Chapter 20: Capital services and the national accounts

A. Introduction

20.1 This chapter differs in content and style from those describing the accounts of the System. Its aim is to show how a link can be made between the value of assets used in production and the gross operating surplus generated. This link has been elaborated over a period of about fifty years in a body of knowledge described as the theory of capital services. However, it is only fairly recently that a few statistical offices have incorporated the ideas from the theory into the measurement of stocks of those assets used in production. Because there is evidence that this approach leads to improved measures of capital stock, it is proposed that, for those offices interested, a supplementary table, that is one additional to the standard accounts, could, if desired, be prepared to display the implicit services provided by non-financial assets. By associating these estimates with the standard breakdown of value added, the contribution of labour and capital to production can be portrayed in a form ready for use in the analysis of productivity in a way entirely consistent with the accounts of the System.

20.2 The rest of the introduction gives a very general overview of the ideas involved in linking capital services with national accounts. The next section shows how the measurement of capital stocks can be aligned with the notion of the efficiency of an asset as well as its price. This is followed by a section showing how to identify flows of capital services within existing entries in the accounts. A further section shows how consideration of the basic link between asset value and contribution to operating surplus can be exploited to determine the appropriate way to account for costs associated with acquiring and disposing of assets and to place a value on assets where limited market price information is available. A final section discusses a possible format for a supplementary table.

1. The basic ideas of capital services

20.3 Non-financial assets give rise to benefits either from being used in production or simply from being held over a period of time. This chapter concerns those non-financial assets that contribute to production and how this contribution is recorded in the accounts. The assets concerned are fixed assets, inventories and natural resources. Valuables give rise to benefits derived from holding them as stores of value rather than using them and so are not the covered by this chapter.

20.4 Assets appear on the balance sheet of the unit to which they belong and the changes in value between one balance sheet and the next have to be identified and included in the appropriate account. Changes in the value of assets due to changes in absolute or relative prices appear in the revaluation account. Changes due to unexpected events appear in the other changes in the volume of assets account. Other changes in value are treated as transactions and must be recorded elsewhere in the System. If the user of the asset is not the legal owner, two sets of transactions are recorded, those giving rise to payments between the user and the owner and those that show the user receiving the benefits of using the asset. These latter are recorded as internal to the user. If the legal owner of the asset is also the user of the asset, only the internal transactions are recorded.

20.5 Assets used in production have to be paid for but the payment is not deducted from the value of production in the period the asset is acquired but is spread over the whole of the period the asset is in use in production. For fixed assets, this gradual payment for an asset is recorded as consumption of fixed capital, which is the decline in the value of the asset due to its use in production. However, assets are not just a charge on production, they also contribute to the profitability of an enterprise by being the source of operating surplus. It has long been commonplace to recognise that operating surplus is the return to capital used in production but an articulation of how this surplus is generated and how it relates to the value of an asset and the way in which this value changes during a period has not previously been included in the System. Among economic analysts, this articulation is known as the theory of capital services. This terminology sits a bit uncomfortably with national accountants since the services referred to are not the outputs of production in the way that transportation or education services, for example, are. Nevertheless, the terminology is well established and should not in itself give rise to problems as long as it is remembered that capital services are not produced services. Alternatively, capital services can be thought of as simply the term for the way in which the changes in value of assets used in production are captured in the production account and the balance sheet.

20.6 Much of the impetus for identifying the entries associated with capital services in the national accounts has come from those interested in the analytical uses that can be made of the information, especially for productivity studies. Because much of this work has been undertaken by researchers, it is perhaps inevitable that the rationale and reasoning behind the proposals should have been expressed in a rather academic manner, in particular making extensive use of sometimes rather complex algebra. This chapter takes a different approach. It aims to show that rather than introducing a new concept into the system, capital services

can, in theory, be identified within the existing accounts. Further, recognizing this can lead to improvements in the estimates of consumption of fixed capital, which are currently required in the production accounts, and of the values of capital stock, which are required in the balance sheets. The derivation of information analytically useful for productivity studies can thus be seen as a by-product of improved national accounts compilation practices and not an additional exercise. The explanation is done in terms of highly simplified numerical examples but still aims to demonstrate the connection between the concepts referred to in studies referring to capital services and the national accounts approach to the valuation of capital and the derivation of stock levels.

20.7 The explanation given here is to some extent superficial since it is intended to give an overview of the concepts and indicate in general terms why the theory of capital services is relevant to national accountants. For a deeper understanding of the subject, reference should be made to the two OECD manuals on the subject (reference) and some of the practical and theoretical work referenced in those manuals.

B. Valuing capital stocks

20.8 Estimating the value of capital stocks is not a straightforward process. Whereas it is possible to measure all new capital formation undertaken in a year directly and simply aggregate it, estimating the total value of a stock of assets, even of the same basic type, but with differing characteristics and of different ages is not simple. In theory, if there were perfect second hand markets for assets of every specification, these observed prices could be used to revalue each asset at the prices prevailing in a given year, but in practice, this sort of information is very seldom available. Thus measures of capital stock must be derived indirectly and this is conventionally done by making assumptions about how the price of an asset declines over time and incorporating this in a perpetual inventory model (PIM). Basically what a PIM does is to write down the value of all assets existing at the beginning of the year in question by the reduction in their value during the year, eliminate those assets that reach the end of their useful lives in the year and add the written down value of assets acquired during the year. This routine is so well established that it is possible to overlook the assumptions it rests on, but it is an investigation of these assumptions that reveals the dual benefits of deriving capital service values.

