Chapter 17: Capital services (chapter 20 in the 2008 SNA, moved upwards, revised title and revised content)

(OLD Chapter 20: Capital services and the national accounts)

A. Introduction

17.1 This chapter differs in content and style from those describing the accounts of the SNA. 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. In recent years, 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 recommended that a table supplementary to the standard accounts is prepared to display the implicit services provided by non-financial assets. The contribution of labour input to production is recognized in remuneration of employees. By also associating estimates of capital services with the standard breakdown of value added, the contributions of both 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 SNA. The methods for measuring the contributions of labour and capital to the analysis of productivity are summarized in section F of chapter 18.

17.2 The rest of the introduction gives a very general overview of the ideas involved in linking capital services with national accounts. Section B shows how the measurement of capital stock can be aligned with the notion of the efficiency of an asset as well as its price. This is followed by section C showing how to identify flows of capital services within existing entries in the accounts. Section D 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. Finally, section E summarizes the fundamental methods of capital measurement and discusses a table on capital services.

1. The basic ideas of capital services

17.3 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 any produced fixed assets (excluding natural capital), non-produced fixed assets (excluding natural capital), or natural capital assets which are used in an on-going basis on production. Valuables give rise to benefits derived from holding them as stores of value rather than using them and so are not covered by this chapter.

17.4 Assets appear on the balance sheet of their economic owner 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 not reflected in transactions appear in the other changes in the volume of assets and liabilities account. Every other change in value is treated as a transaction and must be recorded elsewhere in the SNA. 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.

17.5 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 depreciation, 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 recognize that operating surplus is the return to capital used in production. This chapter presents 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. As noted, 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 the value of assets used in production are captured in the production account and the balance sheet.

17.6 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 SNA, capital services can, in theory, be identified within the existing accounts. Further, recognizing this can lead to improvements in the estimates of depreciation, 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.

17.7 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, *Measuring Capital* (2009) and *Measuring Productivity* (2001), and some of the practical and theoretical work referenced in those manuals.

B. Valuing capital stock

17.8 Estimating the value of capital stock 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. Even if information from a second-hand market is available, there are a number of potential problems with using it to revalue other assets: the market may be extremely thin, so that the assets offered for sale on second-hand markets may be unrepresentative of the assets that are not offered for re-sale; and the prices for second-hand assets may be close to their scrap value, thus not providing a good representation of the capital services that can be derived from them in the remainder of the service life. See the discussion of prices from second-hand markets in paragraphs 4.164 to 4.166 and 4.307. 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 model based on the perpetual inventory model (PIM). Basically the PIM writes down the value of all assets existing at the beginning of the year in question by the reduction in their value during the year, eliminates those assets that reach the end of their useful lives in the year and adds 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.

17.9 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

17.10 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.

17.11 The value of the asset in all five years can be derived using present value techniques as shown in table 17.1. (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. This simplification is made only to facilitate exposition; in practice mid-year figures should be used. It should also be noted that the figures in the tables are rounded and therefore may appear not to add exactly. However, a reader who follows the examples in a spreadsheet will achieve exactly the figures shown.)

17.12 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. (Alternatively, the addition to the value of the asset in year 1 can be viewed as 80 times a discount factor of 0.9524, the reciprocal of 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 earnings 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 of the five years is seen to be 282, 191, 116, 59 and 20.

17.13 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 the owner of the capital can spend and still be as well off at the end of the period as at the beginning.

Table 17.1: 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

17.14 Over the five-year period, the value of income is equal to the difference between the sum of the diagonal elements (300) less the amount 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

17.15 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 17.2 can be calculated. By design, a value series consistent with the figures in table 17.1 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 17.1.

Table 17.2: 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

17.16 In general this is as far as the PIM goes. Its twofold purpose is to calculate asset values for the balance sheet and the figures for depreciation 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 start of year 4 is determined to be 19. Given the value of the asset at the start of year 4 is 59, there must be a figure of 40 contributed to the production in that year. Extending this, for year 3 the value of 116 must consist of 18 representing the contribution to production in year 5 of 20 discounted twice, 38 representing the value contributed to production in year 4 of 40 discounted once and so by residual the value contributed to production in year 3 must be 60. In this way all the top, triangular, part of the table can be completed and the values of the amounts of income in a year be derived just as in table 17.1.

