CHAPTER II

Capital Formation in Great Britain[1]

I. *Justification*

> Conjecture: an opinion formed on slight or defective
> evidence or none.

The above definition conveys very well the true character of many of the results which emerge from the exercise which follows: the estimation of capital accumulation over the period 1760–1860. As will soon be abundantly clear, the sources at present available for this period do not provide the evidence which would enable one to construct even moderately respectable estimates for certain key sectors – notably manufacturing – and hence for the whole economy. At crucial points we are able to proceed only by reliance on conjecture and speculation. The results are accordingly of limited pretension and humble status; the most that can be claimed for them is that they may indicate the broad orders of magnitude of the extent of the capital expenditures in each decade on both fixed assets and inventories, at home and abroad, and of the corresponding growth of the stock of capital; the approximate distribution, by sector, of domestic fixed capital; and the broad pattern and rate of change of capital over the hundred-year period in relation to the growth of population and of the national economy.

What justification is there for attempting at this stage to construct new estimates for the economy as a whole, when so much still remains to be done on the individual sectors which can alone provide a proper foundation for aggregate estimates? Partly the answer is to be found in the great historical importance of this period of early industrialization in Britain, the uncertainty surrounding the existing estimates, and the desirability of bringing together the estimates for individual sectors which have resulted from investigations undertaken since the last synthesis was prepared. Partly – and perhaps paradoxically – the justification for a new estimate lies in the view that a more ambitious and more systematic estimate has something special to contribute. By seeking to make continuous and comprehensive estimates at constant prices for both capital formation and the capital stock, we obviously create additional difficulties and impose greater burdens on an already weak foundation; but to offset this there is the benefit we derive from the framework of an interlocking system. For example, evidence about the capital stock can be used to make or corroborate estimates for the capital

flows, and the need both to reconcile the various components of the system and to consider continuous series provides controls and checks not otherwise accessible.

A further justification, and one which is explained more fully below, is that despite all their limitations these series enable us to construct a new basis for the post-1860 estimates of the capital stock which is substantially more reliable than anything hitherto available.

This chapter is thus primarily devoted to an attempt to establish some rough orders of magnitude for capital formation in each decade from 1760 to 1860 and for the capital stock at four dates, 1760, 1800, 1830, and 1860 – the former measured at both current and constant prices, the latter at constant prices. It is a measure of the difficulties facing quantitative research in this area that despite much enterprising work in recent years a comprehensive set of estimates of this nature is still not available.

The existing estimates are reviewed in section II, and this is followed in section III by brief notes on the conceptual basis of the present estimates and on the procedure used to correct for changing prices. The discussion of the methods adopted to obtain the present estimates of reproducible domestic fixed capital (capital formation and capital stock) occupies section IV, and section V is devoted to the remaining components: circulating capital, farm crops and livestock, overseas assets, and land. The overall results are then compared with the existing estimates in section VI. Finally, in section VII we explore briefly some implications of our main findings and of their relationship to the growth of population and real income.

We shall thus be exclusively concerned with the extent and pattern of capital formation as viewed from the side of investment in real assets;[2] no attempt is made to consider the other side of this process, the flow of savings to finance the construction or acquisition of the capital goods.[3]

II. *The Existing Estimates*

CAPITAL FORMATION[4]

Until quite recently, empirical evidence about levels or rates of capital formation during and immediately after the industrial revolution was almost totally lacking. For the economy as a whole, writers either made no attempt at quantitative assessment, or else relied on *a priori* judgements, as in the much-debated propositions of Rostow and W. Arthur Lewis, regarding the proportion of national income devoted to capital accumulation. For individual sectors a few separate indicators could be assembled; and this approach was most fully exploited by Gayer,

Rostow, and Schwartz, using series in various physical units for brick production, fir timber imports, ships built, and railway mileage opened, together with some related financial series such as new home and foreign issues and the amounts authorized in parliamentary bills for canals and turnpikes.[5]

The first real advance on this front was made in the early 1960s by Phyllis Deane.[6] While still not seeking to provide comprehensive measurements for all sectors at a uniform date, she reviewed the existing evidence – including the work of writers and statisticians of the eighteenth and nineteenth centuries – and offered new estimates for capital expenditure on selected items at various dates. These included enclosures, house-building, roads, docks, shipping, cotton textiles, and iron. This covered a sufficiently large part of the aggregate for Miss Deane to feel justified in drawing a number of tentative conclusions, among which were estimates of the rate of capital formation, i.e. of net capital formation including inventories and foreign investment, expressed as a percentage of net national income. We can summarize these as follows:

Starting from a long-term average of not more than 3 per cent in the seventeenth and early eighteenth centuries,[7] the rate of capital formation began to rise in the middle decades of the eighteenth century; by the end of the century it had reached a 'sustained average of more than 5%' and 'may have somewhat exceeded 6% – most of the shift being attributable to the last quarter';[8] both capital and income rose after the end of the French wars, but at roughly the same pace until the beginning of the railway era in the 1830s; from there on the ratio of capital formation to income again began to increase, moving upwards to about 10 per cent by the later 1850s.[9]

The next major contribution was made by Sidney Pollard in a paper presented in 1965.[10] Here, for the first time, an attempt was made to construct estimates – described with due caution as 'possible orders of magnitude' – which aimed at complete coverage of all capital expenditure in Great Britain at four specified dates. These estimates are summarized in Table 1, together with an estimate of the gross national income and of the corresponding rate of gross capital formation.

Though Pollard had estimated the ratio of gross capital formation to gross national income and Miss Deane had worked with the net rate, he concluded that his results showed that the earlier estimates had seriously understated the proportion of income allocated to investment. This seems plausible: in particular, it is likely that the attempt to extrapolate from partial evidence to a national total without making separate estimates for the missing items could lead to an underestimate, especially for investment in industry and trade. However, as Pollard would readily

Table 1. *Gross Capital Formation, Great Britain, 1770–1835:*
Possible Order of Magnitude suggested by Pollard (£m)

	c. 1770	c. 1790–3	c. 1815	c. 1830–5
1. Gross domestic fixed capital formation	7·2	13·3	21·9	31·0
2. Stockbuilding	1·5	2·0	2·5	2·5
3. Foreign investment and bullion	0·7	0·7	0·7	6·5
Total	9·4	16·0	25·1	40·0
4. Gross national income	140	175	310	360
5. Total as % of 4	6½	9	8	11

SOURCE. Pollard, 'Growth and Distribution of Capital', I, p. 362.

acknowledge, his own estimates were very uncertain, and the issue cannot be settled without further evidence.

Since our main concern in this section is with gross domestic fixed capital formation (line 1 of Table 1), we may look more closely at the components of Pollard's estimates for this item. These are set out in Table 2. Subsequent work on the period covered by Table 2 has been

Table 2. *Gross Domestic Fixed Capital Formation, Great Britain,*
1770–1835: Possible Order of Magnitude suggested by Pollard (£m)

	c. 1770	c. 1790–3	c. 1815	c. 1830–5
1. Agriculture	2·7	3·6	5·3	4·6
2. Transport (incl. ships)	1·3	2·4	3·9	6·7
3. Building	2·3	5·1	8·5	11·5
4. Manufacture, trade, etc.	0·9	2·2	4·2	8·2
Total	7·2	13·3	21·9	31·0
5. Total as % of gross national income	5	7½	7	8½

SOURCE. As for Table 1.

devoted to some of the much-needed investigation in detail of capital formation in particular sectors, including inland transport, agriculture, and textiles; we may defer further reference to these studies until we come (below) to our attempt to make new estimates.

From 1830 onwards, however, we now have a further pioneering study by Miss Deane giving annual estimates of gross domestic fixed capital formation in the United Kingdom at both current and 1900 prices.[11] We may compare the opening years of this new series with Pollard's estimates for Great Britain (i.e. excluding Ireland) for the early 1830s (Table 3).

It is disconcerting to find that Miss Deane's new estimate is only half as large as Pollard's old one. In making the comparison we must allow for the possibility of differences in the scope of the individual sectors, but both estimates relate to substantially the same concept of capital formation. It is unhappily clear from Table 3 that the two leading

Table 3. *Gross Domestic Fixed Capital Formation, 1830–5: Comparison of Estimates by Deane and Pollard (£m p.a.)*

	Deane (UK)	Pollard (GB)
1. Transport		
Water (incl. ships)	2·2	2·5
Road[a]	2·0	2·2
Rail	0·6	2·0
Total (transport)	4·8	6·7
2. Residential building	6·0	10·0
3. Agriculture[b]	—	4·6
4. Industry, trade, etc.	2·9	8·2
5. Public buildings, etc.	2·0	1·5
Total	15·7	31·0

[a] Pollard omits expenditure on horses and carriages.
[b] Deane omits expenditure on land-clearing, drainage, etc.

SOURCES. Deane, 'New Estimates', 111; Pollard, 'Growth and Distribution of Capital', I, p. 362.

authorities are in serious disagreement over the level of gross domestic fixed capital expenditure in the early 1830s, and until this can be resolved similar doubt must attach to their respective estimates for earlier and later years. Equally, comment on, and analysis of, the course and consequences of capital formation must prove unrewarding as long as discrepancies of this magnitude exist.

The differences are largest in agriculture and in industry, trade, etc. In the case of the former, Miss Deane specifically omitted expenditure on land-clearing and drainage and appears also to have omitted farm buildings other than dwellings,[12] whereas Pollard made generous allowance for these assets. For industry, trade, etc. both estimates are exceptionally vulnerable and lack any real foundation. It is in this context that Crouzet has criticized Pollard: 'even a cursory glance at his sectoral estimates seems to reveal some bias towards selecting the highest figures wherever an alternative is available, and pushing upwards many estimates'.[13] Against this we might note that my comparison of Miss Deane's estimates with those which I prepared for the period from 1856

to 1914 led me to conclude that her capital-formation series for the second half of the nineteenth century was in general substantially too low from 1870 onwards, and that the shortfall applied particularly to her allowance for investment in industry, trade, etc.[14]

CAPITAL STOCK

When we turn to the pre-1860 estimates of the stock of fixed capital there is much less to report: quantitative research has not been appreciably advanced since 1889, when Sir Robert Giffen published his study *The Growth of Capital*.[15] In this the first of his own estimates relates to 1863 (though described as 1865), but Giffen also included an historical retrospect, calling attention to estimates of capital and national wealth put forward by earlier writers at various dates from 1679 to 1833. The most important of these contemporary estimates are summarized in Table 4, together with Giffen's own calculation for 1863.

Table 4. *Contemporary Estimates of the National Wealth, 1688–1863 (£m)*

Date	Author	Area	Reproducible capital[a]	Land	Furniture, 'plate', specie, etc.	Total
1688	King–Davenant	England	112	180	28	320
1800	Beeke	GB	665	825	250	1,740
1812	Colquhoun	GB	837	1,079	211	2,127
1832	de Pebrer[b]	GB	1,112	1,438	293	2,843
1863	Giffen	UK	3,749	1,864	500	6,113

[a] Including buildings and equipment, inventories, farm capital, and overseas assets.
[b] Obtained by adding one-third to Colquhoun's estimates; thus, not an independent assessment.

SOURCE. Giffen, *The Growth of Capital* (1889), 43 and 72–108.

These estimates have been frequently discussed and used, most recently by Deane and Cole and by Pollard,[16] but no new estimates of the stock of capital have appeared, apart from the series published in 1972,[17] which begins only in 1855 (considered below, p. 78). Although all the contemporary estimates have something of value to tell us, they are gravely deficient as a basis for long-run measurements of the capital stock designed for use in analysing the contribution of capital to the growth of the national income. Quite apart from the uncertainty of the data underlying the estimates, there are four critical comments which must be made.

First, all are wholly or largely derived by capitalizing estimates of income (profits and rents), and the conceptual basis of a capital series

derived in this way is quite different from that underlying the con-
ventional (perpetual inventory) national accounting estimates of capital.
The essence of the conventional method is an objective cumulation of
actual past capital outlays, revalued at the replacement cost of a given
year.[18] By contrast, the essence of the 'Giffen method' is a subjective
valuation of *expected future incomes*,[19] and the result will be strongly in-
fluenced by the profitability of the given year and by the view taken
with regard to future prospects. There is, moreover, an inherent
ambiguity in this method, and it is not clear to what extent the pro-
cedure allows for the depreciation of the capital assets.[20] Second, the
overall capital–output ratios which can be calculated from such esti-
mates simply reflect the capitalization rates (number of years' purchase)
applied by Giffen and his predecessors in making the original estimates
for each of the components of the capital stock, and thus provide no
additional information.

The third point is that, for various reasons, the weakest item in the
total is the estimate for capital in industry and trade. In the earlier esti-
mates – for example, those of Beeke and Colquhoun – the main prob-
lem is simply the lack of data on trading profits; in later estimates,
including Giffen's, the problem is to know what proportion of the
profit of unincorporated enterprises represents a return on capital as
opposed to the reward for the labour services of the owners. Giffen,
following a suggestion by R. Dudley Baxter, capitalized one-fifth of the
profits of 'trades and professions', but there is very little warrant for
this.[21] Given the interest and importance of this sector, this weakness is
particularly unfortunate. Finally, the method does not enable us to dis-
tinguish between fixed capital and inventories or – in the earlier esti-
mates, including Giffen's for 1863 – between domestic and overseas
assets.

For the capital stock, as for the capital-formation series, our review of
the current situation thus points to the urgent need for further research.
For the former, we have no modern investigation, and the contem-
porary estimates are of limited value. For the latter, we find some
notable advances in recent years, but the position is still very unsatis-
factory. We have Pollard's four benchmark estimates for the period
before 1830 (Tables 1 and 2), but these suggest an appreciably higher
rate of investment than that given by Phyllis Deane (Table 3). From
1830 onwards we have Miss Deane's annual series, but it is only half of
the level of Pollard's at its starting point and is also well below my
estimates for the latter part of the century.

III. *Concepts and Prices*

We begin the presentation of our new estimates with a brief discussion of the relevant concepts, and we then describe the indices which we use to correct for changes in price.

CONCEPTS AND DEFINITIONS

When dealing with reproducible fixed assets we shall be concerned with two basic series. The annual flow of *investment*, I_t, represents capital expenditure on domestic reproducible fixed assets (gross domestic fixed capital formation) and covers both new investment and replacement. It is measured either in current prices, i.e. the prices prevailing in the year in which the expenditure was incurred, or at constant prices, i.e. with all expenditure revalued at the prices of a given year. The corresponding stock estimate is G_t, the end-year gross stock of reproducible fixed assets. For this the actual outlays on the acquisition or construction of all reproducible fixed assets are revalued at the prices of a given year, and all assets remain in the stock at this valuation, regardless of their age or condition, until they are retired (scrapped or sold).

When both the flow, I_t, and the stock, G_t, are valued in the prices of the same year, i.e. at constant prices, they may be related by inclusion of a third series, R_t, the flow of assets *retired* at the end of their working lives as determined by depreciation and obsolescence. For this purpose the assets retired (scrapped or sold) would be taken at their original cost, revalued at the prices of the given year. We thus have the basic identity:

$$G_n = \sum_{t=o}^{n} (I_t - R_t)$$

and if we assume that all assets are automatically retired at the end of their working life of L years,[22] we have:

$$G_n = \sum_{t=o}^{n} (I_t - I_{t-L}) = \sum_{t=n-L}^{n} (I_t)$$

To measure the gross stock at any date, we thus need to estimate the flow of investment expenditure for L years preceding that date for each type of asset included in the stock – i.e. for as many years back as are required to cover the working life of each type of asset. Once we know the stock at any one date we can also cumulate by means of the basic relationship:

$$G_n = G_{n-1} + I_n - R_n$$

It would be possible to extend this set of *gross* estimates by a corresponding set of *net* flows and stocks in which provision would be made for depreciation of the fixed assets, but it did not seem desirable to add a further and even more arbitrary set of estimates at this stage.

For further discussion of the conceptual basis of the estimates the reader is referred to official studies such as *Sources and Methods*,[23] in which the current estimates for the United Kingdom are discussed, and to *National Income, Expenditure and Output*[24] for notes on the broadly comparable estimates for the years 1856–1948, preceding the official estimates. Within the very severe constraints imposed by the extent and quality of the data available, we have attempted to make the present estimates consistent in concept and definition with those for later years.

Two aspects warrant special mention. Firstly, the correction for movements in price. Reference has been made, in the above discussion of the basic concepts, to the need for evaluation of the capital outlays at the prices of a given year. Prices may change because the cost of construction of an asset of given type and quality changes owing to movements in the price of the inputs or in the productivity of the capital-goods sector; or they may change because the quality of the asset has changed as a result of technical progress embodied in new vintages of the asset. In general the price data we have can measure only the first of these causes of change, and even that with only minimal accuracy. We therefore implicitly treat any improvement in the efficiency and productivity of an asset, in excess of the corresponding increase in its cost of construction, as an increase in its quality; we do not treat it as a fall in the price – and thus a rise in the quantity – of a unit of capital of given quality. This procedure is imposed on us by the data but fortunately is also justifiable on theoretical grounds.[25] It has important implications for the measurement of the contribution of capital to the growth of output: the increase in efficiency of the capital goods is reflected as a rise in the measure of output per unit of capital, not in the measure of the capital stock.

Secondly, our measure of gross capital formation is a fairly narrow one, and as far as possible we exclude expenditure on maintenance and repairs. We shall, however, have to reckon with the fact that in some sectors it is extremely difficult to distinguish between outlays which represent new capital formation (i.e. those which will yield benefits in future accounting periods) and outlays which represent maintenance (i.e. those which do not add to the original life of the asset or improve the service which it yields), and this necessarily imparts a further element of approximation to our estimates.[26] This applies particularly in sectors such as agriculture, roads, and canals, where we rely in part on accounting records which made no distinction between new work

and repairs. However, we have preferred to make a rough separation rather than accepting a very gross estimate including repairs. We do so partly because the very gross concept is less relevant and interesting for most purposes, and partly because its use would destroy comparability with estimates for other sectors and with estimates of total capital formation in later periods.