20.9 In the absence of observable prices, the value of an asset may be determined by the present value of its future earnings. Economic theory states that in a well functioning market (suitably defined) even when prices are observable, this identity will hold also. There are thus two sorts of questions that may be posed about the value of an asset; (i) how much would it fetch if sold, and (ii) how much will it contribute to production over its useful life. The first of these is the traditional question asked by national accountants; the second is basic to studies of productivity. However, these two questions are not independent.

1. Knowing the contribution to production

20.10 Suppose an asset will add values of 100, 80, 60, 40 and 20 to production over the next five years. For simplicity assume all products have the same prices and there is no inflation. Assume, further, that the real rate of interest is five per cent per annum for all five years.

20.11 The value of the asset in all five years can be derived using present value techniques as shown in table 20.1. (For simplicity, in this and all the following examples, the values shown are values at the start of the year so that, when discounting, the factor for the whole year is used.) The addition to the value of the asset in year 1 from the expected earnings of 80 in year 2 is 76, that is 80 divided by 1.05. The addition to the value of the asset in year 2 from earnings in year 3 is 57 (60 divided by 1.05) and in year 1 is 54 (57 divided by 1.05) and so on. When the value of 100 for the earnings in the first year is added to 76, the value of the second year's earnings in the first year, and to 54, the value of the third year's earning in the first year and to 35 and 16, representing the value of the earnings in years 4 and 5 in the first year, a value of the asset in year 1 of 282 is derived. When the table is complete, the value of the asset in each if the five years is seen to be 282, 191, 116, 59 and 20.

Table 20.1:Example of deriving the value of capital stock from knowledge of its contribution to production

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4	Year 5	Sum of 5 years
Contribution to asset value from earnings in :						
Year 1	100					
Year 2	76	80				
Year 3	54	57	60			
Year 4	35	36	38	40		
Year 5	16	17	18	19	20	
Value in year	**282**	**191**	**116**	**59**	**20**	
Value index (year on year)	1.00	0.68	0.61	0.51	0.34	
Decline in value	**91**	**74**	**57**	**39**	**20**	**282**
Income	9	6	3	1	0	18

20.12 The decline in value of the asset from year to year can be calculated by deducting each succeeding year's value from the value of the present year. Thus a series of 91, 74, 57, 39 and 20, is derived, a series that sums to 282, the original value of the asset. If the decline in value of the asset (91 in the first year) is deducted from the contribution to production (100 in the first year) the value of income generated in a year results (9 for the first year). To see that this item represents income, consider that the sum of the elements in the first column for years 2 to 5 together (182) represents the value of the same capital stock existing in year 2 but valued in the first year. This value of 182 increases by 9 to 191 between year 1 and year 2. This amount satisfies the criterion for income that it is the

amount that can be spent and still be as well off at the end of the period as at the beginning.

20.13 Over the five-year period, the value of income is equal to the difference between the sum of the diagonal elements (300) less the value of the decline in value (282), or to put it another way, there is an identity between the value of income the asset yields and the discounting inherent in establishing its current value.

2. Knowing the value at any time

20.14 Now suppose nothing is known about the contribution of the asset to production but the decline in the value of the asset over the five years, due to ageing, is known. If this is postulated in terms of a value index relative to the preceding year's value, and the initial value is known to be 282, then the entries in table 20.2 can be calculated. By design, a value series consistent with the figures in table 20.1 is assumed. Applying the decline in value of 0.68 to the initial value of 282 gives a value of 191 for year 2; applying the value decline of 0.61 to 191 gives 116 for year 3 and so on. (Alternatively a time series of values could be postulated and applied to the initial value.) From this the declines in value of the asset from year to year can be deduced and seen to be identical with those in table 20.1.

Table 20.2: Example of deriving the value of capital stock from knowledge of its decline in price

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4	Year 5	Sum of 5 years
Contribution to asset value from earnings in :						
Year 1	100					
Year 2	76	80				
Year 3	54	57	60			
Year 4	35	36	38	40		
Year 5	16	17	18	19	20	
Value in year	**282**	**191**	**116**	**59**	**20**	
Value index (year on year)	1.00	0.68	0.61	0.51	0.34	
Decline in value	**91**	**74**	**57**	**39**	**20**	**282**
Income	9	6	3	1	0	18

In general this is as far as the PIM goes. Its two-fold purpose is to calculate asset values for the balance sheet and the figures for consumption of fixed capital and these requirements are satisfied at this point. But it is in fact possible to go further. The contribution of the asset to production in the final year (20) is the same as the final year's value. If this is discounted by five per cent, the addition to the value of the asset at the end of year four is determined to be 19. Given the value of the asset at the start of year four is 59, there must be a figure of 40 contributed to production in that year. Extending this, for year three the value of 116 must consist of 18 representing the contribution to production in year five of 20 discounted twice, 38 representing the value contributed to production in year four of 40 discounted once and so by residual the value contributed to production in year three must be 60. In this way all the top, diagonal, part of the table can be completed and the values of the amounts of income in a year be derived just as in table 20.1.

