on the assumed lengths of life of assets—though in fact, as will be shown later, the difference made by an error in the assumed lives is not so great as might be expected.

(iii) It will be seen that the method also involves the construction of estimates of gross investment in the past—sometimes the very distant past. No accurate figures can now be compiled of levels of investment for years much earlier than 1948.

Illustrative Example of the Calculation

13. It is perhaps worth while at this stage to set out an example of the way capital consumption (depreciation), net capital formation (net investment) and the net value of capital assets have been calculated. This is shown in the following table and is illustrated by a graph. In the example the life of each asset has been taken to be the same (viz. 10 years).

* Second-hand market values may not, of course, fall linearly with time.

£ *at Constant Prices*

Year	*Gross Capital Formation* (1)	*Gross Value of Assets Discarded* (2)	*Change in Gross Stock of Capital* (3)	*Gross Stock of Capital (end of year)* (4)	*Capital Consumption* (5)	*Net Capital Formation* (6)	*Net Stock of Capital (end of year)* (7)
1	10	—	+10	10	1	+9	9
2	10	—	+10	20	2	+8	17
3	10	—	+10	30	3	+7	24
4	10	—	+10	40	4	+6	30
5	10	—	+10	50	5	+5	35
6	10	—	+10	60	6	+4	39
7	—	—	—	60	6	−6	33
8	—	—	—	60	6	−6	27
9	—	—	—	60	6	−6	21
10	—	—	—	60	6	−6	15
11	10	10	—	60	6	+4	19
12	10	10	—	60	6	+4	23
13	10	10	—	60	6	+4	27
14	10	10	—	60	6	+4	31
15	10	10	—	60	6	+4	35
16	10	10	—	60	6	+4	39
17	—	—	—	60	6	−6	33
18	—	—	—	60	6	−6	27
19	—	—	—	60	6	−6	21
20	—	—	—	60	6	−6	15
21	—	10	−10	50	5	−5	10
22	—	10	−10	40	4	−4	6
23	—	10	−10	30	3	−3	3
24	—	10	−10	20	2	−2	1
25	—	10	−10	10	1	−1	—
26	—	10	−10	—	—	—	—

Col. (2) is similar to col. (1) but is lagged by 10 years (the assumed length of life of the fixed assets in question).
Col. (3) = col. (1) *less* col. (2).
Col. (4) = col. (3) cumulated.
Col. (5) = 0·1 *times* sum of col. (1) in the 10-year period ended in the current year.
= 0·1 *times* col. (4).
Col. (6) = col. (1) *less* col. (5).
Col. (7) = col. (6) cumulated.
= weighted sum of col. (1) in the 10-year period ended in the current year, the respective weights being 0 (for the earliest year), 0·1, 0·2, ... , 0·8 and 0·9 (for the current year).

The example brings out the distinction between the gross value of assets discarded and capital consumption; the corresponding difference between the change in the gross stock of capital and net capital formation; and the consequent difference between the gross stock of capital and the net stock of capital.

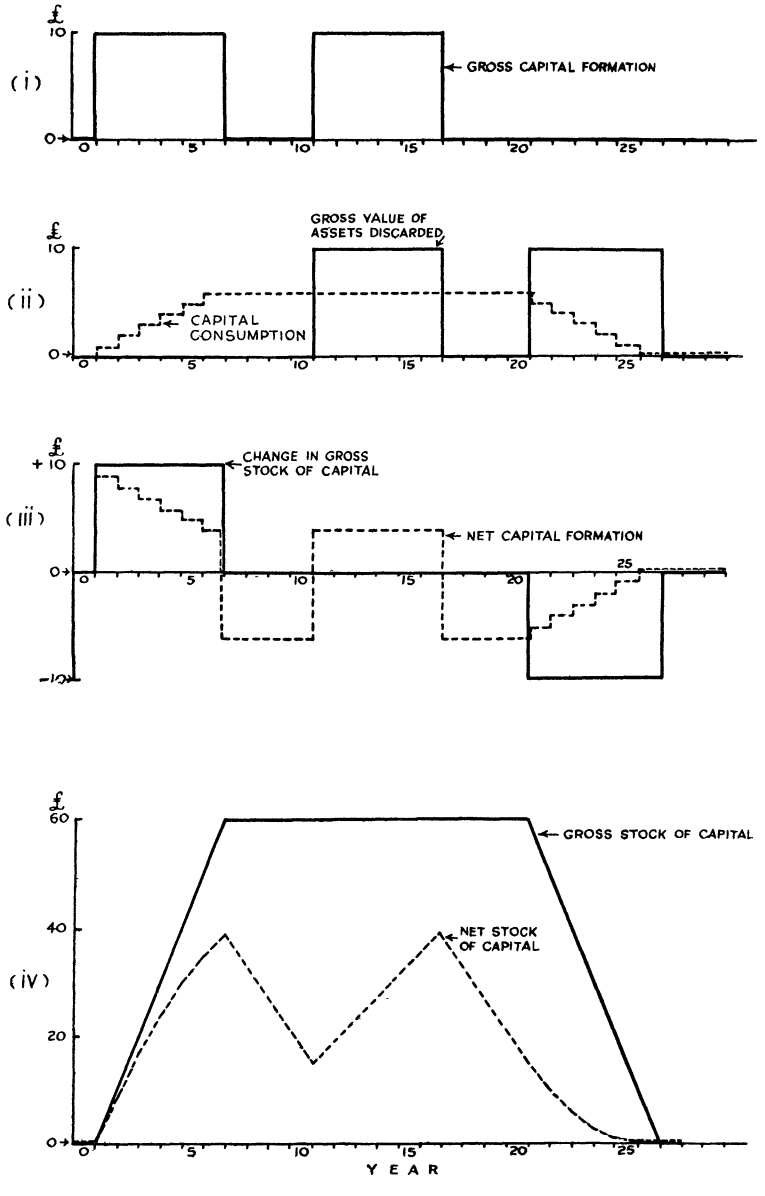
14. The example also shows that positive or negative net capital formation may occur without any change in the quantity of assets in use. Thus net investment is not necessarily a guide to the changes in the size or capacity of any industry. Positive net investment may imply an increase in the quantity of assets in use or capacity, or it may be the consequence of a large renewals programme (as at the end of the war, when it became necessary to replace worn-out equipment) without any current (or prospective) increase in capacity; in other words, net investment represents either an increase in capacity or an increase in the average future life of the assets in use. Similarly, negative net investment may mean a reduction in capacity or it may mean a decrease in the average future life of the assets in use.

II. *Problems which arise in Applying the Proposed Solution*

Length of Life of Assets

15. The principal problem in applying the method just described arises from lack of knowledge about the length of life of the assets being depreciated. Firstly there is lack of knowledge as to how long assets now in existence will last in the future. A machine existing today may last twenty years, it may be destroyed by fire tomorrow or it may obsolesce and be superseded next year,

DIAGRAM ILLUSTRATING TABLE



None can tell. The owner of the asset is therefore obliged to estimate its life as best he can and depreciate it accordingly. If the asset is, in the outcome, scrapped before the end of its estimated life he will have to charge its unexpired value (i.e. its net capital value) to depreciation; on the other hand, if its actual life exceeds the estimated life he may, during the last years of the asset's life, be employing an asset whose net capital value has been written down to nil and for which no further depreciation provision is necessary. In either event the owner of the asset is unlikely to wish to alter retrospectively the depreciation provisions for each year back to the year of installation. But quite apart from lack of knowledge of the unpredictable future, anyone who attempts to compile estimates of depreciation on the lines here described is in practice faced with lack of data which in theory could be gathered if enough time and effort were devoted to their collection. Thus, with a few exceptions, I have not been able to collect any information about the age distribution of assets now extant, nor about the lengths of life of those assets which have already been scrapped; furthermore it is only for a few classes of assets that statistics are available of the total quantity of assets in use.

16. Faced with this situation I have in most cases been forced to make assumptions about the length of life of each class of fixed asset. An asset installed in year X has been assumed to have a life of (say) L years and it has therefore been written off in equal instalments over the years X, $X+1, X+2, \ldots, X+L-1$, irrespective of whether or not the actual life exceeded or fell short of L years.* And my estimates of the gross value of capital at any point of time have been deduced from statistics of the gross value of fixed assets installed in each preceding year coupled with the assumptions about the length of life of such assets. In consequence the calculated estimates of gross value of capital appearing in this paper include (at their full replacement cost) assets which in reality are no longer extant, having been scrapped or destroyed before their assumed life has expired, and exclude assets which, though still extant, have exceeded the length of life assumed in this paper. Similarly the calculated estimates of the *net* value of capital include, at their written-down replacement cost, assets which were disposed of before expiry of the assumed length of life.

17. The estimates in this paper assume that the length of life of each class of asset has remained constant throughout the whole period covered, whereas, because of technical changes, changes in intensity of usage or other reasons, assets may now have longer (or shorter) lives than similar assets did 25, 50 or 100 years ago. The example in paragraph 72 does in fact suggest that average lives of some assets have changed.

18. It is worth noting that the errors in the assumption about length of life usually have a less serious effect on the figures of changes in net capital (i.e. figures of net investment) than on the figures of changes in gross capital. Suppose, for example, that a particular class of asset is assumed to have a life of 40 years whereas in fact each such asset lasts 30 years. Then the calculated figure for the increase in gross capital in 1954 would equal value of new assets installed in 1954 *less* gross value (at replacement cost) of assets installed in 1914; the correct answer should have been the value of new assets installed in 1954 *less* the gross value of assets installed in 1924. On the other hand, the calculated figure for the increase in *net* capital would equal value of new assets installed in 1954 *less* $\frac{1}{40}$th of gross value (at replacement cost) of all assets installed in the 40-year period 1915–1954 inclusive; the correct figure would equal value of new assets installed in 1954 *less* $\frac{1}{30}$th of gross value of all assets installed in the 30-year period 1925–1954 inclusive.† Although the year to year changes in the figures of net capital are less susceptible to errors in the assumed lengths of life than are the year to year changes in the figures of gross capital, the general *level* of both series is affected to the same extent. In the example mentioned the figures for gross and net capital employed at the end of 1954 would (on the assumption that the level of investment had remained constant over the period 1915–1954) each represent $\frac{4}{3}$ of the true figures.

* Exceptions to this statement are the treatment of assets totally destroyed in the war of 1939–1945 (see paragraph 29) and the treatment of ships (see Appendix B, section 9).

† If the investment in each year is of the form

$$i_t = \alpha + \beta t + \varepsilon_t$$

where α and β are constants, t denotes the year and ε_t is a random element with mean zero and standard deviation σ, an error of λ years in the assumed length of life introduces the following errors:

Error in the estimate of the increase during any year in gross value of capital $= \beta\lambda + \zeta$.

Error in the estimate of the increase during the year in net value of capital $= \frac{1}{2}\beta\lambda + \eta$

where ζ and η have distributions with zero means and variances $2\sigma^2$ and $\lambda\sigma^2/L(L+\lambda)$ respectively, and L is the true length of life.

19. Some actual figures illustrating these points are given below.

Net Investment in Plant and Machinery for Manufacturing and Distribution, etc.

	£ *Million at Constant* 1948 *Prices*	
	Assuming Lengths of Life in Range 14 *to* 45 *Years*[1] (A)	*Assuming Lengths of Life Exactly* ¾ *of Lengths Assumed in Column* (A) (B)
Net fixed capital formation:		
1938	88	87
1948	114	106
1949	131	123
1950	160	150
1951	180	170
1952	143	134
Net fixed capital:		
At end of 1938	2,127	1,670
,, ,, ,, 1947	2,234	1,687
,, ,, ,, 1952	2,962	2,370

[1] The estimates shown in this column are those appearing in Table 9.

These figures confirm that the estimates of net capital employed at any point of time will be in error by a percentage approximately equal to the percentage error in the assumed lengths of life, but that the estimates of net investment are in error to a lesser extent.

Obsolescence

20. A general problem encountered in measuring depreciation is what allowance to make for obsolescence. Should the assumed lives be shortened to allow for the fact that, on the basis of past experience, some assets will be superseded before they are physically worn out? As a statement of principle, I accept that the lives should be so shortened. But in practice the lives assumed in this paper are (for most classes of asset) the lives assumed by the tax authorities or by public authorities in their own accounts; and the extent to which these lives take account of obsolescence is not in every case precisely known.

Civil Engineering Works

21. The problem of obsolescence becomes particularly acute in the case of some classes of civil engineering works which, it can be argued, would last for ever if properly maintained. Examples are reservoirs, embankments, tunnels, canals and road beds; the foundations of factories and other buildings might also come into this category. Arguments can be advanced that such fixed assets ought not to be depreciated during their life and that, if ultimately these assets are superseded, either the whole of their value should be written off at the date of scrapping or alternatively their scrapping should be regarded as a capital loss which would not be deducted in arriving at either national income or net investment.

22. The first of these two methods of treatment has already been rejected for reasons explained in paragraph 5. And I have not adopted the second of the alternatives. Instead all the classes of asset in question have, in this paper, been written off over a long—but arbitrary—period of years. My reasons for following this treatment are threefold. Firstly a substantial proportion of these assets do in fact obsolesce even if they do not wear out, and I have here adopted the general principle that annual capital consumption should include allowance for obsolescence. Thus there are many examples of almost forgotten ports round our coastline, of abandoned canals and tram tracks, even of aerodromes which no longer meet the needs for which they were first built. Even if to-day we cannot foresee when a particular civil engineering work will be superseded, that is no reason why it should not be depreciated over a long period of years.

23. The second reason for writing off all civil engineering works is that I am not altogether convinced by the argument that if the assets were properly maintained and they did not obsolesce

they would in fact last indefinitely. Thus sea walls can and do crumble even if properly maintained; and costs of maintenance of (say) a tunnel may become so great that it is more economic to build a new one than to keep the existing one in use.

24. Thirdly, the available statistics in practice rarely separate out those classes of civil engineering work which might be excluded from the depreciation calculation from all other classes of civil engineering and building work. Thus the statistics of expenditure on railway construction do not distinguish between the embankment which could perhaps last indefinitely and the station building which certainly will not do so.

25. It must be admitted however that the lengths of life assumed in this paper for some classes of civil engineering works, such as roads, are extremely arbitrary, and that in some cases choice of a different length of life would have led to somewhat different results. Moreover if the view be taken that no depreciation should be allowed for (say) road foundations, then net investment in this class of asset has been understated, or (as it is in this case) the extent of net disinvestment has been overstated.

Excess Maintenance

26. The value of any asset depends not only on its replacement cost and its age, but also on how well it has been maintained. This could be taken account of in our system of capital accounting if we could adjust our capital consumption estimates to allow for over- or under-maintenance. We can suppose that a given asset such as a house requires a fixed sum spending annually on repairs and maintenance (prices being assumed constant) in order that the asset shall yield the full services required of it for the whole of its expected life. If actual repairs and maintenance in any year exceed this fixed sum, it can be assumed that the net value of the asset is thereby increased by the amount of the excess, either because the future life of the asset has been increased or because the services expected to be rendered by the asset have been enhanced (this would be the case if liabilities for repairs in succeeding years were reduced). We should therefore reduce capital consumption by the amount of the excess repairs; the total charges to operating account for the year in question (viz. capital consumption *plus* actual repairs and maintenance carried out) would be unaffected by the "excess maintenance". Thus excess maintenance, though excluded from gross investment, would nevertheless contribute, as it should do, to net investment. In a similar manner, capital consumption would be increased by the amount of any under-maintenance, and net investment and the net value of assets at the end of the year in question would thereby be reduced.

27. Whilst I recognize that something on these lines should be done if the figures of net investment are to have most meaning,* the depreciation figures given in this paper do not in practice make any allowance for excess maintenance. This is because the data on actual repairs and maintenance carried out and on what a "normal" repair provision would be are totally inadequate for the majority of classes of fixed assets. This must be borne in mind in interpreting the figures given later in the paper. In particular the figures for net value of assets at the end of 1947 have not been reduced on account of *repairable* war damage or wartime arrears of normal maintenance, although the *complete* destruction of assets due to air raids in the 1939–1945 war has been taken into account (see paragraph 29). Moreover war damage repair work has for national income purposes been treated as a current expense, and so excluded from gross investment; reinstatement of completely destroyed assets has been included in gross investment. Consequently the figures of net investment for the period 1948–1953 do not include anything for war damage repair work carried out in that period, but do take account of complete rebuilding of assets destroyed.

Destruction by Fire and War, etc.

28. I have not found it practicable to make any *special* allowances for complete destruction by fire or "Act of God", except in the case of shipping losses and of destruction by air raids in the war of 1939–1945. Except in these special cases, each asset has been written off over its assumed life irrespective of whether in fact it was prematurely destroyed. But the capital consumption allowances are not on this account underestimated, at least so far as the average over a period of years is concerned. The assumed lengths of life may in fact be regarded as making some allowance for fire and other risks by being slightly shorter than they would otherwise be.

* The possibility that the treatment set out in paragraph 26 would eventually be adopted was mentioned in the *National Income Blue Book* of 1953 (p. 94, penultimate paragraph).

29. So far as destruction in the 1939–1945 war is concerned, all fixed assets totally destroyed have been completely eliminated from the post-war gross and net value series. But the data are inadequate to make more than a rough adjustment for this.

III. *Scope of the Estimates*

30. The estimates given in this paper of net investment and depreciation and of the value of gross capital and net capital have (with the exceptions noted in paragraphs 31 and 32 below) the same scope as the estimates of gross fixed capital formation in the *National Income Blue Book* of 1954. It follows that fixed capital assets here exclude consumers' durable goods, such as motor cars and furniture owned by persons, but houses and buildings owned by persons are included. Non-revenue producing assets owned by public authorities, such as roads and schools are also included, but, as in the *Blue Book*, buildings and equipment for the Armed Services are excluded from the scope of the fixed capital estimates.* The estimates do not take account of intangible assets such as financial assets, patents and goodwill, nor of stocks of materials and finished products and work-in-progress.†

31. The estimates given here exclude site values (i.e. land), which do not of course depreciate (in the sense in which the word "depreciate" is used in this paper). Except in Tables 1 and 10 the estimates also exclude expenditure on legal fees and stamp duties incurred when land and property are purchased, though such expenditure is treated as gross fixed capital formation in the *Blue Book*; in Tables 1 and 10, however, expenditure on legal fees and stamp duties has been included in total gross investment, but in deriving totals of net investment in these tables this class of expenditure has been regarded as though it were wholly written off in the year in which it was incurred. No allowance has here been made for the depletion of natural resources such as coal.

32. Because of the absence of suitable data, or because the extraction of suitable material required more time and detailed study than I have so far been able to give it, I have, unfortunately, been obliged to omit from my detailed calculations certain classes of fixed capital assets. These assets are excluded from all the tables in this paper except Tables 1 and 10. The principal omissions are farm buildings, coal industry buildings and mine workings and most of the Central Government's non-trading assets (such as hospitals, Government offices and research establishments).‡ A full list of the omitted classes of assets is given at the end of Appendix B. The omitted classes contribute however only about 6 per cent. of gross domestic fixed capital formation in the years 1948 to 1953, and their omission cannot seriously affect the general results obtained. In Tables 1 and 10, very rough estimates have been included for these assets for the sake of completeness.

IV. *The Methods Employed*

33. The process of estimation used here involves three operations :

(i) Estimates are made of gross fixed capital formation in each past year for each class of asset separately distinguished. To enable net investment and net capital to be calculated for the period 1938–1953, each series has been taken back L years before 1938, where L is the length of life of the asset in question.

(ii) Price indices are built up for the principal classes of assets. By applying these to the gross fixed capital formation series, estimates of gross fixed capital formation at constant prices (of the year 1948) are derived.