3. Age-efficiency and age-price profiles

17.17 Although tables 17.1 and 17.2 start from different assumptions, exactly the same complete table results even though they are filled in a different order in the two cases. Table 17.1 starts from assumptions about the declining contribution to production and derives stock values and the decline in value each year. Table 17.2 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 depreciation. 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).

17.18 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 table 17.3.

Table 17.3: Table 17.2 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

17.19 Table 17.3 again starts from a series of relative price changes as in table 17.2 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 effect 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 282, as in table 17.2 and with cumulative declines in value adding to this amount over five years.

17.20 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 and varies according to the discount factor applied.

17.21 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.

4. The special case of geometrically declining profiles

17.22 A number of patterns can be postulated for either the age-price or age-efficiency profile. These include straight line depreciation and various non-linear forms discussed in *Measuring Capital*. One of particular interest is that where the price declines geometrically, that is each year the price (when adjusted for inflation) is a fixed proportion, f, of the year before. Because such a series converges to, but never actually reaches, zero, it is difficult to portray it in a table such as those shown above but the interesting characteristic can be derived by means of a little very simple algebra. The SNA recommends that the geometric depreciation method be used as a default option; however, other depreciation profiles may be considered more suitable for certain types of assets (see paragraph 7.280).

Commented [ED1]: GN CM.4

17.23 It can be seen from the tables above that the value of an asset at the start of any year, Vt, is equal to the capital services to be rendered in that year, a, plus a discount factor, d, times the value of the asset at the start of the next year, Vt+1. Thus

$V_t = a + d\,V_{t+1}.$

In the case where $V_{t+1} = f\,V_t$, $V_t = a/(1-df)$.

By analogy, if the value of the capital services rendered by the asset in year t=1 is b, $V_{t+1} = b/(1-df)$. But since $V_{t+1} = fV_t$, it follows that b must be equal to af. Thus we have the case that the shape of the age-price profile and the shape of the age-efficiency profile are exactly the same.

17.24 As noted above, there is one and only one age-price profile corresponding to one age-efficiency profile, so it follows that the geometrically declining profile is the only profile that is the same for both the decline in price and the decline in efficiency. One consequence is that figures for capital stock adjusted for the decline in value are equal to those for capital stock adjusted for the decline in efficiency. This property adds to the reasons that can be advanced for choosing this profile to determine the value of capital stock.

5. Practical considerations

17.25 As noted at the outset of this section, there are many simplifications built into the examples presented, made in order to facilitate the explanation of the basic theory behind the idea of capital services to those new to the idea. *Measuring Capital* should be consulted for a more rigorous discussion and for considerations such as the rationale for choosing one age-price (or age-efficiency) profile rather than another, how to estimate life lengths and retirement patterns of assets and the role of expectations in the calculations.

17.26 The manual also discusses the fact that the return to capital must be sufficient to cover taxes levied on the asset in question, a point that is ignored here also in the name of simplification.

17.27 To be precise, a distinction is made between the interest or discount rate, r, usually assumed to be five per cent in this chapter, and the discount factor which is the reciprocal of (1+ r). When r is 5 percent, the discount factor is 95.24 per cent. When the discount factor is 95.0 per cent, the discount rate is 5.26 per cent.

C. Interpreting the flows

17.28 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 depreciation as normally understood in the SNA. 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 17.1 and 17.2, 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 rate. The alternative terminologies are illustrated in table 17.4.

1. Capital services and gross operating surplus

17.29 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 is 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, say. 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 realizing some monopolistic profits. However, 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.

17.30 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 17.4: 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 :						
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					

Value of capital services or gross operating surplus (diagonal: 100, 80, 60, 40, 20)

2. Prices and volumes

17.31 An examination of table 17.1, 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 value but much analysis is done using volume or price information.