3. Age-efficiency and age-price profiles

20.15 Although tables 20.1 and 20.2 start from different assumptions, exactly the same complete table results even though it is filled in a different order in the two cases. Table 20.1 starts from assumptions about the declining contribution to production and derives stock values and the decline in value each year. Table 20.2 starts from assumptions about the decline in value of the stock and derives the contribution to production and the decline in value each year. Both techniques give values of stocks to include in the balance sheets and figures of consumption of fixed capital. The assumptions made in the two cases must be consistent. In fact it can be shown that every pattern of decline in the contribution of an asset to production (usually called the age-efficiency profile) corresponds to one and only one pattern of decline in prices, usually called the age-price profile.

20.16 Given this, it would seem possible to take the information in a set of PIM assumptions and simply derive the contributions to production from these. While it is possible to do this, it is generally held to be preferable to start again by postulating a set of age-efficiency profiles. The reason for this can be illustrated by table20.3.

Table 20.3: Table 20.2 with a slightly different pattern of price decline

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4	Year 5	Sum of 5 years
Contribution to asset value from earnings in :						
Year 1	80					
Year 2	96	101				
Year 3	75	79	83			
Year 4	24	26	27	28		
Year 5	6	6	6	7	7	
Value in year	**282**	**211**	**116**	**35**	**7**	
Value index (year on year)	1.00	0.75	0.55	0.30	0.20	
Decline in value	**70**	**95**	**81**	**28**	**7**	**282**
Income	10	6	2	0	0	18

20.17 Table 20.3 again starts from a series of relative price changes as in table 20.2 but these changes are somewhat different. Instead of a series of 1.00, 0.68, 0.61, 0.51 and 0.34, a series of 1.00, 0.75, 0.55, 0.30 and 0.20 is taken. These changes underestimate the rate of decline in value in the second year and assume a faster rate of decline in later years. At first sight they do not seem unreasonable. However, the effects on the contribution to production is considerable and the resulting series of 80, 101, 83, 28 and 7 is quite implausible. What sort of asset would be over twenty per cent more efficient in its second year than in its first and still more efficient in the third year than in the first before declining quickly thereafter? Yet this pattern of flows is still consistent with an initial value of 281, as in table 20.2 and with cumulative declines in value adding to this amount over five years.

20.18 These are the reasons why it is argued that making assumptions about efficiency decline is likely to lead to superior results for the value of stocks, their decline in value and the income they generate than making assumptions about the rate of price decline. As a further example of why this may also be easier, consider the case of an asset that contributes the same to production, let us say 100, for each of five years and then stops dead, like a

light bulb. It is easy to postulate a constant age-efficiency profile but the corresponding age-price profile is much less intuitively obvious.

20.19 However, while there are good reasons for using age-efficiency profiles as the starting point, where actual information is available on age-price profiles, even partial information, it should be confirmed that the selected age-efficiency profile is consistent with the observed age-price movements. Also, in practice, assets are never valued individually but in cohorts and for similar but not necessarily identical types of assets. This brings other factors into consideration such as the distribution of asset retirements.

C. Interpreting the flows

20.20 The tables above generate three time series of particular interest. One is the contribution to production of an asset over time, one is the decline in the value of the asset and one is the income generated by the asset. Obviously the middle term corresponds to consumption of fixed capital as normally understood in the System. The contribution of capital to production is what is called gross operating surplus and so the third time series, income, corresponds fittingly to net operating surplus. However, these flows can be described by alternative names also. The diagonal element of the tables, showing the contribution to production is also known as the value of capital services. The income element is the return to capital. The rate of return on capital is the ratio of income to the value of capital. For tables 20.1 and 20.2, the income flow as a proportion of the next year's capital stock value (that part not used in the current year) is also five per cent, the same as the discount factor. The alternative terminologies are illustrated in table 20.4.

1. Capital services and gross operating surplus

20.21 At this point, the national accountant asks how can gross operating surplus be estimated in this way when it is derived as a balancing item in the generation of income account? There are two possible answers to this question. The first answer is that there is not a complete identity with gross operating surplus but the value of capital services are implicitly within it so may be noted as an "of which" item relative to gross operating surplus. Suppose the discount rate chosen is the rate that can be obtained on a bank deposit or some other risk free investment. This determines the amount the user of the asset needs to generate as net operating surplus if the asset is to be cost effective. If the figures for capital services and gross operating surplus are both 100, then the producer has made a reasonable choice of asset; it is earning as much for him as leaving his money in the bank. If he earns a little more than 100, he has done better than leaving the money in the bank. If the national accounts show he has earned 150, say, it may be that the producer has been very lucky indeed, perhaps has been able to realise some monopolistic profits, but it is also possible that there is some sort of asset he is using that has not been identified in calculating capital services, one possibility being some form of intangible asset. Similarly if the value of gross operating surplus is much lower than the value of capital services estimated, there may be good reason to question the range and valuation of assets assumed to be used in production or the quality of the estimates of gross operating surplus. Thus deriving the value of capital services in this manner is also a valuable tool for checking data quality.