(iii) Assumptions, supported by varying amounts of evidence, are made about the lengths of life of each class of asset. By writing off the gross investment in each class of asset over the assumed life, estimates of depreciation, net fixed capital formation, and the gross and net value of capital are derived, in terms of constant prices of the year 1948; the table in paragraph 13 illustrates the method of computation. These estimates of depreciation, net fixed capital formation, etc., can then be converted to the prices of other years, if required, by use of the price indices previously referred to.

34. So far as the data have permitted, the estimates have been worked out separately for each industry (e.g. electricity, railways, housing) and within each such industry by type of asset (buildings,

* Married quarters for the Armed Services are an exception and are treated as fixed capital assets.

† Livestock and growing timber are included under stocks and work-in-progress, and so excluded from the estimates given in this paper.

‡ Trunk roads and houses owned by the Central Government are however covered by the estimates.

plant, road goods vehicles, etc.). Unfortunately (with a few exceptions, such as shipping, road passenger transport and agriculture) I have been unable to show separately the figures for individual private industries. This is because the pre-war estimates of gross fixed capital formation outside the "public utility" field must necessarily be derived from production data, and no division of the output data between the different "capital-consuming" private industries is possible. The result is that the tables appearing later in this paper show as a single industry group a rather heterogeneous collection of industries described as "Manufacturing and distribution, etc.", which is analysed only by type of asset (i.e. between vehicles, plant, industrial buildings and commercial buildings). If the statistics of gross investment in 1948–1953 can be taken as a guide, over 80 per cent. of the plant and 95 per cent. of the industrial buildings in this group are employed in manufacturing industry; it is possible, however, that the proportions applying in the period 1948–1953 may differ from the proportions in earlier periods (e.g. because of post-war building controls).

The Estimates of Gross Fixed Capital Formation

35. I will comment briefly on the three operations referred to in paragraph 33, taking first the estimation of gross fixed capital formation. For the years 1948–1953, the figures published in the *National Income Blue Book* of 1954 have been used. For earlier years, I considered the possibility of making use of estimates made by earlier investigators. I concluded, however, that it was necessary to re-work my own estimates from the basic data, because existing estimates of gross investment were not in the necessary detail for my purposes and most of them did not cover a sufficiently wide span of years. Furthermore, if estimates made by earlier investigators had been used, it would have been necessary to make adjustments to the figures to align the definitions (e.g. as regards the treatment of repairs) with those employed here. I have, however, made extensive use of the investment estimates for 1870–1914 given by Professor A. K. Cairncross in *Home and Foreign Investment*, 1870–1913 (1953).

36. Appendix B describes in some detail the sources used for the estimates of gross fixed capital formation for years before 1948. Where possible I have made use of expenditure data—for example, for electricity, railways, the Post Office and local authority services. Series on numbers of road vehicle registrations, on tonnage of ships launched and on number of houses built for private owners have been employed to cover these classes of assets. For the rest, that is for agricultural machinery, coal mining machinery, and machinery and buildings for manufacturing and distribution, the principal source used has been production statistics from the *Census of Production* (*plus* imports and *less* exports); the figures for censual years have been interpolated and extrapolated on the basis of employment in the engineering industries, building plans passed in a sample of towns, and the like.

37. The further one goes back into history the more uncertain the estimates of gross investment become, and I have been forced to hazard many guesses in preparing series running, in some cases, as far back as 1839. For the war years too, 1914–1919 and 1939–1945, the basic data are very fragmentary. In Tables 3, 4 and 9 are set out estimates of gross fixed investment (converted to constant 1948 prices) for the more recent years, to provide a background to the estimates of net investment. These estimates of gross fixed investment are not in any sense a definitive set of figures, as they were obtained primarily as a step towards calculating depreciation. Other investigators are at present engaged in estimating in some detail gross fixed capital formation between the wars.

Prices Indices

38. For few classes of capital assets are there any true price indices. For the important class of plant and machinery I have used figures of average value per ton extracted from the *Census of Production* or export statistics. This may well be the source of substantial error. For in the first place only a single price index has been employed to cover all classes of plant and machinery (but not vehicles), whereas it is probable that price indices for different classes of plant would, if available, be found to diverge considerably. In the second place much uncertainty must always surround price indices for such unstandardised products as plant and machinery. Some aspects of this problem have already been referred to in paragraph 11. The special weakness of these price indices is that changes in quality cannot be fully reflected in them. If the indices overstate the actual rise in the price of an unchanging product (if, for example, most of the products priced have in fact increased in complexity and in efficiency), then the estimated rise in the replacement cost of plant

has been correspondingly overstated, and net investment understated. With the information available, there is no way of measuring the extent of this error and no certainty about its direction.

39. The prices indices for different classes of asset are set out in Appendix A, where they are described in more detail.

The Lengths of Life Assumed

40. For plant and machinery employed in private industry, the assumed lengths of life are those implicit in the rates of depreciation allowed for taxation purposes.* For road vehicles a figure of 10 years has been taken, which again is implicit in the Inland Revenue depreciation allowances. For industrial buildings the Inland Revenue figure of 50 years' life has been assumed. I have taken 75 years for "commercial" buildings such as offices and shops† and for buildings employed in public non-trading services (for example, schools); and 100 years for houses. For the principal "public utilities"—that is gas, electricity, railways and the Post Office—I have so far as practicable used the same lengths of life as the undertakings themselves employ in computing their accounting figures of depreciation; an exception is that the life of railways tracks, buildings and works has been taken as 100 years, there being no depreciation allowance for this class of asset in the railways' own accounts.‡ Fuller information on the lengths of life assumed for each industry is given in Appendix B.

V. *The Results*

41. From what I have already said it will be clear that the estimates here given of net investment and net value of capital cannot be regarded as precise, and the figures for gross value of capital employed are a good deal less reliable than those of net capital. Nevertheless I believe that the estimates do indicate broad orders of magnitude and so represent a step forward from the previously existing state of knowledge. I might add that the investigator who in 50 years' time sets out to perform the same sort of calculations as have been attempted in this paper should have available to him as a starting point a fairly reliable and detailed series for gross fixed investment going back 55 years, in contrast to the situation to-day with detailed statistics of fixed investment going back only some 5 years.

The Main Tables

42. The main results are set out in Tables 1 to 8. In Tables 1 and 2 the estimates are expressed in terms of the current prices of each year, whereas in the remaining tables (3 to 8) the estimates are all in terms of constant prices of the year 1948. Table 1 (current prices) and Table 5 (constant prices) show gross and net fixed capital formation in the years 1938 and 1948 to 1953, with an analysis between six main industry groups.§ Table 2 (current prices) and Table 6 (constant prices) give similar figures analysed this time by type of asset (plant and machinery, houses, other buildings and works, and six types of "vehicle"). Tables 3 and 4 present estimates of gross fixed capital formation at constant prices for the years 1924 to 1938 and 1948 to 1953. These two tables (which give respectively analyses by industry and by type of asset) are intended as a background to the net investment estimates. Estimates of the gross value and net value of capital at the end of the years 1938, 1947 and 1952, in each case expressed in terms of constant prices of the year 1948, appear in Table 7 (with an analysis by industry group) and Table 8 (with an analysis by type of asset).

43. The main Tables 1 to 8 do not give the full industry detail in terms of which the calculations were performed. As this may be of considerable interest in itself, and because it throws light on the results for the broader industry groups in the main tables, the full industry detail is set out in Table 9. But it may be that the figures there given are less reliable than the aggregates for broad industry groups in the main tables.

Conclusions

44. A detailed commentary on the conclusions to be drawn from the tables seems unnecessary, but it may be worth while mentioning some of the main features. Table 10 sets out total net fixed

* See the Inland Revenue's *Income Tax, Wear and Tear Allowances for Machinery or Plant: List of Percentage Rates* (1953).

† Cf. the report of the Millard Tucker Committee (Cmd. 8189, 1951), paragraph 204.

‡ It is worth noting however that the British Transport Commission accounts contain a provision for amortizing their long-term borrowing over a period of 90 years.

§ The industry classification is defined in Appendix B.

TABLE 1

Gross and Net Fixed Capital Formation in Each Industry group. At Current prices

£ *million*

	Agriculture[1]	*Coal*[2], *Gas, Electricity and Water*	*Transport and Communication*[3]	*Manufacturing and Distribution, etc.*[3]	*Housing.*	*Public and Social Services*[4]	*Sub-total*	*Assets omitted from the Detailed Calculations*[5]	*Legal Fees, Stamp Duties, etc.*	*Total*
Gross fixed capital formation:										
1938 . .	6	61	102	211	180	39	599	(40)	17	656
1948 . .	58	156	182	479	342	43	1,260	90	46	1,396
1949 . .	52	196	204	550	332	63	1,397	98	49	1,544
1950 . .	51	214	214	640	331	76	1,526	105	51	1,682
1951 . .	56	237	212	726	372	97	1,700	112	54	1,866
1952 . .	54	265	220	755	489	115	1,898	123	45	2,066
1953 . .	51	299	277	776	631	127	2,161	133	39	2,333
Depreciation:										
1938 . .	5	44	81	126	53	13	322	(22)	(17)	361
1948 . .	32	98	175	293	169	34	801	(54)	(46)	901
1949 . .	36	105	185	318	174	35	853	(57)	(49)	959
1950 . .	39	113	196	352	184	39	923	(62)	(51)	1,036
1951 . .	47	133	221	423	208	44	1,076	(72)	(54)	1,202
1952 . .	54	153	239	495	228	50	1,219	(82)	(45)	1,346
1953 . .	58	161	262	516	233	52	1,282	(86)	(39)	1,407
Net fixed capital formation:										
1938 . .	1	17	21	85	127	26	277	(18)	(—)	295
1948 . .	26	58	7	186	173	9	459	(36)	(—)	495
1949 . .	16	91	19	232	158	28	544	(41)	(—)	585
1950 . .	12	101	18	288	147	37	603	(43)	(—)	646
1951 . .	9	104	−9	303	164	53	624	(40)	(—)	664
1952 . .	—	112	−19	260	261	65	679	(41)	(—)	720
1953 . .	−7	138	15	260	398	75	879	(47)	(—)	926

(1) Plant and machinery only (including tractors).
(2) Plant and machinery and vehicles only.
(3) Road goods transport is included under "Manufacturing and distribution, etc."
(4) This heading includes education (other than private), sewerage and other local authority services, etc. Health services and certain other Central Government services are, however, excluded.
(5) These classes of asset are listed in Appendix B, section 16.
Figures in brackets are very approximate.

TABLE 2

Gross and Net Fixed Capital Formation by Type of Asset. At current prices

£ *million*

	Buses, etc.	*Road Goods Vehicles*	*Passenger Cars* (1)	*Ships*	*Railway Rolling Stock*	*Aircraft*(2)	*Plant and Machinery*	*Housing*	*Other Buildings and Works*	*Total**
Gross fixed capital formation:										
1938 . .	12	26	9	21	14	1	177	180	159	599
1948 . .	33	71	34	56	28	8	482	342	206	1,260
1949 . .	38	75	48	57	29	12	541	332	265	1,397
1950 . .	35	75	45	67	31	8	616	331	318	1,526
1951 . .	24	81	56	66	33	7	713	372	348	1,700
1952 . .	21	83	57	66	27	10	762	489	383	1,898
1953 . .	18	93	60	100	37	10	795	631	417	2,161
Depreciation:										
1938 . .	10	23	8	18	12	1	112	53	85	322
1948 . .	13	41	14	44	23	3	292	169	202	801
1949 . .	15	45	17	48	24	4	318	174	208	853
1950 . .	18	54	20	52	27	3	346	184	219	923
1951 . .	21	71	31	55	29	3	400	208	258	1,076
1952 . .	24	82	40	57	32	5	469	228	282	1,219
1953 . .	25	82	40	74	33	5	502	233	288	1,282
Net fixed capital formation:										
1938 . .	2	3	1	3	2	—	65	127	74	277
1948 . .	20	30	20	12	5	5	190	173	4	459
1949 . .	23	30	31	9	5	8	223	158	57	544
1950 . .	17	21	25	15	4	5	270	147	99	603
1951 . .	3	10	25	11	4	4	313	164	90	624
1952 . .	−3	1	17	9	−5	5	293	261	101	679
1953 . .	−7	11	20	26	4	5	293	398	129	879

(1) Only cars bought by business users are included. The figures are of very doubtful reliability.
(2) The figures for aircraft are of doubtful reliability.

* This table omits certain classes of asset (mainly buildings) listed in Appendix B, section 16. The scope of the "Total" column of this table corresponds with that of the column headed "Sub-total" in Table 1.

capital formation at market prices in relation to national income and expenditure. I have not attempted to estimate net fixed capital formation at factor cost. To do this would have involved reallocating *some* of the indirect taxes shown in the *National Income Blue Book* as falling on gross fixed capital formation, viz. the taxes attributable to the capital consumption component of gross fixed capital formation; these taxes would be reallocated in part to net fixed capital formation, but mainly to the other forms of final expenditure (such as consumers' expenditure) on which the taxes ultimately fall.

45. Table 10 shows that the proportion of gross national product (at factor cost) required to make good depreciation has risen from 7 per cent. in 1938 to a present level of 9 to 10 per cent. Gross domestic fixed investment has been between 11½ and 14 per cent. of gross national product (at market prices). In the post-war years just under two-thirds of this gross investment was required to make good depreciation, and a little over one-third represented net investment; in 1938 the proportions were nearer half-and-half. Net fixed investment has been between 4½ and 6 per cent. of net national product (at market prices). It is important to note that the investment figures given in this paper all refer to domestic investment; that is, they include investment taking place in the United Kingdom but financed from foreign sources, and exclude investment overseas financed by the United Kingdom. This qualification must be borne in mind in interpreting the figures given here of the proportion of national resources devoted to investment.

46. Gross investment between the wars reached its highest level in the years 1936–1938; this

TABLE 3

Gross Fixed Capital Formation in Each Industry Group, 1924–1953. *At constant* 1948 *prices*

£ *million*

	Agriculture[1]	*Coal*[2], *Gas, Electricity and Water*	*Transport and Communication*[3]	*Manufacturing and Distribution etc.*[3]	*Housing*	*Public and Social Services*[4]	*Total**
1924	7	98	243	249	243	30	870
1925	6	111	225	250	284	39	915
1926	7	112	195	272	333	38	957
1927	7	129	232	282	390	40	1,080
1928	6	117	235	300	285	42	985
1929	6	124	259	329	368	46	1,132
1930	7	131	232	318	317	61	1,066
1931	6	138	188	286	352	75	1,045
1932	6	131	130	249	328	59	903
1933	4	115	102	258	451	47	977
1934	8	115	134	334	532	50	1,173
1935	10	134	155	395	540	57	1,291
1936	12	147	204	472	522	68	1,425
1937	17	143	229	513	462	81	1,445
1938	12	138	242	474	474	91	1,431
1948	58	156	182	479	342	43	1,260
1949	50	190	200	532	327	62	1,361
1950	47	198	201	593	315	71	1,425
1951	46	196	179	595	318	79	1,413
1952	40	197	173	555	388	86	1,439
1953	37	220	199	570	500	94	1,620
Averages:							
1924–1929	7	115	232	280	317	39	990
1930–1934	6	126	157	289	396	59	1,033
1935–1938	13	140	208	464	499	74	1,398
1948–1953	46	193	189	554	365	73	1,420

(1) to (4) See corresponding footnotes to Table 1.

* See corresponding footnote to Table 2.

level was attained once again in the years 1950–1952, and has been substantially exceeded for the first time in 1953. But because of the greater quantity of assets now in use as compared with the pre-war period, the amount of resources required to make good depreciation is greater than pre-war. As a result the rate of net investment has reached the peak pre-war level only in 1953.

47. As a result of the reduced rate of investment during the war and of war losses, the net value of fixed assets at the end of 1947 appears to have been over £1,000 million—or 5 per cent.—below the level of 1938 (in terms of constant prices). By the end of 1950, however, the position had been restored, and at the end of 1953 the net value was some 10 per cent. above the end-1938 figure. The net value of fixed assets at the end of 1953 was about £26,000 million at the prices of 1948—or around £34,000 million at prices now current.†

The Position in Individual Industries

48. The amount of net investment taking place in different industry groups has varied considerably. In the fuel and power group, net investment has represented a substantial proportion of gross investment in the post-war years; this is a considerable improvement on the 1938 rate of net investment, so far as the gas industry and investment in plant and machinery in the coal mining industry are concerned.

† These figures include an allowance for assets not covered by Tables 7 and 8.

TABLE 4

Gross Fixed Capital Formation by Type of Asset, 1924–1953. *At constant* 1948 *prices*

£ *million*

	Buses, etc.	*Road Goods Vehicles*	*Passenger Cars*(1)	*Ships*	*Railway Rolling Stock*	*Aircraft*(2)	*Plant and Machinery*	*Housing*	*Other Buildings and Works*	*Total**
1924	17	15	7	104	36	—	249	243	199	870
1925	17	15	8	77	40	—	263	284	211	915
1926	26	23	11	46	34	—	275	333	209	957
1927	27	24	12	81	36	—	290	390	220	1,080
1928	29	26	13	97	27	—	272	285	236	985
1929	31	36	18	107	29	—	287	368	256	1,132
1930	29	36	18	70	24	—	298	317	274	1,066
1931	26	39	19	25	16	—	275	352	293	1,045
1932	18	35	17	11	9	—	248	328	237	903
1933	10	37	18	10	12	—	228	451	211	977
1934	14	50	25	34	18	—	279	532	221	1,173
1935	18	50	25	35	29	—	323	540	271	1,291
1936	21	55	28	60	36	—	377	522	326	1,425
1937	23	58	29	62	36	—	420	462	355	1,445
1938	24	51	25	63	30	2	393	474	369	1,431
1948	33	71	34	56	28	8	482	342	206	1,260
1949	38	73	47	56	28	12	520	327	260	1,361
1950	35	68	44	61	28	7	566	315	301	1,425
1951	23	62	44	55	27	6	595	318	283	1,413
1952	18	57	40	54	20	7	566	388	289	1,439
1953	16	67	46	65	27	7	581	500	311	1,620
Averages:										
1924–1929	24	23	12	85	34	—	273	317	222	990
1930–1934	19	39	19	30	16	—	267	396	247	1,033
1935–1938	21	54	27	55	33	1	378	499	330	1,398
1948–1953	27	66	43	58	26	8	552	365	275	1,420

(1), (2), * See corresponding footnotes to Table 2.

49. Similarly in the group "manufacturing and distribution, etc.", net investment has represented a substantial proportion—nearly 40 per cent.—of gross investment in the post-war period. But this result probably obscures divergent trends between individual industries, in some of which (for example, oil refining) net investment has been very high, while in others net investment may have been low or even negative. Some indication of this divergence of experience is suggested by the figures for the commercial buildings component of this industry group (shops, offices, hotels, etc.); post-war net investment in these buildings appears to have been low, if not negative, in contrast with a considerable rate of net investment in such buildings in 1938. For plant and machinery and industrial buildings in this group of industries—mainly plant and buildings in manufacturing industry—there has been substantial net investment in the period 1948–1953 and at a higher rate than in 1938. The net value of plant and machinery (expressed in terms of constant prices) was about 45 per cent. higher at the end of 1953 than at the end of 1938; for industrial buildings the corresponding figure was 37 per cent. For road goods vehicles, most of which are included in this paper under manufacturing and distribution,† the rate of net investment has fallen off somewhat from the high levels of 1948–1950.

50. Net investment in agricultural machinery was a substantial proportion of gross investment in the earlier part of the period 1948–1953, but the level of gross investment has now fallen to near

† A note on the industrial classification of road vehicles appears in the introductory paragraph of Appendix B.