ADJUSTMENT FOR CHANGING PRICES

For some analytical purposes we require series for capital outlays at current prices; for other purposes, series at constant prices are needed. This case for two series is reinforced by the practical consideration that in some sectors of the economy the best starting point is an estimate in current prices, while in others we can make most progress by working first in the prices of a given year.

These arguments for constructing two sets of estimates have immediately to be weighed against the formidable problems created by the lack of suitable data on price changes. It is not only that we are rarely able to find actual price quotations for capital goods, but also that for much of the period we have great difficulty in getting even the data on movements in the costs of labour and materials used by the capital-goods industries, which in later periods provide a broadly acceptable substitute for asset prices.[27] Nevertheless the variations in prices within the period we cover are so great, especially during and immediately after the Napoleonic Wars, that it seems essential to make some correction; however uncertain the extent, we can at least be confident of the direction. It also seems preferable to use the most relevant of the specific price and wage series available, rather than relying on the much broader existing wholesale price indices, all of which are dominated by the movements in the prices of agricultural products.

We have accordingly compiled three main indices, each combining series for labour[28] and materials[29] used in the production of capital goods:[30]

(i) For houses and other buildings, an unweighted average of building wages and of the price of materials. The materials index is itself an unweighted average of the prices of imported fir timber and of bricks from 1760 to 1820 and of timber, bricks, and iron from 1810 to 1860, with the two indices spliced at 1810–20.

(ii) For agricultural works and buildings, a weighted average of agricultural wages (weight 4), timber (1), and bricks (1).

(iii) For plant and machinery, an index of engineering wages (weight 2) combined with indices for iron (1), and timber (1) for 1780–1820 and with iron only (weight 2) for 1810–60.

The three indices are set out in Table 5 as decade averages with 1851–60 = 100. It will be seen that they measure only the changes in the prices of some of the main inputs, and no allowance is made for changes in productivity in the building and engineering industries, even as measures of the cost of labour and materials, the series are thus very

Table 5. *Price Indices, 1760–1860 (average 1851–60 = 100)*

	(1) Houses and other buildings	(2) Agricultural works and buildings	(3) Plant and machinery	(4) General index of wholesale prices
1761–70	53	55	—	88
1771–80	56	56	—	95
1781–90	59	58	81	102
1791–1800	76	80	109	121
1801–10	121	126	150	152
1811–20	130	129	138	154
1821–30	114	98	117	109
1831–40	106	98	111	104
1841–50	100	97	102	93
1851–60	100	100	100	100

SOURCES

(1)–(3) See text, pp. 37–8 and notes 28–30.
(4) Based on the following indices of domestic and imported commodity prices – mainly wholesale prices and import unit values – spliced at the overlapping decades: for 1761–70 to 1791–1800, average of Schumpeter–Gilboy indices for consumer goods and producer goods; for 1791–1800 to 1841–50, Gayer–Rostow–Schwartz index for domestic and imported commodities; and for 1841–50 to 1851–60, Rousseaux's overall index. For all three indices see B. R. Mitchell, *Abstract of British Historical Statistics* (1962), 468–73.

imperfect. To the extent that productivity change in the construction of machinery is neglected, the index will overstate the rise in prices over the century; as a result the level of capital expenditure at current prices will be understated in years before 1851–60. Note, however, that the estimates at constant prices and the capital stock are not affected since the price index is not used in making these estimates (see below, p. 56).

The index for buildings rises by roughly 150 per cent between 1761–70 and 1811–20 and then drops by almost 25 per cent by the 1840s. In the first phase, building wages double while the index of materials rises threefold; in the second, wages show a slight setback in the 1820s and 1830s and then a small increase, and material prices fall sharply in each of these decades. The index for agricultural buildings and works follows broadly the same course but declines more sharply in the 1820s, when there is a swift fall in agricultural wages. The 'plant and machinery'

index shows a steep fall between the peak of 1801–10 and the end of the period, essentially because of the greater influence of the large reduction in prices of iron and timber.

In the last column of Table 5 a general index of wholesale commodity prices is shown, both for comparison with the indices for capital goods and because it will be needed in section V. In addition to these major indices we also make use of special indices for individual sectors; these are described separately in section IV below.

IV. *Sources and Methods of Estimation*

We are now ready to embark on the main task – the estimation of gross domestic fixed capital formation and of the gross stock of domestic reproducible fixed assets. For the former we give estimates for each decade from 1761–70 to 1851–60, at constant prices of 1851–60 in Table 6 and at current prices in Table 7. For the stock we give estimates in Table 8 at 1851–60 prices, at four dates – 1760, 1800, 1830, and 1860 – reference in each case being to the end of the year. Of these, the 1860 estimates have been the main focus of our attention, and the earlier estimates are progressively more conjectural; despite this, they are given in order to provide some perspective in which to view the growth of the capital stock. All the estimates relate to Great Britain only.[31]

The detailed estimates are based on a classification which is in part by sector of activity and in part by type of asset, and we have thirteen separate estimates which are grouped in the tables on a sectoral classification under four headings: Residential and Social, Agriculture, Industry and Commerce, and Transport. The estimation procedures are described below in the same sequence in which the series are set out in Tables 6, 7, and 8. The description is designed to provide sufficient information about the major sources and methods and to permit future writers to make appropriate criticisms and revisions, but no attempt is made to specify every detail or to justify all the procedures and assumptions employed.

The logical order, if we could always follow the procedure suggested by the second equation on p. 35 above, would be to begin with the flow series for gross domestic fixed capital formation, and to derive from these the estimates for the gross stock of fixed assets. In practice, however, the limitations of the available data are such that in a number of sectors, including most of those which are of greatest importance for the estimates, we are compelled to reverse the procedure: we begin with an estimate of the stock of capital, obtained by some means other than accumulation of capital formation (e.g. from some count of the

Table 6. *Gross Domestic Fixed Capital Formation, Great Britain, 1761–1860, at Constant Prices*
(*£m p.a., decade averages, at 1851–60 prices*)

	1761–70	1771–80	1781–90	1791–1800	1801–10	1811–20	1821–30	1831–40	1841–50	1851–60
Residential and Social										
1. Dwellings	1·49	1·38	2·17	3·35	4·58	5·82	8·91	10·28	7·60	10·25
2. Public buildings and works	0·15	0·14	0·22	0·33	0·46	0·58	1·07	1·54	1·52	2·05
Agriculture										
3. Farm buildings, improvements, and equipment	2·18	2·62	3·31	4·26	4·06	4·45	4·08	4·71	6·16	6·90
Industry and commerce										
4. Industrial and commercial buildings	0·97	0·73	2·13	2·20	3·04	4·16	6·81	8·52	8·15	10·99
5. Industrial machinery and equipment	0·27	0·11	1·10	0·88	0·84	1·28	2·65	3·51	4·18	5·65
6. Mining and quarrying	0·08	0·04	0·08	0·16	0·12	0·25	0·28	0·63	0·88	1·71
7. Gas and water	—	—	—	—	—	0·19	0·23	0·45	1·05	2·32
Total (industry and commerce)	1·32	0·88	3·31	3·24	4·00	5·88	9·97	13·11	14·26	20·67
Transport										
8. Railways	—	—	—	—	—	0·10	0·10	3·67	14·11	8·78
9. Roads and bridges	0·53	0·52	0·53	0·49	0·47	0·78	1·15	1·19	1·02	1·01
10. Carriages and coaches	0·20	0·20	0·30	0·40	0·50	0·60	0·80	1·00	1·30	1·70
11. Canals and waterways	0·22	0·50	0·25	1·04	0·70	0·57	0·52	0·47	0·19	0·17
12. Docks and harbours	0·02	0·04	0·05	0·07	0·68	0·42	0·30	0·45	0·85	1·46
13. Ships	0·53	0·77	0·98	1·13	1·12	1·31	1·39	2·17	2·42	5·00
Total (transport)	1·50	2·03	2·11	3·13	3·47	3·78	4·26	8·95	19·89	18·12
Total	6·64	7·05	11·12	14·31	16·57	20·51	28·29	38·59	49·43	57·99

Table 7. *Gross Domestic Fixed Capital Formation, Great Britain, 1761–1860, at Current Prices (£m p.a., decade averages)*

	1761–70	1771–80	1781–90	1791–1800	1801–10	1811–20	1821–30	1831–40	1841–50	1851–60
Residential and social										
1. Dwellings	0·79	0·77	1·28	2·55	5·54	7·57	10·16	10·90	7·60	10·25
2. Public building and works	0·08	0·08	0·13	0·25	0·55	0·76	1·22	1·64	1·52	2·05
Agriculture										
3. Farm buildings, improvements and equipment	1·20	1·47	1·92	3·41	5·12	5·74	4·00	4·62	5·98	6·90
Industry and commerce										
4. Industrial and commercial buildings	0·51	0·41	1·26	1·67	3·68	5·41	7·76	9·03	8·15	10·99
5. Industrial machinery and equipment	0·22	0·09	0·89	0·96	1·26	1·77	3·10	3·90	4·26	5·65
6. Mining and quarrying	0·04	0·02	0·05	0·12	0·15	0·32	0·32	0·67	0·88	1·71
7. Gas and water	—	—	—	—	—	0·27	0·32	0·52	1·01	2·32
Total (industry and commerce)	0·77	0·52	2·20	2·75	5·09	7·77	11·50	14·12	14·30	20·67
Transport										
8. Railways	—	—	—	—	—	0·10	0·10	3·85	15·25	8·78
9. Roads and bridges	0·33	0·33	0·39	0·49	0·63	1·03	1·19	1·15	0·99	1·01
10. Carriages and coaches	0·10	0·10	0·18	0·30	0·60	0·78	0·92	1·05	1·30	1·70
11. Canals and waterways	0·13	0·29	0·16	0·74	0·71	0·54	0·55	0·48	0·19	0·17
12. Docks and harbours	0·01	0·02	0·03	0·05	0·62	0·44	0·30	0·43	0·83	1·46
13. Ships	0·27	0·41	0·51	0·87	1·52	1·81	1·39	2·24	2·51	5·00
Total (transport)	0·84	1·15	1·27	2·45	4·08	4·70	4·45	9·20	21·07	18·12
Total	3·68	3·99	6·80	11·41	20·38	26·54	31·33	40·48	50·47	57·99

Table 8. *Gross Stock of Domestic Reproducible Fixed Capital, Great Britain, 1760–1860 (£m at 1851–60 replacement cost)*

	1760	1800	1830	1860
Residential and social				
1. Dwellings	191	248	390	599
2. Public works and buildings	19	25	37	80
Agriculture				
3. Farm buildings, improvements, and equipment	210	270	340	430
Industry and commerce				
4. Industrial and commercial buildings	25	75	204	460
5. Industrial machinery and equipment	9	26	61	160
6. Mining and quarrying	2	4	8	35
7. Gas and water	—	—	4	42
Total (industry and commerce)	36	105	277	697
Transport				
8. Railways	—	—	2	268
9. Roads and bridges	15	28	47	66
10. Carriages and coaches	2	5	9	23
11. Canals and waterways	8	23	35	37
12. Docks and harbours	1	3	15	42
13. Ships	12	22	31	68
Total (transport)	38	81	139	504
Total[a]	490	730	1,180	2,310

[a] Rounded to nearest £10m.

stock of assets), and then derive the corresponding capital flow from this. Accordingly, we begin with the stock estimates in some cases, with the flow in others.

I. RESIDENTIAL DWELLINGS

This item covers all dwellings: houses, farmhouses, lodging-houses, and the dwellings component of residential shops and pubs.[32] The number of inhabited houses in England and Wales at the end of each decade from 1800 onwards is given in the decennial Reports on the Census of Population.[33] We have extrapolated this series back to 1761 by reference to the movement of population[34] and on the assumption that the number of persons per dwelling increased slightly during the population upsurge of the late eighteenth century, rising from 5·5 in 1761 to the census-based figure of 5·8 in 1801.[35] In considering the evidence on this point it is necessary to distinguish between persons per home and

persons per family, a distinction not always made, or easy to make, in contemporary enumerations. The assumption that the mean *houseful* size rose over the period – though with little change in mean *household* size – is based primarily on the conclusions drawn by Richard Wall after a systematic survey of all the available material.[36]

For Scotland the Census figures are not usable before 1881 because of confusion in the treatment of the many tenements containing two or more separate dwellings, and a rough estimate was made by assuming that the number of persons per dwelling changed in the same way as in England and Wales between 1761 and 1881. Combining these two series gives the number of dwellings in Great Britain at the end of each decade from 1760 to 1860. For our four benchmark years the figures (in millions) are 1·45, 1·87, 2·93, and 4·35.

The increase in the number of houses between each decennial figure represents effectively the number of new houses built in each decade less the number demolished. Lacking any direct information on demolition, we have attempted to construct a series which seems plausible in relation to (a) the size and age composition of the stock of houses at the beginning of each period, which broadly governs the number of houses likely to be ready for demolition; (b) the number of new houses built during each decade, which might broadly determine the rate at which demolition was undertaken; and (c) an assumed average life of just over 100 years. These assumptions lead to a very approximate series for houses demolished, taken as 40 per cent of the inter-censal increase for the decades 1761–70 to 1841–50, 35 per cent for 1851–60 to 1861–70, and 30 per cent for the remaining decades down to 1901–10.[37]

If dwellings were always built, on average, to a uniform standard of size and quality, we could treat these estimates of the decennial building and of the stock of dwellings as being measured in comparable units, which we could then proceed to value. In fact, of course, this is not the case, and we must first make some correction for the overall effect on dwellings of the extension of building regulations, the general rise in the standard of living, improvements in the standards of public health and sanitation affecting housing, and changes in the type of materials used. We have very little direct evidence on the effect of these factors, but have assumed that there was on average no appreciable change until 1810, and that thereafter housing standards began to rise – at first rather slowly, at an assumed annual rate of 0·1 per cent from 1811 to 1820 and 0·2 per cent from 1821 to 1840; and then a little more rapidly, by 0·5 per cent, from 1841 to 1860, as the building improvement laws began to take effect in a succession of major urban areas, and living standards began to rise, not for all but certainly for many groups within the

population. These assumptions would mean, for example, that the average new house built in 1860 would be roughly 15 per cent bigger and better than the corresponding dwelling of 1810 or earlier.[38]

Our estimates of the dwellings built in each decade and of the stock of dwellings at the four benchmark dates can then be adjusted to comparable units of 1851–60 standard. For the stock, the standardized figures (in millions) become 1·28, 1·65, 2·60, and 4·00.

At this stage we attempted a partial check on our estimates of the number of (standardized) houses built in each decade by relating them to the widely used series for the output of bricks from 1791 to 1849.[39] It appeared from this that the present estimates understated the level of house-building in 1791–1800 and 1821–30 and overstated it in the two intervening decades. Close correspondence with the brick series is, of course, not to be expected: a changing proportion of houses was made with stone and timber, and bricks were used in fluctuating and unknown quantities for other purposes including canals, farm buildings, mills, factories, and warehouses; also, no allowance is made for changes in stocks of bricks. However, the discrepancy seemed too large to be

Table 9. *Relationship of House-Building to Brick Output, 1791–1850*

	Output of bricks (millions)	House-building (standardized houses, thousands)	Implied bricks per house
1791–1800	6,410	223	28,700
1801–10	8,250	305	27,100
1811–20	8,630	388	22,200
1821–30	12,310	594	20,700
1831–40	13,370	685	19,500
1841–50	10,560	507	20,800

SOURCE. See text.

explained by these factors, and a rough adjustment was made to the initial estimates, adding some 30,000 houses to the previous estimate for the number built in 1791–1800, subtracting 20,000 in 1801–10 and 30,000 in 1811–20, and adding 20,000 in 1821–30. These adjustments thus cancel out and so involve no change in the initial estimates of the total number of dwellings in 1830 and subsequent years or in those for 1790 and earlier. They represent adjustments of moderate proportions (the largest is 17 per cent in 1791–1800, the smallest 3 per cent in 1821–30) in the estimates of houses built, but of very small proportion (2 per cent or less) in the estimates of the total stock of dwellings in 1800, 1810, and 1820, from which the series for the numbers built was derived by difference, and can thus readily be accepted as plausible.

After these adjustments the relationship to the brick series is as shown in Table 9. The sharp drop in the implied figure for bricks per house between 1801–10 and 1811–20 suggests that the estimate of the number of houses built may be too low in the first decades (or too high in the last four – but these are likely to be more reliable), though this may be partly accounted for by the canal boom.