20.22 The alternative to treating capital services as an element of gross operating surplus, is to equate gross operating surplus with capital services exactly and to do this by determining a rate of return (discount rate) that brings this about. Many traditional analyses of productivity have used this approach and some cross-country comparisons of productivity depend on this assumption. Other studies, used at the industry level, suggest that the variation in apparent rate of return obtained in this way needs to be used, if at all, with very great caution. There is still robust discussion in academic circles about the preferred way of determining the rate of return, exogenously as described in the preceding paragraph or endogenously as described here. One way of interpreting the difference is to say that using an exogenous rate of return simply confronts the cost of capital (capital services) with the benefits (gross operating surplus); the endogenous rate of return gives a single figure to be contrasted with the yardstick of a "normal" rate of return.

Table 20.4: Capital services and SNA terminology

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4	Year 5	Sum of 5 years
Contribution to asset value from earnings in :	Value of capital services or gross operating surplus					
Year 1	100					
Year 2	76	80				
Year 3	54	57	60			
Year 4	35	36	38	40		
Year 5	16	17	18	19	20	
Value in year	**282**	**191**	**116**	**59**	**20**	
Value index (year on year)	1.00	0.68	0.61	0.51	0.34	
Decline in value	**91**	**74**	**57**	**39**	**20**	**282**
	Consumption of fixed capital					
Income	9	6	3	1	0	18
	Return to capital or net operating surplus					

2. Prices and volumes

20.23 An examination of table 20.1, or indeed any of the others, shows that the value of an asset at a point in time, such as the start of a year, can be expressed rather neatly as the sum of the capital services rendered in the year plus the discounted value of the asset at the end of the year. This is the starting point of much of the algebraic elaboration of capital services in the literature, but with one important difference. Whereas most national accountants tend to think first in terms of current price aggregates and later (possibly) a breakdown into a volume aggregate plus a corresponding price, most descriptions of capital services

run in the other direction. They assume a volume and develop a theory of the corresponding price (the "user cost"). These could be multiplied together to give a current price figure but much analysis is done using volume or price information.

20.24 One reason for working this way is that the assumption underlying table 20.1, that the contributions to production over the life of the asset are known, is not often true in practice. What is known, or estimated, is an *index* of how the efficiency changes over time. Equally the value of the asset assumed known in table 20.2 is only known on an asset-by-asset basis when each is new; all other value figures are estimates for reasons explained above. It is possible to convert the identity that the start-of-year value of an asset equals capital services rendered in the year plus the discounted end-of-year value, all expressed in index number form, into one that expresses the user cost in terms of the factors underlying the relationship between start- and end-year values and the reasons for the decline. Specifically the user cost can be expressed in terms of the real cost of financial capital, a general inflation index and a depreciation factor. It is also possible then to have different prices for different sorts of assets and look at differential movements between asset prices and the movements in the general level of inflation. (Table 20.1 was based on the very restrictive assumptions of there being neither absolute nor relative price inflation.)

20.25 Another important consideration passed over in the simple numeric tables is the following. For balance sheet data, values at the date the balance sheet is drawn up are needed. For estimates of capital services/gross operating surplus as well as for consumption of fixed capital and income flows, data related to the middle of the period and at average-year prices is needed.

D. Applying the capital service model

20.26 Once a theoretical link between the content of gross operating surplus and the capital services embodied in an asset used in production is accepted, there are a number of other beneficial implications for the national accounts. These include the question of the use of land in production, the valuation of natural resources, the separation of mixed income into the labour and capital components, the measurement of assets with a residual value, the treatment of costs of ownership transfer on acquisition, the treatment of terminal costs, capital maintenance, the valuation of work in progress on long-term projects, an alternative approach to estimating the imputed rent of owner-occupied dwellings and the separation of the payments under a financial lease into the element to be regarded as the repayment of principle from the element regarded as interest. Each of these will be explained a little further below.

1. Land

20.27 It is not only produced assets that are used in production. The first and oldest recognised form of non-produced capital is land. Land is special in that under good management, the value is assumed to remain constant from year to year except for the effects of inflation in land prices. That is to say, there is no depreciation of land and all the contribution to production can be regarded as income. To show how this can be related to the previous examples, Table 20.5 shows part of a corresponding table for land that contributes 20 to production in perpetuity. A full table would have an infinite number of rows and columns. Here only a selection of five are shown and some very simple algebra (with explanation) is used to explain how the totals are reached.