TABLE 5

Gross and Net Fixed Capital Formation in Each Industry Group. At constant 1948 *prices*

£ *million*

	Agriculture(1)	*Coal*(2), *Gas, Electricity and Water*	*Transport and communication*(3)	*Manufacturing and Distribution, etc.*(3)	*Housing*	*Public and Social Services*(4)	*Total**
Gross fixed capital formation:							
1938 . .	12	138	242	474	474	91	1,431
1948 . .	58	156	182	479	342	43	1,260
1949 . .	50	190	200	532	327	62	1,361
1950 . .	47	198	201	593	315	71	1,425
1951 . .	46	196	179	595	318	79	1,413
1952 . .	40	197	173	555	388	86	1,439
1953 . .	37	220	199	570	500	94	1,620
Depreciation:							
1938 . .	9	100	192	283	141	30	755
1948 . .	32	98	175	293	169	34	801
1949 . .	34	102	181	307	172	35	831
1950 . .	36	105	184	326	175	36	862
1951 . .	38	110	186	346	178	36	894
1952 . .	40	114	189	362	181	37	923
1953 . .	42	119	191	379	184	38	953
Net fixed capital formation:							
1938 . .	3	38	50	191	333	61	676
1948 . .	26	58	7	186	173	9	459
1949 . .	16	88	19	225	155	27	530
1950 . .	11	93	17	267	140	35	563
1951 . .	8	86	−7	249	140	43	519
1952 . .	—	83	−16	193	207	49	516
1953 . .	−5	101	8	191	316	56	667
Percentage distribution of:							
Gross fixed capital formation, 1948–1953 . .	*3*	*14*	*13*	*39*	*26*	*5*	*100*
Net fixed capital formation, 1948–1953 . .	*2*	*15*	*1*	*40*	*35*	*7*	*100*
Net capital formation as a percentage of gross capital formation, 1948–1953 .	*20*	*44*	*2*	*39*	*52*	*50*	*38*

(1) to (4) See corresponding footnotes to Table 1.

* See corresponding footnote to Table 2.

"replacement level". A notable feature of investment in agricultural machinery is the rapid growth since 1938 in the stock of capital; the end-1953 net value appears to be four times the end-1938 figure (at constant prices). If buildings and works (e.g. drainage) had been taken account of in this paper the overall picture of agricultural investment might well have been different.

51. For housing, which represents some 40 per cent. of the net value of domestic capital, there has been a high rate of net investment in the post-war years. The rate of net investment achieved in 1953—about equal to the net rate of 1938—represented over 60 per cent. of the gross investment in housing. This may have been offset to some extent by excessive deterioration of existing houses

TABLE 6

Gross and Net Fixed Capital Formation by Type of Asset. At constant 1948 prices

£ *million*

	Buses, etc.	*Road Goods Vehicles*	*Passenger Cars*(1)	*Ships*	*Railway Rolling Stock*	*Aircraft*(2)	*Plant and Machinery*	*Housing*	*Other Buildings and Works*	*Total**
Gross fixed capital formation:										
1938	24	51	25	63	30	2	393	474	369	1,431
1948	33	71	34	56	28	8	482	342	206	1,260
1949	38	73	47	56	28	12	520	327	260	1,361
1950	35	68	44	61	28	7	566	315	301	1,425
1951	23	62	44	55	27	6	595	318	283	1,413
1952	18	57	40	54	20	7	566	388	289	1,439
1953	16	67	46	65	27	7	581	500	311	1,620
Depreciation:										
1938	21	45	22	53	25	1	249	141	198	755
1948	13	41	14	44	23	3	292	169	202	801
1949	15	44	16	48	23	4	305	172	204	831
1950	18	49	20	48	24	3	318	175	207	862
1951	20	54	24	47	24	3	334	178	210	894
1952	21	56	28	48	24	3	349	181	213	923
1953	22	59	31	48	24	3	367	184	215	953
Net fixed capital formation:										
1938	3	6	3	10	5	1	144	333	171	676
1948	20	30	20	12	5	5	190	173	4	459
1949	23	29	31	8	5	8	215	155	56	530
1950	17	19	24	13	4	4	248	140	94	563
1951	3	8	20	8	3	3	261	140	73	519
1952	−3	1	12	6	−4	4	217	207	76	516
1953	−6	8	15	17	3	4	214	316	96	667
Percentage distribution of:										
Gross fixed capital formation, 1948–1953	*1·9*	*4·7*	*3·0*	*4·1*	*1·8*	*0·5*	*38·9*	*25·7*	*19·4*	*100*
Net fixed capital formation, 1948–1953	*1·7*	*2·9*	*3·7*	*2·0*	*0·5*	*0·9*	*41·3*	*34·7*	*12·3*	*100*
Net capital formation as a percentage of gross capital formation, 1948–1953	*33*	*24*	*48*	*18*	*10*	*60*	*41*	*52*	*24*	*38*

(1), (2), * See corresponding footnotes to Table 2.

TABLE 7

Gross and Net Fixed Capital in Each Industry Group. At constant 1948 *prices*

£ *million*

	Agriculture[1]	*Coal*[2], *Gas, Electricity and Water*	*Transport and Communication*[3]	*Manufacturing and Distribution, etc.*[3]	*Housing*	*Public and Social Services*[4]	*Total**
Gross fixed capital:							
End of 1938 .	89	3,653	8,379	9,755	14,051	2,308	38,235
„ „ 1947 .	272	3,636	7,710	9,844	14,538	2,522	38,522
„ „ 1952 .	398	4,162	7,772	11,574	15,981	2,792	42,679
Accrued depreciation:							
End of 1938 .	41	1,642	4,371	4,310	4,710	870	15,944
„ „ 1947 .	132	1,918	4,152	4,583	5,469	1,095	17,349
„ „ 1952 .	197	2,036	4,194	5,193	6,097	1,202	18,919
Net fixed capital:							
End of 1938 .	48	2,011	4,008	5,445	9,341	1,438	22,291
„ „ 1947 .	140	1,718	3,558	5,261	9,069	1,427	21,173
„ „ 1948 .	166	1,776	3,565	5,447	9,242	1,436	21,632
„ „ 1949 .	182	1,864	3,584	5,672	9,397	1,463	22,162
„ „ 1950 .	193	1,957	3,601	5,939	9,537	1,498	22,725
„ „ 1951 .	201	2,043	3,594	6,188	9,677	1,541	23,244
„ „ 1952 .	201	2,126	3,578	6,381	9,884	1,590	23,760
„ „ 1953 .	196	2,227	3,586	6,572	10,200	1,646	24,427
Percentage distribution of net fixed capital at end of 1953 . . .	*1*	*9*	*14*	*27*	*42*	*7*	*100*

([1]) to ([4]) See corresponding footnotes to Table 1.

* See corresponding footnote to Table 2.

through failure to carry out adequate repairs and maintenance, but this aspect is not taken account of in the figures here presented.

52. In public and social services, which include, for example, schools (other than private), sewerage undertakings, local government offices, etc., the level of gross investment has risen from a little above replacement level in 1948 until it now includes a very substantial element of net investment. Hospitals are excluded from the figures for "public and social services" given in this paper.

53. One of the most striking of the conclusions on rates of net investment refers to the transport and communication field (excluding road goods transport operators and "C" licence operators whose vehicles are here included in the manufacturing and distribution group). Whereas in 1938 the level of gross investment was enough to permit a modest element of net investment, the post-war level of gross investment has been barely above the "replacement level".

54. Within the transport field there have however been marked contrasts. In shipping there would seem to have been a moderate rate of net investment, so that the net value of the fleet is now greater (in terms of constant prices) than at the end of 1938. This latter conclusion in no way contradicts the fact that the gross value of the fleet (a measure of the size of the fleet taking no account of its age distribution) is less than in 1938; the figures in Table 13 confirm that the fleet tonnage is at present no larger than in 1938, and in fact, if allowance is made for the reduced tonnage of the more highly priced passenger vessels and the increased tonnage of the cheaper tankers, the gross value does show a reduction compared with 1938. It follows that the average unexpired life of ships is now greater than in 1938; post-war replacements have "rejuvenated" the fleet.

TABLE 8

Gross and Net Fixed Capital by Type of Asset†. At constant 1948 prices

£ million

	Buses, etc.	*Road Goods Vehicles*	*Passenger Cars*(1)	*Ships*	*Railway Rolling Stock*	*Aircraft*(2)	*Plant and Machinery*	*Housing*	*Other Buildings and Works*	*Total**
Gross fixed capital:										
End of 1938	210	446	222	1,256	756	3	6,964	14,051	14,327	38,235
„ „ 1947	123	386	126	1,016	688	14	7,404	14,538	14,227	38,522
„ „ 1952	212	561	283	1,139	734	43	9,055	15,981	14,671	42,679
Accrued depreciation:										
End of 1938	122	224	111	645	387	2	3,205	4,710	6,538	15,944
„ „ 1947	68	185	60	378	363	2	3,667	5,469	7,157	17,349
„ „ 1952	97	273	110	454	396	7	4,187	6,097	7,298	18,919
Net fixed capital:										
End of 1938	88	222	111	611	369	1	3,759	9,341	7,789	22,291
„ „ 1947	55	201	66	638	325	12	3,737	9,069	7,070	21,173
„ „ 1948	75	231	86	650	330	17	3,927	9,242	7,074	21,632
„ „ 1949	98	260	117	658	335	25	4,142	9,397	7,130	22,162
„ „ 1950	115	279	141	671	339	29	4,390	9,537	7,224	22,725
„ „ 1951	118	287	161	679	342	32	4,651	9,677	7,297	23,244
„ „ 1952	115	288	173	685	338	36	4,868	9,884	7,373	23,760
„ „ 1953	109	296	188	702	341	40	5,082	10,200	7,469	24,427
Percentage distribution of net fixed capital at end of 1953 . .	*0·4*	*1·2*	*0·8*	*2·9*	*1·4*	*0·2*	*20·8*	*41·7*	*30·6*	*100*

(1), (2), * See corresponding footnotes to Table 2.

† Estimates of the gross and net value of fixed capital analysed by type of asset and expressed in terms of *current* prices may be obtained by multiplying the figures in this table by the price indices given in Appendix A.

55. For road passenger transport (i.e. bus undertakings), the high level of gross investment of 1948–1950 has now fallen off to near "replacement level". In the Post Office, there has been steady net investment, though the post-war rate of net investment seems to be below the 1938 level. In air transport—a relatively new industry—the major part of gross investment has represented net investment.

56. The marked contrasts to this pattern occur in two of the older established industries—railways and ports—and in roads. The levels of gross investment in post-war years have been inadequate to make good depreciation including obsolescence (on the definitions here employed). The negative figures of net investment in these industries should not be interpreted as meaning that the *quantity* of assets in use has fallen, but rather that the average age of assets in use has increased. Considering railway rolling stock by itself, the level of gross investment has been slightly above replacement level, but has not been adequate to make good arrears accumulated during the war. Although the net value of rolling stock is thus less than in 1938, the *gross* value, which is a measure of the volume or quantity of rolling stock in use taking no account of its age distribution, is little different from the 1938 level (a fact confirmed by the quantity figures given in Table 13). This suggests that the average age of rolling stock is now somewhat greater than in 1938 or, to put it the other way round, the average unexpired life is less than in 1938.

TABLE 9—*Gross and Net Fixed Capital*

	Fuel and Power, and Water					
	Coal[1]	*Gas*	*Electricity*	*Water*	*Railways*	*Road Passenger Transport*
At Current Prices.						
Gross fixed capital formation:						
1938	3	8	40	10	24	15
1948	18	26	99	13	36	35
1949	23	29	124	20	38	40
1950	18	34	138	24	40	39
1951	18	41	150	28	42	29
1952	26	46	159	34	36	26
1953	36	47	178	38	49	23
Net fixed capital formation:						
1938	1	1	14	1	−4	4
1948	12	12	39	−5	−21	19
1949	16	14	60	1	−20	22
1950	11	17	68	5	−19	19
1951	10	20	69	5	−26	4
1952	16	23	64	9	−37	−2
1953	25	22	79	12	−24	−6
At Constant Prices of 1948.						
Gross fixed capital formation:						
Average 1924–1929	6	21	69	19	47	30
„ 1930–1934	5	14	90	17	34	24
„ 1935–1938	6	18	97	19	48	28
„ 1948–1953	19	32	120	22	35	30
1938	7	18	91	22	53	31
1948	18	26	99	13	36	35
1949	22	28	120	20	37	40
1950	16	32	127	23	38	39
1951	15	34	124	23	34	27
1952	19	35	118	25	27	22
1953	26	35	131	28	36	20
Net fixed capital formation:						
1938	2	1	31	4	−10	8
1948	12	12	39	−5	−21	19
1949	15	14	58	1	−20	23
1950	9	16	63	5	−18	19
1951	8	17	57	4	−21	4
1952	11	17	48	7	−28	−2
1953	18	16	58	9	−18	−5
Gross fixed capital:						
End of 1938	148	500	1,617	1,388	4,146	308
„ „ 1947	151	431	1,678	1,376	3,784	233
„ „ 1952	216	494	2,067	1,385	3,548	331
Net fixed capital:						
End of 1938	71	242	1,006	692	1,758	158
„ „ 1947	79	192	851	596	1,454	120
„ „ 1952	134	268	1,116	608	1,346	183
„ „ 1953	152	284	1,174	617	1,328	178

(1) Plant and machinery and vehicles only.

Formation in Individual Industries

£ *million*

Transport and Communication					*Manufacturing and Distribution, etc.*[2]			
Roads	*Shipping*	*Harbours, Docks and Canals*	*Air Transport*	*Postal and Telephone Communication*	*Vehicles*	*Plant and Machinery*	*Industrial Buildings*	*Commercial Buildings*
15	20	2	1	25	32	104	23	52
6	53	6	12	34	99	275	90	15
8	53	8	17	40	114	312	98	26
8	64	9	13	41	113	367	114	46
8	64	9	13	47	125	440	118	43
9	64	11	15	59	127	458	131	39
10	98	13	17	67	141	456	140	39
8	3	−4	1	13	4	40	7	34
−8	10	−5	8	4	49	114	48	−25
−7	7	−3	11	9	57	136	53	−14
−8	13	−3	8	8	45	174	66	3
−9	9	−5	8	10	32	216	61	−6
−10	11	−4	8	15	14	193	69	−16
−11	28	−1	10	19	27	174	75	−16
27	81	10	—	37	32	148	34	66
32	27	8	—	32	54	130	34	71
28	52	4	1	47	74	218	63	109
7	55	8	13	41	101	325	99	29
34	60	5	2	57	70	230	54	120
6	53	6	12	34	99	275	90	15
8	52	8	16	39	111	300	96	25
7	58	8	12	39	105	337	108	43
7	53	7	11	40	97	367	96	35
7	53	8	11	45	88	339	99	29
7	64	10	13	49	104	333	104	29
19	11	−8	2	28	8	88	17	78
−8	10	−5	8	4	49	114	48	−25
−7	7	−3	11	8	56	131	52	−14
−8	12	−3	8	7	42	160	62	3
−8	7	−4	7	8	25	180	49	−5
−7	7	−3	6	11	10	143	52	−12
−8	18	−1	8	14	20	127	56	−12
1,059	1,174	955	10	727	608	4,141	1,865	3,141
1,082	954	803	51	803	464	4,346	2,071	2,963
1,072	1,075	752	104	890	773	5,399	2,392	3,010
662	572	413	7	438	302	2,127	1,016	2,000
594	603	305	41	441	241	2,234	1,074	1,712
556	646	287	81	479	423	2,962	1,337	1,659
548	664	286	89	493	443	3,089	1,393	1,647

(2) Including road goods transport and vehicles employed in agriculture.

TABLE

Net Fixed Capital Formation in Relation

£ *million*

Income	*1938*	*1948*	*1949*	*1950*	*1951*	*1952*	*1953*
1. National income	4,771	9,349	10,011	10,509	11,513	12,392	13,389
2. Indirect taxes *less* subsidies	585	1,449	1,457	1,586	1,804	1,867	2,015
3. Net national product at market prices	5,356	10,798	11,468	12,095	13,317	14,259	15,404
4. Depreciation	361	901	959	1,036	1,202	1,346	1,407
5. Gross national product at market prices	5,717	11,699	12,427	13,131	14,519	15,605	16,811

The following percentages may be derived:

	1938	*1948*	*1949*	*1950*	*1951*	*1952*	*1953*
Depreciation as a percentage of gross national product at factor cost(2)	*7·0*	*8·8*	*8·7*	*9·0*	*9·5*	*9·8*	*9·5*
Gross fixed capital formation as a percentage of gross national product at market prices	*11·5*	*11·9*	*12·4*	*12·8*	*12·9*	*13·2*	*13·9*
Net fixed capital formation as a percentage of net national product at market prices	*5·5*	*4·6*	*5·1*	*5·3*	*5·0*	*5·0*	*6·0*
Net fixed capital formation as a percentage of gross fixed capital formation	*45*	*35*	*38*	*38*	*36*	*35*	*40*

57. Railways, ports and roads are three of the industries (if indeed we can speak of roads, divorced from the vehicles that run on them, as an "industry") to which the remarks in paragraph 25 are applicable. That is to say, each of them involves civil engineering works of a very permanent character, to which only most arbitrary lengths of life can be given. If no depreciation at all were to be allowed in respect of "everlasting" assets, the level of net investment would be higher (i.e. the level of net disinvestment would be less) than is stated in this paper. A study of the composition of railway investment suggests, however, that if no depreciation were to be allowed for the permanent way, but only for rolling stock, vehicles, plant and buildings, the estimates of post-war net investment in this industry would still be negative.

58. Tables 3, 4 and 9, which give historical series for gross investment at constant prices, add support to these conclusions. They suggest that in the manufacturing and distribution group post-war gross investment has been some 20 per cent. above the 1935–1938 rate and nearly double the rate of the decade 1924–1934. For plant and machinery and industrial buildings taken separately, gross investment in 1948–1953 was in each case about 50 per cent. over the 1935–1938 level and well over twice the level of 1924–1934. But for commercial buildings (offices, shops, hotels, etc.) post-war gross investment appears to have been well below the level of any of the inter-war period.

59. In the fuel and power group post-war investment appears to have been substantially above the pre-war level.

60. In transport and communication (excluding road goods transport and "C" licence vehicles) the post-war level of gross investment in the group as a whole is below the levels of 1924–1929 and 1935–1938, but not so low as the level of the 1930–1934 depression. This reduction in the level of gross investment is accounted for mainly by the much lower level of investment in railways and roads. The post-war level of capital expenditure on the railways is about equal to the low level in the depression of 1930–1934. For railway buildings and works considered by themselves, the post-war level of capital expenditure compares very unfavourably with that of any inter-war period, and the same conclusion applies to roads. It is worth mentioning in passing that the figures of gross investment in railways and roads are not directly comparable, since the former include all rolling stock, whereas the figures for roads exclude all the vehicles running on them.

10

to National Income and Expenditure (1)

£ *million*

Expenditure at Market Prices	*1938*	*1948*	*1949*	*1950*	*1951*	*1952*	*1953*
6. Net domestic fixed capital formation	295	495	585	646	664	720	926
7. Other final expenditure	5,061	10,303	10,883	11,449	12,653	13,539	14,478
8. Net national expenditure at market prices	5,356	10,798	11,468	12,095	13,317	14,259	15,404
9. Depreciation	361	901	959	1,036	1,202	1,346	1,407
10. Gross national expenditure at market prices	5,717	11,699	12,427	13,131	14,519	15,605	16,811

(1) The sources for items 2 and 5 of this Table are *National Income Blue Book*, 1954, Table 1, and *Annual Abstract of Statistics*, No. 91, Table 282. Strictly gross national product at market prices (item 5) is underestimated. The reason is that one of the elements in building up estimates of gross national expenditure represents the imputed rental payments for the owner-occupation of houses, and for the owner-use of assets by the non-trading branches of public authorities; and these imputed rental payments generally include either no allowance for depreciation or an allowance based on original cost. This understatement, which involves a corresponding understatement in the figure for national income, is probably not sufficiently important to invalidate the conclusions drawn in this paper.