Finally, we can value the estimates at the average price per dwelling for houses built in 1851–60. We take this average price as £150 – this represents the cost of a house built at 1851–60 prices to 1851–60 standards, and is assumed to include an allowance for the costs of street improvements provided by builders and estate developers.[40]

There is no direct procedure by which we can obtain the required estimate of the average cost of dwellings. One very indirect method is to extrapolate back to 1851–60 the average cost per dwelling derived primarily from the 1907 Census of Production, the first comprehensive return of the value of work on new houses in Great Britain. This yields an 1851–60 average price of about £125, but both the base figure and the extrapolation over more than half a century are rather uncertain.[41]

A second possibility is to break the problem down by dealing separately with each of the main categories of dwelling. This is the method underlying the estimate actually adopted, and it leads to a figure which may at first glance appear rather high but is in fact quite reasonable when the upper end of the tremendous range in the standard

Table 10. *Average Cost of Houses in 1860 (at 1851–60 prices) based on Classification by Annual Value*

Annual value £		Number (thousands)	Per cent of total	Possible estimate of cost (1851–60 prices) £
	Under 5	2,070	47·6	30
5 ⎱	10	1,115	25·6	70
10	15	520	12·0	120
15 ⎰ and under ⎱ 20	280	6·4	180
20	30	135	3·1	300
30	50	120	2·8	500
50 ⎰	100	73	1·7	1,000
	Over 100	37	0·8	5,000
Total		4,350	100·0	Weighted average £138

SOURCE. See text.

of houses built is fully taken into account. Fortunately, we have fairly reliable sources on which to base a detailed classification by annual value of the total stock of inhabited houses in Great Britain in 1860,[42]

and with this as the framework it turns out that plausible estimates of
the cost at 1851–60 prices for each of eight categories of house are con-
sistent with a weighted overall average of about £150. Almost half the
1860 stock of houses are taken at an estimated cost at 1851–60 prices
(but actual standards) of only £30;[43] and a further quarter are taken at
£70.[44] The cost rises through £120 to £180 for the next two categories,
covering the better class of urban houses and rural cottages built in
moderate numbers in the first half of the nineteenth centu.y; and then
through £300 and £500 to £1,000 for the smaller number of really
substantial town and country houses built for the most prosperous of
the commercial and professional classes.[45] Finally, for the top (and
open-ended) group of some 37,000 of the grandest town and country
residences we take a rather arbitrary but not, I think, excessive figure of
£5,000.[46]

    The result of a classification on this basis is set out in Table 10. The
estimates adopted thus lead to a weighted average of £138 for the cost
at 1851–60 prices of the total stock of houses in Great Britain in 1860.
However, since we have previously attempted to allow for the im-
provement in the size and quality of houses built after 1810 by reducing
all estimates of houses built to comparable units at 1851–60 standards,
we must now make a corresponding upwards adjustment to the esti-
mated cost; this gives us a figure of £150 for the cost at 1851–60 prices
of houses of 1851–60 standard.[47] The same figure can be applied to the
standardized estimates of houses built in each decade or to those in the
stock at the earlier benchmark dates, if we assume that there were no
significant changes in the relative composition of the houses built.

    A third source of information, which became available only after the
preliminary draft of this chapter had been completed, is the extensive
collection of data assembled by C. W. Chalklin in his important study
of the building process in a representative group of seven provincial
towns in the period 1740–1820. Chalklin states his conclusions with
respect to the average cost of *new* dwellings in the early nineteenth
century as follows:

My own evidence, concerning provincial urban figures alone, cannot of
course be used to estimate a national average, but I believe that such an
average may have been at least as high as £150. Although the smallest new
tenements in provincial towns cost only about £60–£80 after 1800, and
country cottages as little as £40–£60, the *average* would have been pushed up
strongly by the (relatively few) houses in the £500–£1,500 price range,
which included some farmhouses as well as town houses and of course, the
dwellings of intermediate value.[48]

Some allowance should be made for the difference in dates, but this may
be taken as broadly confirming the present estimate.

We thus take the standardized figures for new building in each decade and for the stock of dwellings at the four dates at an average value of £150 per dwelling, and this gives the series for capital formation at 1851–60 prices in Table 6 and for the stock of dwellings in Table 8. To obtain capital formation at current prices for Table 7, the series at 1851–60 prices was multiplied by the price index for buildings in the first column of Table 5.

2. PUBLIC BUILDINGS AND WORKS

This series is intended to cover all public buildings including town halls, schools,[49] hospitals, museums, workhouses, prisons, and churches, and also sewers and sewage disposal works. On the basis of two contemporary estimates we can put the value of the civilian public buildings and works in 1800 at roughly £25 million at 1851–60 prices.[50] This represents 10 per cent of our estimate of the value of the stock of dwellings at that date.

Given this, we have assumed that the value of the gross stock of public buildings in 1760 was also 10 per cent of the value of dwellings, and further, that capital formation in each decade from 1761–70 to 1811–20 was 10 per cent of the corresponding expenditure (at constant and current prices respectively) on dwellings. We have then assumed an increase in the ratio to 12 per cent in 1821–30, 15 per cent in 1831–40, and 20 per cent in 1841–60. This increase is designed in the first place to capture the substantial expenditure in these decades on state and civic buildings, including Buckingham Palace, the Houses of Parliament, the British Museum, the National Gallery, and the Public Record Office, all financed by the Treasury, as well as the Royal Exchange and the Coal Exchange in London, St George's Hall in Liverpool and the Town Hall in Birmingham, the Ashmolean and Fitzwilliam Museums, Lincoln's Inn, and the National Gallery of Scotland, and numerous other exchanges, markets, town halls, and other monuments to the growing size and prosperity of urban Britain.[51] Secondly, the rise in the series is intended to cover the gradual expansion of capital outlays by the emerging local government institutions in the fields of public health and sanitation.[52]

To complete the estimates of the value of the gross stock of these assets, it was further assumed that they had an average life of 100 years; the stock in 1830 was taken as equal to 40 per cent of the stock in 1760 plus the cumulated expenditure at 1851–60 prices from 1761 to 1830, and the stock in 1860 as equal to the cumulative total of capital expenditure over the preceding century.

3. AGRICULTURE

This important component of domestic capital accumulation covers all capital outlays by both landowners and tenants on farm buildings (other than dwelling-houses); on enclosures, reclamation, drainage, and other improvements to the land; on farm roads (especially in association with enclosures); and on carts, equipment, and machinery. It does not cover livestock or horses, which are dealt with in section V below.

We begin the estimates for this sector with a series for capital formation at current prices derived by estimating the average gross rent in each decade and expressing the capital expenditure by both landowners and tenant farmers as a proportion of that gross rent. This procedure is adopted as a way of obtaining an indication of the likely order of magnitude: we can estimate the total rent for land in Great Britain, and we have evidence from some estates of the proportion of rent devoted to improvements. It is not assumed that the level of capital expenditure is directly determined by the level of rent received. The series for the gross rent of land in Britain is reasonably well founded. From 1842 onwards we know the gross rent of land (including tithes) assessed for Schedule A of the Income Tax, and we also have the earlier Schedule A assessment for 1806, 1808, 1810, and 1814.[53] For 1800 we have Beeke's carefully considered estimate,[54] and we have taken the gross rent in 1760 as £20 million.[55] We then interpolated between these benchmarks to complete the estimates for 1760–1842, using the series on farm rents compiled by Thompson and by Norton, Trist, and Gilbert.[56] The resulting series is shown in the first column of Table 11.

The proportion of gross rent to be regarded as being expended on capital outlays is a much more difficult and uncertain item to estimate. Holderness has recently discussed the problems of estimating capital formation in agriculture and has provided some valuable leads,[57] but his own work is still in progress, and we must await its completion to obtain adequate estimates for this sector. To make the present very provisional estimates we have taken capital expenditure on new works and improvements by landlord and tenant as amounting to 6 per cent of the gross rental in the 1760s, and then rising steadily to a peak during the great upsurge in enclosures and improvement which occurred from about 1795 to 1815 under the influence of rapidly increasing demand and the greatly inflated levels to which prices of agricultural products soared during the Napoleonic Wars. The decade averages adopted (second column of Table 11) partly conceal this peak but nevertheless show investment at current prices increasing threefold from £1·9 million per annum in the 1780s to £5·7 million per annum in 1811–20. The ratio is lowered during the years of post-war depression and then

moved upward again to cover the substantial outlays on drainage in the Fens and the heavy clay lands under the stimulus of technical advances and parliamentary loans, and the more general investment in farm buildings and covered yards, in iron implements and steam machinery, which (together with improved techniques and use of fertilizers) helped to make these mid-century decades the 'golden age' of British farming. The resulting estimates show investment increasing by some 70 per cent between the 1820s and the 1850s.

Table 11. *Fixed Capital Formation in Agriculture: Farm Buildings, Improvements, and Equipment, Great Britain, 1761–1860*

	(1)	(2)	(3)	(4)	(5)
			Capital		Capital
	Gross rent	Capital	expenditure		expenditure
	(excluding	expenditure	at current	Price	at 1851–60
	farmhouses)	as % of	prices	index	prices
	(£m p.a.)	gross rent	(£m p.a.)	(1851–60 = 100)	(£m p.a.)
1761–70	20	6	1·20	55	2·18
1771–80	21	7	1·47	56	2·62
1781–90	24	8	1·92	58	3·31
1791–1800	31	11	3·41	80	4·26
1801–10	32	16	5·12	126	4·06
1811–20	41	14	5·74	129	4·45
1821–30	40	10	4·00	98	4·08
1831–40	42	11	4·62	98	4·71
1841–50	46	13	5·98	97	6·16
1851–60	46	15	6·90	100	6·90

SOURCES. (1) and (2) see text. (3) = (1) × (2). (4) = col. 2 of Table 5. (5) = (3)/(4).

The full details of the estimation and the resulting series for capital expenditure at current and 1851–60 prices are set out in Table 11. The assets are assumed to have an average life of 100 years,[58] and the series at constant prices in column 5 is then cumulated over the century from 1761 to give the 1860 value of the stock of fixed capital in agriculture, some £430 million. Before proceeding further this result may be compared with two alternative estimates to provide a check on both the 1860 stock and the underlying estimates of capital expenditure. The first check is made by deducting £30 million from the total for 1860 to cover the implements, carts, etc. provided by the tenants,[59] and dividing the estimated value of the landlords' capital by the total area of agricultural land in Great Britain (crops and grass), taken as about thirty-one million acres. This gives a capital value per acre of some £13. To evaluate this result we can compare it with the estimate by R. J. Thompson (for England and Wales) that the capital outlay incurred by landowners for drainage and fencing, farm roads, and buildings averaged

£12 per acre.[60] This figure must however be adjusted in two respects. Firstly, it includes the cost of the farmhouse and farm cottages which should be excluded for the present purpose since they are covered in our estimates of dwellings: this would reduce Thompson's figure by £4 or £5 per acre. Secondly, his estimate explicitly excludes any initial outlay on felling, clearing and grubbing or marling, and allowance for this and similar costs would roughly offset the deduction for houses.[61] We are thus left with an estimate of about £12 per acre, suggesting that our estimate may be marginally on the high side.

The second and more uncertain alternative valuation is obtained by dividing the rent of land into that part which in Ricardo's terms represents the payment for 'the original and indestructible powers of the soil' and that part which is 'paid for the use of the capital which had been employed in ameliorating the quality of the land and in erecting such buildings as were necessary to secure and preserve the produce',[62] and capitalizing the latter. Various authors have estimated the proportion of the rental which might be regarded as the interest on the buildings and improvements, and the best-supported of these fall in a range from 25 to 50 per cent.[63] If we take 40 per cent and apply this to the £48 million for the rent of land as assessed for Schedule A in 1860 (after deducting £2 million for farm-houses), we have a figure of some £19 million, and if this is capitalized at twenty years' purchase[64] we obtain a capital value of £380 million to which (say) £30 million should be added for implements etc. provided by the tenants. The resulting total of £410 million could easily be varied either way – for example, by taking a lower proportion of the rent than 40 per cent, or by taking slightly more than twenty years' purchase as the multiplier – but it broadly confirms the order of magnitude of the present estimates of capital formation and capital stock.[65]

To complete the capital stock series we first require an estimate for 1760. The farm land in Britain at that date might be valued at some £500 million at current prices,[66] but the greater part of that would be pure rent, since by that date only limited improvements had as yet been undertaken.[67] If we take the proportion represented by buildings and improvements at a rather arbitrary 25 per cent,[68] this puts their value at £125 million, and deflation by the price index for agriculture assets raises this to £210 million for the value of the stock in 1760 at the prices of 1851–60. We further assume that 70 per cent of these assets survived to 1800 and 40 per cent to 1830,[69] and the value of the stock at these dates is then obtained from the sum of these survivals from 1760 plus the cumulated fixed capital expenditure from 1761 to the respective dates.

4. INDUSTRIAL AND COMMERCIAL BUILDING

We turn next to the industrial and commercial sector, for which there are four separate series, covering in aggregate all buildings and equipment in manufacturing, building, distribution, catering, mining, quarrying, and gas and water supply.

For these buildings the only reliable evidence available for any date in the nineteenth century is the assessment, for tax purposes, of the gross annual value (equivalent to gross rental) of trade premises. We therefore begin with the gross annual value in 1860 and from this is derived the estimated gross stock. This in turn provides a basis for the estimates of capital formation. It might be desirable to separate industrial from commercial buildings, but since there is no reliable statistical basis for the division, and since the distinction was in practice somewhat blurred, particularly for the eighteenth and early nineteenth centuries, we have not attempted to do so.

The statistics of trade premises exempt from Inhabited House Duty were not published until 1874–5. For years from 1842–3 these buildings were assessed (on the same basis) for Schedule A of the Income Tax, but the amount of the assessment was not distinguished in the published statistics from those for dwellings and other buildings. The derivation of the implicit gross annual value of trade premises in 1860 is explained in the Appendix, and is estimated at £25·5 million. This covers lock-up shops, the trade component of residential shops, hotels, pubs, stores and warehouses, offices, factories, and other trade premises.

In order to convert this annual value into estimates of the 1860 gross stock at prices of 1851–60, we assume that the ratio of the gross stock to the annual value is the same for these buildings as for dwellings.[70] The annual value of dwellings in 1860 is taken as £33 million (see below, p. 96), and the value of the 1860 gross stock at 1851–60 prices as estimated above was £600 million, giving a multiplier of 18.[71] Applying this to the annual value yields an estimate of some £460 million for the 1860 gross stock of industrial and commercial buildings.

To complete the estimates, we then divide the stock into two parts,[72] each assumed to have been accumulated over a period of 80 years. One part covers the factory buildings, warehouses, and offices, and it is assumed that capital expenditure on these buildings was proportional to the increase in industrial production.[73] This component thus rises rapidly in the last four decades (from £1·4 million per annum in 1811–20 to £6·5 million in 1851–60), reflecting both the increase in mills and factories required for the swift expansion of manufacturing output, and also the development of commercial architecture to provide the great cities with the massive bank and insurance premises,

commercial chambers, and warehouses which were becoming common in the early Victorian period.[74] The second part of the stock covers the small but numerous residential and lock-up shops and the public houses and coffee houses, and for these it is assumed that capital formation moved in proportion to construction of dwellings.[75] This component thus starts at a higher level but rises much more sedately after 1820.

The sum of these two components is the series at 1851-60 prices in Table 6, and the standard index of building prices (Table 5) was applied to this to give the alternative series at current prices. Finally, the gross stock in 1760 at 1851–60 prices was assumed to be £25 million, with 60 per cent of this surviving to 1800 and 15 per cent to 1830,[76] and the gross stock in 1800 and 1830 could then be estimated as the sum of the surviving pre-1760 stock plus the cumulated expenditure to the respective dates.[77]

5. MACHINERY, EQUIPMENT, ETC. IN MANUFACTURING AND BUILDING

This series represents one of the most important and interesting aspects of capital formation in the early stages of industrialization, but it is the one for which we have probably the least information. It should cover all the new machinery and plant which symbolizes the industrial revolution: Cartwright's looms and Watt's steam engines, Cort's iron-works and Wedgwood's potteries, the machine tools of Maudslay and Nasmyth, the new iron machinery introduced in breweries and paper-mills, flour-mills, and chemical works. It should also include all the many survivals of older hand-working equipment, together with the tools, implements, utensils, and other minor items which are individually small but collectively important. Unfortunately, the textile industry is the only one for which we have some basis for direct estimates, and even here it is only for the cotton trade that moderately reliable information is available. We begin with estimates of the stock of machinery, etc. in textiles and move from this to cover the rest of manufacturing and building. We then derive from this the series for capital formation.

A widely used method of estimating the cost of fixed capital in the spinning sector of the cotton industry was to express the total cost (i.e. mill, power, preparatory machinery, and spindles) in terms of the price per spindle. Similarly the capital expenditure on the weaving sheds could be expressed in terms of the cost per loom. We have attempted to apply this method both to cotton and to the other branches of the textile industry. In each branch we take the numbers of spindles and looms in Great Britain in 1861, as shown by the Factory Inspectors' *Returns*,

and value these at a figure intended to represent the replacement cost (at 1851–60 prices) of the mills and machinery. To this we add an estimate for hosiery and lace manufacture, and for printing, bleaching, and dyeing works. The detailed figures and sources are set out in Table 12, and it will be evident that for sectors other than cotton the estimates are very approximate indeed.

Table 12. *Fixed Capital in the Textile Industry of Great Britain, 1860*

	(1) Spindles (thousands)	(2) Power looms	(3) 1851–60 replacement cost per unit £ s. d.	(4) Total value (£m)
Cotton				
spinning	30,267		1 4 0	36·3
weaving		398	24 0 0	9·6
Woollen and worsted				
spinning	3,447		2 10 0	8·6
weaving		65	70 0 0	4·5
Silk				
spinning	1,337		1 4 0	1·6
weaving		11	40 0 0	0·4
Flax, etc.				
spinning	656		4 0 0	2·6
weaving		10	42 0 0	0·4
Lace and hosiery				4·0
Finishing trades (cotton)				14·0
				82·0

SOURCES

(1) and (2) 1861 *Returns*, PP 1862, LV.

(3) *Cotton.* A steady 24s. per spindle for the all-in cost of a *new* mill is quoted by a succession of writers, including Ashton in 1841, Baines in 1857, the Factory Inspectors in 1871, and Ellison in 1886: for all these see M. Blaug, 'The Productivity of Capital in the Lancashire Cotton Industry during the Nineteenth Century', *Economic History Review*, 2nd ser., XIII (1961), 372–4. (The only exception discovered was J. Platt, the textile machinery manufacturer, who gave a figure of 18s. in 1866: 'On Machinery for the Preparing and Spinning of Cotton', *Proceedings of the Institute of Mechanical Engineers*, 1866, 240. This was possibly a time when prices were still depressed by the 'famine'.) For weaving, the same sources – Baines, the Factory Inspectors, and Ellison, again quoted by Blaug – are agreed on the figure of £24 per loom as the comprehensive cost of new weaving sheds.