20.28 The value of the first column is the sum of 20, 20 discounted once (the second year's contribution to production discounted once), 20 discounted twice for the third year and so on if not for ever, at least for very many years. With a discount factor of 5 per cent as before, the sum of this column is 400. To see that this is so, consider a simple geometric progression. What is required is the sum of a series that can be written

$$S_n=a+ar+ar^2+ar^3+ar^4+ar^5+\ldots+ar^n$$

If every term in the equation is multiplied by an extra factor r the result is:

$$rS_n= ar+ar^2+ar^3+ar^4+ar^5+\ldots \quad +ar^{n+1}$$

Subtracting the second expression from the first gives

$$S_n (1-r) = a (1-r^{n+1})$$

If r is less than unity (as it will be in a discounting framework) and n is very large, that last term becomes insignificant and the sum of the series, S_n, can be determined as a/(1-r). In table 20.5, a is 20 and r is 0.95, so the sum of the series is 400.

20.29 However, since each of the columns of the table, though one term shorter than the previous one, is also an infinite series beginning in exactly the same way, the sum of each column is also 400. Thus the decline in value of the land from year to year is zero and the whole of the 20 is not just the contribution to production but also income. In national accounts parlance, the gross and net operating surplus are both 20 and there is no depreciation. Equally the value of the capital service and the return to capital are both 20. The rate of return to capital is 20 divided by 400 or five per cent.

20.30 As noted above, it may seem slightly odd to think of a non-produced asset contributing a "service" since in national accounts services are always produced. This is simply a reflection of the words chosen by economists to describe the contribution of capital to production without connecting

the word "service" to the specific interpretation given to it in the System. Similarly one may hear compensation of employees described as the cost of labour services.

Table 20.5: The case of land

	Discount rate 5%					
	Year 1	Year 2	Year 3	Year 4	Year 5	. . . Year 10 . . .
Contribution to asset value from earnings in :						
Year 1	20					
Year 2	19	20				
Year 3	18	19	20			
Year 4	17	18	19	20		
Year 10	14	14	15	16	16	. . . . . 20 . . .
Year 25	7	7	7	8	8	. . . . . 11 . . .
Year 40	3	3	3	4	4	. . . . . 5 . . .
Value in year	**400**	**400**	**400**	**400**	**400**	**. . . . .400 . . .**
Value index (year on year)	1.00	1.00	1.00	1.00	1.00	. . . . 1.00 . . .
Decline in value	**0**	**0**	**0**	**0**	**0**	**. . . . . 0 . . .**
Income	20	20	20	20	20	. . . . . 20 . . .

20.31 Another term used for capital services is economic rent and this initially seems more applicable in the case of land but is also a pitfall. In table 20.5, the economic rent of land is the extent to which the farmer benefits from using the land for agricultural production (20). This rent accrues whether the farmer is farming his own land or is a tenant farmer. The amount that the tenant farmer is due to pay his landlord is what the national accounts show as rent under property income. In the days when a farmer paid his rent as a share of the crop yield, the link was more obvious. What he retained represented enough to cover his costs and the cost of his own (and any hired) labour. In a monetised economy, the rent payable to the landlord is often agreed a very long time in advance. Comparing the rent earned (as operating surplus) with the rent payable as property income shows whether the agreed rent is "fair" or perhaps excessive relative to the farming income. The fact that land usually earns more under buildings than when it is farmed, explains why building land is typically more highly valued than farm land.

2. Valuing natural resources

20.32 There is an increasing interest in placing a capital value on natural resources but since these assets are seldom sold on the market, there has been doubt about how to do this. Looking at the economic rent to be earned by a mineral deposit or a natural forest, for example, is one way to solve the problem.

20.33 Suppose that a mining company knows the size of the deposit being mined, the average rate of extraction and the costs of extraction of one unit. After allowing for all intermediate costs, labour and the cost of fixed assets used, what is left must represent the economic rent of the natural resource. By applying this to the expected future extractions, a stream of future income can be estimated and from this, using the techniques already described, a figure for the value of the stock of the resource at any point in time.

20.34 In fact, the application of the capital service technique goes further than this. In the case of a natural forest, if the rate of re-growth is at least equal to the rate of harvest, then the value of the forest does not decline and the rate of harvest is sustainable. However, in the case of a mineral deposit with no natural renewable capability, then it is possible as before to separate the contribution to production into an element showing the decline in value of the deposit and a residual element. Because this residual amount is consistent with the idea of maintaining the level of wealth intact, it can be regarded as income. Clearly this leads into the area of so-called green accounting and the possibility of allowing for consumption of natural capital as well as consumption of fixed capital in an alternative set of national accounts. Indeed, this is the argument developed at greater length and with applications to specific resources in section D of chapter 7 in the SEEA. (reference)

3. Mixed income

20.35 When discussing land, above, it was pointed out that the economic rent of the land was the part that was not otherwise accounted for by intermediate consumption, the cost of hired labour and the capital services rendered by fixed assets and the labour cost of the farmer. Very often, it is difficult to put a value on the labour of a self-employed person and so this may be merged with the economic rent on land and the capital services rendered by any fixed assets used and described as mixed income. In principle, though, if a separate estimate of the capital services rendered by fixed assets can be made from information about the services rendered by similar assets in other parts of the economy, then mixed income can be split into its labour and capital components.