(2) Gross national product at factor cost is the sum of items 1 and 4 of this Table.

61. In housing the pre-war peak level of gross investment was reached in the period 1933–1938. This level was again reached in 1953.

62. Considering all new buildings and civil engineering works together, including houses,* the post-war level of gross investment up to 1952 appears to have been well below the best inter-war levels; but the pre-war peak level was reached again in 1953.

The Distribution of the Net Value of Capital Assets between Industries and Types of Asset

63. The estimates of the net value of capital in Tables 7 and 8 must be qualified in two ways. Firstly, they omit some classes of asset mainly on the building side. Secondly, the magnitude of the estimates relies fairly heavily on the assumptions about length of life. We may, however, draw the following general conclusions. Some 75 per cent. of the net value of fixed assets consists of buildings and works, and over half of this is housing. Plant and machinery and vehicles, though they account for over half of post-war gross investment and around 40 per cent. of gross investment in the 1930's, represent about a quarter of the net value of fixed assets; the length of life of plant and vehicles is, of course, shorter than that of buildings.

64. Outside the field of housing and public and social services, about half the net value of fixed capital is invested in the manufacturing and distribution group of industries and the remaining half in the "public utility" field (that is fuel and power industries, water, and transport and communication).

VI. *Comments on the Supplementary Tables* 11 *to* 13

Capital to Output Ratios in Different Industries

65. It is instructive to compare the gross capital employed in various industries with their repective annual contributions to gross national product; this contribution is a measure of each industry's "net output" reckoned *before* deduction of depreciation. Table 11 shows the comparison, and it also gives figures of depreciation (at replacement cost) for each industry.

* Buildings and works for the Armed Services, other than married quarters, are however excluded.

66. Table 11, column (*e*), shows that for the "public utilities" (gas, electricity, water, railways and postal and telephone communication), as well as for shipping, depreciation (at replacement cost) represented 20 per cent. or more of their net output in 1952, but that for the manufacturing and distribution group as a whole the percentage was only 6. Column (*d*) shows that the gross capital employed in the same public utilities was over 6 times their annual net output; for railways and electricity the ratio was some 15 times, and for water 46 times. For the manufacturing and distribution group, however, the gross capital employed was about 1·8 times their annual net output. These figures should be treated with caution, because (i) it has only been possible to get approximate agreement between the industrial classification of the net output figures and the classification of investment, (ii) the gross capital figures are, for reasons already given, liable to considerable error, and (iii) the ratio of gross capital to annual net output is dependent on whether the assets in question are being fully employed or not. Despite these qualifications the table shows quite clearly the much heavier capital requirements per unit of output in the "public utility" field than in the manufacturing and distribution field.

The Relationship between Depreciation at Original Cost and Depreciation at Replacement Cost

67. Table 12 gives estimates of depreciation at *original* cost and at replacement cost for five particular groups of assets, viz. gas, electricity, railway rolling stock, postal and telephone communication, and plant and machinery in the manufacturing and distribution group of industries. The estimates at original cost have been derived in exactly the same way as the estimates of depreciation at replacement cost (that is, as in the example set out in paragraph 13) except that an historical series for gross fixed investment at *current* (i.e. original) cost has been used in place of the constant price series. These estimates of depreciation at original cost are compared in Table 12 with depreciation at original cost as published in the accounts of the undertakings concerned (except in the case of the manufacturing and distribution industries for which no such figures are available).* The table shows good agreement between the alternative sets of figures at original cost. So far as the assets covered by the table are concerned I therefore conclude: firstly, that my estimates

TABLE 11

Relationship between the Gross Capital Employed in certain Industries, their Contributions to Gross National Product, and Depreciation. Year 1952

Industry	*Gross Capital at End of Year*[1] £ *million* (*a*)	*Depreciation in Year*[1] £ *million* (*b*)	*Contribution to Gross National Product*[2] £ *million* (*c*)	*Ratio of* (*a*) : (*c*) (*d*)	*Ratio of* (*b*) : (*c*) (*e*)
Gas	665	23	98	6·8	0·23
Electricity	2,783	95	170	16·4	0·56
Water	1,844	25	40	46	0·63
Railways	4,740	73	310	15·3	0·24
Road passenger transport	400	28	165	2·4	0·17
Shipping	1,666	53[4]	275	6·0	0·19
Postal and telephone communication	1,200	44	185	6·5	0·24
Manufacturing, distribution and other transport, etc.[3]	16,734	517	9,265	1·8	0·06
Total of industries above	30,032	858	10,508	2·9	0·08

(1) At replacement costs of 1952.
(2) The estimates in this column are a subdivision of those given in Table 10(i) of the *National Income Blue Book*, 1954.
(3) This item corresponds to the following headings in Table 9: manufacturing and distribution, etc.; harbours, docks and canals; and air transport.
(4) The excess of the proceeds of sales during the year of second-hand ships to foreign owners *over* their written-down replacement value has been deducted in arriving at depreciation. In the absence of such sales a higher figure of depreciation would appear in this table.

* All the published depreciation figures shown in Table 12 are based on the "straight-line" rule.

for earlier years of gross fixed investment at current prices are not seriously in error; and, secondly, the fact that my estimates of depreciation at original cost have necessarily been worked out in far less detail than the published figures of depreciation does not seem to have introduced substantial error.

68. The figures in Table 12 suggest that for a considerable range of plant and machinery depreciation at current replacement cost in the years 1948 to 1953 was nearly twice the depreciation at original cost, and that the net value of assets at the end of 1952 at 1952 replacement cost was about 1·6 or 1·7 times the net value at original cost. It is important to note, however, that the ratios just quoted are dependent on the assumption made throughout this paper that depreciation is calculated on a straight-line rule. Thus, if depreciation is calculated on the reducing balance principle, the ratio of replacement cost depreciation to original cost depreciation may be much less than the 2 : 1 mentioned above. This is because with the reducing balance formula a relatively heavier weight is attached to recent purchases (for which the ratio of replacement cost to original cost is nearer unity) than to earlier purchases.

Comparisons with Statistics of the Physical Quantity of Assets in Use

69. I have already explained that the methods adopted in this paper are one particular way of measuring the growth of assets, but not the only one. An obvious alternative is to measure the change in the physical quantity of assets in use (e.g. number of road vehicles in use). Unfortun-

TABLE 12

Depreciation and the Net Value of Fixed Assets Evaluated at Original Cost, Compared with the same Evaluated at Replacement Cost

£ *million*

	Gas		*Electricity*(1)		*Railway Rolling Stock*(2)		*Postal and Telephone Communication*		*Plant and Machinery in Manufacturing and Distribution, etc.*
	P	*C*	*P*	*C*	*P*	*C*	*P*	*C*	*C*
Depreciation at original cost:									
1948 . .	..	7	..	29	12	12	18	17	85
1949 . .	..	8	33	33	13	12	20	18	95
1950 . .	11	10	36	37	13	13	22	20	108
1951 . .	12	11	40	42	14	13	22	22	124
1952 . .	14	13	44	47	15	14	23	24	142
1953 . .	16	15	50	52	15	15	26	27	161
Depreciation at the replacement cost of each year:									
1948 . .	..	14	..	58	..	22	..	30	161
1949 . .	..	15	..	63	..	23	..	31	176
1950 . .	..	17	..	69	..	26	..	33	193
1951 . .	..	21	..	80	..	28	..	37	224
1952 . .	..	23	..	93	..	31	..	44	265
1953 . .	..	25	..	97	..	32	..	48	282
Net value of fixed assets at end of 1952:									
At original cost .	275(3)	225	889(3)	888	286	247	352	344	2,521
At the replacement cost of 1952 . .	..	360	..	1,472	..	433	..	644	4,000

P = Published in the accounts of the undertakings concerned (for sources see Appendix C).
C = Calculated.
(1) Great Britain only.
(2) British Transport Commission rolling stock only.
(3) Including land.

TABLE 13.—*Quantity of Capital (in Physical Units) Employed in Great Britain, Compared with Indices*

For the indices, end

	Unit	1927	1931	1935	1938
1. Agricultural machinery:					
Weighted index of number of machines in use[2]		..	..	..	..
Index of gross capital		..	..	..	*22*
2. Coal mining machinery in deep mines:					
Horsepower of electric motors installed[3]	000 H.P.	1,667	1,817	1,996	2,229
Index of horsepower of electric motors		*51*	*55*	*61*	*68*
„ „ *gross capital*		..	..	..	*69*
3. Electricity:					
Generating plant capacity	000 M.W.	5·3	7·2	8·1	9·4
Number of consumers	Million	2·6	4·6	7·7	10·1
Index of generating plant capacity		*30*	*40*	*46*	*53*
„ „ *number of consumers*		*18*	*33*	*55*	*72*
„ „ *gross capital*		..	..	..	*78*
4. Railway rolling stock[4]:					
Locomotives (empty weight)	000 tons	1,084[5]	1,054	993	985
Passenger carriages	000	52·5	50·0	47·3	47·2
Wagons and containers (capacity)	Million tons	15·0[6]	..	..	15·3[6]
Weighted index of quantity of rolling stock[7]		*105*	..	..	*100*
Index of gross capital		..	..	..	*103*
5. Road passenger transport vehicles[8]:					
Buses, 9–40 seats	000	36·3	39·4	34·0	33·8
„ 41 and over seats	000	6·4	9·7	12·0	16·5
Trolley vehicles	000	..[9]	..[9]	1·18	2·72
Tramcars	000	14·1	13·01	10·87	9·0
Total number	000	56·8	62·1	58·1	62·0
Weighted index of number of vehicles[10]		*70*	*76*	*72*	*76*
Index of gross capital		..	..	..	*99*
6. Road goods vehicles (total employed in all industries)[8][11]:					
Not exceeding 1½ tons unladen weight	000	184	215	206	210
Exceeding 1½ tons but not exceeding 4 tons unladen weight	000	65	110	203	262
Exceeding 4 tons unladen weight	000	34	36	26	23
Total number	000	283	361	435	495
Weighted index of number of vehicles[12]		*28*	*36*	*45*	*52*
Index of gross capital		..	..	..	*80*
7. Ships (total employed in all industries)[13]:					
Passenger vessels	Million gross tons	..	..	..	..
Dry cargo vessels	„ „ „	..	..	..	..
Tankers	„ „ „	..	..	..	..
Total tonnage	„ „ „	18·13	19·03	16·25	16·72
Weighted index of gross tonnage[14]		..	..	..	..
Index of gross capital		..	..	..	*110*
8. Postal and telephone communication[15]:					
Length of single wire in telephone and telegraph system	Million miles	7·5	10·2	12·5	15·3
Telephone stations	Million	1·64	2·07	2·58	3·24
Index of length of single wire		*25*	*34*	*42*	*51*
„ „ *number of telephone stations*		*28*	*35*	*44*	*55*
„ „ *gross capital*		..	..	..	*82*

of the Gross Value of Capital Derived from Tables 7 to 9. Figures refer to the end of each year (1).

of 1952 = 100

1939	1945	1946	1947	1948	1949	1950	1951	1952	1953
..	*63*	..	*73*	..	*87*	..	*94*	..	*106*
..	..	..	*68*	..	..	..	..	*100*	..
2,286	2,554	2,633	2,718	2,797	2,954	3,036	3,148	3,289	3,418
70	*78*	*80*	*83*	*85*	*90*	*92*	*96*	*100*	*104*
..	..	..	*70*	..	..	..	..	*100*	..
9·7	12·3	12·5	13·0	13·2	13·9	15·1	16·3	17·8	19·3
10·6	11·0	11·5	11·9	12·3	12·7	13·2	13·7	14·1	..
54	*69*	*70*	*73*	*74*	*78*	*85*	*92*	*100*	*108*
75	*78*	*82*	*84*	*87*	*90*	*94*	*97*	*100*	..
..	..	..	*81*	..	..	..	..	*100*	..
987	1,037	1,054	1,051	1,078	1,066	1,062	1,044	1,041	1,034
47·6	45·0	44·7	44·5	44·5	45·4	46·5	46·3	46·2	46·1
15·3	15·9	15·8	15·7	15·1	14·6	14·7	15·0	15·1	15·3
101	*102*	*102*	*101*	*100*	*98*	*99*	*100*	*100*	*100*
..	..	..	*94*	..	..	..	..	*100*	..
..	..	29·9	33·6	36·8	40·6	41·6	41·2	40·4	38·5
..	..	23·5	25·0	27·5	29·4	31·8	33·8	35·3	37·3
..	..	3·84	3·87	4·21	4·06	4·18	4·06	4·03	3·93
7·9	6·2	6·12	5·75	5·56	5·25	4·61	4·21	3·64	3·01
..	..	63·4	68·2	74·1	79·3	82·2	83·3	83·4	82·8
..	..	*78*	*83*	*90*	*96*	*99*	*100*	*100*	*99*
..	..	..	*58*	..	..	..	..	*100*	..
..	..	220	259	315	355	384	407	436	468
..	..	314	380	420	451	471	484	482	479
..	..	26	30	34	37	40	43	45	48
488	473	560	669	769	843	895	934	963	995
..	..	*60*	*72*	*82*	*89*	*94*	*98*	*100*	*102*
..	..	..	*69*	..	..	..	..	*100*	..
3·91	2·83	2·76	2·86	2·96	2·98	2·94	2·99	2·94	2·82
9·95	7·71	7·94	9·25	9·50	9·66	9·67	9·35	9·23	9·36
3·03	2·70	2·96	3·40	3·59	3·68	3·95	4·19	4·43	4·64
16·89	13·24	13·66	15·51	16·05	16·32	16·56	16·53	16·60	16·82
107	*83*	*85*	*95*	*98*	*100*	*101*	*100*	*100*	*100*
..	..	..	*89*	..	..	..	..	*100*	..
..	23·8	24·3	25·0	26·0	26·9	27·8	28·9	29·9	..
3·34	3·94	4·32	4·65	4·92	5·17	5·43	5·72	5·93	6·15
..	*80*	*81*	*84*	*87*	*90*	*93*	*97*	*100*	..
56	*66*	*73*	*78*	*83*	*87*	*92*	*96*	*100*	*104*
..	..	..	*90*	..	..	..	..	*100*	..

(Notes to Table 13 on p. 168.)

ately such statistics of physical quantities exist only for a limited number of classes of assets. For these few classes, however, it is interesting to compare the changes through time in the quantity of assets in use with the changes in the volume of capital employed as derived by the methods set out earlier in this paper. The figures of the net value of capital given in this paper take account not only of the quantity of assets, but also of their average unexpired life—the "two-dimensional" concept; it is therefore the figures of the gross value of capital—which do not take account of the time-factor (i.e. are "one-dimensional")—which can be most closely related to statistics of the physical quantity of assets in use.

70. Table 13 shows for eight groups of assets statistics of the quantity of assets in use in physical units for the period 1927 to 1953; these series have also been expressed in index form taking 1952 = 100. Alongside these indices appear the corresponding estimates of the gross value of capital evaluated at constant 1948 prices and also expressed in index form (with 1952 = 100); the latter indices have been derived directly from Tables 7 to 9 of this paper. Only gross capital figures for the end of 1938, 1947 and 1952 are shown, because the estimated changes in the gross value of capital over short periods of time, such as a year, are likely to contain large errors arising from errors in the assumptions about length of life.

71. For some groups of assets the index of gross capital is in fairly good agreement with the index of physical quantity—for example, for agricultural machinery, railway rolling stock and ships. For other assets the agreement is less good, and for some it is distinctly poor. That this should be so is not altogether surprising. In some instances the causes may be errors in the figures of gross value of capital resulting from errors in the lengths of life assumed, or in the price indices employed, or in the series for gross investment in the past. In other instances the statistics of physical units employed may be an inadequate or incomplete measure of the volume of capital. For example, electricity generating capacity is a measure of only one part of the capital employed in the electricity industry, and the series for number of consumers is a poor measure of the capital on the distribu-

---

NOTES TO TABLE 13

(1) Unless otherwise stated, figures of quantity of assets refer to a date between October 1st of the stated year and March 31st of the following year. For sources of the statistics of quantity, see Appendix C.

(2) This index has been derived from statistics of numbers of machines in use; the series for different classes of machine have been weighted by average 1945 values per machine. For this index, the average of end-1951 and end-1953 has been taken to be 100.

(3) Figures refer to June 30th. For 1946 and earlier the figures include certain mines not producing coal; on this basis the 1947 figure is 2,737.

(4) For 1948 and later, the figures of quantity of rolling stock exclude certain minor lines not nationalised.

(5) Figure for 1928.

(6) The components of the figures for 1927 and 1938 relating to private owners' wagons refer respectively to 1928 and 1937.

(7) The following weights (which relate to approximate replacement costs in 1948) have been used: Locomotives, £150 per ton empty weight. Passenger carriages, £5,000 each. Wagons and containers, £25 per ton capacity.

(8) Figures of numbers of vehicles refer to vehicles for which licences were current at any time during the quarter ended September 30th, except for the figures for 1939 and 1945 which refer to vehicles with licences current at August 31st.

(9) Included under the heading "Buses".

(10) The following weights (which relate to approximate replacement costs in 1948) have been used: Buses 9–40 seats, £3,450 each. Buses 41 seats and over, £4,100 each. Trolley vehicles and tramcars, £5,600 each.

(11) Figures of numbers of vehicles exclude "exempt" vehicles.

(12) The following weights (which relate to approximate replacement costs in 1948) have been used: Not exceeding 1½ tons unladen weight, £420 each. Exceeding 1½ tons, but not exceeding 4 tons, £875 each. Exceeding 4 tons, £1,650 each.

(13) The figures of tonnage refer to vessels of 500 gross tons and over on the United Kingdom register excluding (i) vessels on bareboat charter or requisition from other registers, (ii) Canadian-owned tonnage permanently transferred to the United Kingdom register, (iii) craft not mechanically propelled, and (iv) (from 1939 onwards) miscellaneous non-trading craft. The 1939 figures refer to September 3rd.

(14) The following weights (which relate to approximate replacement costs in 1948) have been used: Passenger vessels, £119 per gross ton. Dry cargo vessels, £79 per gross ton. Tankers, £53 per gross ton.

(15) All figures refer to the United Kingdom.

tive side of the industry. Similarly, numbers of machines, without any adjustment for size or complexity, cannot be regarded as a very satisfactory measure of the volume of capital in an industry.

72. It is not possible in every case to identify precisely the causes of divergence between the alternative indices of the volume of capital given in Table 13. But in the two cases where the discrepancy is largest—road passenger transport vehicles (mainly buses) and road goods vehicles—the divergence is accounted for almost wholly by errors in the assumed lengths of life. In fact, post-war buses are being kept in service for much longer than pre-war. The number of buses and trolley buses in use at the end of 1938 represented the vehicle intake of the preceding 9·3 years, whereas both at the end of 1947 and at the end of 1952 the number in service equalled the intake of the preceding 16·3 years. The calculated figures of the gross capital value of road passenger transport vehicles in Table 8 assume a life of 10 years for buses, so that the estimates relating to the end of 1947 and the end of 1952 necessarily understate the gross value of capital in use. A similar explanation applies to road goods vehicles.

73. The conclusion to be drawn from Table 13 is that, in the absence of supporting evidence, the reliability of the gross value figures as a measure of the change in volume of capital employed must always be in doubt. But I have explained earlier (paragraphs 18 and 19) why the estimates of net investment can be accepted with a good deal less reserve, at least so far as errors due to length of life assumptions are concerned.