Woollen and Worsted. I have not come across any direct statements regarding the capital cost per spindle required for spinning wool. A figure of about £3 15s. 0d. per spindle in 1824 can be derived from the records of the Trowbridge firm of J. and T. Clark reproduced in R. P. Beckinsale, *The Trowbridge Woollen Industry* (1951), 113, 122, 130, 137, 180, and 191, but this is probably too high as a capital cost for spinning only since the firm had invested considerable sums in equipment for the finishing

work on cloth produced by independent weavers. A more appropriate estimate is perhaps the £2 6s. 0d. per spindle indicated by the 1837 data for Black Dyke worsted mills given in E. M. Sigsworth, *Black Dyke Mills* (1958), 171–3 and 207–8. A capital cost about double that for spinning cotton is plausible, given the additional preparation which equipment and machinery required for wool (carding, combing, etc.), and is supported by the Returns of Horsepower, which show 18·4 h.p. per thousand spindles in woollen and worsted factories compared with 9·6 per thousand spindles in cotton. For weaving there is again a lack of information; as yet I have discovered only two estimates. The first is Heaton's statement (made without giving a specific source) that in the 1830s 'a power loom shed could be built and equipped with 50 looms for about £5000', i.e. about £100 per loom. See H. Heaton, 'Financing the Industrial Revolution' (1937), reprinted in Crouzet (ed.), *Capital Formation*, 86. The second is in the evidence given by Sir Jacob Behrens to the Royal Commission on the Depression in Trade and Industry in 1886, where it is stated that the total cost (including land) of a complete mill with all equipment for 500 broad and 500 narrow looms would be about £70,000 (PP 1886, XXI, *Minutes of Evidence*, Q. 6716). The same figure of £70 per loom has been adopted for the 1850s, and it is assumed to include equipment for dyeing and finishing, hence its high level relative to the capital costs for weaving in the other textile trades.

Silk. There is again very little information, and the estimates are based largely on the evidence of one of the leading manufacturers, Joseph Grout, given in 1831 to the Select Committee on the Silk Trade, PP 1831–2, XIX, *Minutes of Evidence*, Q. 10, 295–303. His figure for looms is £34 10s. 0d. ('exclusive of the steam engines') and this has been raised to £40 to cover the engines. The cost of his mills (excluding looms but including land) works out at about £1 8s. 0d. per spindle and it was assumed that for the 1850s the cost was the same as for cotton-spinning.

Flax, Jute, and Hemp. For spinning the figure used was given by T. Greenwood, 'On Machinery Employed in the Preparation and Spinning of Flax', *Proceedings of the Institute of Mechanical Engineers*, 1865, 123. For weaving the estimate was given by W. Charley, *Flax and its Products in Ireland* (1862), 92.

Lace and Hosiery. The cost of fixed capital is based largely on W. Felkin, *A History of the Machine-Wrought Hosiery and Lace Manufactures* (1867), 396–7 and 449, and the estimates for 1831 and 1886 quoted in Blaug, 'Productivity of Capital', 371–4.

Finishing trades. Taken as 30 per cent of the fixed capital in cotton-spinning and weaving, based on *ibid.*, 372–4.

The resulting estimate of the total gross stock of reproducible fixed assets in the textile industry, at 1851–60 prices, thus comes out at £82 million. The share of machinery in this (including engines and accessories) would be about 65 per cent, or £53 million.[78] This covers only the mechanized factories, and we must make a small addition for the equipment of hand workers, who still survived in 1861 in some sectors, notably woollen spinning and weaving.[79] The difference of some 450,000 between the 1861 Census of Population count of the occupied population in textile production and the 1861 Factory Inspectors' Returns of numbers employed in textile factories provides one clue to the extent of hand working in Great Britain at that date.[80] An allowance of £10 per head for equipment, etc. for this group would

add £4·5 million, bringing the total for the textile industries to about £58 million.

We next use this result as a starting point for a highly conjectural extension to cover the remaining manufacturing industries. The only statistics which cover the whole of the manufacturing sector in 1860 are those for the occupied population given in the Census of Population, and we take this as our 'control', multiplying the number of workers by estimates of capital per head to obtain the total stock. According to the 1861 census there were some 3·6 million workers in manufacturing; these can be divided into five main groups, as shown in the first column of Table 13. For the factory sector of textiles, the estimate of £53

Table 13. *Stock of Machinery and Equipment in Manufacturing, Great Britain, 1860*

	(1) Occupied population (thousands)	(2) Machinery per worker £	(3) Stock at 1851–60 replacement cost (£m)
Textiles			
Factory	730	73	53
Hand	450	10	5
Total (textiles)		—	58
Metal-making, engineering, and shipbuilding	650	75	49
Clothing	1,030	5	5
Other manufacturing[a]	730	60	44
Total (non-textile)		—	98
Total	3,590	43	156

[a] Includes food and drink, chemicals, wood and furniture, paper and printing, pottery, glass, and furs and leather.

SOURCES

(1) Booth, 'Occupations of the People of the United Kingdom', 415–19; see also note 80 below.
(2) See text.
(3) Textiles: see text; others: col. (1) × col. (2).

million obtained above yields a figure of some £73 for the replacement cost (at 1851–60 prices) of machinery and equipment per factory worker, and we allowed £10 per head for the hand workers. With these as guidelines we assume that for the metal-making, shipbuilding, and engineering industries the machinery per worker would average

roughly the same as in the textile factories, say £75 per worker; for the substantial numbers engaged in making clothing (tailors, dressmakers, boot- and shoemakers, etc.) we take £5 per head; and for the remaining industries we assume an average of £60, about 20 per cent below the textile factories.[81] It would obviously be desirable to check the order of magnitude for as many as possible of the individual industries other than textiles and clothing, but it has not been possible to do this for the present chapter. It should be stressed, however, that the two estimates given for the metal and engineering industries and for the residual group are intended as averages – it is not suggested that they are appropriate for each industry within the two groups. In the former category, for example, the capital-intensive metal-making sector has to be set against the large number of workers employed in small and imperfectly mechanized workshops in the mechanical engineering trades: Clapham[82] discusses a return of the numbers employed in industry at the census of 1851 showing that of 677 English and Welsh engine and machine-makers who made returns, 447 employed one to nine men and a further 90 employed ten to nineteen; only 34 employed 100 or more.

Applying the above estimates to the numbers occupied gives an estimate of £98 million for industries other than textiles, and of £156 million for manufacturing as a whole. Some small allowance should also be made for equipment used in building and contracting, in which some 630,000 were occupied in 1861, and we add £4 million for this sector (roughly £6 per head), bringing our estimate of the total gross stock in manufacturing and building to £160 million.

To estimate the gross stock at earlier dates we assume that it grew proportionately with the index of industrial production;[83] this assumption of a constant capital–output ratio is clearly unsatisfactory, but there does not at present appear to be a better method of estimation. This gives estimates, at 1851–60 prices, of £9 million in 1760, £26 million in 1800, and £61 million in 1830.[84] We may compare the figure for 1800 with Sir Frederick Eden's estimate in 1803 that the sum invested in 'steam engines and other expensive machinery' was not less than £40 million.[85] Adjustment for the fall in prices to 1851–60 would lower this to perhaps £30 million, which is broadly consistent with the present estimate.

The estimates of capital formation at 1851–60 prices are obtained by assuming a life of forty years for these assets: that is, the stocks at each benchmark date are assumed to have been accumulated over the preceding period of forty years, the expenditure being allocated by decade *pro rata* to the increase in industrial production.[86] The price index in column 3 of Table 5 was then used to convert to current prices.

6. MINING AND QUARRYING

For this sector we again begin with an estimate of the stock of capital in 1860. The estimate covers all fixed assets and all forms of mining and quarrying, though it is based largely on data for coal-mining.

In the early years of the present century it was frequently suggested that the capital cost in coal-mining was 10s. per ton. This was, for example, the figure used by Flux in the Final Report on the 1907 Census of Production (p. 35); and it was defended as a reliable estimate before the Sankey and Samuel Commissions of 1919 and 1925. The origins, basis, and accuracy of the estimate were discussed and clarified in evidence to these Commissions by Lord Stamp and others,[87] and it appears from this that the estimate was originally put forward as an average for the 1890s and that it relates to the replacement cost of the fixed assets (shafts, equipment, etc.) in coal mines. The major component of the capital expenditure in mining is the labour cost, and as miners' wages in the 1850s were between 20 and 30 per cent below the level of the 1890s,[88] a significantly lower cost per ton would be appropriate for the replacement cost of the end-1860 stock at 1851–60 prices. It is also necessary to make allowance for the fact that shafts sunk before 1860 would not have been as deep as those of the later period. We therefore take a figure of 7s. per ton as the cost appropriate for 1860 at 1851–60 prices. To get a corresponding figure for the earlier benchmark dates we reduce this to 6s. for 1830 and to 5s. for 1760 and 1800 to allow for the shallower pits of the earliest collieries.[89]

These estimates are then applied to the series for the tonnage of coal produced in Britain[90] to obtain the gross stock of capital in coal-mining at 1851–60 prices at the four dates. For the 1860 output of £80 million tons this gives a value of £28 million, and an addition for iron ore, copper, and other mines and for quarries raises this to some £35 million.[91] A proportionate adjustment was made to the estimates for the three earlier dates.

Estimates of capital formation at 1851–60 prices were then obtained by assuming that these estimated stocks of capital were accumulated over a life of some forty years and that expenditure per decade was proportional to the increase in coal output. The standard index of building prices was then used to convert this series to current prices.

7. GAS AND WATER

We here rely on unpublished estimates of capital formation at current and 1900 prices kindly made available by B. R. Mitchell. For the gas industry he compiled estimates of cumulative capital cost for a sample

of undertakings, and he expressed these in terms of the cost per head of the population in the area covered by the undertaking. Census of Population data were then used to expand this to cover all areas with a supply of gas. This was done for each census year from 1821, and the increment in the series over the decade was taken as the capital expenditure at current prices.

For water supply Mitchell drew on parliamentary papers and company reports to make similar estimates of accumulated capital expenditure at decade intervals from 1811 onwards for a sample of areas, and again he used population statistics to extend this to cover the total supply. As with gas the increase over the decade was taken as the capital expenditure at current prices.

These series at current prices are combined in Table 7 (with an addition for gas of £1 million for the decade 1811–20). Mitchell's corresponding series at 1900 prices were converted to 1851–60 prices to obtain the estimates for Table 6, and these were in turn cumulated over the period from 1811 to obtain the capital stock estimates for 1830 and 1860 for Table 8. The 1860 stock of £42 million (at 1851–60 prices) is evenly divided between gas supply and water supply.

8. RAILWAYS

We now move on to six separate estimates of capital formation in transport, beginning with the railways.

Estimates of capital expenditure on the permanent way and works and on railway rolling stock have been made by B. R. Mitchell from 1831 and by A. G. Kenwood from 1825.[92] Mitchell's estimate is consistently somewhat higher, particularly from 1845 onwards.[93] It includes estimated expenditure on renewals but excludes repairs, purchases of land, and transfer payments such as interest, subscriptions to other companies, and purchases of existing lines. We have adopted this series for the present estimates. It is limited to expenditure on the railways and does not include ancillary assets such as canals, docks, or hotels, which we cover elsewhere. The estimates are derived from the accounts of the railway companies and are subject to certain reservations regarding the accounting practices adopted in allocating expenditure to capital or revenue account; however, they are certainly among the most reliable of the series included in the present estimates.

Mitchell's estimates at current prices are shown in Table 7 (with a notional addition for 1811–30); his series at constant (1869) prices, obtained by constructing special price indices for work on the permanent way and for rolling stock,[94] has been adjusted to constant prices of 1851–60 to get the series in Table 6. This series was in turn cumulated

over the period from 1811 to get the capital stock estimates in 1830 and 1860 for Table 8.

9. ROADS AND BRIDGES

In the case of roads we have to deal with an asset to which the application of the conceptual approach outlined above (p. 35) is particularly difficult. A basic assumption underlying that approach is that we are dealing with assets which are newly created by specific capital outlays on construction or purchase, maintained by expenditure on repairs during a finite lifetime, and then discarded at the end of that life as a result of depreciation and obsolescence.[95] Road-building does not normally conform to this pattern. We do occasionally have the creation of a new road in the period we are considering, but more commonly we have work undertaken on roads originally constructed centuries before – in some cases going back to the Roman era – and this work simultaneously involves elements of improvement and of repair. A further and equally fundamental difficulty is that the accounts kept by the authorities responsible for this expenditure typically distinguish only the type of outlay (e.g. labour, materials, etc.) but not the nature of the work, so that it is generally impossible to separate new work from repairs on the basis of the recorded information. One solution would be to abandon the distinction and include all repairs in the estimates of gross investment. However, for the reasons given above (p. 37) this was considered unsatisfactory, and we have preferred to take a proportion of the total expenditure as representing new work and major improvements, even though the choice of the proportion would necessarily have to be fairly arbitrary.

We begin with estimates of capital formation based largely on work by J. E. Ginarlis. In an unpublished dissertation Ginarlis has estimated what he terms 'quasi-net' expenditure on roads.[96] This covers new work and improvements, all expenditure on repairs and maintenance, and parliamentary and legal fees, but it excludes transfer payments such as purchase of land, compensation, and interest. His estimates cover the expenditure on the turnpikes, bridges, and parish roads and also the small amount of direct government expenditure on roads and bridges.

For the turnpikes Ginarlis computed estimates of quasi-net expenditure for 1822–56 from data compiled from parliamentary returns.[97] He extrapolated this series back to 1750 by an elaborate and careful procedure which involved a classification of all turnpikes according to their date of origin, mileage, and level of expenditure in the 1820s, as well as the use of a small sample of account books of turnpike trusts for the pre-1820 period. Each trust was allocated a pattern of expenditure over

the period from 1750 (or from its origin, if formed after that date) to 1820 on the basis of the growth of expenditure shown by a sample trust of corresponding length and level of expenditure in the 1820s.[98] This series was extended to the end of the 1850s from the *Abstract of Turnpike Trust Expenditure* available for this period in Parliamentary Papers.[99] It was generally recognized that the activities of the turnpike trusts brought about a considerable improvement in the quality of Britain's roads,[100] so that it is appropriate that we should take a substantial proportion of Ginarlis's quasi-net expenditure to represent new works and improvements, and we have taken 60 per cent of his series as the measure of capital formation as we have defined it.[101]

The second component of the estimates covers the 96,000 miles of parish roads. For these Ginarlis based his estimates on returns to parliament for 1812–14, 1827, 1837–9, 1841, and 1847,[102] interpolated and extrapolated to cover the period 1750–1850 by means of data derived from a sample of parish surveyors' account books.[103] The sample is very small (1 per cent or less of expenditure in 1813) and the reliability of the series accordingly rather poor. The series again covers both maintenance and improvements, and the former would account for a much larger share of expenditure than was the case with the turnpikes. However, there is evidence of some improvement in the standard of parish roads over the period,[104] and we have taken a very arbitrary 20 per cent of Ginarlis's series to represent capital formation. From 1851 the series can be extrapolated to 1860 on the basis of the *Abstracts of Highway Expenditure*.[105]

Finally, Ginarlis has constructed a series for capital expenditure by bridge trusts and companies,[106] and we add this to the adjusted estimates for turnpikes and parish roads to obtain the series for capital formation at current prices in Table 7 above. It does not cover capital expenditure on road-making associated with the work of either the enclosure commissioners in rural areas or the improvement commissioners and private builders in urban areas; an implicit allowance for the former is included in the previous estimates for farm buildings and improvements, and for the latter in the series for residential building.

To convert the series to 1851–60 prices for Table 6 a special index was used, combining an index for labourers' earnings represented by the series for agricultural wages (weight 2);[107] and an index for the price of materials, represented by the series given by Ginarlis for the cost of gravel (weight 1).[108]

The value of the stock of roads and bridges in 1860 (at 1851–60 prices) was then taken as the accumulated total of capital expenditure over the eighty years from 1781, giving an estimate of £66 million. To obtain the stock at the earlier dates we first need some estimate of the

stock in 1760, and we take this at a very uncertain £15 million,[109] of which one-half is assumed to survive to 1800 and one-eighth to 1830. The stock at these two dates is then obtained from the accumulated capital expenditure from 1761 to the respective dates, added to the surviving value of the pre-1760 roads.

As a first step towards an evaluation of these results we may note that the turnpikes account for £44 million of the estimated £66 million for the value of the stock of roads in 1860 at 1851–60 prices, and that there were approximately 27,000 miles of turnpike roads in Great Britain at that date.[110] The implied cost of construction is thus some £1,630 per mile. This is broadly corroborated by other evidence on construction costs. Sir James McAdam informed a Select Committee in 1836 that the cost of a gravel road four inches thick constructed on the principles he and his father followed would be £1,760 per mile.[111] Another source quotes figures of 1s. 2d. to 1s. 6d. per square yard for the cost of macadam roads in Scotland in the 1860s, and 1s. 6d. per square yard for macadam roads six inches thick in Birmingham in the early 1850s; assuming an average width of twelve yards, this works out at a cost per mile of roughly £1,200 to £1,600.[112]

A similar calculation for the estimate of £22 million for the value in 1860 of the 115,000 miles[113] of parish roads and highways yields a construction cost of £190 per mile, and if we assume an average width for these roads of about six yards[114] this is roughly 4d. per square yard. This may be compared with a cost of 1d. to 2d. per yard, varying with the quality of stone to be broken, quoted by McAdam for lifting a rough road and rendering it 'smooth and solid', and a cost of 3d. per yard for lifting, etc. plus 4d. per yard for three inches of extra stone, which he quoted as his price in a letter to the trustees of a turnpike road.[115] The present estimate thus appears to be of roughly the right order of magnitude; without an appropriately weighted average compiled from much more detailed information on both the mileage and the construction costs of each of a range of different categories of road, we cannot make a more precise check.

10. CARRIAGES AND COACHES

This estimate is intended to cover all carriages and coaches used for passenger transport, whether privately owned or hired, and some part of the vehicles used for goods transport.[116] The horses are included with livestock in section V.