20.36 In practice this has often proved difficult since the residual amount for self-employed income may turn out to be very small or even negative. The most obvious cause of this is that the estimates for the capital services are too high. This may be because larger companies are able to make more efficient use of capital, for example using a high value piece of equipment continuously rather than intermittently, or because they actually have other, intangible, assets, which have not been taken into account. This means the capital services for these unmeasured assets are attributed to those that are recognised but this addition is not appropriate for the self-employed worker. Thus the acceptance of the capital services model is unlikely to provide a quick and accurate breakdown of mixed income but it does show the way to probe the data for both large and small enterprises to ensure that capital is being measured comprehensively and consistently.

4. Assets with a residual value

20.37 Very many assets are used by a single owner until they are worn out and worth nothing. However, this is not the case for all assets. Some are disposed of after a few years, perhaps because the cost of regular maintenance is deemed by the current owner to be too high relative to the value the asset contributes to production. Some airlines, for example, may wish to use the fact that they keep up-to-date fleets of aircraft as part of their advertising appeal. In other cases, for example with construction equipment, the original owner may simply have no further use for the asset.

20.38 Table 20.6 shows an example of an asset that is used for only four years and then disposed of for a value of 300. The top, triangular, part of the table shows the normal calculation of the value of the capital services to be rendered in these four years, a value that at the outset is seen to be 1 107. To this the discounted value of the residual value of 300 must be added. This value is 247, making the total value of the asset 1,354. The decline in the value of the asset including the residual value is lower year by year than the decline in the capital services to be rendered in these four years because there is an income element coming from the fact that the residual value increases as the time for disposal of the asset gets closer. The total of the decline in the value of the asset, to be shown as consumption of fixed capital, is 1 054. This value, together with the residual value of 300, is equal to the original value of 1 354, The total income (net operating surplus) is 121, the sum of the income arising from the use in production (68) plus the income arising from the unwinding of the discount factor on the terminal value (53).

Table 20.6: An asset with a residual value

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4	Residual value	Sum of 4 years
Contribution to asset value from earnings in :						
Year 1	400					
Year 2	286	300				
Year 3	227	238	250			
Year 4	194	204	214	225		
Value in year	**1 107**	**742**	**464**	**225**	**0**	
Decline in value	**365**	**278**	**239**	**225**		**1 107**
Income	35	22	11	0		68
Residual value	**247**	**259**	**272**	**286**	**300**	
Income	12	13	14	14		53
Joint value	**1 354**	**1 001**	**736**	**511**	**300**	
Decline in value	**352**	**265**	**226**	**211**		**1 054**
Income	48	35	24	14		121

Table 20.6 illustrates that the cumulative value of the consumption of fixed capital calculated in respect of an asset should be equal to the initial value of the asset, treated as fixed capital formation, less the value to the owner on disposal of the asset. This holds whether the asset passes into use as a fixed asset by another user, is used for another purpose in the same economy or is exported.

5. Costs of ownership transfer on acquisition

20.39 The costs of ownership transfer incurred on acquisition of an asset are treated as fixed capital formation. This assertion is equivalent to assuming that the services rendered by the asset must be sufficient to cover both the costs of the asset and the costs of ownership transfer. Table 20.7 shows an example where costs of 30 are incurred on the acquisition of the asset in table 20.6. In order for the asset to have exactly the same value as before on disposal, 300, the costs of ownership transfer have to be accounted for during the period in which the owner who incurred the costs uses the asset in production. The figures in the triangular part of table 20.7 are added to those in the corresponding part of table 20.6 giving increased value to the asset in each year until the end of year 4, increased consumption of fixed capital and slightly increased income, because the costs of ownership transfer are also viewed as the present value of the extra services required to meet the costs.

Table 20.7: Example of costs of ownership transfer on the acquisition of the asset in table 20.6

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4		Sum of 4 years
Contribution to asset value from earnings in :						
Year 1	10					
Year 2	9	9				
Year 3	6	7	7			
Year 4	5	5	6	6		
Value in year	**30**	**21**	**13**	**6**		
Decline in value	**9**	**8**	**7**	**6**		**30**
Income	1	1	0	0		2
Residual value	**1 384**	**1 022**	**749**	**517**	**300**	
Decline in value	**361**	**273**	**232**	**217**		**1 084**
Income	49	36	25	14		123

20.40 If the costs of ownership transfer were to be attributed to the whole life of the asset and not just that part for which the unit who paid the costs owns the asset, there is a mismatch between the calculated value of the asset and the market value demonstrated in the sale at a value of 300. In such a case, the data have to be brought back into reconciliation by means of an entry in the other changes in the volume of assets account but this means that not all of the costs incurred by the initial owner are shown as a charge against gross value added and so income is over stated. This may be inevitable when assets are sold unexpectedly but in the case of many vehicles and large mobile construction equipment, the purchaser may well take account of the value to be realised on sale after a given period and when this is so, every effort should be made to take account not only of the residual value but also factor the expected life length into the calculations of the amount of consumption of fixed capital to be attributed to the costs of ownership transfer so there is no residual value of these costs left on disposal.