Acknowledgements

74. In conclusion, I would like to acknowledge the encouragement I have received from Mr. W. A. B. Hopkin, who first suggested that I should undertake this investigation, and from Mr. C. T. Saunders; both have given me much valuable advice during the progress of the study. Though the great bulk of the statistics on which the calculations are based are published statistics, I gratefully acknowledge the help of a number of Government departments and individuals in making available to me unpublished data. I, of course, accept full responsibility for any errors and shortcomings in this paper. Last, but not least, I wish to place on record my thanks to Mrs. J. E. Manley and Miss W. J. Wilkins who have painstakingly carried out a heavy volume of computing work.

Appendix A

The Price Indices

Sources Used for the Price Indices

For the period 1947 to 1953 the indices are those employed in the derivation of Table 45 of the *National Income Blue Book*, 1954; they may be obtained by taking the ratio of corresponding items in Tables 44 and 45. For 1946 and earlier years, the sources of the indices are set out below.

Buses and Trolley Buses

Average ex-factory values per vehicle were worked out from the 1935 and 1948 Censuses of Production and from the 1937 Import Duties Enquiry. This was done separately for six classes of complete vehicle or chassis and the six series of average values were then weighted in proportion to the number of vehicles of each class produced in 1935. An average value index was thus derived linking 1935, 1937 and 1948. The estimates for other years between 1925 and 1939 were then made by extrapolating or interpolating from the 1935 and 1937 figures by reference to an index of commercial vehicle retail prices published by the Society of Motor Manufacturers and Traders (*Motor Industry of Great Britain*, 1939, p. 47). Rough guesses have been added for 1923–1924 and 1940–1946.

Road Goods Vehicles

The method described above for buses cannot be applied to goods vehicles because of differences in the classification of vehicles in the post-war and pre-war censuses. For buses and passenger cars, the indices of average ex-factory value in 1935 were respectively 50 and 49 (1948 = 100). For goods vehicles the corresponding index was therefore assumed to be 50. Indices for the rest of the period 1925 to 1939 were then obtained by extrapolating from the 1935 figure by reference to the Society of Motor Manufacturers and Traders' index of commercial vehicle prices. The index for 1923–1924 and 1940–1946 is largely guesswork.

Passenger Cars

For linking 1935, 1937 and 1948 a method similar to that described for buses was employed (see above); ten classes of complete car or chassis were distinguished in the calculation. The links between 1935, 1937 and 1948 so obtained relate to ex-factory values, and to translate these into an index of retail prices account has to be taken, in the case of cars, of the incidence of purchase tax in 1948. Estimates for the rest of the period 1923–1939 were obtained by interpolating and extrapolating from the 1935 and 1937 figures by reference to an index of retail prices of passenger cars published by the Society of Motor Manufacturers and Traders. The index for 1940–1946 is mainly guesswork, but changes in the rates of purchase tax have been allowed for.

Railway Rolling Stock

Average values per ton were calculated from the 1935 and 1948 Censuses of Production and from the export statistics for the same two years. These average values were worked out separately for different classes of rolling stock, and the results combined to give an average value index linking 1935 and 1948. The index for 1935 (with 1948 = 100) was 37, the same as for plant and machinery, and I have assumed that the index for plant and machinery was applicable also to railway rolling stock for all years under consideration.

Price Indices, 1839–1918

1948 = 100

	Buildings and Works[1]		*Plant and Machinery*	*Buildings and Works*[1]
1839–1850	21	1885	..	21
1851	20	1886	..	21
1852	19	1887	..	21
1853	20	1888	..	21
1854	21	1889	15	22
1855	21	1890	16	21
1856	22	1891	16	20
1857	21	1892	16	20
1858	22	1893	15	19
1859	22	1894	15	19
1860	21	1895	15	19
1861	20	1896	15	19
1862	20	1897	16	20
1863	21	1898	16	20
1864	21	1899	17	21
1865	21	1900	19	21
1866	22	1901	19	21
1867	22	1902	19	20
1868	24	1903	18	20
1869	22	1904	18	20
1870	22	1905	18	20
1871	22	1906	19	20
1872	22	1907	19	20
1873	23	1908	19	20
1874	24	1909	19	20
1875	23	1910	19	20
1876	24	1911	19	20
1877	24	1912	20	20
1878	24	1913	21	21
1879	23	1914	20	21
1880	24	1915	24	26
1881	23	1916	28	33
1882	22	1917	33	42
1883	22	1918	39	53
1884	22			

(1) Including housing

Ships

The price indices shown in the table are applicable only to expenditure on newly built ships. The link between 1938 and 1948 is based principally on Fairplay's index for the cost of a 9,500 d.w.t. motor cargo ship (see M. G. Kendall, *J.R. Statist. Soc.*, 1948, p. 142).

The proceeds of sales of second-hand ships to foreign owners in the years 1948 to 1953 (which represent a deduction in arriving at figures of gross investment) have been converted into terms of constant 1948 prices by means other than the use of a price index. The tonnage of each ship sold has been multiplied by the average 1948 replacement cost per ton, and 1/24th has then been deducted for every completed year of age of the ship in order to obtain its estimated "written-down" replacement value at 1948 prices. Estimates of gross investment in the years 1948 to 1953 in terms of 1948 prices have been derived by deducting the aggregate written down replacement value (at 1948 prices) of all ships sold from the estimated value (at 1948 prices) of all newly built ships.

Price Indices, 1919–1953

1948 = 100

	Buses, etc.	*Road Goods Vehicles*	*Passenger Cars*	*Ships*	*Plant and Machinery*	*New Housing*	*Other New Buildings and Works*
1919	..	..	..	..	46	68	64
1920	..	..	..	..	54	78	71
1921	..	..	..	..	60	68	58
1922	..	..	..	..	52	40	45
1923	97	99	90	..	40	41	40
1924	89	91	82	..	39	41	42
1925	78	80	73	..	38	46	42
1926	70	72	70	..	37	46	42
1927	72	74	69	..	37	43	42
1928	66	68	66	..	37	40	41
1929	67	69	58	..	37	38	41
1930	66	68	54	..	37	37	40
1931	62	64	49	..	38	36	38
1932	59	60	44	..	37	34	37
1933	57	59	43	..	37	34	35
1934	54	56	45	..	36	34	36
1935	50	50	38	..	37	33	38
1936	49	49	36	..	38	35	40
1937	50	48	36	..	41	39	42
1938	51	51	37	33	45	38	43
1939	49	49	35	..	47	40	42
1940	53	53	40	..	52	45	45
1941	57	57	54	..	58	50	50
1942	61	62	59	..	64	56	56
1943	66	67	64	..	74	63	63
1944	71	72	69	..	78	71	71
1945	77	78	76	..	78	80	80
1946	83	84	82	..	78	86	86
1947	89	91	89	90	90	94	93
1948	100	100	100	100	100	100	100
1949	99	102	102	108	104	102	102
1950	99	111	104	116	109	105	106
1951	105	132	127	134	120	117	123
1952	114	145	143	155	135	126	133
1953	113	139	130	155	137	126	134

Aircraft

In the absence of any price index specifically relating to aircraft, the price index for plant and machinery has been used.

Plant and Machinery

The index for years up to 1948 is essentially a measure of changes in average value per ton of specific classes of plant and machinery. The data are obtained from the export and import statistics and, for censual years, from the Censuses of Production and Import Duties Enquiries. The method has been described fully by H. J. D. Cole in the *Bulletin of the Oxford Institute of Statistics* (March 1951 issue), and in fact I have made use of the estimates he gives. Cole's estimates for export and import average values cover the years 1920 to 1939 and also 1947, and, using similar methods, I have extended these figures (for exports only) to cover each year from 1939 to 1948. Similarly Cole's estimates for average values of home-produced machinery cover the censual years 1924, 1930 and 1933 to 1935, and I have again extended the estimates both backwards and forwards to cover the Censuses of Production of 1907 and 1948.

The indices of average value derived from the two alternative sources (i.e. from export and import data and from production data) are in fairly good agreement; taking 1948 = 100 there is only a difference of about one point between the alternative estimates for any of the census years 1924, 1930 and 1933 to 1935.

The methods described cover the years 1907 and 1920 to 1948. The estimates for 1889 to 1914 have been obtained by extrapolating from the 1907 figure by reference to figures of average value of machinery per ton given in A. K. Cairncross's *Home and Foreign Investment*, 1870–1913 (1953), Table 37.

The figures for 1915 to 1919 are guesses.

New Housing and Other New Buildings and Works

A number of indices of building costs have been published in the past. They have been compiled on differing bases, are of varying reliability and cover different periods of years. These indices have been "spliced together" to form the indices used in this paper. Where, for some period of years, alternative published indices were available and there seemed no strong grounds for regarding one of them as more reliable or relevant than the others, a rough average of the indices has been taken.

The following are the published indices from which the indices used in this paper have been compiled. The figures in square brackets indicate the years covered by each index.

(i) G. T. Jones' index of selling prices of buildings (given in his *Increasing Returns* (1932)). [1845–1922.]

(ii) H. J. Venning's estimates of the building cost of single storey factories and working-class flats (published in *The Architect*, January 12th, 1934, and reproduced in an article by Colin Clark in Special Memorandum No. 38 of the London and Cambridge Economic Service (September, 1934)). [1914, 1924, 1929–1930, 1933.]

(iii) Costs per square foot of non-parlour houses for which tenders were received by local authorities in England and Wales (set out in *Private Enterprise Housing* (H.M.S.O., 1944), Appendix V*b*). [1919–1939.]

(iv) Colin Clark, in London and Cambridge Economic Service Special Memorandum No. 38, gives a weighted mean of the prices of specific items of building work (e.g. a rod of brickwork) taken from *The Builder* and *The Illustrated Carpenter and Builder*. [1920–1933.]

(v) *The Economist* worked out an index of building costs by taking an unweighted mean of indices of wage rates and materials prices (reproduced in H. W. Robinson's *Economics of Building* (1939), Appendix 2). [1924–1937.]

(vi) The Girdwood Reports on *The Cost of Housebuilding* (H.M.S.O., 1948, 1950 and 1952) give estimated changes in the cost of a standard 3-bedroom local authority house. [1938–39, 1947, 1949, 1951.]

(vii) *The Report of the Working Party on Building* (H.M.S.O., 1950) gives an index of building

costs, based on a combination of indices of materials cost, earnings per hour, output per man hour and overheads. [1939 and 1946–1948.]

The published indices which refer specifically to new housing (i.e. (ii), (iii) and (vi) above) have been employed in compiling the index of new housing prices covering the years 1919 onwards which is set out earlier in this Appendix. Before 1919 a single index for both housing and other building work has been used.

Appendix B

I. *Definitions of the Industries;* II. *Lengths of Life Assumed; and* III. *Sources of the Estimates of Gross Fixed Investment*

The industrial classification follows that of the *National Income Blue Book*, 1954, Table 46, except where otherwise noted below. As in the *National Income Blue Book*, vehicles and ships owned by establishments in industries outside transport have been classified so far as possible to the industries owning them and not to the transport industry. An exception is road vehicles employed in agriculture, which are here included under manufacturing and distribution. In consequence about 90 per cent. of all investment in road vehicles (other than buses) appears in this paper under the heading "Manufacturing and Distribution, etc."; the only significant cases of road vehicles (other than buses) classified outside this industry group are vehicles employed in the fuel and power industries, railways, the Post Office and public and social services (e.g. fire and police).

For the years 1948 to 1953, the estimates of gross fixed capital formation given in the *Blue Book*, 1954, Tables 43 to 47 have been used. For earlier years the principal sources are set out below.

Estimates of the value of assets destroyed in the war have (except for houses and shipping) been based on the compensation paid under the War Damage Act, 1943, and the War Damage (Public Utility Undertakings, etc.) Act, 1949. Only complete losses have been taken into account, and this has entailed making an approximate division of compensation between such losses and repairable damage.

1. *Agriculture*

I. The estimates relate to plant and machinery only. Vehicles employed in agriculture are in this paper included under the heading "Manufacturing and Distribution, etc."

II. The lengths of life assumed are those set out in *Agricultural Machinery* (P. E. P. Report 1949), Table 11, column I.

III. Statistics of numbers of different types of machine produced for the home market in the years 1937 onwards have been converted to current value terms by multiplying by the average 1945 values per machine (given in *Agricultural Machinery*, Table 11) and then applying the plant and machinery price index. An addition, based on Trade Statistics, has been made for imports, and the resultant has been employed as an indicator to extrapolate the 1948–1953 estimates of gross investment back through each year to 1937.

Estimates of the ex-factory value of agricultural machinery (excluding parts) produced in the censual years 1924, 1930, 1933–1935 and 1948 have been derived from the Censuses of Production and Import Duties Enquiries. After deducting exports and adding imports, an indicator has been obtained to extrapolate the 1948 figure of gross investment back to 1924, 1930 and 1933–1935. Estimates of gross investment in the intervening years have then been obtained by interpolating the censal year figures by reference to employment in general engineering (production of agricultural machinery at constant prices having been assumed to vary in accordance with this level of employment) and data on exports and imports.

2. *Coal Mining*

I. The estimates relate to plant and machinery and vehicles only, that is excluding mine workings and buildings. Purchases of colliery-owned railway wagons now vested in British Railways have been excluded, and treated as part of the investment of the railway industry.

II. The lengths of life assumed have been based on the rates of depreciation allowed to collieries by the Inland Revenue,* and are as follows.

Surface machinery or plant, other than electrical	34 years
Electrical plant at the surface and all underground plant installed in the shaft pillar	30 ,,
Other underground plant	22 ,,

III. The estimate of gross investment in 1947 is from the National Coal Board's Report. For 1907, 1924, 1930, 1933–1935, 1937 and 1946, the estimates have been derived by extrapolating the 1948 gross investment figure on the basis of data on mining machinery taken from the Censuses of Production and Trade Statistics; the method is similar to that employed for estimating agricultural investment before 1937 (see above), and it relies on the perhaps doubtful assumption that the trend in the intake of general-purpose machinery to coal-mines was the same as the trend of the intake of specialized mining machinery. Estimates for other pre-war years have been obtained by interpolating as for agriculture.

For 1939–1945 the estimates of gross investment were deduced from the year-to-year changes in the depreciation allowed to colliery undertakings by the Inland Revenue. This method is similar to that employed for estimating wartime investment in plant by manufacturing and distribution (see section 13, III (b) of this Appendix).

3. *Gas*

II. The lengths of life have been based on the lives assumed by the Gas Council in calculating depreciation (see their Annual Report for 1950–51 pp. 87–90), and are as follows:

Buildings and works:	
Buildings	50 years
Mains: 75 per cent. of each year's investment in mains has been assumed to have a life of 50 years, and 25 per cent. a life of 30 years	
Consumers' services	10 ,,
Plant and vehicles:	
Gasholders	50 ,,
Gas transmission plant	50 per cent. of 40 ,,
	and 50 per cent. of 30 ,,
Gas manufacture plant	24 per cent. of 40 ,,
	24 per cent. of 30 ,,
	and 52 per cent. of 20 ,,
Ships	25 ,,
Meters	15 ,,
Motor vehicles	10 ,,
Appliances on hire and prepayment installations	7 ,,
Furniture, fittings and office machinery	7 ,,

III. For local authority-owned undertakings the figures of gross investment before 1948 are from the published local authorities' financial returns (see section 15, III). On the basis of Census of Production statistics of output in years from 1924 to 1948 and of census statistics of capital expenditure in 1948 (wherein figures for local authority-owned and company-owned undertakings are given separately), companies' gross investment in the gas industry in each year has been assumed to be exactly twice that of local authorities. The analysis of each year's investment by type of asset has been based on the analysis for post-vesting years shown in the Gas Council's Annual Reports.

4. *Electricity*

II. The lengths of life have been based on the lives assumed by the British Electricity Authority in calculating depreciation (see their Annual Report for 1949–50, Appendix 43), and are as follows:

(*) See the Inland Revenue publication *Income Tax, Wear and Tear Allowances for Machinery or Plant: List of Percentage Rates* (H.M.S.O., 1953).

Buildings and works	40 years
Plant and vehicles:	
Underground mains	40 „
Overhead mains	30 „
Plant and machinery generally	25 „
Consumers' services	25 „
Ships	25 „
Consumers' meters	15 „
Furniture, fittings and fixtures	10 „
Motor vehicles	10 „
Office machinery	7 „
Apparatus on hire	7 „

III. For 1922 to 1947, the estimates of gross investment are the "net" capital expenditure figures given in the annual *Engineering and Financial Statistics* published by the Electricity Commissioners (with a deduction for land and an addition for Northern Ireland). For years before 1922 the series has been extrapolated back, using as an indicator the returns of local authorities' capital expenditure on their electricity undertakings, i.e. assuming local authorities' investment represented a constant proportion of the whole.

5. *Water*

II. Lives of all assets have been assumed to be 75 years. In theory different lengths of life should have been assumed for buildings, civil engineering works, mains and machinery; but such a procedure was not justified here because of the relatively small magnitudes involved and absence of data on the analysis of investment between different types of asset.

III. The figures of gross investment before 1948 were compiled on the same principles as for the gas industry (section 3, III, above). The gross investment of companies in each year was taken to be a fifth of that of local authorities. For 1904 and earlier an approximate adjustment was applied to the published series for local authority capital expenditure to allow for the exclusion therefrom of the undertakings forming the Metropolitan Water Board.

6. *Railways*

I. This item excludes railway-owned docks, canals and hotels, but includes investment in (i) buildings and plant for railway workshops, (ii) railway-owned ships and cartage vehicles, and (iii) privately owned wagons subsequently vested in British Railways. The investment estimates given in this paper exclude renewals of buildings and works which are charged to revenue in the railways' accounts; for this reason the gross investment estimates for 1948–1953 in Table 9 are somewhat less than the figures appearing in Table 46 (item 12) of the *Blue Book*, 1954. If the amount of these renewals is increasing, their exclusion here may result in some overstatement of the extent of net disinvestment.

II. Lengths of life, based except for buildings and works on lives assumed by the British Transport Commission (see their Annual Accounts for 1951, paragraph 55), have been taken to be :

Buildings and works	100 years
Railway rolling stock	30 „
Plant	25 „
Ships	25 „
Road vehicles	10 „

III. Estimates of gross investment for years from 1913 to 1947 have been derived from the annual increases in the railways' capital expenditure (as shown, up to 1938, in the Ministry of Transport's annual *Railway Returns*) *plus* the amounts expended annually on complete renewals of railway rolling stock (from the same source). Additions have been made for (i) expenditure on new privately-owned wagons (based on numbers newly licensed each year), (ii) expenditure on London Transport Railways not covered by the *Railway Returns* after mid-1933 (from the London Passenger Transport Board's Accounts) and (iii) some wartime government-financed expenditure. A deduction has been made for purchases of land.

From 1870 to 1912 the estimates have been based on A. K. Cairncross's figures for railway

capital expenditure (given in *Home and Foreign Investment*, 1870–1913 (1953), Table 26). Cairncross's figures were extrapolated back to 1839 by reference to a smoothed series for the annual additions to the paid-up capital of the railway companies.

7. *Road Passenger Transport*

II. Lengths of life except for buildings have been based on those assumed by the British Transport Commission or implied by the Inland Revenue depreciation allowances; they are:

Buildings	50 years
Plant	25 „
Buses and trolley buses	10 „

III. For vehicles, the estimates of gross investment from 1927 onwards have been derived from statistics of numbers newly registered in each of several categories of vehicle; the numbers have been converted to current prices using average 1948 values per vehicle and multiplying the resultant by a price index. For 1924–1926, statistics of production (quoted in *The Motor Industry of Great Britain*, 1953, which is published by the Society of Motor Manufacturers and Traders) and of exports and imports have been used instead of the registration data.

The estimates of gross investment in plant and buildings are only approximate; they take account of the capital expenditure figures given in the London Passenger Transport Board's Accounts (from 1933 onwards).

8. *Roads*

I. This item covers also public lighting and a small amount of investment by highway authorities in road making plant.

II. The length of life of all assets has been taken to be 75 years. The remarks in section 5, II, of this Appendix apply here also.