We begin with the series for the stock of capital, obtained from estimates of the number of vehicles at each of the four benchmark dates and of their average (1851–60) price. For the numbers we rely largely on

official statistics: various categories of carriage and coach were subject to taxation or licensing from the mid eighteenth century onwards, and though the coverage of the duties and licences varied over time and the underlying statistics were not published before 1810, we have fairly comprehensive information for 1810–28 and for 1854–69, so that we have a moderately secure basis for the main estimates.[117] The average prices at which these are valued are rather more approximate; but fortunately we have sufficient information to deal separately with six categories of vehicle, and we are thus less liable to be substantially in error than if we attempted a single average for all sizes and types.[118] For 1860 this yields an estimate for the gross stock of some £23 million, covering over 280,000 carriages, coaches, and omnibuses.

The estimates of capital expenditure at 1851–60 prices were derived from the stock estimates on the assumption that the average life of the vehicles was around fifteen years. For 1810–24 we can check this with the aid of statistics derived from a tax levied for a few years on carriages and carts made for sale.[119] We have no suitable means of adjusting this for price changes, and as a very rough approximation the standard index of building prices (Table 5) was used to convert the estimates to current prices.

II. CANALS AND WATERWAYS

Canals present similar problems to those encountered in the estimates for roads, and we attempt to deal with them in a similar fashion. We begin with the estimate for capital formation at current prices, built up from three components.

The first covers all work on *new* construction of canals and inland waterways and is derived from estimates of the mileage opened in each decade and of the average cost per mile of new work. For the former we use the series compiled by Ginarlis for the mileage of canals, and of rivers on which expenditure had been incurred to improve navigation.[120] It rises from 990 miles in 1760 to 1,750 in 1780, 2,690 in 1800, 3,190 in 1820, and 3,470 in 1840. For the average construction cost per mile we have relied on the figure for twenty-five canals assembled by Hadfield[121] together with information in Ginarlis.[122]

The second component is designed to cover the expenditure on improvements of existing canals and is confined to the period 1760–1840. For this we have taken Ginarlis's estimates of quasi-net expenditure (defined as for roads),[123] deducted the above estimate of new work, and then assumed that 20 per cent of the balance (representing approximately the expenditure on repairs and improvements) could be taken as an estimate of the outlays on improvements.

To convert the combined series for these first two components from current to 1851–60 prices we used a special index combining building wages (weight 2) and brick prices (weight 1). The aggregate value of the expenditure on new work and improvements over the century to 1860 comes to some £34 million at 1851–60 prices,[124] and we take this as the value of the stock (before adding in the third component) in 1860. The new work alone accounts for some £27 million, equivalent to a construction cost (at 1851-60 prices) of roughly £7,700 per mile, and we applied this to the mileage in 1760 to obtain the corresponding value of the canals at that date. The value in 1800 and 1830 was then obtained by assuming that the opening stock depreciated steadily at a rate of 10 per cent per decade (i.e. over a life of 100 years) and adding on the accumulated capital outlays from 1761 to the respective dates.

The third components covers the barges, pumping engines, hoists, and other ancillary equipment. G. B. Poole reckoned the value of these assets at £3 million in 1850.[125] We have assumed that the value at other dates was proportional to the mileage opened, and capital formation at 1851–60 prices was obtained by spreading the stock at the end of each decade over the two preceding decades – this represents an assumed life of 20 years for these assets. The standard index of machinery prices was used to convert this series to current prices. The stock and flow estimates for these items were then added to the corresponding estimates for the first two components to obtain the series shown in Tables 6 to 8.

12. DOCKS AND HARBOURS

For investment outlays on docks and harbours at current prices we have relied on information assembled by D. Swann for the period 1761–1830,[126] and on unpublished estimates by Mitchell covering the period from 1756 to 1914. These were based on a number of sources, including the accounts of dock companies and port authorities and a valuable parliamentary return of government expenditure.[127] This series was deflated by the index used above for canals to get the estimates at 1851–60 prices. We have taken the capital stock in 1760 at a notional £1 million and cumulated subsequent capital formation to get the value of the stock at the later dates.

13. SHIPS

The last item to be considered is shipping,[128] under which heading we cover all merchant vessels (whether cargo, passenger or fishing, coastal, or ocean-going) but not naval vessels. The series for gross capital formation at prices of 1851–60 is derived by valuing the tonnage built at an

appropriate cost per ton. For the former, the main component is the
tonnage built and first registered in Britain, statistics for which are avail-
able from 1787 onwards, with steamers distinguished from sailing ships
after 1814.[129] For 1760–86 we have no record of annual shipbuilding,
but the register of total tonnage belonging to Britain was compiled
from 1788 onwards, and the tonnage built from 1760 to 1786 was esti-
mated by assuming that the ships on the register in 1788 had been
constructed or purchased over the previous twenty-five years, with an
upward trend in the series.[130]

Craig has rightly insisted on the need to supplement the shipbuilding
in British yards by allowing for the tonnage bought by British owners
from outside the United Kingdom, particularly from the colonies in
British North America[131] and also – after the repeal of the Navigation
Laws in 1849 – from the United States. For 1821–60 a series is available
in the parliamentary papers showing the tonnage of colonial-built
vessels registered each year at each of the ports of the United Kingdom,
but it is impossible to reconcile these figures with other returns, com-
piled by the same department, showing the total tonnage of colonial-
built vessels registered at each port at the end of 1831, 1841, and 1846.[132]
It seems that the annual series seriously understate the extent to which
British shipbuilding were acquiring ships from the colonies, and we have
constructed alternative estimates by spreading the total tonnage regis-
tered at the above dates over the preceding twenty years in proportion
to the total tonnage built and registered in the colonies.[133] For years
after 1846 there does not appear to be any published return of the ton-
nage of colonial-built vessels on the register at any one date, and we
have assumed that the proportion of colonial-built vessels bought by
British owners was about the same in 1847–60 (which includes the boom
years of the mid-fifties) as in 1841–6. This gives a series for the colonial
tonnage bought by British owners, rising from 100,000 tons in the
1820s to 400,000 tons in the 1840s and 500,000 tons (some 30 per cent of
the tonnage of sailing ships built in British yards) in the 1850s.[134]

For the final component – the ships bought from the United States
and other foreign countries after 1849 – we have taken the annual
returns of foreign-built tonnage registered in Great Britain, available
for 1850 to 1860.[135]

We thus have four categories of tonnage and require four estimates of
the average value at prices of 1851–60. The first and most important is
the estimate for home-built sailing vessels, for which we take £15 per
registered ton to cover the replacement cost (at 1851–60 prices) of the
hulls and of the masts, yards, and other fittings required to make the
vessel 'ready for sea'. There is no lack of individual examples of ship-
building costs, and once again the uncertainty arises in trying to strike

an appropriate average within a wide range. For example, Hutchins quotes figures for British shipbuilding costs in 1860 varying from £16 16s. to £21 per ton for fourteen-year first-grade wooden ships, coppered and fitted with double outfits, down to £10 for low-grade eight-year vessels.[136] From all the evidence available an average of £15 seems about right for the whole range of sailing vessels and boats constructed in Britain.[137]

For the British-built steamers we take the 1851–60 price per gross ton of £25 10s.[138] given by Maywald, and raise this by 55 per cent to a price per net registered ton of £40.[139] The tonnage built in the Colonies was significantly cheaper than the British – that was its attraction for British owners and speculators – and prices were quoted varying from £10 to as little as £3 10s. per ton. The American ships purchased in the 1850s were generally of better quality and would have cost around £10 to £15 per ton. We have taken overall averages of £7 for colonial tonnage and £10 for United States tonnage.[140] The four components were valued and aggregated to give the estimates for capital formation at 1851–60 prices in Table 6.

The estimates of capital formation at current prices were then obtained by means of a price index combining engineering wages and timber prices[141] with equal weights. This gives an implicit price per ton for the sailing ships of around £8 in the period 1760–90, rising to £20 in 1801–20 and dropping back to about £15 from 1821 onwards. This is broadly consistent with the information available for these periods.[142]

The estimates of the value of the gross stock of merchant ships at replacement costs of 1851–60 were arrived at by valuing the tonnage on the register in England, Wales, and Scotland at the four benchmark dates. For 1860 we use the estimates of colonial and foreign tonnage described above (p. 65) to allocate the tonnage of sailing vessels on the register between British-, colonial-, and foreign-built, and value each of these, and the steamers, at the average 1851–60 prices given above. Similarly, for 1830 we distinguish colonial from British sailing vessels. For 1760 the total tonnage was estimated by extrapolating backwards from the start of the register in 1788, using a series for the tonnage of English-owned shipping given by R. Davis.[143]

V.   Circulating Capital, Overseas Assets, and Land

Our aim in this section is to provide some rough orders of magnitude for three further categories of tangible wealth and, where appropriate, of their associated flows.

The first category is circulating capital in the form of stocks

(inventories) and work in progress in industry, trade, and agriculture. This covers (1) non-farm stock-in-trade, i.e. stocks of home-produced and imported raw materials, semi-manufactured products, work in progress, and finished goods held by manufacturers and traders; and (2) farm crops (harvested and standing) and livestock, including horses whether used on farms or elsewhere in the economy. This circulating capital, together with the fixed capital already covered in section IV, constitutes the major part of domestic reproducible wealth.[144] We also estimate the changes in the circulating capital to derive series for stock-building – the value, at either current or constant (1851–60) prices, of the physical increase in stocks and work in progress – and these are added to the corresponding series for gross domestic fixed capital formation to obtain total capital formation.

The second category is the accumulated holding of overseas assets by British residents, net of assets in Britain owned by non-residents. This category differs from those previously estimated in that it covers both physical and financial assets. The assets and liabilities are valued on acquisition at their original cost, and the cumulative estimates require an adjustment to express this in terms of replacement at 1851–60 prices, but no adjustment is made for subsequent appreciation or depreciation of the assets.[145] Together with these assets we cover the holdings of gold and silver coin and bullion.[146] The change in the holdings of overseas assets and of gold and silver represents net investment abroad, and series for this – again valued at either current or 1851–60 prices – are added to the corresponding series for domestic capital formation to obtain estimates of total investment by Great Britain.

The final category of wealth to be covered is land, in which we include the unimproved value of farm land, the land underlying dwellings and other buildings and structures, and the value of standing timber. This is by far the most important component of non-reproducible tangible domestic wealth, and it is included because of its value and interest and for comparison with the estimates of reproducible domestic wealth and overseas assets.[147]

The estimates for all four categories are, at best, reasonable approximations, but they should serve to supplement the series in Tables 6–8 for reproducible fixed capital and to permit a broad assessment of the changing structure and rates of growth of the national wealth and investment of Great Britain in the century from 1760 to 1860.

I. NON-FARM STOCK-IN-TRADE

If we have hitherto laboured to make bricks without straw we have now to work without benefit of either straw or clay. Isolated series of

stocks held are available for a few commodities,[148] but these provide no possible basis for an overall estimate; and no direct count of aggregate non-farm inventories was attempted prior to the post-war Censuses of Production (1948) and Distribution (1950).

The nearest approach to an overall total for the nineteenth century is an estimate which can be derived from the statistics of Fire Insurance Duty. In 1864, shortly before the duty was finally abolished, a reduced rate was charged on insurance of 'any Goods, Wares or Merchandise being Stock in Trade, or of any Machinery, Fixtures, Implements or Utensils used for the purpose of any Manufacture or Trade'.[149] From the return of the duty collected in 1863–4 at the reduced and higher rates it can be calculated that the value of the insured stock-in-trade, machinery, etc. was 33 per cent of the total value of property insured; applying this to the property insured in Great Britain in 1860 gives a figure of some £330 million.[150] If we then deduct from this our estimate of the value of industrial machinery and equipment in 1860 (Table 8), we are left with £170 million for the stock-in-trade.

This may safely be taken as the lower limit for the value of stock-in-trade, since even though the estimate for machinery, etc. may be somewhat too low (cf. p. 78 below), it is certain that not all stock-in-trade and machinery was insured and that the property which was covered was not always insured at its full value.[151] However, we are told that 'the destructible stock of producers and traders' was the 'most completely insured' of all forms of property,[152] and given the extent to which the practice of fire insurance had developed by 1860 it would seem likely that the full value of non-farm stock-in-trade in 1860 would be somewhere in the range of £200–250 million.

The only other estimate we have found is that made by Sir Frederick Eden, Chairman of the Globe Insurance Company, for c. 1800. This was derived as follows:[153]

British manufactures for home consumption	£76,000,000
for exportation	40,000,000
Foreign merchandise in Great Britain	40,000,000
	156,000,000

Of which total amount it is supposed that one-fourth is insurable or £39,000,000.

For a distant star to guide us between these two points we look to the twentieth century, and we find that the book value of non-farm stock-in-trade and work in progress in the inter-war years amounted to some 20 per cent of total final expenditure (i.e. GDP plus imports) at current prices, and that in the post-war period the ratio for 1948–58 was around

30 per cent and dropped by the late 1960s to 25 per cent.[154] We might expect there to be a downward trend in the ratio of stocks to turnover during the nineteenth century, and particularly after 1830, as improvements in transport and communication reduced the relative size of the stocks it was necessary to hold at each stage of the process of production and distribution,[155] though this might possibly be offset to some extent by an increase in the variety of goods offered.

Table 14. *Non-Farm Stock-in-Trade, 1760–1860*

	1760	1800	1830	1860
1. Final expenditure (£m)	120	294	392	858
2. Stocks as % of 1	30	30	30	25
3. Stocks at current prices (£m)	36	88	118	215
4. Price index (1851–60 = 100)	90	128	106	103
5. Stocks at 1851–60 prices (£m)	40	69	111	209

In the light of the foregoing discussion, we derive estimates of the value of non-farm stock-in-trade at current prices at the four benchmark dates by assuming that they amounted to 30 per cent of total final expenditure in 1760, 1800, and 1830, and 25 per cent in 1860.[156] A general index of wholesale prices was then used to value the resulting estimates at prices of 1851–60.[157] The successive stages are set out for the selected years in Table 14. The estimates of non-farm stock-in-trade at 1851–60 prices in line 5 are carried to Table 15, rounded to the

Table 15. *Stock of Circulating Capital, Overseas Assets, Coin and Bullion, and Land, Great Britain, 1760–1860[a]* (£m at 1861–60 prices)

	1760	1800	1830	1860
Circulating capital				
Non-farm stock-in-trade	40	70	110	210
Farm crops, livestock, and horses	140	190	220	240
Total	180	260	330	450
Overseas assets				
Accumulated net holdings of overseas assets	—20	10	90	360
Gold and silver coin and bullion	20	30	60	100
Total	0	40	150	460
Land				
Farm land (including woodlands)	900	940	990	1,000
Other	60	100	190	420
Total	960	1,040	1,180	1,420

[a] All values rounded to the nearest £10m.
SOURCE. See text, section V.

nearest £10 million as a reminder of their very approximate character.

From line 5 we can also estimate the value of stock-building at constant prices: the annual rate averages less than £1 million for 1760 to 1800, then rises to £1·4 million from 1800 to 1830 and to over £3 million over the last three decades to 1860. For the series shown in

Table 16. *Stockbuilding and Net Investment Abroad,[a] 1761–1860*
(*£m p.a., decade averages, at current and constant prices*)

| | Value of physical increase in stock and work in progress | | Net investment abroad[b] | |
	at current prices	at 1851–60 prices	at current prices	at 1851–60 prices
1761–70	1·0	1·0	0·5	0·5
1771–80	2·0	2·0	0·5	1·0
1781–90	2·0	2·0	1·5	1·5
1791–1800	3·5	3·0	1·5	1·5
1801–10	1·5	1·0	—3·0	—2·0
1811–20	3·0	2·0	7·5	5·0
1821–30	4·5	4·0	8·5	7·5
1831–40	3·5	3·5	4·5	4·5
1841–50	4·5	5·0	6·5	6·5
1851–60	3·5	3·5	20·0	20·0

[a] Rounded to nearest £0·5m.
[b] Including net changes in gold and silver coin and bullion.
SOURCE. See text, section V.

Table 16 we extend these results (by the same procedure as was used above) in order to obtain estimates of stockbuilding in each decade; the resulting series is then revalued at current prices.[158]

2. FARM CROPS, LIVESTOCK, AND HORSES

A continuous series of official agricultural statistics is not available for Great Britain until 1867, but fortunately the importance of farming attracted several careful investigators, and their studies, together with estimates of farm output and capital compiled after 1867, provide a reasonable starting point for the present estimates.[159] Even so, however, the final results necessarily involve a fair measure of conjecture and approximation, particularly with regard to the relationship of the feed crops to the valuation of the livestock.

Our initial objective is to estimate the value, at 1851–60 prices at the four selected dates, of (a) stocks of harvested and standing crops, (b) livestock, and (c) horses. The total of these items covers the major part of

tenants' or occupiers' capital, but we exclude the machinery, equipment, etc. – which has already been covered in the comprehensive estimate for fixed capital in agriculture (see p. 48 above) – and include non-farm horses.

For the farm crops we begin with estimates of production or of crop acreage and yields at each of the four benchmark dates for wheat, barley, oats, and rye.[160] The estimated production of each crop was valued at the average *Gazette* prices of 1851–60.[161] The resulting series was then raised by 60 per cent to cover peas, beans, potatoes, turnips and other fodder crops, flax, and hops.[162] Finally, it was assumed, following Boreham,[163] that stocks of harvested and standing crops represented 85 per cent of crop production.[164]

For livestock we have made estimates of the numbers in Great Britain at the four selected dates,[165] and valued these on a basis intended to correspond roughly to store prices of 1851–60. These were taken to be: for all cows, heifers, and other cattle, an average of £9 10s.; for sheep and lambs, an average of £1 15s.; and for pigs, £2.[166] The resulting values were then raised by 2 per cent to cover asses, goats, and poultry; and, finally, the estimates for 1760, 1800, and 1830 were reduced by 20, 10, and 5 per cent respectively as a very rough allowance for the improvement in the weight and quality of the livestock over the period.[167] The estimates of farm and non-farm horses at the four dates were valued at an average (1851–60) price of £20.[168] The result of these estimates is:

	1760	1800	1830	1860
Harvested and standing crops	£56m	£69m	£83m	£89m
Livestock	66m	89m	99m	109m
Farmhorses	16m	27m	28m	25m
Other horses	4m	11m	14m	17m
Total	£142m	196m	224m	240m

These totals are rounded to the nearest £10 million and carried to Table 15.