17.32 One reason for working this way is that the assumption underlying table 17.1, that the contributions to production over the life of the asset are known, is not often true in practice. What is known, estimated or simply assumed is an index of how the efficiency changes over time. Equally the value of the asset assumed known in table 17.2 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 use 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 and assuming no inflation, into one that expresses the value of the capital services as dependent on the decline in the value of the asset due to ageing (the depreciation element) and the rate of return (the opportunity cost of money). If the impact of general inflation is now taken into account, the price of the capital services (usually called the user cost) can be expressed as depending on the increase in value of a new asset of the same type, the nominal cost of money and the relative year-on-year decline in value of the asset due to ageing.

17.33 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 17.1 was based on the very restrictive assumptions of there being neither absolute nor relative price inflation.)

17.34 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 depreciation and income flows, values at average-year prices are needed. In practice, the mid-year observations are often assumed to be close approximations to the annual averages but this is not always so, especially in times of significant inflation.

D. Applying the capital service model

17.35 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 non-produced 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 rentals 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.

17.36 Before discussing land and other non-produced natural resources, it is useful to recall the consequences of an asset being used by a unit not the legal owner of the asset. The important distinction is whether the user does or does not assume the risks associated with its use in production. When the user does not assume the risks, the asset is regarded as being subject to an operational lease. In such a case the payment to use the asset is a rental and forms part of intermediate consumption. The benefits from using the asset in production accrue to the owner in the operating surplus of the production account relating to his leasing activity. (See paragraphs 27.6 to 27.8.)

Formatted: Font: 10 pt, Highlight

Formatted: Font: 10 pt, English (United States), Not Expanded by / Condensed by , Highlight

17.37 When the user does assume the risks associated with the use of the asset in production, the benefits from using the asset in production accrue to the user and appear in his operating surplus. This is true of both produced and non-produced assets. The difference between produced and non-produced assets concerns the type of lease existing between the legal owner and the user and the type of property income paid to the legal owner of the asset.

17.38 In the case of a produced asset, the user of the asset who assumes all risks associated with the asset becomes the economic owner of the asset. The asset appears on the balance sheet of the economic owner. If the legal owner is different, any payment from the economic owner to the legal owner is recorded as property income payable under a financial lease. (See paragraphs 27.9 to 27.15.)

Formatted: Font: 10 pt, Highlight

Formatted: Font: 10 pt, Highlight

17.39 In the case of a non-produced asset, when the user of the resource and legal owner differ, three different sets of conditions may apply. First, the legal owner may permit the resource to be used to extinction and thus transfers economic ownership of the resource. Second, the legal owner can extend or withhold permission to continued use of the resource from one year to the next and thus retains economic ownership of the resource. In this case the asset remains on the balance sheet of the legal owner but a resource lease between the legal owner and user obliges the latter to pay the former property income in the form of rent. Under the third option the economic ownership of the resource is shared to the extent that both the user and the legal owner are entitled to future economic benefits from the use of the resource. (See paragraphs 27.19 to 27.24.)

Commented [ED2]: Split asset approach - WS.6, WS.8, WS.11

Formatted: Font: 10 pt, Highlight

Formatted: Font: 10 pt, Not Expanded by / Condensed by , Highlight

17.40 For all non-financial assets used in production, the estimation of the value of the capital services associated with the asset allows this to be contrasted with the property income payable for its use to determine whether the use of the asset is cost-effective.

1. Land

17.41 The first and oldest recognized 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 17.5 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 few are shown and some very simple algebra (with explanation) is used to explain how the totals are reached.

17.42 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 rate of 5 per cent as before, the sum of this column is 420. To see that this is so, consider a simple geometric progression. What is required is the sum of a series that can be written as:

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

where a is the return to the asset in every period and d is the discount factor. (As noted earlier. for a discount rate of 5 per cent, the discount factor is 95.24 per cent.) If every term in the equation is multiplied by an extra factor d the result is:

$$dS_n= ad+ad^2+ad^3+ad^4+ad^5+\ldots +ad^{n+1}$$

Subtracting the second expression from the first gives:

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

If d 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-d). In table 17.5, a is 20 and d is 0.9524, so the sum of the series is 420.