6. Terminal costs

20.41 Table 20.6 considered the case where an asset had a residual value at the time the current owner disposed of it. It is also possible to have assets that have significantly large costs associated with disposal. Examples include the decommissioning costs of nuclear power stations or oil rigs or the clean up costs of landfill sites. These costs are similar to capital formation in that they should be covered by income generated during the time the asset is used in production. If this is not done within the accounts, these large costs may be treated as intermediate costs at a time when there is no longer any income being generated from production and so lead to negative value added. Alternatively, they are recorded as capital formation but instead of the costs being recovered from value added, these costs are simply written off in the other changes in the volume of assets account. This procedure omits from the macro-economic aggregates a legitimate cost to business and so overstates gross and net domestic product over a period of years.

20.42 Table 20.8 shows an example of how terminal costs should be recorded. The data in fact correspond to the numbers in table 20.6 but in this case the residual value is negative rather than positive.

20.43 The analysis of the data follows that for table 20.6 exactly. The value of the capital services to be provided by the asset

in use is still 1,107. However, since the present value of the terminal cost is -247, the total value of the asset is 860. As before, the cumulated value of consumption of fixed capital, 1,160 is equal to this value less the terminal value of -300. Not only is the value of the asset in each year lower than the value of the use in production, in year 4 the value is actually negative. The rationale of this is that although the asset will yield services of 225 in that year, the impending costs of 300 mean that the owner would not be able to sell the asset; he would in fact have to pay another owner to take over the asset since it would then be the responsibility of the new owner to meet the disposal costs of 300.

Table 20.8: An asset with a terminal cost

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4	Residual value	Sum of 4 years
Contribution to asset value from earnings in :						
Year 1	400					
Year 2	286	300				
Year 3	227	238	250			
Year 4	194	204	214	225		
Value in year	**1 107**	**742**	**464**	**225**	**0**	
Decline in value	**365**	**278**	**239**	**225**		**1 107**
Income	35	22	11	0		68
Residual value	**- 247**	**- 259**	**- 272**	**- 286**	**- 300**	
Income	- 12	- 13	- 14	- 14		- 53
Joint value	**860**	**483**	**192**	**- 61**	**- 300**	
Decline in value	**377**	**291**	**253**	**239**		**1 160**
Income	23	9	- 3	- 14		15

7. Major repairs and renovations

20.44 Major repairs and renovations that extend the life of an asset are treated as capital formation and the value of the repairs and renovations is added to the value of the asset before the work was undertaken. The example of costs of ownership transfer on acquisition of an asset can be applied directly in this case, excepting only that the costs are incurred in a year other than the year of acquisition. The value of the capital repairs is supposed equal to the discounted value of the increased services that the asset will yield, either by increasing the services in each of the remaining years of the initial life length, or extending the life length, or both.

20.45 The analysis of the value of the capital repairs can be done by merging the value with that of the asset in question and reworking all the calculations of the services to be rendered, the income generated and the consumption of fixed capital for the asset and the maintenance taken together. However, as table 20.5 shows, it is also possible to leave the calculations for the asset as they were and simply aggregate them with a separate analysis of the maintenance undertaken as if it related to a wholly new asset.

8. Work-in-progress for long term projects

20.46 Table 20.9 relates to an asset with a final value of 200 that is to be constructed over a period of four years. One possibility is that assuming no inflation, work in progress of 50 should be recorded in each of the four years. However, consistent with the notion of discounting future income an alternative view is preferable. Suppose still that there is a discount rate of five per cent. In each year, the value of the completed asset in each of years 1 to 3 will be 172.8, 181.4 and 190.5, each of which will cumulate to a value of 200 after, respectively, one, two or three years accumulation in value of 5 per cent. Dividing each of these by four implies that even if equal amounts of work are put in place in each year, the values to be recorded should be 43.2, 45.4, 47.6 and 50.0. In addition, though, there will be income arising from a return to the work already put in place. This would give a time series for the work put in place and other income of 2.2, 4.5 and 7.1 in each of years two to four giving the value of the partially complete structure as 43.2, 90.7, 142.9 and 200.0. These are the values that a purchaser of the partially completed structure would be willing to pay, given that he would forgo the income from the finished structure for up to three years.

9. Owner-occupied dwellings

20.47 The System specifies that an imputed rent on owner-occupied housing should be included in the production boundary and form part of household consumption. In a situation where there is either no rental market in such properties or only a very limited one, this is difficult to implement and cross-country comparisons of the results (as in the International Comparisons Project exercise) show that the different techniques used produce highly variable results. Here too, the use of the techniques described in this chapter may be helpful.

Table 20.9: Valuing work-in-progress spanning several years

Discount rate 5%

	Year 1	Year 2	Year 3	Year 4
Value of final product in each year	172.8	181.4	190.5	200.0
Value of construction activity (one quarter of final value)	43.2	45.4	47.6	50.0
Income accruing on work put in place				
In year 1		2.2	2.3	2.4
In year 2			2.3	2.4
In year 3				2.4
End year value	43.2	90.7	142.9	200.0

20.48 In the example for land, it is possible to deduce a value of 400 for the land that yielded economic rent of 20 every year in perpetuity. While modern houses do not last for ever, if they are assumed to last for, say, fifty years the discount factor applied over this period gives contributions to the value of the asset that are negligible at the end and again it may be supposed that if the value of the house is 400, then the imputed rent is 20. Given that the market for houses is much better established than for rented housing, this may also provide a source of useful and comparable data for a troublesome area of national accounts. However, this method should be used with caution since houses are often bought in the expectation of making significant real holding gains. It should also be recognised that the rental for a house usually includes land rent.