As a rough test of the reliability of the above estimates, we may note that if they are expressed in terms of the capital per acre (taking the total area of cultivated land in Great Britain at a steady 30 million acres up to 1860) and adjusted to current prices by means of an index of wholesale prices for agricultural products,[169] we get the following:

	1760	1800	1830	1860
Farmers' capital, £ per acre	3·5	10·6	8·0	8·4

These figures seem reasonable when compared with previous estimates of tenants' capital for corresponding dates, including £4 per acre given by Arthur Young for England and Wales for 1770, £10 per acre suggested by Stevenson for 1800, £6 to £7 per acre suggested by McCulloch for 1837 and 1846, £9 10s. per acre obtained by adjusting Boreham's estimate for 1867–73 for the United Kingdom to 1860 prices, and £8 per acre obtained by adjusting Turnbull's result for 1874 for the United Kingdom to 1860 prices.[170]

Finally, we can derive estimates of the contribution of farm crops and livestock to stock-building at 1851–60 prices by taking the change in the series shown above. Expressed as a rate per annum we have an average of £1·4 million for 1760–1800, £0·9 million for 1800–30, and £0·5 million for 1830–60. For the purposes of Table 16 we interpolate very roughly between the benchmark estimates to obtain the average for each decade. The series is then adjusted by the general index of wholesale prices[171] to get estimates at current prices.

3. NET HOLDINGS OF OVERSEAS ASSETS

From 1815 onwards we have Imlah's carefully constructed series for the net export of capital, obtained by estimating the annual balance on current account and deducting the estimated net imports of gold and silver bullion and specie.[172] To obtain estimates of the accumulated net holdings of overseas assets in terms of 1851–60 purchasing power, we accept Imlah's starting point of a net credit of £10 million at the end of 1815, and cumulate on this the net credit in each quinquennium, deflated by the general index of wholesale prices.[173] This gives the required values for 1830 and 1860.

For 1760 we have detailed estimates from both British and Dutch sources, indicating that total Dutch investment in Britain at that date was between £25 million and £30 million, and allowance for other foreign holdings would raise this to some £30–5 million.[174] The extent of British investment abroad to be set against that is unknown, but we may say £10–15 million and put the net debit in 1851–60 prices at £20 million. For 1800 we take foreign holdings in Britain as reduced to some £25–30 million,[175] and raise British investments abroad to some £35–45 million, making a net credit of some £10 million.[176] These results are shown for the four benchmark dates in Table 15.

For Table 16 we need estimates of the flow of capital abroad in each decade at current and 1851–60 prices. From 1815 to 1860 we have Imlah's estimates for the former and the deflated series for the latter. For 1760 to 1815 we interpolate between the estimates of the accumulated net credit abroad, assuming a broadly steady increase in British holdings

of foreign assets and adjusting foreign investment in Britain in the light of the available information.[177]

4. GOLD AND SILVER COIN AND BULLION

One part of the net imports of gold and silver would be used for the manufacture of plate, jewellery, etc., and this does not affect the present estimates.[178] The remainder would be added to Britain's monetary holdings of coin and bullion, and since these represent a potential claim on foreigners they can be regarded as equivalent to overseas assets, with changes in the amount of monetary gold and silver treated as part of net investment abroad.[179]

Various estimates are available regarding the gold and silver coin in circulation in Britain in the nineteenth century,[180] and in the light of these we take the coin in circulation at the four selected dates, together with the bullion held by the Bank of England,[181] as:

	1760	1800	1830	1860
Bullion and specie	£20m	£30m	£60m	£100m

The same values are entered in Table 15, since the price of gold was broadly the same in 1851–60 as at the selected dates.

The annual net increase in the monetary holdings of gold and silver is thus some £0·25 million between 1760 and 1800, £1 million from 1800 to 1830, and £1·3 million from 1830 to 1860. These estimates form the basis for the series incorporated in Table 16 with interpolation in the light of the sources quoted above.[182]

5. FARM LAND (INCLUDING WOODS AND PLANTATIONS)

To form a rough estimate of the unimproved value of farm land we take estimates of the gross rent (including tithes) of farm lands and buildings at the four selected dates, and capitalize these at twenty-five years' purchase for 1760, twenty-eight years for 1800 and 1830, and thirty for 1860.[183] We then deduct from this the estimated value of farm buildings, drainage, and other improvements.[184] The resulting value of unimproved farm land at current prices is:

	1760	1800	1830	1860
Farm land	£380m	£630m	£820m	£1,020m

This is assumed to include the capital value of woods and plantations.[185] To obtain the series at constant prices, we could deflate by an index of land prices, but no suitable index is available.[186] Instead, we have

adjusted the value of unimproved farm land in 1860 to 1851–60 prices, giving £1,000 million, and assume that the value would be the same for the earlier years at constant prices except to the extent that new land was brought into cultivation by enclosure of waste, heath, and moor, the drainage of marsh and fen, etc. The precise extent of this addition to the area of agricultural land is not known but seems likely to have been about three million acres, increasing the acreage by about 5 per cent between 1760 and 1800, by a further 5 per cent to 1830, and by about 1 per cent to around thirty-one million acres in 1860.[187] The estimates obtained on this basis are shown in Table 15.[188]

6. OTHER LAND

The value of urban land rent in England and Wales has been estimated by Singer at £14 million in 1861.[189] This represents 26 per cent of the gross rental (as assessed for Schedule A) of houses and other non-farm buildings. If we take the same proportion of (a) the gross rent for houses, etc. in Scotland, and (b) the gross income of railways, mines, and other property not covered by Schedule A, this would raise the total urban rent to some £21 million,[190] and if this is capitalized at twenty years' purchase it gives a capital value of some £420 million,[191] of which the land underlying dwellings and that underlying industrial and commercial buildings account for some £160 million and £150 million respectively, and the land for the railways for some £70 million.[192]

The estimates of the value of land at 1851–60 prices at the three earlier dates were obtained by assuming that the ratio of land to buildings and works was the same as in 1860 for each of the four items (dwellings; industrial and commercial buildings; railways; mines, canals, and gasworks). The resulting series is shown in line 6 of Table 15.

VI. *Comparison with Other Estimates*

The estimates for the component series in sections IV and V have already been compared, wherever possible, with estimates made by others or with estimates which we could derive by alternative procedures, and the following comments are confined to comparisons covering total fixed capital formation and the total stock of capital.

FIXED CAPITAL FORMATION

For total gross domestic fixed capital formation we can make the first comparison with the 'orders of magnitude' suggested by Pollard, to

which we referred in section I. The comparison is not exact, because of the different dates to which the estimates relate; but with this reservation, we see from Table 17 that the new estimates lie very far below Pollard's for *c.* 1770 and well above his for *c.* 1815. Fixed capital formation thus increases over the period at a rate more than double that previously suggested. For the final date, *c.* 1830–5, the two estimates agree quite well.

Table 17. *Gross Fixed Capital Formation, Great Britain, c. 1770–1835:* *Comparison with Pollard's Estimates (£m p.a. at current prices)*

	c. 1770	*c.* 1790–3	*c.* 1815	*c.* 1830–5
1. Pollard	7·2	13·3	21·9	31·0
2. Feinstein: Present estimates	4·0	11·4	26·5	28·2
3. 1 minus 2	3·2	1·9	−4·6	2·8
4. 3 as % of 2	80	17	−17	10

SOURCE

   Line 1: Pollard, 'Growth and Distribution of Capital', 362.

   Line 2: See Table 7 above. The estimate taken for comparison for *c.* 1770 is the average for the decade 1771–80; for *c.* 1790–3, the average for 1791–1800; and for *c.* 1815, the average for 1811–20. For 1830–5, the present estimates for each item for 1831–40 were allocated between the two quinquennia in the proportions indicated by the annual estimates made for that decade by Deane, 'New Estimates'. (Miss Deane has very kindly made available the separate estimates underlying her published totals.)

   Examination of the components (see Tables 2 and 7) shows even greater discrepancies. For *c.* 1770, all the present estimates are lower than Pollard's except for transport, and the absolute difference is greatest in agriculture and buildings (dwellings and public buildings). For *c.* 1790–3 the estimate for buildings is responsible for almost all of the difference in the two totals, and the other sectors agree moderately well. At the next date, *c.* 1815, there is again one sector which accounts for the greater part of the difference between the two estimates, but on this occasion it is manufacturing and trade. If the expansion over the period 1770–1815 is measured by expressing the level of gross domestic fixed capital formation at current prices *c.* 1815 as a ratio to the level *c.* 1770, we have the following contrast:

	Pollard	Present estimate
Agriculture	2·0	3·9
Transport	3·0	4·0
Building	3·7	9·8
Manufacturing, trade, etc.	4·7	14·9
Total	3·0	6·7

The discrepancies in the movement over this period are thus smallest for transport and largest for manufacturing, trade, etc.; and the overall impression given by the new estimates is thus substantially different.

For 1830–5 we can extend the comparison with Pollard to cover also the first years of Miss Deane's series. Their two estimates have already been compared with each other (see Table 3 and pp. 31–2 above) and found to show completely different orders of magnitude for fixed capital formation in Britain on the eve of the railway era. Table 18 now

Table 18. *Fixed Capital Formation, 1830–5: Comparison with Estimates by Pollard and Deane ($£m$ p.a. at current prices)*

	(1) Pollard (GB)	(2) Deane (UK)	(3) Feinstein: present estimate (GB)
1. Dwellings	10·0	6·0	8·7
2. Public building and works, etc.	1·5	2·0[a]	1·5
3. Agriculture	4·6	—[b]	3·4
4. Industry and commerce	8·2	2·9	9·5
5. Transport	6·7	4·8	5·1
Total	31·0	15·7	28·2

[a] Includes expenditure on new works and buildings by navy, army, and ordnance departments, and on naval vessels (Deane, 'New Estimates', 111). These items are not treated as capital expenditure in the present estimates: see Feinstein, *National Income*, 192.
[b] Farm implements and machinery are included by Deane in the estimates for industry and commerce; farm buildings and works are omitted altogether (*op. cit.*, 111).

SOURCES
    (1) Pollard, 'Growth and Distribution of Capital', 362.
    (2) Deane, 'New Estimates', 104, and unpublished information kindly provided for the individual sectors.
    (3) See Table 7 above, and the note to Table 17.

indicates that the new estimate is only $£3$ million (10 per cent) *below* Pollard's, with compensating differences of $£1$ to $£1·5$ million on all the main items, whereas it is over $£12$ million (44 per cent) *above* Deane's estimate. There is a broad measure of agreement on public buildings and works and transport (lines 2 and 5), but the present estimate is substantially higher than Deane's for dwellings, and there is a second major discrepancy in the key sector of industry and commerce, where the present estimate of $£9·5$ million is over three times the $£3$ million suggested by Deane. The third significant difference, in agriculture, is not a question of estimation, since Deane explicitly omitted

the expenditures on farm buildings, land-clearing, drainage, and other improvements.

The same three sectors – industry and commerce, agriculture, and (to a lesser extent) dwellings – account for most of the differences which we find if we continue the comparison with Deane's estimates down to 1860. This is done in Table 19. The discrepancy is broadly steady in

Table 19. *Fixed Capital Formation, 1831–60: Comparison with Deane's Estimates ($\pounds$m p.a., decade averages, at current prices)*

	1831–40	1841–50	1851–60
1. Deane (UK)	22·9	34·5	39·7
2. Feinstein: present estimate (GB)	40·5	50·5	58·0
3. 2 minus 1	17·6	16·0	18·3
4. 3 as % of 2	43	32	32

SOURCES

  Line 1: Deane, 'New Estimates', 104.
  Line 2: See Table 7 above.

absolute terms and so drops a little in size relative to the present estimates, but it is still extremely high (32 per cent) in the 1850s. A more detailed comparison of the components is made in Table 20 for the 1850s, and the picture this reveals is fully representative of the two earlier decades. Miss Deane would presumably not wish to defend the

Table 20. *Fixed Capital Formation, 1851–60, by Sector: Comparison with Deane's Estimates ($\pounds$m p.a., decade average, at current prices)*

	(1) Deane (UK)	(2) Feinstein: present estimate (GB)
1. Dwellings	7·4	10·3
2. Other public buildings and works	4·9[a]	2·0
3. Agriculture	—[b]	6·9
4. Industry and commerce	9·0	20·7
5. Transport	18·4	18·1
Total	39·7	58·0

[a] See note a to Table 18.
[b] See note b to Table 18.

SOURCES

  (1) Deane, 'New Estimates', 104, and unpublished information kindly provided for the individual sectors.
  (2) Table 7 above.

omission of farm buildings and works, so that the main disagreement over estimation is concentrated on the level of capital expenditure in the industrial and commercial sector: £9 million per annum in Deane against £21 million according to the new estimate. Despite all the uncertainty regarding the estimates obtained for this sector, it is hard to believe that they overstate the true level so seriously that they should be reduced by more than half – particularly for the period 1831–60, for which they have a reasonably secure foundation in the assessments for Schedule A and the Inhabited House Duty. Since this sector is of such importance, not only for the estimates but also for our understanding of economic developments in this period, one obvious conclusion to be drawn from the analysis of Tables 18, 19, and 20 is that this is the area in which future research on capital formation should be concentrated.

The final comparison which can be made with a comprehensive estimate of gross fixed capital formation arises at the point where the present estimates overlap those which I have previously published for the years from 1856 onwards. This is given in Table 21 and can be done

Table 21. *Fixed Capital Formation 1856–60, by Type of Asset: Comparison with Previous Estimates, by Sector: (£m p.a. at current prices)*

	(1) Feinstein: previous estimates (UK)	(2) Feinstein: present estimates (GB)
1. Dwellings	6	9·5
2. Non-residential buildings and works		
a. Farm	—	7·0
b. Railways, docks, and harbours	8	8
c. Others	7	18·5
3. Plant and machinery	10	7
4. Ships	5	5
5. Vehicles	1	3
Total	37	58

SOURCES
(1) Feinstein, *National Income*, Table 39, p. T85, and supporting worksheets.
(2) Table 7 above, average for 1851–60, spread between the two halves of the decade (see the note to Table 17), and roughly allocated by type of asset.

only by type of asset, not by sector. The present estimates are higher by some £21 million (36 per cent), and of this over £8 million is accounted for by the farm buildings and works and the carriages and coaches which were omitted from the previous estimates (reflecting, to a large extent, their origin in the rather different economic circumstances of 1907);[193] while a further £11 million appears in the other

buildings and works (line 2c of Table 21), mainly relating to the industrial and commercial buildings. This again calls for further investigation of this sector, but on the evidence now available I would consider the present estimate appreciably more reliable than the earlier extrapolation from the 1907 benchmark.[194] A further difference, in the opposite direction, occurs in the estimates for plant and machinery (line 3), and though it is smaller than that for the buildings it is not negligible. In this case I find it more difficult to take a view on the relative merits of the two estimates derived by totally independent and different procedures. However, taking the estimates as a whole, it seems clear that the previous estimate of £37 million per annum for the late 1850s was too low, and I would feel reasonably confident that the true value lies within a margin of error of ±15 per cent of the present estimates.

CAPITAL STOCK

For the estimates of the gross stock of fixed capital the only alternative estimates we have for comparison with the present results are the series which I published in 1972, starting in 1855 and classified by type of asset. Table 22 reveals the enormous discrepancy between these two attempts to value the stock of fixed assets: the previous estimate of £3,380 million is 46 per cent higher than the present figure of £2,310 million. The difference in prices underlying the two estimates (1860 replacement cost for the former, and the average of 1851–60 for the latter) is negligible,[195] but some allowance should be made for the exclusion of Ireland from the present estimates, and this might raise them by some 5 per cent.[196] This would still leave a great gulf of over £900 million.

   The disagreement is at its worst in the estimate for plant, ships, and vehicles, and within this it arises primarily in the value of industrial plant and equipment. It is smallest for non-residential buildings and works, but within this aggregate the amount allowed in the present estimate for industrial and commercial buildings (£460 million) is substantially less than the amount of around £800 million implicit in the earlier work. This is partially offset by the larger value which the present estimates assign to farm buildings and works. Finally, there is a serious difference over the estimates for dwellings.

   This is not the place for a full investigation of these discrepancies, but it seems desirable to make a brief comment. The earlier estimates were obtained by taking the end-1920 figures at 1930 replacement cost from the study of capital formation in the inter-war period,[197] making a small addition for Southern Ireland so as to cover the whole of the British Isles, adjusting from 1930 to 1900 prices, and then extrapolating

backwards by means of a reversal of the perpetual inventory formula.[198] Finally a further price adjustment was made to convert from 1900 to current prices, so as to obtain, for example, the estimate for 1860 at 1860 replacement cost used in the comparison in Table 22.[199] It was always

Table 22. *Gross Capital Stock in 1860: Comparison with Previous Estimate* (£m *at replacement cost*)

	(1) Feinstein: present estimates (GB at 1851–60 replacement cost)	(2) Feinstein: previous estimate (UK at 1860 replacement cost)
1. Dwellings	600	850
2. Other buildings and works	1,370	1,630
3. Plant, ships, and vehicles	340	900
4. Total	2,310	3,380

SOURCES

(1) Table 8 above, with an approximate allocation of certain items by type of asset.
(2) Feinstein, *National Income*, Table 46, p. T103.

recognized that this indirect route was likely to lead to very unreliable results,[200] but obviously the full extent of the probable error was not correctly anticipated. The crucial question for the present is whether the new estimates can be regarded as likely to be more nearly correct and, if not, where the true estimate will fall between £2,400 million and £3,400 million. As a first step towards an answer, we may note that errors of overstatement could enter the results published in 1972 if:

(a) the initial benchmark obtained for the inter-war years was too high: in this connection, it is a critical consequence of the method that what may be a fairly minor error relative to the level of the stock in 1920 or later will be carried backwards as an unchanging absolute amount (at constant prices) and could then be a very large error relative to the level of the stock in 1860;[201]

(b) the estimates of gross fixed capital formation deducted from the end-1920 stock were too low; or

(c) the estimates of capital scrapped or sold, which are added to the 1920 stock as it is extrapolated back to earlier years, were too high.