III. The estimates of local authorities' gross investment have been derived from their financial returns (as described for other local authority services in section 15, III). Capital expenditure incurred by the Central Government in respect of Trunk Roads (from 1937 onwards) has been added.

9. *Shipping*

I. This item includes all ships apart from fishing vessels and a small number of vessels appearing under other industrial headings (e.g. railways).

II. Lengths of life have been based on depreciation rates granted by the Inland Revenue; they are :

Tankers	20 years
Other ships	25 „

III. Estimates of gross investment in pre-war years have been based on Lloyd's Register figures of tonnage of merchant vessels launched for home registration. To obtain investment at current prices the tonnage launched has been multiplied successively by average 1948 costs per ton and by a price index; allowance has been made for the varying proportion of passenger vessels, dry cargo vessels and tankers in each year's output, since the costs per ton of these three types differ substantially.

Because of the extent of transactions with foreign owners in second-hand ships and of war losses to shipping, the method of computing depreciation illustrated in the table in paragraph 13 of this paper has been considerably modified. The first step in the calculation has been to estimate the gross replacement value at 1948 prices of all ships in the United Kingdom merchant fleet at the end of each year, exclusive of fishing vessels, etc., and exclusive of ships of age 25 years and over (20 years and over in the case of tankers); to do this, reference has been made to the analysis of the fleet by age and type of vessel given in the *Annual Abstract of Statistics* (e.g. 1954 issue, Table 246 (i)). Depreciation in any year (in terms of 1948 prices) has then been calculated as $\frac{1}{25}$th of the gross replacement value at the end of the year ($\frac{1}{20}$th in the case of the tanker component of the fleet). A small addition to the depreciation figures has been made in respect of ships lost or scrapped before expiry of their assumed life (based on tonnage and age of vessels lost and scrapped in each year).

Net investment at 1948 prices has been derived by deducting depreciation at 1948 prices from gross investment at 1948 prices. Net investment in terms of current prices has then been obtained by multiplying the figures of net investment at constant 1948 prices by the price index shown in Appendix A,

10. *Harbours, Docks and Canals*

II. All assets have been assumed to have lives of 75 years. The remarks in section 5, II, of this Appendix apply here also.

III. For local authority-owned undertakings estimates of gross investment in each year are from the local authority financial returns (as described in section 15, III, of this Appendix); an approximate adjustment to the estimates for years 1909 and earlier has been made to allow for the exclusion from the returns for those years of undertakings forming the Port of London Authority. For railway-owned docks and canals, the estimates are derived in a similar manner to the figures of railway investment (see section 6, III).

11. *Air Transport*

II. The lives of assets set out below have been based on the lengths of life assumed for the purposes of their accounts by the Airways Corporations and the Ministry of Transport and Civil Aviation (the principal civil aerodrome authority); for the latter see *Trading Accounts and Balance Sheets*, 1948–49 (H.M.S.O.), p. 41.

Airways Corporations:	
Buildings and hangars	20 years
Aircraft	Up to 14 „
Operating ground equipment and commercial equipment	8 „
Civil aerodromes:	
Hangars and workshops	45 „
Runways, aprons, etc.	40 „
Other buildings	30 „
Plant and vehicles	15 „

III. In the main the estimates of gross investment before 1948 have been derived from the Airways Corporations' published accounts and the accounts relating to the Ministry of Civil Aviation's aerodromes. I have made no detailed analysis of pre-war investment but have assumed it to be fairly negligible. For years immediately preceding the vesting of the Airways Corporations, rough estimates of gross investment in aircraft, etc., have been based on the book value of assets taken over at vesting date.

12. *Postal and Telephone Communication*

I. The estimates of gross investment given in this paper differ slightly from the figures shown in the *Blue Book*, 1954, Table 46, item 19, owing to the exclusion from the present figures of expenditure on the renewals of certain assets.

II. The lives set out below are based on those assumed by the Post Office in their Commercial Accounts; see 4th Report from the Select Committee on Estimates, Session 1950, p. 122.

Buildings	60 years
Plant:	
Trunk lines	46 „
Local lines and submarine cables	36 „
Exchanges, wireless and postal services	20 „
Subscribers' circuits	7 „

III. The figures for gross investment before 1948 are taken from the Post Office Commercial Accounts and Appropriation Accounts. Expenditure on renewals of equipment (so far as is shown in the Commercial Accounts) has been included. Additions have been made for (i) war plant provided out of Votes of Credit and (ii) estimated capital expenditure on the postal and telegraph services in 1928 and earlier (excluded from the capital expenditure figures in the Commercial Accounts); and a deduction has been made for land. The capital expended on the purchase of the

National Telephone Company's system in 1911–1913 has been "spread back" over the preceding decade.

13. *Manufacturing and Distribution, etc.*

I. This heading covers a wide range of industries, mainly, but not wholly, in the private sector, namely: mining and quarrying other than coal, manufacturing, building and contracting, road goods transport, broadcasting and distribution and other service industries (i.e. it corresponds to items 5, 6, 8, 14, 20 and 21 of Table 46 of the *Blue Book*, 1954). The estimates omit investment in those factories and plant financed by the Government during the war, which are now *leased* by the Ministry of Supply to private firms. Road vehicles employed in agriculture have been included in this heading.

No analysis between the individual industries comprising the group has been possible Instead, Table 9 gives an analysis by type of asset: namely (i) vehicles (mainly road vehicles), (ii) plant and machinery, (iii) industrial buildings (i.e. buildings used in the manufacturing, building and contracting and mining and quarrying industries), and (iv) commercial buildings (e.g. offices, shops, hotels). The vehicles heading (i) covers about 90 per cent. of all investment in road vehicles (other than buses) in the United Kingdom (see introductory paragraph to this Appendix).

II. The assumed lengths of life, except for commercial buildings and plant for Royal Ordnance Factories, are based on the rates of depreciation allowed by the Inland Revenue for taxation purposes.

Industrial buildings	50 years
Commercial buildings	75 „
Road goods vehicles	10 „
Passenger cars	10 „

Plant and machinery has been divided into five classes with lengths of life of 45, 30, 22, 17 and 14 years; these lives correspond to Inland Revenue basic rates of depreciation on the reducing balance principle of 5, 7½, 10, 12½ and 15 per cent. respectively. It has been assumed that the gross investment of each year after 1944 was subdivided between these five classes in the proportions of 15, 39, 40, 2 and 4 per cent. respectively; and that the gross investment of 1944 and each earlier year was subdivided in the proportions 15, 51, 31, 1 and 2 respectively. These proportions have been worked out by classifying according to depreciation rate the output of machinery as returned in the Censuses of Production of 1935 and 1948 (omitting machinery which is specific to other industries such as coal-mining or agriculture); the depreciation rates are given in the Inland Revenue's publication *Income Tax, Wear and Tear Allowances for Machinery or Plant: List of Percentage Rates* (1953). For plant and machinery in Royal Ordnance Factories, a life of 14 years has been assumed, on the basis of the rates of depreciation employed in the Trading Accounts (see the *Trading Accounts and Balance Sheets*, 1946–47, p. 65).

III(a).—*Vehicles*

Estimates of total gross domestic investment in road goods vehicles and passenger cars have been compiled. A deduction has then been made in respect of vehicles acquired by other industries (e.g. fuel and power industries and the railways) in order to arrive at the investment in "manufacturing and distribution, etc." and a small addition made in respect of railway rolling stock used in private sidings, etc.

Estimates of the total gross domestic investment in road goods vehicles have been derived in a similar way to buses (see section 7, III, of this Appendix). For passenger cars entirely arbitrary assumptions have had to be made, because of the impossibility of distinguishing in the statistics of new registrations between cars bought by businesses and cars bought by consumers, and lack of information on second-hand transactions. I have assumed that in 1946 and 1947 total gross domestic investment in cars equalled half the value of all new cars registered, but that in the war years 1941 to 1945 the proportion was $\frac{4}{5}$ths. For each year before 1941, the total gross investment in cars expressed at the prices of 1948 has been assumed to equal half the total gross investment in road goods vehicles (also expressed at 1948 prices); this implies that gross investment in cars in 1939 and earlier years was $\frac{1}{5}$th or less of the value of all cars newly registered. (It may be noted

that figures for cars expressed in terms of 1948 prices contain an element, viz. 25 per cent. of the whole, representing purchase tax.)

III(b).—*Plant and Machinery*

For the censal years 1907, 1924, 1930, 1933–1935, 1937 and 1948 data on production of complete machines, other than those specific to other industries (e.g. agriculture), have been taken from the Census of Production for the mechanical engineering industry. After deducting exports and adding imports a series has been obtained which has been used as an indicator to extrapolate back the 1948 figure of gross investment. Interpolation and extrapolation between 1923 and 1938 has been on the basis of employment in the general engineering industry and export and import statistics.

For projecting the 1923 estimate back each year to 1920, estimates of production of machinery (in terms of constant prices) have been based on figures of consumption of iron products and steel (given by C. T. Saunders, *J. R. Statist. Soc.*, 1952, p. 343), with a deduction for consumption in shipyards.

The estimates of value of machinery retained for home use given by Cairncross (*Home and Foreign Investment*, 1870–1913, Table 37) have been used as an indicator to extrapolate my 1907 figure of gross investment over the period 1894–1914. For the years 1915–1919, rough guesses of gross investment have perforce been made.

From the estimates of investment in machinery and vehicles for years up to 1938, the depreciation allowable for the year 1938 computed according to the rules laid down in the Income Tax Acts has been worked out. The result is in good agreement with the allowances actually granted for that year by the Inland Revenue, so providing a general check on the validity of the estimates of investment for pre-war years.

For the years 1939–1947, the estimates of gross investment in machinery and vehicles in the non-Government part of "manufacturing and distribution, etc." have been deduced from a study of the year-to-year changes in the depreciation allowed by the taxation authorities during this period; the estimate of investment in vehicles (see section 13, III (a)) has then been deducted. In this study of the income tax depreciation allowances, account has been taken of war destruction of equipment (which resulted in reductions in the allowances) and of additional wear-and-tear allowances granted for double-shift working, etc. For the years 1944–1947 the estimates of investment have been based partly on the year-to-year changes in the annual depreciation allowances and partly also on the special "initial allowances" granted by the tax authorities.

Additions for Government investment in the years 1939–1947 in plant for Royal Ordnance Factories have been based on the R.O.F. Trading Accounts and Appropriation Accounts; but of the wartime purchases only plant still employed in R.O.F.s after the war (as shown in the first post-war balance sheet for R.O.F.s, for 1946–47) has been included. (Government equipment declared surplus after the war and sold to private firms before the date of the first post-war balance sheet has been treated in this paper solely as private investment occurring at the date of private purchase and at the price paid by the private purchaser.)

III(c).—*Industrial and Commercial Buildings*

The starting point for the estimates of pre-war gross investment has been the Census of Production returns for the building industry for 1935 and, in the case of industrial buildings, for 1930 also. Additions have been made to the census figures for (i) the output of small firms which did not give any return of output, (ii) the output of trades outside the building industry, and (iii) architects' fees; and deductions have been made for electricity stations and gas works (included in the returns with "factories"). The estimates for the censal years 1930 and 1935 have been interpolated and extrapolated to cover each year from 1864 to 1938 by reference to the following series which have been used as "indicators"; the years for which each series has been used is indicated by square brackets :

(i) The value of plans approved in 146 towns in the categories "Factories and workshops" and "Shops, offices, warehouses and other business premises" (published in the *Ministry of Labour Gazette*, e.g. 1939, p. 46). [1924–1938.]

(ii) The value of plans approved in 78 towns in the same two categories. [1912–1921 linked with 1924.]

(iii) The annual value of new buildings assessed to Schedule A income tax for the first time in the categories "Factories, warehouses, mills, offices, etc." and "Shops (residential and lock-up), hotels, inns, restaurants and lodging houses, and places of entertainment" [1922–1928.]

(iv) The net increase in the annual value of buildings not charged to Inhabited House Duty in the category "Premises not used as dwellings." This series, which does not distinguish industrial from commercial buildings, has been adjusted in years in which assessments were revised. [1875–1911 linked with 1912–1913.]

(v) Estimates of gross investment in houses (see section 14, III of this Appendix). [1864–1874 linked with later years.]

The ratio of the gross investment series so derived to the annual value series (iii) above gives the "number of years' purchase" of the buildings in question (if adjustment is made for differences in scope between the two series). This provides a general check on the validity of the estimates.

The estimates of gross investment in industrial and commercial buildings in the years 1939–1947 are of very variable reliability; they are based on (i) data collected by the Ministry of Works, (ii) the "partial" Census of Production of 1946, and (iii) information derived from the Trading Accounts and Appropriation Accounts for Royal Ordnance Factories and Government-owned factories in Development Areas. Government ordnance factories built during the war and subsequently disposed of, either to private firms or to the Board of Trade, have been treated in the same way as surplus plant (see section 13, III (b)); in the case of transfers to the Board of Trade, the valuation at transfer has been taken to be the equivalent of the price paid by a private purchaser.

14. *Houses*

I. This heading covers all dwelling houses whatever their ownership.

II. The length of life of permanent houses has been assumed to be 100 years and of temporary prefabricated houses, built just after the last war, 10 years. The national stock of houses in the year 1951 exceeds the estimated numbers built in the preceding century, thus suggesting a length of life in excess of 100 years.

III. For the years 1922–1923 and 1939–1947, gross investment has been estimated by aggregating the investment of the four "sectors" responsible viz. (i) private owners, (ii) local authorities, (iii) public corporations (which have operated extensively in the housing field only since 1939) and (iv) Government departments. The estimates for local authorities have been derived from their financial returns (see section 15, III, below). The public corporations' gross investment has been extracted from their accounts (a deduction being made for land). Expenditure by the Government on the temporary housing programme after the 1939–1945 war has been derived from Government accounts. Finally, gross investment by private owners, and by Government departments on permanent houses, has been calculated, broadly speaking, by multiplying the numbers of houses built for such owners by an estimate of average cost per house (the latter being extrapolated from data on average costs per house in 1924–1938 and 1948 onwards).

For all other years (i.e. 1839 to 1938 excepting 1922 and 1923) a combined total for all "sectors" has been calculated. For 1924 to 1938, the numbers built have been multiplied by the estimated average cost per house; the latter has been taken from the data on building plans approved in 146 towns (given in the *Ministry of Labour Gazette*). The estimates of gross investment for 1924 onwards have been extrapolated back through each year from 1915 to 1921, using as an indicator the series for value of new housing plans approved in 78 towns.

For 1871 to 1914, the figures of numbers of houses built have been taken from Cairncross (*Home and Foreign Investment*, 1870–1913, Table 35). For the period 1831–1870, average rates of house-building in each decade have been estimated from the statistics of numbers of houses given in the Censuses of Population; 25 per cent. has been added to the figures of the inter-censal increases in the number of houses occupied and unoccupied to allow for houses falling out of use. The average cost per house in 1907 has been taken as £250 (a figure quoted by Cairncross (p. 108)) and this has been extrapolated for each year in the period 1839 to 1914 by reference to the index of prices (see Appendix A) and an "index of size and complexity" of houses; the latter, which is given by Cairncross (Table 35), rises linearly from 80 in 1830 to 100 in 1870 and 120 in 1910.

The ratio of the gross investment estimates for 1922 to 1929 to the corresponding figures for

the annual value of all new houses assessed to Schedule A Income Tax gives the "number of years' purchase" for the houses in question; this provides a general check on the validity of the gross investment estimates.

The estimate of the value of houses destroyed by air raids in the 1939–1945 war has been based on statistics of numbers completely destroyed or damaged beyond repair (given in Cmd. 6707 (1945)).

15. *Public and Social Services*

I. This heading covers the following non-trading services: education (other than privately-owned schools and universities), child care, police and prisons, the fire service, sewerage, arterial drainage and coast protection and other local authority services (items 24, 25, 27–30 and 32 of Table 46 of the *Blue Book*, 1954, except for the private element of item 24). Plant and buildings for the health services and certain other Central Government services are excluded, but vehicles for these services are included.

II. The length of life of all assets (mainly buildings) has been assumed to be 75 years. The remarks in section 5, II, of this Appendix apply here also.

III. The investment included in this heading is almost entirely within the local authority sector. The capital expediture of local authorities, with an analysis by service, is given in the *Local Government Financial Statistics* covering England and Wales and similar publications for Scotland. To arrive at figures of gross investment deductions have been made for (i) purchases of land, (ii) expenditure in connection with small dwellings acquisitions, and (iii) expenditure representing "sums repaid to lenders or transferred to sinking funds out of unexpended balances of loans or other capital receipts". Before 1935, the published figures for England and Wales exclude capital expenditure out of sums transferred from revenue and from special funds; and before 1928 they also exclude capital expenditure out of government grants and other capital receipts (i.e. the published figures before 1928 represent only expenditure out of loans). Approximate additions (on a percentage basis) have been made to the published figures to allow for these omissions. For 1883 and earlier the analysis of loan expenditure by type of service is not, in general, available, and approximate estimates have been made, mainly on the basis of the analysis by type of service of the loan debt outstanding at the end of 1884. Cairncross gives figures of loan expenditure for 1870–1914 in *Home and Foreign Investment*, 1870–1913, pp. 142–145.

16. *Industries and Assets not Covered by the Estimates in Tables 2 to 9*

The industries in question are listed below. References in square brackets are to the items of Table 46 of the *Blue Book*, 1954.

(i) Agricultural buildings [part of 1].
(ii) Forestry and fishing [2, 3].
(iii) Coal industry workings and buildings [part of 4].
(iv) Factories and plant purchased at Government expense during the 1939–1945 war and now *leased* by the Ministry of Supply to private firms [part of 6a].
(v) Ministry of Supply research and development [7].
(vi) Certain assets financed from the revenue account of the British Transport Commission and its predecessors (viz. renewals of buildings and works on the railways) and from the revenue account of the Post Office [parts of 12 and 19].
(vii) The private element of education, i.e. privately-owned schools and universities [part of 24].
(viii) Plant and buildings for the health services [26 except the vehicle component].
(ix) Central Government office buildings, and plant and buildings for certain other Central Government services [31, except the vehicle component].
(x) Legal fees and stamp duties, etc. [34].

In Tables 1 and 10, a rough estimate of depreciation in respect of the assets listed in (i) to (ix) above has been made. In 1948 to 1953 gross investment in these classes of assets averaged 6·7 per cent. of gross investment in all other assets (excluding legal fees, stamp duties, etc.), and this percentage has been assumed to apply also to the depreciation figures for each year.

Appendix C

Sources of the Published Accounts Figures Reproduced in Table 12

Gas: Annual Reports of the Gas Council. In estimating the net value of fixed assets at the end of 1952, a deduction of £13 million has been made from the figure given in the Accounts in respect of intangible assets taken over at vesting date.

Electricity: Annual Reports of the British Electricity Authority and North of Scotland Hydro-Electric Board. The amounts charged by the N.S.H.E.B. to their revenue account in respect of capital redemption have been treated here as the equivalent of depreciation.

Railways: Annual Reports of the British Transport Commission.

Postal and telephone communication: Commercial Accounts of the Post Office.

In the case of the Gas Council, British Electricity Authority and the Post Office, figures for financial years ended March 31st have been interpolated to give calendar year estimates.