Table 17.5: 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	13	14	14	15	16	. . . . . 20 . . .
Year 25	6	7	7	8	8	. . . . . 10 . . .
Year 40	3	3	3	3	4	. . . . . 5 . . .
Value in year	**420**	**420**	**420**	**420**	**420**	**420**
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 . . .

17.43 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 420. 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.

17.44 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 SNA. Similarly one may hear remuneration of employees described as the cost of labour services.

17.45 Another term used for capital services is resource rent and this initially seems more applicable in the case of land but is also a pitfall. In table 17.5, the resource 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 monetized 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.

2. Valuing non-produced natural resources

17.46 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 resource rent to be earned by a mineral deposit, for example, is one way to solve the problem.

17.47 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 capital services of all non-financial assets used in production including any rents paid on the use of non-produced non-financial assets, what is left must represent the resource 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.

17.48 In fact, the application of the capital service technique goes further than this. In the case of renewable non-produced natural resources such as fish in open waters, if the rate of regrowth is at least equal to the rate of extraction, then the value of the fish does not decline and the rate of extraction 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 depletion (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.

Commented [ED3]: WS.6, WS.8, and WS.11 on depletion

3. Mixed income

17.49 When discussing land, above, it was pointed out that the resource 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 non-financial 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 resource rent on land and the capital services rendered by any non-financial 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.

17.50 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. Among the possible causes of this are that the value of output may be volatile due to such things as fluctuations in output prices or the impact of weather. The estimates for the capital services may also be high 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 recognized 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.

Formatted: Font: 10 pt, Complex Script Font: 10 pt, Not Highlight

Formatted: Font: 10 pt, Complex Script Font: 10 pt, Not Highlight

Formatted: Font: 10 pt, Complex Script Font: 10 pt, Not Highlight

4. Assets with a residual value

17.51 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.

17.52 Table 17.6 shows an example of an asset that is used for only four years and then disposed of for a value of 300. Again for simplicity it is assumed that the disposal value after four years is known when the asset is acquired. For example, the market in used assets may be sufficient to ensure that the value at any point is equal to the remaining services to be delivered by the asset. Inflation is still assumed to be zero.

17.53 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. As in the case where an asset is held to exhaustion, 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 remaining 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 depreciation, 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 17.6: 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

17.54 Table 17.6 illustrates that the cumulative value of the depreciation 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

17.55 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 17.7 shows an example where costs of 30 are incurred on the acquisition of the asset in table 17.6. 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 17.7 are added to those in the corresponding part of table 17.6 giving increased value to the asset in each year until the end of year 4, increased depreciation 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.

17.56 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 that 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 and liabilities 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 realized on sale after a given period. 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 depreciation to be attributed to the costs of ownership transfer so there is no residual value of these costs left on disposal.

Table 17.7: Example of costs of ownership transfer on the acquisition of the asset in table 17.6

	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

6. Terminal costs

17.57 Table 17.6 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 that the owner is obligated to incur. Examples include the decommissioning costs of nuclear power stations or oil rigs or the clean-up costs of landfill sites. The following discussion is not meant to downplay the practical difficulty of estimating terminal costs, simply to demonstrate why in principle the existence of terminal costs should reduce the value of the asset throughout its life.

17.58 Terminal costs are similar to capital formation in that they should be covered by income generated during the time the asset is used in production. To avoid a negative value of the asset at the end of its life, the expected terminal costs are added to the value of the asset at the time the asset enters the balance sheet, with a counterparty entry of provisions at the liability side, both to be recorded in the other changes in the volume of assets and liabilities account. At the end of the life of the asset, the actual investment expenditures on terminal costs, which lead to a positive change in the value of the asset, are counterbalanced with a reversal of the flows in the beginning of the period, i.e., a decline in the value of assets with a concomitant decline of the related provisions, again recorded as other changes in the volume of assets and liabilities.