A preliminary reconsideration of the 1972 estimates suggests that there are compensating errors in all three categories. In particular, it seems likely that the inter-war benchmark for commercial buildings was seriously overstated and that the estimates for dwellings and for industrial buildings and works (including mining) were also too high,[202]

and that the estimates of capital expenditure, especially on non-residen-
tial building, were too low.[203] As a partial offset, the allowance for
machinery and equipment scrapped was too high,[204] and the earlier
estimates made too little allowance for the scrapping of farm assets dur-
ing the late-nineteenth-century depression in the arable farming areas.[205]

It seems likely that correction for these factors would eliminate most
of the differences shown in Table 22; but it is also, of course, possible
that the present estimates are too low for some sectors, and this seems
most likely to be the case for industrial machinery and equipment. As a
very tentative conclusion at this stage, we might say that we expect the
true value of the 1860 stock of fixed capital assets in Great Britain to lie
between £2,200 million and £2,800 million, but a firm judgement
will require a good deal of further research.

To round off this discussion of our methods and results we can com-
pare the present estimate of national wealth in 1860 with Giffen's esti-
mate, adjusted so as to be broadly comparable in coverage.[206] However,
as we have already noted,[207] the two estimates differ conceptually, and
close agreement is not to be expected. A valuation by Giffen's method
should be lower than the present estimate to the extent that it allows for
depreciation of fixed assets; it might be higher or lower to the extent
that capitalization of future prospects diverges from the accumulation
of actual past outlays.

As the comparison in Table 23 shows, the present total is only £120
million, or 3 per cent below the adjusted Giffen estimate. If the estimate
for lands is excluded on the grounds that the source and the method
used for the present estimate of the total are essentially the same as for
Giffen's,[208] the discrepancy is still only 3 per cent though the sign
changes, i.e. the present estimate is then marginally higher. This out-
come is, however, the reflection of some compensating differences. The
present estimate is one-third higher for houses and other buildings, and
the difference would be substantial even if farmhouses were added to
Giffen's estimate. It is also higher for mines, gas and water supply,
canals, etc., where there is some reason to think that Giffen capitalized
at too low a rate.[209] Our estimates are substantially lower than Giffen's
for farmers' capital, on which Giffen had been the subject of criticism
by contemporaries,[210] and for the domestic and foreign capital, fixed
and circulating, of industry and trade, etc., where Giffen's method is
particularly uncertain,[211] but where the present estimates are also highly
conjectural.

The comparison in Table 23 is also of interest in bringing out the very
heterogeneous character of some of the items covered by a single figure
in Giffen's estimate, and in emphasizing the potentially misleading
nature of some of his titles, e.g. 'lands' or 'houses'.

Table 23. *National Capital, Great Britain, 1860: Comparison with Giffen's Estimate* (£m)

	(1) Feinstein: present estimate	(2) Giffen (adjusted)	(3) (2)—(1)
1. Lands			
a. Farm land (unimproved)	1,000		
b. Buildings and improvements	400		
	—— 1,400	1,610	210
2. Houses, etc.			
a. Dwellings	600		
b. Industrial and commercial buildings	460		
c. Land	310		
	—— 1,370	890	—480
3. Farmers' capital			
a. Farm crops, livestock, horses	240		
b. Implements, tools, etc.	30		
	—— 270	490	220
4. Businesses, etc.			
a. Industrial machinery and equipment	160		
b. Non-farm stock-in-trade	210		
c. Ships, carriages, coaches	90		
d. Overseas assets	360		
	—— 820	1,010	190
5. Railways			
a. Buildings, rolling stock, track, etc.	270		
b. Land	70		
	—— 340	350	10
6. Mines, etc.			
a. Mines, gasworks, water supply, canals, etc.	110		
b. Land	40		
	—— 150	110	—40
7. Government and local property			
a. Roads and bridges	70		
b. Docks and harbours	40		
c. Public works and buildings	80		
	—— 190	200	10
	4,540	4,660	120

SOURCES

(1) See Tables 8 and 15 above. The value of gold and silver coin and bullion has been omitted since this item is not covered by Giffen; the estimates for non-farm land have been allocated to their respective buildings and structures in lines 2c, 5b, and 6b; and £30m for farmers' implements, etc. has been transferred from 1b to 3b.

(2) Giffen's published estimate for 1865 was £6,114m ('On Recent Accumulations of Capital in the United Kingdom', *J. R. Stat. Soc.*, XLI (1878), 11; also *Growth of Capital*, 43). This has been adjusted (a) to exclude his estimate of £500m for movable

property *not yielding income*: (*b*) to exclude army and navy property, taken at a very round £100m; (*c*) to exclude some £35m for Ireland from the remaining items on the basis of the proportions shown by Giffen for 1885 (*Growth of Capital*, 163–5); and (*d*) to change the underlying income estimates to correspond more closely with an estimate of the capital stock in 1860 by moving from the income of 1864–5 used by Giffen to the income of, e.g. 1860–1 for assessments on a current-year basis, or of 1862–3 where the average of the three preceding years was assessed for tax. The assessments used were those given by Giffen, 'Recent Accumulations', 29–30. This reduces the total by a further £510m.

VII.   *Capital Accumulation and Economic Growth*

In this final section we step back to look at the broad outlines of the results we have obtained and to make a preliminary analysis of some of their main implications for an understanding of the process of economic growth of the British economy from the pre-industrial condition of 1760 through the industrial revolution and the transformation of agriculture and transport to the industrialized and urbanized society of 1860.

As will be painfully clear to anyone who has studied the preceding pages, there have been very few items for which precise, objective, and comprehensive data could be found: we have hardly any records of actual capital expenditure or statistics of the number of assets of a particular type constructed or in place. In almost every case we have had to rely on fragmentary evidence held together by a multitude of more or less arbitrary assumptions. In the main, however, these have been specific and self-contained assumptions concerning, for example, the rate of improvement in the standard of dwellings, the proportion of farm rents represented by capital expenditure, the level of capital per head in textiles relative to other manufacturing industries, the average cost of sailing ships, the yield per acre of farm crops, and so on. With a few exceptions, we have not assumed a particular relationship between the level or growth of capital and the level or growth of population or of real national product.[212] Thus it is legitimate and may also be interesting to explore the consequences of all the assumptions and conjectures which have been made, and to see what they imply at an aggregate level about the growth and structure of the capital stock[213] and capital formation, and their relationship to population and real GNP. In what follows we shall make a preliminary attempt to do this; we shall not explicitly qualify every comment ('If the estimates are approximately correct . . .'), but the very large margins of error must, of course, be kept in mind throughout.

CAPITAL, POPULATION, AND OUTPUT

In Table 24 we look first at the levels and rates of growth of three of the main aggregates for the stock of capital: fixed capital, fixed and circulating (domestic reproducible) capital, and total capital or national wealth, including land and overseas assets. The first two measures of capital show broadly the same result: over the century to 1860, they rise to over four times their initial level, at an average annual rate of

Table 24. *Levels and Rates of Growth of the Stock of Capital,*
Great Britain, 1760–1860

	(1)	(2)	(3)
	Fixed capital	Domestic reproducible capital	National wealth
A. End-year levels (£m at 1851–60 prices)			
1760	490	670	1,630
1800	730	990	2,070
1830	1,180	1,510	2,840
1860	2,310	2,760	4,640
B. Growth rates (% p.a.)			
1761–1800	1·0	1·0	0·6
1801–30	1·6	1·4	1·0
1831–60	2·3	2·0	1·6
1761–1860	1·6	1·4	1·0

SOURCES
(1) Table 8 above.
(2) = (1) plus total circulating capital (Table 15).
(3) = (2) plus land and overseas assets (Table 15).

growth of about $1\frac{1}{2}$ per cent per annum (compound); the rate of expansion is marginally greater for fixed capital than for domestic reproducible capital. The inclusion of land in the third series – total national wealth – slows down the rate of growth of this measure to about 1 per cent per annum. We defer further consideration of the differences between the three measures of capital to a later stage, where we examine the changes in the composition of the stock of capital (p. 87 below); for the moment, we confine our attention to the domestic reproducible capital.

The main series for reproducible capital, population, and real output[214] are set out in Table 25. The levels of the three primary series and their corresponding ratios – capital per head of the population, output per head of the population, and capital per unit of output – are shown

Table 25. *Levels and Rates of Growth of Capital, Population,*
and Output, Great Britain, 1760–1860

	(1) Domestic reproducible capital (£m at 1851–60 prices)	(2) Population (millions)	(3) Real output (GDP) (£m at 1851–60 prices)	(4) Capital per head	(5) Output per head	(6) Capital/output ratio
				(£ at 1851–60 prices)		
A. End-year levels						
1760	670	7·87	90	85	11	7·4
1800	990	10·76	140	92	13	7·1
1830	1,510	16·34	310	92	19	4·9
1860	2,760	23·13	650	120	28	4·3
B. Growth rates (% p.a.)						
1761–1800	1·0	0·8	1·1	0·2	0·3	−0·1
1801–30	1·4	1·4	2·7	—	1·3	−1·2
1831–60	2·0	1·2	2·5	0·9	1·3	−0·4
1761–1860	1·4	1·1	2·0	0·3	0·9	−0·6

SOURCES
(1) Total fixed capital (Table 8 above) plus circulating capital (Table 15).
(2) Deane and Cole, *British Economic Growth*, 6, and Mitchell, *Abstract*, 6–7 (including allowance for the armed forces and merchant service in 1801 and 1831).
(3) GNP at factor cost in 1860 from Deane, 'New Estimates', 104, adjusted to exclude Ireland on the basis of Deane and Cole, *op. cit.*, 335, and converted to 1851–60 prices; extrapolated to 1830 on the basis of Deane, 'New Estimates', 98, to 1800 on the basis of Deane and Cole, *op. cit.*, 282, and to 1760 using the Deane and Cole indices but with 1800 weights, *op. cit.*, 78–9. This final link (1760–1800) is particularly uncertain. To obtain GDP at 1851–60 factor cost, this series was then adjusted to exclude net property income from abroad: Imlah, *Economic Elements in the Pax Britannica* (1958), 70–2.
(4) = (1)/(2).   (5) = (3)/(2).   (6) = (1)/(3).

in the upper part of the table for the benchmark dates, and the rates of growth are given in the lower part.

While reproducible capital increased fourfold over the century at a rate of about 1½ per cent per annum, population expanded threefold at a rate of about 1 per cent per annum, and so capital per head shows a modest increase. As shown in column 4 of Table 25 it rises (at 1851–60 prices) from £85 in 1760 to £120 in 1860. Real output outpaces both capital and population over the century, increasing more than sevenfold at a rate of some 2 per cent per annum. There is thus a persistent downward trend in the capital–output ratio at a rate of about 0·5 per cent per annum.

The same relationship can be expressed in a slightly different way by

noting that a rise in capital per head of population, at a rate of less than
0·5 per cent per annum, was accompanied by – and in some degree
associated with – a rise in output per head of population, at about 1 per
cent per annum. The degree of association and the nature of the causal
relationships between the growth of output and the growth of capital
must be left as subjects for further investigation.[215]

If we now look more closely at the pattern of growth *within* the
century, we see that the estimates in Table 25 show a steady increase in
the rate of growth of reproducible capital, from about 1 per cent per
annum in the first of the three sub-periods distinguished in the table
(1761–1800) to about $1\frac{1}{2}$ per cent per annum in the second (1801–30)
and 2 per cent in the third (1831–60). In the first two periods population
more or less keeps pace with capital, so that almost all of the increase in
capital per head observed previously in fact occurs in the final three
decades, when it rises from £92 to £120 (at constant prices), at a rate of
about 1 per cent per annum.

Output rises at about the same rate as capital from 1760 to 1800, but
thereafter it goes ahead much more rapidly, particularly in the three
decades 1801–30 before the coming of the railways, and the capital–
output ratio falls from about 7 in 1800 to just over 4 in 1860.[216]

CAPITAL, LABOUR, OUTPUT, AND PRODUCTIVITY

Up to this point we have considered the relationship of capital to output
and population. However, in the context of an analysis of the growth of
productivity, to which we now turn, the relevant variable is not
population but labour. From 1800 onwards we have a very approximate
estimate of the labour force (total occupied population), derived from
the Census of Population, and this shows an increase from 4·8 million
in 1801 to 7·2 million in 1831 and 10·8 million in 1861.[217] The corre-
sponding participation rates are: 44, 44, and 47 per cent[218] – i.e. the
rate of growth of the labour force was the same as that of the total
population from 1800 to 1830 (1·4 per cent per annum) and only
marginally faster from 1830 to 1860 (1·4 as against 1·2 per cent per
annum). If we assume in the light of this that there was also no signifi-
cant change in the overall participation rate in the period from 1760 to
1800, we can extend the labour series back to 1760. We can then make
a very broad analysis of the productivity of both labour and capital.[219]
We take as the most appropriate measure of capital the domestic
reproducible assets. The corresponding measure of real output is again
the gross domestic product. The relevant series are set out in Table 26,
together with estimates of the combined input of labour and capital and
of the 'residual' or output per unit of total inputs.[220]

Table 26. *Inputs, Output, and Total Factor Productivity, Great Britain, 1760–1860*

	(1) Output	(2)	(3) Inputs	(4)	(5)	(6) Productivity	(7)
	GDP at constant factor cost	Labour	Domestic reproducible capital	Total inputs	Output per worker	Output per unit of capital	Output per unit of total inputs
A. End-year levels (index: base = 100)							
1760	14	32	24	28	44	58	50
1800	21	44	36	40	48	58	52
1830	48	67	55	61	72	87	79
1860	100	100	100	100	100	100	100
B. Growth rates (% p.a.)							
1761–1800	1·0	0·8	1·0	0·9	0·2	—	0·3
1801–60	2·6	1·4	1·7	1·5	1·2	0·9	1·0
1801–30	2·8	1·4	1·4	1·4	1·4	1·4	1·4
1831–60	2·5	1·4	2·0	1·7	1·1	0·5	0·8
1761–1860	2·0	1·1	1·4	1·3	0·8	0·5	0·7

SOURCES

(1) See column (3) of Table 25 above.
(2) See text, p. 85.
(3) Total fixed capital (Table 8) plus circulating capital and land (Table 15), all at 1851–60 prices.
(4) Cols. (2) and (3) combined with equal weights on basis of roughly equal distribution of factor incomes between labour and property (profits plus rent, adjusted to exclude the estimated pure rent of land) in 1860: see Feinstein, *National Income*, Table 18, p. T44.
(5) = (1)/(2).
(6) = (1)/(3).
(7) = (1)/(4).

Our major findings with respect to the growth of output, capital, an labour inputs and productivity between 1760 and 1860 may be summarized as follows:[221]

(i) Real output (GDP) increased at a rate of about 1 per cent per annum from 1760 to 1800 and then accelerated to about $2\frac{1}{2}$ per cent from 1800 to 1860.

(ii) The labour force increased at just under 1 per cent per annum from 1760 to 1800 and at just under $1\frac{1}{2}$ per cent from 1800 to 1860.

(iii) The growth rate of the domestic reproducible capital stock increased steadily, rising from 1 per cent per annum in 1760–1800 to $1\frac{1}{2}$ per cent per annum in 1800–30, and to 2 per cent per annum in 1830–60.

(iv) The rate of increase of the combined inputs was thus about 1 per cent per annum from 1760 to 1800 and $1\frac{1}{2}$ per cent from 1800 to 1860.

(v) Capital and labour grew at about the same rate from 1760 through to 1830, so that there was effectively no change in the capital–labour ratio in these seven decades. In the last three decades the ratio did rise, as capital per worker increased at a rate of about $\frac{1}{2}$ per cent per annum.

(vi) In the first four decades output and inputs grew at about the same rate, so that there was effectively no improvement in the productivity of labour, or of labour and capital combined. From 1800 to 1860, however, we find that output per worker and per unit of capital increased at about 1 per cent per annum, and the 'residual' or total factor productivity also increased at 1 per cent. The rate of growth of total productivity is greater from 1800 to 1830 than from 1830 to 1860 because of the slower growth of capital in the first of these sub-periods.

(vii) With minor exceptions the main break in trend rates of growth, as indicated by the above summary, occurs around the end of the eighteenth century, with outputs, inputs, and productivity all growing appreciably more rapidly from 1800 to 1860 than from 1760 to 1800.

CHANGES IN THE STRUCTURE OF NATIONAL WEALTH

A detailed picture of the changes in the structure of national wealth is set out in Table 27, in order to provide more information about the forces underlying the trends in total capital input described in the preceding pages. The percentage composition of total national wealth is shown by type of asset in the upper part of the table and by economic sector in the middle part, and the lower part gives the percentage composition of domestic reproducible capital by sector and type of asset.

The major feature of the first part of the table is the decline in the

Table 27. *Composition of National Wealth, 1760–1860, by Type of Asset and by Sector (per cent)*

	1760	1800	1830	1860
A. National wealth by type of asset				
1. Fixed assets	30	35	42	50
2. Circulating capital	11	13	11	9
3. Domestic reproducible capital	41	48	53	59
4. Land	59	50	42	31
5. Total domestic capital	100	98	95	90
6. Overseas assets[a]	—	2	5	10
National wealth	100	100	100	100
B. National wealth by sector				
1. Residential and social	16	16	19	18
2. Agriculture	77	68	55	36
3. Industry and commerce	5	10	16	23
4. Transport	2	4	5	13
5. Overseas assets[a]	—	2	5	10
National wealth	100	100	100	100
C. Domestic reproducible capital by sector and type of asset				
1. Residential and social	31	28	28	24
2. Agriculture: fixed	31	27	22	16
3. Agriculture: circulating	21	19	15	9
4. Industry and commerce: fixed	5	11	18	25
5. Industry and commerce: circulating	6	7	7	8
6. Transport	6	8	9	18
Total	100	100	100	100

[a] Including gold and silver.