Sources used in Compiling the Statistics of Quantity of Capital in Table 13

1. Agricultural machinery: the figures of numbers of machines in use are from the *Annual Abstract of Statistics*, 1954 issue, Table 198; the average 1945 values per machine are derived from *Agricultural Machinery* (P.E.P. Report, 1949), Table 11.
2. Coal mining machinery in deep mines : *Ministry of Fuel and Power Statistical Digest*, 1953 issue, Table 27.
3. Electricity: *Ministry of Fuel and Power Statistical Digest*, e.g. 1953 issue, Tables 96 and 121.
4. Railway rolling stock: *Annual Abstract of Statistics*, e.g. 1954 issue, Table 234; Annual Reports of the British Transport Commission, e.g. 1953 Accounts, Statements VII.2 to VII.6; pre-war *Railway Returns* published by the Ministry of Transport.
5. Road passenger transport vehicles: *Return of Mechanically Propelled Road Vehicles*, e.g. Return No. 164A gives figures for 1953.
6. Road goods vehicles: Same source as for Road passenger transport vehicles.
7. Ships: Ministry of Transport records.
8. Postal and telephone communication: *Annual Abstract of Statistics*, e.g. 1954 issue, Table 253.

Discussion on Paper by Mr. Redfern

Mr. W. A. B. Hopkin (in proposing the vote of thanks); Mr. Redfern has made a most important contribution to our knowledge of a subject which is both very important and very difficult. As far as the United Kingdon is concerned it is pioneering work, and it is remarkable how much he has been able to achieve.

One might comment on the paper from any of three different aspects: first the fundamental objectives and principles of the study, secondly the statistical methods, and thirdly the conclusions. As regards fundamental objectives I think there is an important distinction between the objective of getting a measure of the national income which makes a proper allowance for capital consumption, and the objective of measuring the growth of the stock of capital as a factor in production. The first objective, that of getting a proper measure of the national income, is an important one and I think Mr. Redfern's methods achieve it in a degree which in an imperfect world can be regarded as satisfactory.

The second fundamental objective, that of measuring the growth of real capital, is even more important: and here I think Mr. Redfern's method has inherent limitations—at least if you believe, as I do, that the most important reason for being interested in the stock of capital is that it has a bearing on the level of national production. His "net stock of capital" concept suffers from a characteristic which from the "national income" point of view is a merit, namely its two-dimensional character, to use the phrase taken by Mr. Redfern from Professor Pigou. His "gross stock of capital" concept is only one-dimensional, but will not approximate closely to the quantity of capital in the economy unless the actual lengths of life of capital assets conform closely to the assumptions made in the paper. In short, Mr. Redfern is measuring the stock of capital in a rather special way, and we have to remember this all the time in using his figures. Only with a good deal of experience can we learn fully how they can rightly be used. I am not suggesting that Mr. Redfern himself is not quite aware of all this; indeed he gives a full account of the reasons why the stock of capital, in either of the two senses in which he defines it for measurement, may not correspond in its movements to the quantity of capital in any sense relevant to current production.

I think that there is an example of the importance of referring back to fundamental objectives in the treatment of obsolescence. I do not feel entirely happy about Mr. Redfern's treatment on this point, in particular about his insistence on depreciating every kind of capital asset, however durable. At least I think it needs rather more discussion. It is arguable that, at least from the "income measurement" angle, obsolescence due to technical improvements ought not to be treated as a cost in reckoning the national income. From the point of view of measuring the stock of capital, on the other hand, anything that in fact reduces the quantity of capital assets needs to be allowed for, whatever its character, and so a realistic allowance for wastage due to obsolescence can be justified.

On Mr. Redfern's sources and detailed statistical methods I do not want to make more than one quite general comment. There are, no doubt, many weak spots in the mass of data, some of them stretching far back into the relatively unmeasured past, which he has employed. In order to do the job at all Mr. Redfern has had to use many dubious figures and make many questionable assumptions. If he had waited for accurate data on all the relevant points to present themselves he would never have started. To do the job is the best way of improving the data for the next man. In the meantime let us proceed with caution in the application of Mr. Redfern's results, but with a proper sense of gratitude to the man who got them.

I have no time to comment on those results in detail, but will just mention rapidly one or two of their more striking features. Mr. Redfern's figures bring out strikingly the sharp growth in the net stock of capital of manufacturing industry and distribution, etc., since the end of the war: also that this has occurred principally in plant and machinery. The fuel and power industries also show sharp increases, though we must remember the coal figures are for plant and machinery and vehicles only. The stagnation of capital in the transport industry, except for road vehicles, is also very evident. The net stock of capital of the nation as a whole seems to have grown at about $2\frac{1}{2}$ per cent. per annum on average from the beginning of 1948 to the beginning of 1953. The figures are worthy of study in detail and will, I am sure, receive it. Their implications are many and important. I only plead that if they get used in public discussion—and I think it is inevitable that they should be so used—they will be employed with a proper regard for their true meaning, for their margins of error and for their limitations.

Let me then conclude by saying how grateful I think we should all be to Mr. Redfern for the hard thought and hard work that has gone into this paper. We should also be grateful to Mr. Campion and Mr. Saunders for having encouraged this research. I believe this to be one of the most important pieces of work done in the field of economic statistics in this country since the end of the war. In that belief I am happy to propose the vote of thanks.

Mr. R. GLENDAY (in seconding the vote of thanks): The Society is fortunate in having Mr. Redfern's paper on the Net Investment in Fixed Assets in the United Kingdom at a time when the President's inaugural address on the so-called Macmillan Gap and the Shortage of Risk Capital is still fresh in its mind. Mr. Redfern's paper, as I see it, may be regarded as covering a complementary aspect of the same problem. Lord Piercy, if I understood his purpose aright, was primarily concerned with the availability of funds for certain types of investment. Mr. Redfern's purpose is to show how some of those funds were invested in real resources.

In the background we have the general problem which is comprised in the allegation made by the Chancellor of the Exchequer that the overall investment of industry is insufficient for the needs of a progressive industrial nation operating in a world market of highly competitive manufacture. While that problem is not strictly relevant to the material of Mr. Redfern's paper I do suggest it is vital to the interpretation that is likely to be placed on some of his results.

While industrialists are by no means of one mind as to the justice of this charge, I believe they would all agree that had it not been for certain acts of Government policy in the fields both of taxation and investment since the end of the war there would to-day have been a substantially larger total of private investment in Britain.

On the taxation side, the concession made by the Chancellor of the Exchequer in his last Budget seems a partial admission of the justice of industry's complaint at least so far as depreciation allowance is concerned.

But few seem to be aware of the extent to which post-war Government policy has hampered industry on the material side by preventing it from securing its full share of the real resources which it felt it needed to maintain and improve its efficiency. It is not so long ago that the Government of the day officially approached industry in its corporate capacity asking for its co-operation in putting a brake on investment by private business.

As is well known, the export drive and rearmament also checked the supplies of machinery and plant available for ordinary home investment and there have been restrictions on not only commercial but also on industrial building. It is true that most of these restrictions were subsequently modified, but, unfortunately, planning of investment by the average business man is not

something capable of year to year control by Government fiat—like turning on and off a bath tap—without danger of causing serious interruption in the ordinary long-run evolution of business activity.

In any event the factors that will govern the behaviour of the average business man are by no means always the same as those that will influence Government planning. In fact, they may quite possibly operate in a contrary direction. Besides, the manner in which the average manufacturer behaves will be affected by such things as changes in the world pattern of industry, the business climate and the needs of the market for which he caters. These are matters which do not normally come within the purview of Government.

Lord Piercy in his Presidential address referred to the effect on the conclusions of the Macmillan Committee of the dramatic changes which were taking place in the organization of the capital issues market during the years which came under its review. It is quite possible, I suggest, that Mr. Redfern may also find in the years to come that he, too, was looking back at the middle of a period of transition so that some of the current conclusions derived from his paper may have to be revised later.

This is in no sense a criticism of his analysis as such nor is it intended to imply that his work has not been an extremely worth while effort. It is in any case to be warmly commended for the light which it throws on the growth of Capital formation in the British economy since the war. Besides, anything that can be done to assist economists, statisticians and indeed the general public to pierce the veil that shrouds the figures provided periodically by the Central Statistical Office deserves, I suggest, every encouragement.

Mr. Redfern is, I consider, particularly to be commended for the modesty and caution with which he has presented his results. He admits the limitations of his data and that there "was probably no perfect statistical solution to the problem posed by the economists". He recognizes most of the principal snags: the difficulty of constructing suitable price indices for products whose character is continually changing, the problem of arriving at suitable writing down values of assets, and last, but by no means least, the impossibility of expressing in any accurate way the concept of "maintaining capital intact".

This third snag seems to me to raise an issue of major importance since the period covered by Mr. Redfern's figures was notable for the incorporation over a wide range of industry of new methods and processes resulting from recent discoveries and inventions whose adoption was held over owing to preoccupation with the needs of the war-time effort.

I agree that Mr. Redfern is aware of this difficulty. He writes, "A worn-out machine is rarely replaced by a precisely identical machine; it may be replaced by a more efficient machine, or because some new process has been invented, the worn-out machine may not be replaced at all". But what did worry me in reading his paper was the concluding sentence of the next paragraph, para. 11, in which he explains that "the figures of net investment appearing in this paper tend to omit increases in productive resources arising not from the increase in the number of assets in use but from an increase in their efficiency". If this means what it seems to mean it is surely a startling attitude to take towards investment figures covering a period notorious for major innovations in the field of efficiency and capital-saving inventions over a wide field.

While I fully understand why it was impracticable for Mr. Redfern to take proper account of this factor I do feel that some of the conclusions likely to be drawn from his results, particularly by the incautious reader, may lead to misunderstandings, for it involves ignoring the basic essential features of a period of transition and innovation when capital formation in Britain was higher than ever before.

Incidentally, it must not be forgotten that this was the same period of transition in which the orderly recovery of industry from the war was being interrupted by largely fortuitous and unpredictable alterations in important sections of Government policy made to meet the special needs of the change-over to peace-time conditions.

In view of this, it is not surprising that certain of Mr. Redfern's tables suggest at first sight disconcerting conclusions. Table 5, for example, implies that the aggregate net capital formation in manufacturing and distribution in 1953 was exactly the same as that in 1938. On the other hand, when we turn to Table 9 in which the aggregate figures are subdivided into four categories we find that what actually happened in the period 1948–53 was that the annual amount of net investment in plant and machinery was on the average 60 per cent. greater than in 1938 and net investment in industrial buildings was up on the average by three or four times, while investment in vehicles on the same basis was more than trebled. The feature mainly responsible for the disturbing deduction drawn from Table 5 was, it appears, the heavy disinvestment in commercial building from + 78 in 1938 to − 12 in 1953, a change for which, if my memory serves me aright, Government investment policy was largely directly responsible.

Another feature of interest is that the peaks of investment in the different sectors during the period occurred at different dates. The peak in vehicles was in 1949, in industrial building in 1950,

in plant and machinery in 1951. It would be interesting to see what a still further subdivision of those categories would reveal. It would also be useful to examine to what extent it would be feasible to correlate the course of events in the different sectors in these years with known fluctuations in Government policy in these same years, or with prominent changes in the field of industry itself.

Nothing in the above observations is intended to depreciate the worth of Mr. Redfern's paper. I agree with every word that the proposer of the vote of thanks has had to say about it. Mr. Redfern is to be congratulated on having provided the first statistical measure of Britain's investment performance since the war. It is greatly to be hoped that the reception given to this paper will lead the Central Statistical Office to encourage other members of its staff to present this Society with similar papers on its statistical compilations.

It gives me very great pleasure to second the vote of thanks.

The vote of thanks was put to the meeting and carried unanimously.

Mr. J. STAFFORD: It is a very great pleasure indeed to associate myself with what Mr. Hopkin and Mr. Glenday have said about this paper. It is a most important paper and one that represents a great deal of hard and original work. The information and estimates in the tables will be of very great use and interest to people both inside and outside the Government service.

In the paper Mr. Redfern goes out of his way to indicate some of the conceptual difficulties he has had to face in making these various estimates. I am sure, therefore, he is very aware of these difficulties; but because they are so important I should like to say something about them and perhaps pose them in a rather different fashion.

The first difficulty, I expect, is to be found in answering the major question of whether it is wise to attempt a measurement of net income or of net investment. There is one simple way of measuring net income (and net investment); and there are other, more complicated, ways which involve one in all kinds of problems. The simple way is to regard investment as an immediate cost, like the purchase of other factors of production, and to write it off as it is incurred, so that no part of investment is brought into the concept of net income. Or one can abandon the concept of net investment and rest content with the identification of gross investment and gross income.

Perhaps there is something to be said for that simple alternative when one is concerned with the measurement of national income. There is less to be said for it if one is dealing with the practical affairs of business and the striking of profits.

From the standpoint of a community, the difficulties of determining how to bring depreciation into account can perhaps be illustrated by a very simple kind of example. Suppose that an individual put up a toll-bridge at the cost of £100 and a decision was made that the bridge was likely to last 100 years and should be depreciated at, say, £1 per year. After 50 years the river dries up, the bridge becomes unnecessary and obsolete and no one pays the toll. If the owner of the bridge or the statistician has been depreciating at £1 a year there is still £50 undepreciated. Should this be an obsolescence charge on the community income? Or should the accounting recognize that the community is better and not worse off when the bridge becomes obsolete?

The other difficulty, of course, is the conceptual one to which Mr. Redfern also refers. If we introduce the problem of the price level at the time the bridge becomes obsolete, what amount should be allowed for obsolescence if the cost of the replacement is "different" from the original cost? Is there any real economic reason for posing the question, "What is half the present cost of building the bridge which is no longer required?" and striking that as an obsolescence charge? Would it not be just as meaningful to say that 50 years ago the next most remunerative project was putting down cucumber frames and the correct thing to do, therefore, at the end of the 50th year, is to measure half the cost of replacing the cucumber frames that were not installed? That would give, I think, conceptually as good an answer.

These are the theoretical niceties and the kind of thing which perhaps should guide the statistician dealing with national aggregates. When you come down to more mundane matters you are faced with more compelling difficulties of making decisions about these matters which will help to clarify the situation of an individual business. The business community does demand some kind of answer to the question "What is the proper depreciation allowance and should it be based upon the cost of replacement?"

Mr. Redfern, I think, says in effect that the depreciation allowance should be based upon replacing the same kind of thing, so that the depreciation allowance for buses should be computed according to the movement in the price of buses, and for a locomotive according to the movement in the price of locomotives. I wonder if that is the right solution for the business community. Necessarily over a period of years the prices of capital equipment will move variously. Some equipment will become comparatively expensive to replace and there seems perhaps no very good

reason why the depreciation allowances on these particular things should be geared to the differentially increasing cost of replacing them. Some wider concept of replacement cost and some more general index of prices are required. But I have no helpful suggestion to put forward on the form which these might take.

Mr. H. C. COTTRELL: The only point of detail which I raise is the problem of fire losses which have been set off in the paper against some of the other imponderables or unassessables. One would have thought that the fire offices could give a little more information on that point. Total fire losses covering both capital equipment and consumption goods are not published, but one would hope that with sufficient pressure the fire offices might be co-operative.

Turning to the implications of the tables, I feel that the comparison of the contribution to gross national product with gross existing capital is less satisfactory than a comparison of net capital with the contribution to the net national product, that is, after deducting depreciation in each case.

Using Mr. Redfern's paper and the *Blue Book* I compared the capital equipment needed in various industrial groups to produce £100 m. of net product a year. In gas, electricity and water £1,100 m. is needed, in transport and communications £430 m., and in manufacturing and distribution only £75 m.

As to labour, to produce the same £100 m. of net national product one needs 207,000 workers in gas, electricity and water, 206,000 workers in the transport and communications industries and only 150,000 workers in manufacturing and distribution.

It seems, therefore, that in order to obtain a given level of net national product it is far better to devote one's resources to the transport and the manufacturing industries rather than to the first group of industries.

One can, therefore, question whether it has been right to devote over £700 m. of new gross capital to the electricity industry since the war, when the return is likely to be so low compared with other industries. It may be, of course, that the pricing of electricity is wrong. It may be that what is really needed is the differential off-peak rate for electricity to encourage industry to have more 24-hour working, so that the electricity industry would not be compelled to install capacity to cope with a peak load twice a day and work at rather a lower level during the night.

To raise the net capital in the transport industry to the level of 1938 would apparently take something like £550 m. of capital, at current prices. To increase the capital in the transport industry by the same proportion as manufacturing industry's capital has increased since 1938 would apparently take about £1,600 m. at current prices. Even this would only be adequate if one accepted that the transport industry had adequate capital in 1938—a proposition which few would accept.

Net fixed capital in railways fell from £1,758 m. to £1,358 m. between 1938 and 1953 despite the fact that freights carried had increased by 30 per cent. Passenger journeys were slightly lower over the same period, there being a little less than a 10 per cent. fall.

It seems quite obvious on these figures that Mr. Redfern has underlined very strongly the hopeless condition of the transport and communications industries at the moment. There is, however, some difficulty in that if we increase the net capital of the transport industry and improve roads there is no obvious income. One reduces the costs of industry, but nowhere is there a figure of which we can say, "This is the national income produced by having a better road".

Looking to the future, I believe that the analysis by types of assets and by broad groups of industries will prove to be inadequate. In order to make policy one will need more detail, which will in turn lead to improved techniques in their interpretation.

The Government in this country must do some planning, and if the purpose of planning is to ensure that such resources as we have are used to the greatest advantage of all, to raise our standard of living, then the people who are taking the planning decisions must have the raw material upon which they can work and a very much more advanced version of Mr. Redfern's approach will be a great help.

Mr. H. G. CLARKE: I have listened to Mr. Redfern this evening with considerable interest because few of us would deny that if reliable estimates of the rate of net capital formation could be made they would provide a most important guide to our national economic progress. The main purpose of our discussion must surely be therefore to examine the author's methods with a view to assessing what degree of reliability can be attached to his results.

In fairness to the author we must admit that he has been at pains to point out the limitations attaching to his methods and thereby the qualifications and deficiencies attaching to his results. In one important aspect however he imputes a deficiency to his figures which in my view does not apply, at least to anything like the extent which he appears to believe. I refer to his statement that the figures of net investment appearing in his paper tend to omit increases in productive capacity arising from improvements in efficiency and design, and the main purpose of my remarks is to endeavour to reassure him somewhat on this point.

It is generally accepted that the value of an investment at any point of time is based on the present value of the future income expected to be derived from that investment. In the same way the value of a fixed capital asset must be based on the present value of the output expected to be derived from that asset. Thus in building up a figure of capital formation, the values of the assets included in that figure should be such values as reflect the output expected to be derived from them in the future. In other words, and citing the author's own example, if a new machine is designed and produced which gives an output 50 per cent. greater than an old machine, then (*a*) provided the expected lives of the two machines are equal and (*b*) provided the other costs of operation are the same, the value of the new type machines incorporated in a capital formation figure should, in my opinion, be 1·5 times the value of the old.

Mr. Redfern takes the view that the price indices he has employed reflect changes in the quantity of factors of production employed rather than changes in productive capacity. I do not agree with this view, in fact I cannot conceive of a unit of factors of production other than in the form of such unit having a given productive capacity. The factors of production required to make one new machine may appear to be the same quantitatively as those required to make one old machine, but qualitatively they must be different, the former displaying greater efficiency and technical ability. They do not therefore represent identical units of factors of production and can only be related through their productive capacities, which indeed will, in the long run, determine their relative ultimate rewards.

If the price at which the new and more efficient machine is sold is one and a half times the selling price of the old machine, then it will have been incorporated in the capital formation figure at its correct value. Furthermore, if the new machine is sold at this price then, on the provisos I have made above, there would in theory be no inducement to manufacturers to scrap existing old machines before the termination of their useful life in order to replace them with new machines. Thus so long as his depreciation allowances are correct the author's figure for net capital formation will be correct.