Commented [ED4]: WS.9

17.59 Table 17.8 shows an example of how terminal costs should be recorded. The analysis of the data is similar to that for table 17.6 but also includes the recording of provision charges for the terminal cost (see paragraphs 11.223 to 11.225). The value of the capital services to be provided by the asset in use is still 1 107. The value of the asset must also account for the terminal cost of -300 which will be incurred when the asset is disposed of. Subtracting the present value of the anticipated terminal cost of -247 from the present value of the capital services implies that the initial value of the asset of 860 is lower than without the presence of terminal costs. The initial value of 860 is recorded as capital formation in year 1. The terminal cost will be recorded as capital formation at the time of disposal, but it is important that the depreciation associated with the terminal cost be charged against the income earned during the time that the asset is in service. Hence, two entries for provisions are made in the other changes of assets and liabilities account. The present value of the terminal cost (with a positive sign) is added to the value of the asset, allowing the terminal investment to be written off. To maintain the correct contribution of the asset to net worth, a contingent liability (a provision) of the same amount is also entered. The value of the asset shown on the balance sheet, 1 107 in year 1, is equal to the capital formation for the initial acquisition of the asset plus the discounted value of the capital formation associated with the terminal costs. When discounting is used, the carrying amount of a provision increases in each period to reflect the passage of time. These amounts (shown in the row "unwinding of the discount") also need to be recorded as positive and negative entries in the other changes in volume of assets and liability account each year. The depreciation recorded should equal the change in the value of the asset plus the unwinding of the discount to ensure that the total value of the terminal costs are fully depreciated. If this combined amount is recorded as depreciation, then the cumulated value of depreciation, 1 160, is equal to the capital formation associated with the acquisition of the asset plus the capital formation associated with its disposal of the asset. At the time that the asset is decommissioned and the terminal costs are incurred, gross capital formation of 300 is recorded. In addition, the provisions are reversed, showing an entry -300 in other changes in volume of assets and 300 in other changes in volume of liabilities, bringing the cumulative value of the provision charges to zero.

~~17.59~~17.60 Anticipated costs on ownership transfer on disposal of an asset, including legal fees, commission, transport and disassembly, etc., should in principle be treated in the same way as terminal costs.

Table 17.8: 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 excluding terminal cost	**1,107**	**742**	**464**	**225**	**0**	
Terminal cost	**-247**	**-259**	**-272**	**-286**	**-300**	
Joint value	**860**	**483**	**192**	**-61**		
Initial value of provision	247					
Unwinding of the discount	12	13	14	14		
Joint value plus provision	**1,107**	**742**	**464**	**225**		
Decline in value	365	278	239	225		
Depreciation	**377**	**291**	**253**	**239**		**1,160**
= decline in value + unwinding of discount						
Income	23	9	-3	-14		15
SNA values:						
GFCF	860				300	1,160
Provision charge	259	13	14	14	-300	0
(= other change in volume)						
Asset value	1,107	742	464	225	0	
Depreciation	377	291	253	239		1,160
Provision (= contingent liability)	-259	-13	-14	-14	300	0

7. Major repairs and renovations

~~17.60~~17.61 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 to be 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.

~~17.61~~17.62 The value of the capital repairs can be analysed 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 depreciation for the asset and the maintenance taken together. However, as table 17.7 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

~~17.62~~17.63 Table 17.9 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, three, two or one 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.

Table 17.9: 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

9. Owner-occupied dwellings

~~17.63~~17.64 The SNA specifies that an imputed rental 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. Cross-country comparisons of the results (as in the International Comparison Program) show that the different techniques used produce highly variable results. Here too, the use of the techniques described in this chapter may be helpful.

~~17.64~~17.65 In the example for land, it is possible to deduce a value of 420 for the land that yielded resource rent of 20 every year in perpetuity. While modern houses do not last forever, 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 420, then the imputed rental 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 recognized that the rental for a house usually includes land rent.