SOURCE. Estimates at 1851–60 prices in Tables 8 and 15 above. Components may not add to totals because of rounding.

relative importance of land and of circulating capital. The given, non-reproducible component of national wealth increased at a rate of less than $\frac{1}{2}$ per cent per annum over the whole century, and its share in the national wealth (which was growing at about 1 per cent per annum) thus fell from about 60 per cent in 1760 to 30 per cent in 1860. In assessing this trend, it must be remembered that the very large increase in the price of farm land relative to other prices (see note 188), and the increase in urban site values, have the effect of giving land a much

larger weight relative to other assets, at the given base-period prices (1851–60), than it would have if land and other assets were valued at current prices in each period. Circulating capital in agriculture, industry, and trade also grew quite slowly (the rate was just under 1 per cent per annum), and there was a consequent fall in its share of national wealth, from a peak of 13 per cent in 1800 to 9 per cent in 1860. The categories which rise in importance are fixed capital and overseas assets. The former's share of the national wealth rises strongly from 30 per cent to 50 per cent; the latter's share rises from nothing to 10 per cent. The changing ratio of fixed to circulating capital which emerges from this process is thus quite striking: from 3:1 in 1760 to 5:1 a hundred years later.

The outstanding feature of the classification by sector in the middle part of Table 27 is the diminution of the share of national wealth in the agricultural sector. At the beginning of the century under review, agriculture accounted for 77 per cent of the total; by the end its share had plummeted to 36 per cent – that is, its relative importance had been halved. This huge change in the significance of the capital in agriculture reflects principally the fall in the relative importance of land already noted; fixed and circulating capital in agriculture held its share of the total steady at about 22 per cent until 1830 and then dropped to 14 per cent. The proportion of the national wealth in the form of housing and public buildings was broadly unchanged throughout the century, and it was the three remaining sectors which came to occupy a more prominent position in the nation's wealth. Between 1800 and 1860, the transformation of the economy is reflected in the rise in the share of industry and commerce from 10 per cent to 23 per cent, of transport from 4 per cent to 13 per cent, and of overseas assets from 2 per cent to 10 per cent.

The last part of Table 27, in which land and overseas assets are excluded, is in some ways the most interesting. It again shows a marked fall in the importance of capital in agriculture, with a decline from over half the total in 1760 to one-quarter in 1860. Both fixed and circulating capital in agriculture experience this continuous downward trend in their relative importance, the former from 31 per cent of domestic reproducible capital in 1760 to 16 per cent in 1860, and the latter from 21 per cent to 9 per cent. The share of residential and social capital also falls, though less dramatically, from 31 per cent to 24 per cent. By contrast, industrial and commercial capital rises very steeply, from 11 per cent of the total in 1760 to 18 per cent in 1800 and 33 per cent in 1860. A notable feature of this increase is that it is almost entirely due to the expansion of the stock of fixed assets; these assets increase at a rate of some 3 per cent per annum and consequently enhance their position from

a lowly 5 per cent in 1760 to a dominant 25 per cent in 1860, by when
they are larger than any other category shown in Table 27. A further
consequence of these trends is the sharp rise in the ratio of fixed to
circulating capital within the industrial and commercial sector. In 1760
the value of fixed capital was marginally less than the value of inven-
tories; by 1800 it was considerably higher, and the ratio of fixed to
circulating capital was 1·5:1; by 1830 the ratio was 2·5:1, and by 1860
it had climbed to 3·3:1. Finally, we may note that fixed capital in trans-
port also shows a substantial increase, mainly after 1830, when the
construction of the railways lifted the share of this sector from 9 per
cent to 18 per cent.

THE INVESTMENT RATIO

One of the major issues which has been discussed with regard to capital
formation is the investment (or savings) ratio, the proportion of
national income devoted to investment. To see the implications of the
present estimates for the hypothesis that an increase in the ratio is an
essential feature of the industrialization process,[222] we turn to Table 28.
All three of the investment series set out there show broadly the same
picture. Gross domestic fixed capital formation (line 5) rises from about
7 per cent of GDP[223] in the 1760s and 1770s to a peak of 11 per cent in
the period of rapid industrial advance from 1791 to 1800, then drops
back a fraction during the war years, and thereafter remains remarkably
steady at a rate of 10 or 11 per cent of income all the way down to
1851–60. The picture shown by the other two ratios is essentially the
same. Total investment (line 7) rises from 8 per cent of national income
in 1761–70 to 14 per cent in 1791–1800, falls quite sharply during the
wartime decade 1801–10, bounces back to 13 per cent in the following
decade, and then remains obstinately at about that level for the re-
mainder of the period.[224]

   There are two major conclusions to be drawn from the present
estimates:

   (i) Contrary to the view tentatively advanced by Deane and Cole
and now widely (and sometimes dogmatically) accepted,[225] the invest-
ment ratio did rise during the eighteenth century, and by quite a sub-
stantial margin: on the evidence of line 7 of Table 28, it rose from 8 per
cent in the 1760s (and presumably somewhat less than this earlier in the
century) to 14 per cent in the 1790s.

   (ii) After the recovery from the wartime dip in the ratio at the begin-
ning of the nineteenth century, there was no further increase; and –
again contrary to the view generally held – the investment ratio was
not significantly lifted by the railway-construction booms of the 1840s

Table 28. *Investment and Domestic Product, 1760–1860*

	1761–70	1771–80	1781–90	1791–1800	1801–10	1811–20	1821–30	1831–40	1841–50	1851–60
1. Gross domestic fixed capital formation[a] (£m p.a.)	6·5	7·0	11·0	14·5	16·5	20·5	28·5	38·5	49·5	58·0
2. Total domestic investment[a] (£m p.a.)	7·5	9·0	13·0	17·5	17·5	22·5	32·5	42·0	54·5	61·5
3. Total investment[a] (£m p.a.)	8·0	10·0	14·5	19·0	15·5	27·5	40·0	46·5	61·0	81·5
4. GDP[b] (£m p.a.)	95	100	110	135	160	200	275	365	450	595
5. 1 as % of 4	7	7	10	11	10	10	10	11	11	10
6. 2 as % of 4	8	9	12	13	11	11	12	12	12	10
7. 3 as % of 4	8	10	13	14	10	14	14	13	14	14

[a] (1)—(3): decade averages at 1851–60 prices, rounded to nearest £0·5m.
[b] (4): decade averages at 1851–60 prices, rounded to nearest £5m.

SOURCES

(1) Table 6 above.
(2) = (1) plus stockbuilding, second column of Table 16.
(3) = (2) plus overseas investment, last column of Table 16.
(4) Real GDP at factor cost at 1851–60 prices using the sources listed in the notes to column 3 of Table 25, but taking annual averages per decade. For 1831–60, annual estimates are available as the basis for this; for 1801–30, the figures at decade intervals have been averaged (e.g. 1801–10 equals half of 1801 and 1811); and for 1761–1800, the decennial averages have been adjusted so that, for example, 1761–70 equals four-tenths of 1755–64 plus six-tenths of 1765–74. The level of the series is very uncertain throughout. See also note 223 above.

and 1850s. Investment, of course, was rising through the first half of the nineteenth century, but so too was income, and the level of investment relative to income did not change appreciably.

If these findings are confirmed by further studies of the trends of capital accumulation and GDP, they will have some significance for the analysis of such issues as the role of capital in the process of industrialization and the effects of early industrialization on the material standard of living of the working classes.

CHANGES IN THE STRUCTURE OF INVESTMENT

Two aspects of the changing structure of investment are set out in Table 29. The upper part shows, firstly, the investment in additions to stocks as a percentage of fixed capital formation and, secondly, the net investment abroad as a percentage of total domestic investment. Within the main productive sectors, i.e. industry, commerce, and agriculture (line 1a), the additions to stocks average almost 40 per cent of the fixed capital accumulation in the period 1761–1800, and this drops to an average of about 20 per cent in the first six decades of the nineteenth century. There is thus a marked decline in the relative importance of investment in stocks and work in progress. If the stockbuilding is expressed as a percentage of total domestic fixed capital formation (line 1b), the ratio declines from an average of about 20 per cent in 1761–1800 to just under half this level (9 per cent) in 1801–60. Line 2 shows net investment abroad steady at about one-tenth of domestic investment in the last four decades of the eighteenth century, and negative during the capital inflow of 1801–10; it then rises to over one-fifth in the two decades 1811–30, falls back sharply to eighteenth-century proportions in the next two decades, and finally climbs to record levels to equal one-third of the domestic investment in 1851–60.

The lower part of Table 29 indicates the very considerable changes which occurred in the composition of domestic fixed capital formation during this century of industrialization and modern economic growth. The outstanding – but not unexpected – features are:

(i) There is an uninterrupted fall in the share of investment in farm buildings and improvements, from 35 per cent at the beginning of the period (1761–80) to 12 per cent at the end.

(ii) The share of fixed investment absorbed by the industrial and commercial sector rises from under 20 per cent in the first two decades to an average of about 26 per cent in the period 1781–1820 and to over 33 per cent in the period 1821–60. Within this sector the share of buildings changes relatively little after 1780, and the upward trend in the total for the sector is essentially due to the increased investment in

Table 29. *The Structure of Investment, 1761–1850 (per cent)*

	1761–70	1771–80	1781–90	1791–1800	1801–10	1811–20	1821–30	1831–40	1841–50	1851–60
1. Stockbuilding as % of fixed capital formation										
a. Industry, commerce, and agriculture	29	57	30	40	12	19	30	19	24	13
b. Total economy	15	28	18	21	6	10	14	9	10	6
2. Net investment abroad as % of total domestic investment	7	11	11	9	—11	22	23	11	12	33
3. Structure of domestic fixed capital formation by sector and type of asset[a]										
a. Residential and social	25	22	21	26	30	31	35	30	18	21
b. Agriculture	33	37	30	30	25	22	16	13	13	12
c. Industry and commerce										
Buildings	15	10	19	15	18	20	24	22	16	19
Machinery	4	2	10	6	5	6	9	9	9	10
Mining, gas, and water	1	—	1	1	1	2	2	3	4	7
Total (industry and commerce)	20	12	30	23	24	29	35	34	29	36
d. Transport										
Railways	—	—	—	—	—	—	—	9	28	15
Ships	8	11	9	8	7	6	5	6	7	9
Other	14	18	10	14	14	12	10	8	5	7
Total (transport)	22	29	19	22	21	18	15	23	40	31
e. Total	100	100	100	100	100	100	100	100	100	100

[a] Components may not add to totals because of rounding.

SOURCES. All the underlying estimates are decade averages at 1851–60 prices.

Part 1a: Table 16, second column as % of Table 6, lines 3–7.   Part 1b: Table 16, second column, as % of Table 6, lines 1–13.

Part 2: Table 16, last column as % of Table 6 (total) plus Table 16, second column.   Part 3: Table 6.

machinery and equipment in manufacturing, mining, and the utilities. These assets – the capital goods that (together with the railways) most directly embody the technological changes which give this period its great historical significance – increase their share from 5 per cent or less in the mid eighteenth century to 17 per cent a century later.

(iii) The first canal boom makes its presence evident in the 1770s, but in general the share of fixed capital devoted to transport is steady at about one-fifth of the total until the end of the 1830s, when it leaps to double that proportion under the impact of the great railway boom of the 1840s. In that decade the railways alone account for some 28 per cent of domestic fixed capital formation; but this was not sustained, and the proportion dropped sharply to 15 per cent in the 1850s. Investment in ships is broadly stable at around 8 per cent of the total for most of the period; while investment in the other assets (roads, carriages, canals, and docks) is steady – and substantial – at around 14 per cent of the total for the first five decades (1761–1810) but in the next five decades shows a marked decline, to end at about 6 per cent in the period 1841–60.

(iv) Three phases are apparent in the capital expenditure on dwellings and public buildings and works (line 3a of Table 29). From 1761 to 1800 they account for about 23 per cent of the total; their share then rises sharply to about 32 per cent in the next four decades (1801–40) and finally falls back to about 20 per cent in the last two decades, to make way for the huge programme of railway construction.

APPENDIX

Number and Gross Annual Value of Buildings in 1860

The major sources of statistical information about buildings in the nineteenth century are the decennial Census of Population enumerations of inhabited and uninhabited houses from 1801; the assessments, for Schedule A of the Income Tax, of the gross annual value of all buildings (except farm buildings and farmhouses occupied by tenant farmers, which were assessed with land) from 1842–3; and the assessments, for Inhabited House Duty, of the number and gross annual value (equivalent to gross rental) of buildings char d with duty from 1851–2, supplemented from 1874–5 with corresponding details f buildings exempt from duty. By using all three of these sources we can c 'i-pile an estimate of the number and annual value of buildings in Britain in 1860.

The number of inhabited houses at the end of each decade was given in the Census of Population *Reports* for England and Wales.[226] The census definition

of houses covered private dwellings, farmhouses, residential shops, hotels, clubs, public houses, hospitals, and schools, as well as warehouses, offices, etc. when inhabited by resident caretakers. Blocks of flats and blocks of shops with residences above were each reckoned as one house.[227] The census gives only an aggregate figure for the stock of buildings (until 1911), and in order to get a more detailed picture we must turn to the Inhabited House Duty statistics. The duty was levied from 1796 to 1834 and was reintroduced in 1852–3, but it is only from 1874–5 that full statistics are given for the build-ings exempt from duty (i.e. those with a gross annual value of less than £20, and those not used as dwellings) as well as for those charged. Thus 1880 is the earliest year for which we can make a full comparison of the census and Inhabited House Duty enumerations; it is instructive to do this even though it lies outside our period. The number of inhabited houses in Great Britain at the census of 1881 was 5,570,000. In 1880–1, the number of dwelling-houses, residential shops, hotels, pubs, etc. and farmhouses assessed for duty was 5,413,000, to which we must add some 300,000 farmhouses with an annual value of less than £20 which were not covered by the assessment[228] – i.e., a total of 5,713,000. This is some 143,000 (2½ per cent) in excess of the census figure, and we thus have a broad confirmation of the census total and a reasonable indication of its coverage.[229]

We cannot make a similar comparison for 1860, but we can use the House Duty and other statistics[230] to make a broad classification of the estimated total of 4,350,000 inhabited houses, derived from the 1861 census for England and Wales plus an estimate for Scotland; this classification is shown in Table 30.

Table 30. *Number of Houses in Britain in 1860 (thousands)*

	Annual value less than £20	Annual value £20 or more	Total
Dwelling-houses	3,365	345	3,710
Farmhouses	300	20	320
Residential shops	135	135	270
Hotels, pubs, etc.	—[a]	50	50
Total	3,800	500	4,350

[a] Included with dwelling-houses.

We now turn from the number of houses to their annual value as assessed for Income Tax and Inhabited House Duty, and with the aid of one key assumption (see Table 31, note *a*) we obtain the classification shown in Table 31.

Combining the census data with the results of Table 31 we thus have the following picture for all inhabited houses in 1860:

	Number	Annual value	Average value
Private houses (incl. farmhouses)	4,030,000	£30·6m	£7·6
Residential shops, hotels, pubs, etc.	320,000	10·4m	32·5
	4,350,000	£41·0m	£9·4

Table 31. *Gross Annual Value of Buildings in Great Britain in 1860 (£m)*

	Annual value less than £20	Annual value £20 or more	Total
Dwelling-houses	12·1[a]	16·5[b]	28·6
Residential shops, hotels, pubs, etc.	2·0[b]	8·4[b]	10·4
Farmhouses	1·2[c]	0·8[b]	2·0
Hospitals, etc.	—	—	0·4[d]
Trade premises	—	—	17·5[e]
Total			58·9[f]

[a] The annual value of these premises is assumed to be 85 per cent of the value of dwelling-houses of £20 or more, based on the ratio in reassessment years from 1874–5 onwards when both categories are given. The residential shops, etc. are estimated to account for £2·0m of this, calculated as 135,000 at an average value of £15 (cf. Stamp, *British Incomes and Property*, 118).
[b] Houses, etc. charged with House Duty as given in the Inland Revenue *Reports*.
[c] 300,000 farmhouses (see p. 95 above) assumed to have an average annual value of £4 per annum.
[d] Estimated on basis of assessments from 1874–5 onwards.
[e] Obtained as a residual; covers lock-up shops, factories, warehouses, etc.
[f] The total gross annual value of all houses, etc. assessed to Schedule A in 1860–1 (adjusted for understatement by interpolation between the reassessment years 1857–8 and 1861–2 – see Stamp, *op. cit.*, 31–6 and 50), plus the estimated value of farmhouses assessed to Schedule A as lands.

SOURCE. *Reports of H.M. Commissioners of Inland Revenue.*

The important conclusion to be drawn from this is the disproportionate weight in terms of annual value – and thus of cost of construction – of the relatively small number of residential shops, hotels, etc. Since we must include all the 320,000 shops, hotels, etc. in our total in order to make up the *number* of inhabited houses as shown by the census, we divide the residential shops, etc. into a 'dwelling' component, assumed to have the same average value as the private houses, and a 'shop' component, accounting for the remainder. We thus have a final figure of 4,350,000 private houses at an aggregate annual value in 1860 of £33·0 million (£28·6 million for the dwelling-houses, £2·0 million for the farmhouses, and £2·4 million for the 'dwellings' component of the residential shops, etc.). For the industrial and commercial buildings we have a corresponding annual value of £25·5 million, made up of £8·0 million for the 'shop' component of the residential shops, etc. and £17·5 million for the trade premises, covering lock-up shops, factories, warehouses, etc.

These two estimates together cover the main categories of building. Among those not covered are (a) hospitals, museums, churches, prisons, and other public buildings; (b) farm buildings; (c) buildings associated with mines or with gas and water supply; and (d) buildings on railway premises. These are included in the estimates in lines 2, 3, 6, 7, and 8 of Tables 6–8 respectively.