We must next examine what we believe happens in practice. In the long run the workings of a free economy will, I think, result in the new machine being ultimately priced at one and a half times the old machine, but the firm which has developed the new and more efficient machine will be unlikely at the outset to charge as much as this, as it will have its eye on the possibilities of expanding its sales and output at the expense of other firms still producing the old type of machine. If the new machine is priced at something less than one and a half times the old there will be an inducement to manufacturers at some stage to scrap existing old machines before their normal life has expired and substitute new machines. In this event two things will happen to Mr. Redfern's figures. In the first place the value at which he includes the new machines in his gross capital formation figure will be lower than it should be. On the other hand the depreciation he allows in respect of the old machines will also be lower than it should be. These two discrepancies tend to cancel each other out when one is subtracted from the other to arrive at the figure for net capital formation. I do not suggest that the two discrepancies will exactly compensate, but at least it must be true to say that the resulting figure for net capital formation does reflect in some measure the results of technical improvements and increased efficiency. I believe therefore that Mr. Redfern has done his own figures some injustice when he says that they tend to omit the effects of such developments.

Whilst I hope that what I have said may be reassuring to Mr. Redfern on this particular aspect of his problem, nevertheless I hasten to add that there are other difficulties involved of such magnitude that the figures which he has produced must be treated with great caution. In order to measure the annual rate of net capital formation accurately we require an annual valuation of existing capital assets, such valuations being based on expected future productive capacity. I admit that such valuations will probably never be practical, but to build up the answer from figures of gross annual capital formation and depreciation allowances based on assumed lives could be very wide of the mark. Not only is there some doubt about the values at which capital formation is recorded and considerable doubt about the assumed lives, but this method takes no account of the fact that there will be "good" and "bad" capital investments.

This, however, should not be allowed to detract unduly from the merit of the task which the author has carried out. By doing the best possible with the very inadequate data at his disposal and promoting a discussion of the limitations and deficiencies of the results thereby obtained, the author has surely done something to encourage the recording of statistics in the future which may give a more reliable picture of the country's net capital formation.

Mr. C. T. SAUNDERS: I should like to add my tribute to those that have already been offered for this highly individual piece of work, which I can imagine few other people undertaking or carrying through.

The best way of testing a new set of data is to try to use it, preferably for some illegitimate

purpose. One purpose for which a lot of people are going to try to use the figures is to derive relationships between changes in capital stock and changes in output.

This has been done in the United States and has produced an extremely interesting result. A very similar calculation* to that of Mr. Redfern has been compared with changes in output and has shown a quite remarkable fact—a consistent fall in the net value at constant prices of capital per unit of output in manufacturing industry over the past twenty or thirty years. At first sight it appears that much the same conclusion can be drawn about the United Kingdom.

The first fact to take into account, however, is that the degree of utilization of plant was obviously very much less in 1938 than it is to-day; to get a comparable degree of full employment of plant you must add on a percentage to the output figure of 1938. One then gets somewhere near a constant capital-output ratio.

The next thing one wants to examine is the rise in the capital-output ratio during post-war years, which is rather striking from 1949 onwards. How far is this due to the fact that the capital assets of to-day are on average newer than the capital assets of 1949? As Mr. Redfern points out, it would be wrong to take these changes in assets as representing changes in productive capacity.

One notices, looking at the short-term changes, the comparative steadiness with which the rise in assets goes on. A particularly striking case is 1952, when output fell but the amount of gross investment continued to rise. It is only, presumably, the long-term changes that one can reasonably compare.

Clearly, as other speakers have said, more work needs to be done in the breakdown of these changes in capital assets, but, as I understand it, it would probably need a very different kind of approach from that which Mr. Redfern has adopted—probably on the lines of that indicated by Mr. Hopkin, rather than an approach based on data from the census of production, etc., which can be dealt with only in the broadest groups.

Mr. T. K. GRIBBIN: There is a point which I feel will be of some importance in the discussion which this paper will arouse outside. Mr. Redfern has outlined the limitations of his methods and results so well that, perversely, these limitations will be disregarded in public discussion which involves the use of these figures. It is paragraph 47 which I feel will be most quoted in public discussion, the section which says, "As a result of the reduced rate of investment during the war and of war losses, the net value of fixed assets at the end of 1947 appears to have been over £1,000 million—or 5 per cent.—below the level of 1938 (in terms of constant prices)".

It is well known that one does get different results when one works out indices of quantity and price changes with different weights, and as the change here is so small, 5 per cent. for the 1947–38 comparison, I wonder what kind of result we should have got for this comparison if it had been also calculated in terms of 1938 prices.

The PRESIDENT: I should like to say that to my mind this paper is a most impressive performance. We realize that the results must be handled with caution, but the mere statistical results are very interesting and they are distinctly instructive. The only theoretical challenge which came to-night was that of Mr. Stafford, and if time permitted I should like to have broken a small lance with him. However, we have all enjoyed this paper and the discussion, and I shall now ask Mr. Redfern if he wishes to say anything on any point, though he will have the opportunity to deal at length with the various contributions that have been made, in the *Journal*.

The following contribution was received in writing after the meeting:

Mr. R. E. BEALES: In paragraph 7 of his paper Mr. Redfern refers to the alternative methods—"straight line" and "reducing balance"—of calculating depreciation. I would not disagree with his decision to use the "straight line" method in the case of assets, such as buildings, with a very long life, but I think there are points in favour of the "reducing balance" method for plant and machinery. "Wear and tear" allowances for plant and machinery were first recognized in the income tax legislation in 1878 although for a number of years before some bodies of General Commissioners had conceded claims by individual taxpayers for such allowances. It is difficult to believe that at that stage the use of a "reducing balance" method was anything other than the acceptance of recognized accountancy practice. The second point is referred to briefly in paragraph 9 of Mr. Redfern's paper, namely the test of the second-hand prices obtainable in stable conditions. Unfortunately it is difficult to find any goods at present for which there is a sufficiently large second-hand market unaffected by other factors. In the pre-war period, however, there was such a market for passenger cars, and second-hand prices undoubtedly followed a course which was much closer to a "reducing balance" basis than to "straight-line". If gross investment remained

* *Capital and Output Trends in Manufacturing Industries*, 1880–1948. By David Creamer. National Bureau of Economic Research. Occasional Papers, No. 41, 1954.

unchanged over a sufficiently long period there would, of course, be no difference between the results under the two methods, but with gross investment in plant and machinery for manufacturing industry now at a rate nearly double that of the inter-war years reducing balance allowances would be appreciably higher than the straight-line figures, with net investment correspondingly lower. It would be most interesting if Mr. Redfern could tell us just what the effect of such a change in his assumptions would be—it is not possible to work it out from the figures given in the paper since he has not published his estimates of gross investment for the years 1939–1947.

Two of the speakers in the discussion suggested that a comparison of Mr. Redfern's figures with those on page 88 of the latest National Income *Blue Book* supported the contention that the depreciation allowances given for tax purposes were inadequate. If, however, the two sets of figures are rearranged to cover, as far as possible, the same classes of asset and the initial allowances (now replaced by investment allowances) are taken into account, this is very far from being the case. The figures are as follows:

£ *million*

	1948	*1949*	*1950*	*1951*	*1952*	*1953*
Mr. Redfern's figures:—						
Manufacturing, distribution, etc. (Table 1)	293	318	352	423	495	516
Water (Table 9)	18	19	19	23	25	26
Road passenger transport (Table 9)	16	18	20	25	28	29
Shipping (Table 9)	43	46	51	55	53	70
Totals	370	401	442	526	601	641
Blue Book (Inland Revenue) figures:—						
Professions	6	8	9	9	6	7
Other sole traders and partnerships (except farmers) Initial	12	20	23	28	12	14
Other sole traders and partnerships (except farmers) Annual	28	29	28	26	26	29
Companies Initial	94	182	231	255	132	136
Companies Annual	208	222	242	246	270	350
Totals	348	461	533	564	446	536

Mr. Redfern's figures include, and the Inland Revenue figures exclude, the depreciation of the nationalized portions of the road passenger, road goods, and iron and steel industries and of the transport and water undertakings of local authorities. If allowance is made for this it appears that for 1948 the two figures were approximately equal, for 1949–1951 the Inland Revenue allowances were substantially higher and that only for 1952 and 1953, when initial allowances operated for part of the year only, were Inland Revenue allowances lower. This is in spite of the fact that Mr. Redfern's figures include allowances, ranging from £40 m. to £55 m., in respect of commercial buildings for which no allowances are given for tax purposes. It may well be that the position would be changed appreciably if Mr. Redfern's figures were recalculated on a "reducing balance" basis and this is perhaps a further reason for suggesting that this should be done.

Mr. REDFERN subsequently replied in writing as follows: Mr. Hopkin has emphasized the different objectives one may have in attempting to measure capital consumption: (i) the estimation of national income, and (ii) the measurement of the growth of capital stock. He suggests that there may be a difference in the treatment of obsolescence according to which of the two objectives one chooses, and Mr. Stafford's fascinating example of the toll bridge raises just this problem. From the point of view of measuring the stock of capital, it is necessary to eliminate the half-depreciated toll bridge from the figures of capital stock, so justifying an obsolescence charge of £50 at the end of the 50th year. Mr. Hopkin, I think, agrees with me on this. In practice, because the fact that the toll bridge had fallen into disuse after 50 years' service was unknown to me, I should have continued to depreciate the bridge at £1 per annum for 50 years after the date it fell into disuse.

But both Mr. Hopkin and Mr. Stafford seem to doubt whether one should adopt the same procedure if the problem is considered from the income measurement angle. I would argue that one should adopt the same procedure, at least if one is considering the *aggregate* income arising from the bridge during its whole life. For the total cost of the asset must be charged as an operating expense at some time or other. But if one is considering the income in the year in which the river dries up *in isolation* from the income in other years, then I agree that no allowance for obsolescence seems called for.

This line of argument can, I believe, be sustained irrespective of the reason for the bridge falling into disuse: the river might have dried up, the construction of a tunnel might have reduced the road traffic to nil, or the structure might have worn out prematurely and collapsed. Indeed it

does not seem to me part of the job of the national income statistician to try to distinguish between the factors contributing to the bridge's disuse.

Mr. Glenday and Mr. Clarke have commented on the statement (at the end of paragraph 11) that "the figures of net investment appearing in this paper tend to omit increases in productive resources arising not from the increase in number of assets in use but from an increase in their efficiency." Both these speakers implied that the estimates of stock of capital should ideally give some sort of measure of the productive capacity. It is however arguable that what is more important and interesting is a measure of the quantity of factors of production incorporated in a capital asset (i.e. a measure of the "inputs" into, or cost of production of, a capital asset, rather than its potential output).

I will put forward two reasons for this statement. In the first place not every capital asset can be measured solely in terms of its productive capacity, in any sensible way. How is the productive capacity of a public garden or a sea defence work to be measured? And are we to say that Euston Station minus its Doric Arch would be the equal of the station with its Arch because both could handle x passengers per hour—to take an example from industry?

The second reason is perhaps more important. Suppose first of all that the quantity of capital is measured solely by output capacity; for example the capital embodied in an electricity generating plant would be proportional to the number of units of electricity which it could generate per hour. Then so long as capital equipment was fully employed the index of quantity of capital would move identically with the index of output. The ratio of capital to output would vary only on account of changes in the hours worked per week. This would throw very little new light on the growth of capital and its changing importance as a factor of production. Again, if a new machine were installed in substitution for an old machine scrapped, and the new machine gave the same (gross) output as the old machine but with fewer inputs (e.g. if it required less labour, or consumed less raw materials), the proposed method would show capital as constant. But it would be more realistic to regard the constant gross output as the resultant of less labour being combined with *more* capital. This suggests that another method of measuring the quantity of capital would be in terms, not of its gross output capacity, but of its *net* output capacity. Thus the net output capacity of the electricity generator would be its output capacity (in units of electricity per hour) *less* a deduction for other factors of production contributing to that gross output (i.e. costs in real terms of labour, fuel, management and so on). This solution would seem to have many merits were it not for the fact that it is impossible to disentangle the respective contributions to gross output of (a) the capital asset and (b) management and enterprise. In other words, we can treat either profits or depreciation as the residual in the operating account, but the two of them cannot each be derived by this method.

These considerations suggest therefore that the only method of measuring quantity of capital which is both useful and feasible is in terms of its cost of production; this is, broadly, the method followed in my paper. When this method is followed, a new machine of improved design installed in place of an old machine is regarded as embodying more capital only if it costs more (in real terms) than the old machine—which is not always the case. I should add that the arguments set out in the preceding paragraph have been developed at length by E. F. Denison in a paper "Quality Change, Capital Consumption, and Net Capital Formation".*

Mr. Cottrell suggested that statistics of actual fire losses should be taken into account in the calculation of depreciation. I doubt however whether the additional complication involved in this refinement would be worth while, since annual destruction by fire is equivalent to only about 2 per cent. of annual depreciation.

Mr. Cottrell also suggested that a comparison of the *net* capital employed in an industry with its contribution to *net* national product was preferable to the comparison (given in Table 11) of gross capital with contribution to gross national product. I chose to make my comparisons in terms of the gross capital employed in each industry, because this concept is (in theory) not a function of the age composition of assets and is therefore probably more closely related to output than is net capital. (Though I have to admit that the estimates of gross capital in this paper are particularly liable to error.) Whilst the contribution of an industry to gross national product is "inflated" by the depreciation element, yet contribution to net national product can also be misleading in some cases. In fact in a world of imperfect competition, the social "return" of an industry, or of a piece of capital, cannot be measured simply by its contribution to either net or gross national product.

Mr. Cottrell commented on the decrease in the net capital of railways between 1938 and 1953. It is especially important in a case like this to remember that the concept of net capital takes into account the age of assets as well as the quantity of assets, and that a reduction in net capital does not, of itself, imply a reduction in the quantity of assets or in the railways' passenger and freight-

* Paper read at the American Conference on Research in Income and Wealth, October 9–11, 1953.

carrying capacities. Nor in this case do the figures of gross capital throw much light on the quantity of assets in use, because of errors introduced by the assumptions on lengths of life. (A life of 100 years has been assumed for railway works and buildings, but this is obviously too short a life for many of these assets.) Incidentally the number of passenger-miles on British Railways, which shows an *increase* of about 10 per cent. between 1938 and 1953, is perhaps a better indicator of the volume of passenger traffic than the number of passenger journeys quoted by Mr. Cottrell.

Mr. Saunders mentioned the subject of changes in capital to output ratios, on which interesting conclusions have been reached in the United States. I agree that no firm conclusions for the United Kingdom can be drawn from the results contained in the present paper—partly, no doubt, because of the relatively short period of years covered by the data in this paper, and partly because it is difficult to assess how much of the change in net value of assets between (say) 1938 and 1953 is due to a changed age composition. If satisfactory estimates of the gross value of assets could be derived by the methods set out in this paper, it might be preferable to study changes in the ratio of gross capital to output rather than the ratio of net capital to output.

Mr. Gribbin asked whether the percentage reduction in the net value of assets between 1938 and 1947, in terms of constant prices would have been different if the comparison had been calculated in terms of 1938 prices rather than 1948 prices. Since the meeting Mr. Gribbin has performed this calculation and shown that the reduction works out to almost identically the same percentage whichever set of prices is used.

Mr. Beales has advanced various reasons for using the "reducing balance" formula for writing off assets. It is true that the reducing balance system is used in accountancy, but this of itself does not constitute a good reason for its use in the present context. Moreover the straight line system is also used widely in accountancy, for example by most, if not all, the public corporations. Nor do I think that the evidence of the second-hand market in cars can be regarded as a significant pointer in favour of the reducing balance principle. If the second-hand price of a car falls as much in the first (say) three years of its life as in the whole of the remainder of its life, part of this fall is probably a reflection of changes in fashions, and of the supposed prestige attaching to ownership of a new car. And such considerations do not apply to the majority of capital assets.

A more important reason for adopting the reducing balance principle—and one which Mr. Beales did not mention—is that the cost of maintenance of an asset tends to increase as the asset ages. In other words, its *net* contribution to output tends to fall as its age increases. This can be allowed for by assuming a higher level of depreciation in the early years of an asset's life than in its later years. Without data to show the extent to which maintenance costs do in practice increase with age of asset, it is difficult to judge how far the argument I gave in paragraph 7 for adopting the straight line basis is invalidated: this argument was that "in a great number of cases the productive services rendered by an asset are likely to be more nearly constant over time than to reduce exponentially."

To illustrate how different the results would be if the reducing balance formula had been used, I have computed the estimates shown below.*

Depreciation of Plant and Machinery in Manufacturing and Distribution, etc.

	Straight Line Formula	*Reducing Balance Formula*
		£ *million*
At original cost:		
1948	85	112
1949	95	132
1950	108	155
1951	124	185
1952	142	216
1953	161	241
At the replacement cost of each year:		
1948	161	175
1949	176	195
1950	193	221
1951	224	265
1952	265	318
1953	282	338

* For this purpose the "basic" percentage rate of depreciation (on the reducing balance principle) has been chosen for each class of asset in such a way that 90 per cent. of each asset has been written off by the end of its assumed length of life. The allowances computed by application of this "basic" rate have then been increased by 1/9th, in order to write off the whole (and not just 90 per cent.) of the cost of the asset by the end of its assumed life.

Because of the higher level of post-war investment as compared with pre-war (in terms of constant prices), depreciation at the replacement cost of each year for plant in manufacturing and distribution is higher for the years 1948 to 1953 if calculated on the reducing balance formula than if calculated on the straight line formula. The reducing balance formula works out at between 8 and 20 per cent. higher. It will also be noted that the ratio of replacement cost depreciation to original cost depreciation is less on the reducing balance rule (between 1·40 and 1·56) than on the straight line rule (where the ratio is between 1·75 and 1·89). The reason for this is stated in paragraph 68.

Mr. Beales includes in his contribution a table showing depreciation at replacement cost for what are, broadly speaking, fixed assets owned by companies and persons, other than farm assets and houses. Certain adjustments to the figures he gives must be made in order to derive estimates for the companies and persons sectors. He mentions nationalized road transport and iron and steel, but certain other adjustments are required, e.g. the elimination of the local authority component of water and road passenger transport, the elimination of Government-owned manufacturing facilities, and the addition of company-owned gas and electricity undertakings before the date of nationalization.

The following table gives an approximate sector analysis of the total depreciation shown in Table 1. The sectors are defined in the same way as in the National Income Blue Books.

Depreciation by Sector, at the Replacement Cost of each year

£ *million*

	Persons	*Companies*	*Public Corporations*	*Central Government*	*Local Authorities*	*Total*
1938 . .	92	185	5	17	62	361
1948 . .	251	310	136	79	125	901
1949 . .	262	320	173	89	115	959
1950 . .	278	348	189	95	126	1,036
1951 . .	318	389	243	106	146	1,202
1952 . .	338	445	278	123	162	1,346
1953 . .	340	478	287	130	172	1,407

The figures shown for persons include depreciation on houses, agricultural machinery and farm buildings, very rough allowances for private non-profit making institutions such as universities, and allowances for legal fees and stamp duties (assumed to be written off in the year in which the expenditure was incurred). These figures for persons cannot therefore be compared with the Inland Revenue allowances for professional persons and other sole traders and partnerships given by Mr. Beales. But the companies' figures shown above may be compared with the Inland Revenue allowances for companies quoted by Mr. Beales; though, as he mentions, the Inland Revenue figures contain nothing for commercial buildings on which no tax allowance is given.

From the sector analysis of depreciation given above and the sector analysis of gross fixed investment in Table 43 of the National Income Blue Book of 1954, it is possible to derive a sector analysis of net fixed investment. The resultant negative figures of net investment by persons in 1948 to 1952 are the result of the low rate of privately-financed house building in those years.

As a result of the ballot taken during the meeting, the candidates named below were elected Fellows of the Society:

Dev Raj Bhatia.
Richard Ian Cole.
Homi Pestonji Dalal.
Pramatha Chandra Datta.
John Lunn Douglas.
David Evans.
Gordon Forsyth.
Norman Willis Fox.
Sigbert J. Prais.
Maurice Seymour Rothera.
Brian John Stops.
John Raymond Turcan.
Bernard Roy West.