10. A financial lease

17.6517.66 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 17.10 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. However, the way in which the balance between interest and repayment of principal changes over time as the loan is repaid holds.)

17.6617.67 The arithmetic behind table 17.10 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 depreciation 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 depreciation and a repayment of capital feature in the accumulation accounts as changing the value of the stock of assets. The contributions to net operating surplus and interest are both income flows and are shown in the current accounts.

17.6717.68 This duality is especially important when an asset is acquired under a financial lease. In this case, table 17.10 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.

Table 17.10: The case of a financial lease

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 principal	**181**	**190**	**200**	**210**	**220**	**1000**
Interest	39	30	20	10	0	100

E. Capital measurement

17.69 Capital services is just one part of capital measurement in the SNA. This section provides an overview of a set of accounts that encompass all aspects of capital measurement, including wealth stocks, productive stocks, depreciation, revaluation, other changes in volume of assets and liabilities, and capital services. These measures are all closely associated with the PIM, and if they are compiled in an integrated manner, the quality of key measures such as net domestic product, net worth and productivity will be enhanced. These measures encompass at least fixed assets and natural resources, but more broadly could encompass other non-financial assets that might be compiled using the PIM including inventories, valuables and consumer durables (which are allowed as a supplementary item on the balance sheet).

Commented [ED5]: New section based on recommendation from GN CM.4 that chapter 17 "should provide an all-inclusive coverage of measuring capital: all stocks and flows of fixed assets, natural resources and land. The new chapter should cover and explain the differences between both wealth and productive capital stocks." The section also includes the content of the 2008 SNA section E, "A supplementary table on capital services", as its final subsection.

1. Basics of capital measurement

17.70 Because capital plays two basic roles in the SNA, as a contributor to wealth and income and as a contributor to the production process, the capital measures in the SNA fit in two broad categories. Wealth stocks represent the value of the capital stock and show how these add to the net worth of institutional sectors and the total economy. Associated with wealth stocks are flows such as capital formation, depreciation, and other changes in assets and liabilities that are related to the measurement of net value added from production, net income and the acquisition of wealth. These measures are associated with changes from period to period in the value of the wealth stock and contribute to the important net measures that appear in the national accounts, institutional sector accounts and balance sheets. The second category of measures is associated with the efficiency of the stock of assets in providing capital services. A measure of stock that is adjusted for current and past declines in efficiency is called the productive stock, and it is used in preparing aggregate measures of capital services. The set of measures that focus on capital services are used especially for estimating productivity and the contribution of the capital stock to economic growth. While both sets of measures are constructed from the same capital flows, it is important that compilers and users of the data should clearly distinguish between the two.

17.71 Before getting into the details of measurement, it is appropriate to recall briefly the various simplifying assumptions that underlie the numeric examples in the chapter, assumptions that would be totally inappropriate in serious estimation of capital service flows. The most important are:

Commented [ED6]: This paragraph and the next one are from 2008 SNA 20.69 to 20.70 with some editing.

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 overall 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. Use of geometric depreciation simplifies this choice by using a single depreciation rate to describe both the age-efficiency and age-price patterns.

17.72 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.

17.73 So far, this chapter has mostly focused on a single asset, for which it is assumed that the owner of the asset is able to calculate, at least approximately, its capital service—the contribution of the asset in the production process—over the anticipated life of the asset. Using this information, it is possible to derive the basic stocks and flows associated with the asset.

17.74 For national accounts compilers, the situation is different. There is a vast variety of assets, including non-produced natural resources and fixed assets of different ages. Information on capital services is not readily available and must be inferred from other information. Prices of fixed assets may only be observed when the asset is initially acquired. The assets can be organized by classifications, such as the SNA's classifications of fixed assets and of natural resources, and possibly by more detailed classifications such as the Central Product Classification, Version 2.1. The data on fixed assets recorded in company accounts may be of limited usefulness to compilers because it is recorded at historical cost.