10. A financial lease

20.49 The process of discounting future income streams to determine present value applies to financial assets as well as to non-financial assets. Consider an agreement with a bank to borrow 1,000 over a period of five years at five per cent interest. The total amount to be paid to the bank will be

1,100 at a rate of 220 per year. But, as table 20.12 shows, each year's payment does not consist of repayment of principal of 200 and interest of 20, Interest is payable on the remaining balance so is highest in the first year and is zero in the last year. (This is a result of the simplifications used in the chapter. In practice interest would be charged daily and so even in the last year some interest would be payable but the principle of the way in which the balance between interest and repayment of principle changes over time as the loan is repaid holds.)

20.50 The arithmetic behind table 20.10 is indistinguishable from any of the other tables in this chapter demonstrating that the same principles hold for valuing financial assets as for non-financial assets. The same methodology that can be used to show how much of the contribution to production is consumption of fixed capital and how much contributes to net operating surplus can also be used to show how much of the payment to the bank is a repayment of capital and how much is interest. Both consumption of fixed capital and a repayment of capital feature in the accumulation accounts as changing the value of the stock of assets. The contribution to net operating surplus and interest are both income flows and are shown in the current accounts.

Table 20.10: The case of a financial loan

	Interest rate 5%					
	Year 1	Year 2	Year 3	Year 4	Year 5	Sum of 5 years
Contribution to loan value from payments due in :						
Year 1	220					
Year 2	210	220				
Year 3	200	210	220			
Year 4	190	200	210	220		
Year 5	181	190	200	210	220	
Loan value in year	**1000**	**819**	**629**	**430**	**220**	
Repayment of principle	**181**	**190**	**200**	**210**	**220**	**1000**
Interest	39	30	20	10	0	100

20.51 This duality is especially important when an asset in acquired under a financial lease. In this case table 20.10 can be used to show both the change in value of the asset and the change in the loan taken out to pay for it. Cost benefit analyses of the merits of borrowing to acquire assets also depend on this sort of calculation. Unless the asset can contribute at least as much to production as the interest due to the lender, it is not a good investment. Even if a producer has sufficient funds available to purchase an asset without borrowing, it makes sense to undertake such an analysis since the alternative to acquiring the asset is to convert the funds to an asset that will either earn income or appreciate and yield holding gains.

E. A supplementary table on capital services

20.52 This section describes a table that could be compiled to confront data coming from the standard national accounts tables for the elements of gross value added with those derived from applying the theory of capital services to the national accounts data on capital stocks. Before presenting the table, though, it is appropriate to recall briefly the various simplifying assumptions that underlie the numeric examples in the earlier part of the chapter, assumptions that would be totally inappropriate in serious estimation of capital service flows. The most important are:

a. Somewhat different figures would emerge if any of the tables were to be calculated for the start of year, end of year or mid-year. Mid-year flows need to be discounted by half the annual discount rate to give start of year figures, for example.

b. The assumption that there is no price inflation, either over all or between different assets, is clearly unrealistic. Changes due to price movements need to be separately identified and included in the revaluation account.

c. The general preference for an age-efficiency approach to determine the value of capital stock should not be taken to mean that information on age-price decline, when such exists is to be ignored. The solution is to find an age-efficiency pattern that matches the observed decline in prices. Where such a match can be made, this may inform the choice of age-efficiency declines where no matching price information is available.

20.53 There is a question about the appropriate level of detail to be used for assets. They are very diverse and even products that appear superficially similar, such as aircraft, may have quite different specifications. This is a problem that must be resolved whatever means of determining a stock figure for assets is used. The final choice may be a source of inaccuracies, or conversely, may lead to extra resource cost for little improvement in the results.

20.54 The first level of detail that might be examined is given in table 20.11. This assumes that information on value added by institutional sector is available. The figures for operating surplus for non-financial and financial corporations may be compared with capital services from fixed assets used by these sectors adjusted as necessary for natural resources and inventories. The figures for general government and NPISHs must be equal between the national accounts data and capital services data. The capital services for household dwellings should match operating surplus for households and the figure for capital services for other household unincorporated enterprises is to be compared with the national accounts figure for mixed income (which should include a labour compensation element also).

Table 20.1: The outline of a possible supplementary table on capital services

National accounts data	Total/Gross	Consumption of fixed capital	Net
Gross value added			
Compensation of employees			
Mixed income			
Operating surplus			
Non-financial corporations			
Financial corporations			
General government			
NPISHs			
Households			
Taxes less subsidies on production			
Capital services	Capital services	Decline in value	Return to capital
Fixed assets			
Market producers (excluding households)			
Non-financial corporations			
Financial corporations			
Non-market producers			
General government			
NPISHs			
Households			
Dwellings			
Other unincorporated enterprises			
Natural resources			
Inventories			