17.75 In practice, the measurement of capital is usually based in part on estimates that may have been prepared as part of the compilation of GDP. These estimates need to be organized in time series to support a PIM. For fixed assets, including cultivated biological resources yielding repeat products, the basic information required for the PIM is:

a. Time series of estimates of gross fixed capital formation (GFCF) by type of asset (according to the

SNA's classification of fixed assets) at current prices and in volume terms;

b. Time series of price indices that can be used as deflators for each type of asset;

c. An age-price profile (or an associated age-efficiency profile) for each type of asset. If geometric depreciation is used (as the SNA recommends as a default option—see paragraph 7.280), then the only information needed is a depreciation rate for each type of asset. In paragraphs 17.22 to 17.24, one can see that in the case of geometric depreciation, the age-price profile and the age-efficiency profile are the same. If geometric depreciation is not used, the age-price profile must be derived from the age-efficiency profile (or vice versa) to ensure that the two profiles are consistent (see Annex D of *Measuring Capital*).

d. If other changes in the volume of assets are relevant for a type of asset, those other changes in volume should be added to the value of the assets.

e. To support the calculation of net value added and net operating surplus by industry, as well as multifactor productivity estimates by industry, the PIM will need to be calculated by industry as well as by type of asset. Therefore, time series of fixed capital formation and other changes in volume of assets by type of asset need to be prepared for each industry.

f. To support wealth and depreciation estimates for institutional sector accounts, the PIM will need to be calculated by institutional sector as well as by type of asset. Therefore, time series of fixed capital formation and other changes in volume of assets by type of asset need to be prepared for each institutional sector. Typically, price indices and depreciation rates differ across types of assets but are assumed not to differ between institutional sectors for each type of asset.

2. Calculating depreciation

17.76 Depreciation is defined as "the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage" (see paragraph 7.264). A decline in value during the accounting period can be understood as the sum of two components. One component is the price change that reflects the price movement of the asset class under consideration, *given a particular age* (and measured, for example, by comparing the price of a new asset at the beginning of the period with the price of a new asset at the end of the period). Another component is the price change that reflects the ageing of the asset *given a particular price level for the asset class* (and measured, for example, by comparing the price of a new asset with the price of a one-year-old asset). Depreciation is measured as the price change due to ageing, thereby controlling for the overall movements in asset prices. This fits with the idea that "depreciation must be measured with reference to a given set of prices, i.e. the average prices of the period" (see paragraph 11.218).

17.77 The measurement of depreciation is directly associated with the age-price profile of an asset or of a cohort of assets. The rate of depreciation of a t-year-old asset is the difference in the price of a t-year-old asset and a t+1-year-old asset, expressed as a proportion of the t-year old asset. For geometric depreciation, this proportion is constant for all years t.

17.78 Careful consideration should be given to selecting the depreciation rates, or more generally, the age-price profiles. Some fixed assets (such as motor vehicles) have prices from sales of used, or second-hand assets that can be used to directly estimate the depreciation rate. In other cases, information on the typical service lives of the asset can be used. The selection of depreciation rates is discussed in more detail in *Measuring Capital*.

3. Calculating the net ("wealth") stock

17.79 The stock of assets surviving from past periods and corrected for depreciation is the "net" or "wealth" capital stock. The net stock is valued as if the capital good (used or new) were acquired on the date to which a balance sheet relates. The net stock is designed to reflect the wealth of the owner of the asset at a particular point in time. Hence, the notion of "wealth" stock seems more descriptive than "net" stock because there are other types of "net" capital measures. The wealth stock is the measure that enters balance sheets of the national and of institutional sectors.

4. Calculating productive stock

17.80 The stock of a particular type of asset surviving from past periods and corrected for its loss in productive efficiency is the productive capital stock. Productive stocks constitute an intermediate step towards the measurement of capital services. The flow of capital services is assumed to be proportional to the productive stock of an asset class. If the factor of proportionality is constant, the rate of change of capital services will equal the rate of change of the productive stock. The rate of change of the productive stock is assumed to be the volume component when it comes to splitting the change in the total value of capital services at current prices into a price and a volume component. The concept of a productive stock is only meaningful at the disaggregated level of a particular type of asset. Once each asset's productive stock is combined with the corresponding capital service price, the resulting value represents the flow of capital services, which is the relevant variable for aggregation across different types of assets.

5. Perpetual inventory model for non-renewable mineral and energy resources

17.81 For non-renewable mineral and energy resources, the PIM should be applied for each type of asset, with the resulting estimates then summed across asset types for wealth stocks or aggregated using chain indices for volume estimates. Data may be available on stocks and extraction in physical volume terms. The valuation of stocks is explained in paragraphs 14.56 to 14.57 and the measurement of depletion is explained in 11.232 to 11.234. A PIM for each type of asset can be calculated in physical terms or in constant prices. Compared with fixed assets, the PIM for a mineral resource is simpler in that depreciation does not need to be calculated. The opening stock for each year is carried forward from the closing stock of the previous year. There is no gross capital formation, so additions to the stock consist solely of other changes in the volume of assets (if any), which might include new discoveries, for example. Extraction of the resource is recorded as depletion and is subtracted in the calculation of the closing stock. The closing stock at the end of the year is equal to the opening stock plus other changes in the volume of assets less depletion.

6. User costs

17.82 Capital services are considered the appropriate measure of capital input in the production process, but to make them useful one needs to develop measures of value, price and volume of capital services. Depreciation does not represent the full cost of using a fixed asset, as one can see by imagining a case where the fixed asset is leased by its owner to another unit that uses it in production. The owner will charge a rental price that includes not only depreciation but also a net return on capital that reflects the financing costs of capital.

17.83 If there are rental markets, observed rentals could provide a first approximation to the user cost of capital for owner-users of the same assets. While rental markets may be common for some types of assets, such as dwellings, for most asset types rental prices are not available. Thus, various components of cost must be added up to approximate the cost of capital services. In the simplest case, three main cost elements are considered: (i) the cost of financing or the opportunity cost of the financial capital tied up through the purchase of the asset (which is used for calculating the return on non-financial assets used in producing non-market output) (ii) depreciation, i.e. the value loss due to ageing; (iii) revaluation, i.e. the expected price change of the class of assets under consideration. National accounts data on depreciation and prices can be used for estimating components (ii) and (iii), while component (i) might be based on gross operating surplus (along with a portion of gross mixed income) as part of the calculation of the net return to capital. Implementing the user cost methodology requires various assumptions that are discussed in *Measuring Capital*.

7. Aggregation

17.84 The final step in the compilation of capital stock and capital service statistics is to aggregate across asset types to calculate aggregate stocks for institutional sectors, industries or the total economy. In current prices, aggregation is taken as the simple summation of stocks or capital services across asset types. Balance sheets are generally compiled in the current prices of the beginning/end of the period.

17.85 For aggregation in volume terms, the calculations described in chapter 18 are typically applied. Because the wealth) stock is presented in current prices in the balance sheet, it may not be necessary to calculate it in volume terms. But if desired, the volume measure of the wealth stock can be calculated.

8. A table on capital services

17.6817.86 This section describes a table that can be compiled to compare 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 stock. The table can be prepared in current prices and in volume terms, with the capital service values in volume terms used for analysis of capital and multifactor productivity as described in section F of chapter 18.

17.6917.87 The first level of detail that might be examined is given in table 17.11. 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 non-produced natural resources, other non-produced non-financial assets and inventories. The figures for operating surplus of general government and NPISHs and those for capital services of those sectors must be equal except for possible adjustments for inventories and depletion. This is because by convention the net return to capital on assets used in non-market production is derived from an opportunity cost perspective when output is estimated as the sum of costs (see paragraphs 4.295 and 4.296). 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 remuneration element also).

Commented [ED7]: Issue X.55

Table 17.11: The outline of a table on capital services

National accounts data	Total/Gross	Depreciation	Depletion	Net
Gross value added				
Remuneration 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
Total economy				
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				

Commented [ED8]: The line for the total was omitted from the 2008 SNA version of the table. If multifactor productivity is calculated for the total economy, the total (in volume terms) is needed.