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SURVEY OF NATIONAL PRACTICES IN ESTIMATING SERVICE LIVES OF CAPITAL ASSETS

Paper submitted by the ECE secretariat[1]

This report presents the first results of a survey carried out by the UNECE secretariat in Spring 2003. It is still work-in-progress and is submitted to the Joint National Accounts Meeting for information. Comments on the structure and analysis of the summary results would be highly appreciated.

[1] Matthew Shearing and Lidia Bratanova of the ECE secretariat have worked on the project.

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CHAPTER 1: INTRODUCTION

Background

1. The 1993 System of National Accounts (1993 SNA) includes capital stocks as an integral part of the accounting system. The OECD Manual on Measuring Capital (2001), from hereon referred to as the OECD Manual, to which the ECE also contributed, took the measurement of capital a long way forward. Some unresolved issues requiring further research work were however pointed out by the Manual. One of these issues is concerned with the service lives of assets. The accuracy of capital stock estimates derived from a Perpetual Inventory Method (PIM), which the Manual recommends, is crucially dependent on service lives – i.e. on the length of time that assets are retained in the capital stock. Errors in service life estimates can affect the accuracy of measures of gross (and net) capital stock and consumption of fixed capital.

2. Interest in the measurement of capital stock has been increasing recently and the work to improve measures reflects both the interest amongst policy analysts and developments in the methods for the measurement of capital stock. The 1993 revision to the SNA and the 1992 revision of the Standard Industrial Classification (ISIC 92) have driven a lot of the work to improve the PIM. SNA93 introduced new classifications of assets, while ISIC 92 altered the underlying industrial breakdown.

3. Meanwhile, changing investment patterns, largely emerging during the ‘investment boom’ of the 1990s, have seen a shift towards short-lived high technology assets (such as computers) and intangible assets (such as software). The transition of ex-centrally planned economies in the 1990s also brought about major challenges not only in adapting to new systems of data collection but also to high rates of flux in the economy – leading for instance to high and unpredictable premature scrapping rates. Throughout all UNECE countries, service lives of capital assets (both how they are determined and how they are applied) have therefore become a crucial issue.

The Survey

4. The Joint ECE/Eurostat/OECD Meeting on National Accounts held in Geneva, from April 24-26, 2002 recommended that the ECE should undertake a survey of national practices in ECE countries for estimating the service lives of fixed capital assets. As a step towards establishing best practice in this area, a survey of national practices in measuring service lives was thus carried out in Spring 2003. A questionnaire was sent to all 55 UNECE member states, and 5 non-European members of OECD, of which 41 provided responses.

5. Responses were received from: Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Canada, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, the Republic of Korea, Kyrgyzstan, Latvia, Lithuania, Mexico, Moldova, the Netherlands, New Zealand, Norway, Poland, the Russian Federation, Serbia & Montenegro, Slovakia, Slovenia, Spain, Sweden, Switzerland, the former Yugoslav Republic of Macedonia, Turkey, the United Kingdom, and the United States of America.

6. This paper analyses the results of the survey, building on previous work in this area of economic statistics. Unlike earlier studies however, which have been centred on a more limited range of countries, this survey has drawn on the experiences of a wide range of countries with differing 'statistical environments', i.e. those at different levels of statistical and economic development . This includes not only OECD countries but also those countries developing their statistical systems in the context of the transition from centrally planned to market economies.

7. This report is written with regard to the research agenda for capital stocks and flows as set out by the OECD Manual, which states: that at least in the case of tangible fixed assets, research needs to be directed towards obtaining more and better information rather than refining the underlying theory[2]. The results of the survey allow information on service lives to be summarised and shared, providing an important set of data which could inform the process of improving capital stock measurements.

The importance of capital stock measurements

8. The accurate measurement of capital stock is important both in the calculation of national accounts and in modelling production in the economy. Capital stock data are used as a basis for work on multi-factor productivity estimation and profitability assessments, and as an important input to certain parts of the balance sheet compilation in national accounts. In most OECD countries, however, official estimates of capital stock have only been introduced to the national accounts since the 1970s. This has been due, not in small part, to the fact that estimating capital stocks has proven one of the most challenging areas of measuring market economies. Direct observation has been almost impossible due to the cost and complications involved.

9. The transition economies were, however, able to produce more comprehensive data under centrally planned economies through the Balance of Fixed Assets (BFA) system (see 'Basic definition of terms' section below). The transition has meant however that most of these countries can no longer rely on this method of data collection. They must now meet the challenges of accurately capturing changes in capital stocks, in a market economy context, more familiar to other UNECE member states.

10. The Perpetual Inventory Method (PIM) is the recommended method for estimating capital stocks in the OECD Manual. Some countries are able to follow the recommendations rigorously, for others, however, elements of the BFA system are now combined with the PIM, and in other non-transition economies the PIM (as recommended by the OECD Manual) is only partially applied. In brief, there exists a patchwork of approaches to measuring capital stock. This patchwork of approaches also extends to the variety of assumptions which are used concerning the service lives of assets, and scrapping patterns, within individual models within different countries. As demonstrated in the following section, information regarding service lives is crucial to the overall accuracy of capital stock estimates, but is perceived by most experts as being of generally poor quality.

11. Such diversity in approaches has serious implications regarding the international comparability of national accounts data and the accuracy of individual national accounts, both

[2] OECD Manual on Measuring Capital, p.107.

on aggregate and disaggregated levels. Indeed, existing methodologies for measuring capital stocks can be seen as one of the weakest areas of economic statistics. The UN Statistical Commission's Working Group on International Statistical Programmes and Co-ordination, of April 1996, recognised it as one of the fifteen so-called critical problems in economic statistics. The purpose of this report is to contribute to the resolution of problems associated with capital stock measurements. This is achieved by presenting and analysing the varying practices used by countries in estimating the service lives of assets. A synthesis of the results from a wide range of countries should provide useful lessons for the development of this area of statistics.

12. The audience for this report is expected to be those with an interest in developing economic statistics. It is therefore assumed the reader has some knowledge of the fundamentals of National Accounting and economic statistics in general, although a general understanding of the technical terms to be used is given in the following chapter.

CHAPTER 2: BASIC DEFINITION OF TERMS

13. This section provides a brief description of the terms that are most often used in dealing with capital stock statistics in general, and the service lives of assets in particular.

Capital Stocks and capital formation

14. The word **capital** can mean many things in economics. In the context of this report, '**capital assets**' refers to produced goods which are different from the materials and fuels used up in the production process because they are not used up during one particular period of time (a year) but are required for the production process to take place. The System of National Accounts 1993 (SNA 93) distinguishes between two types of capital assets:

15. *'Produced assets'* are non-financial assets that have come into existence as outputs from processes which fall within the production boundary of the SNA - consisting of fixed assets, inventories and valuables[3].

16. *'Non-produced assets'* are those that come into existence other than through processes of production[4]. Examples include naturally occurring assets such as land and certain uncultivated forests and mineral deposits.

17. Non-produced assets and some produced assets are however excluded from the measurement of **capital stock** in most countries**.** The value of the capital stock could be taken to mean the value of all capital assets installed in producers' establishments, at a given point in time. In this paper, however, to focus on the issue at hand, it is taken to mean the value of only those assets which are included in countries' estimates of **Gross Fixed Capital Formation (GFCF)**. GFCF is broadly defined as the value of acquisitions, less disposals, of new and used (second-hand) fixed assets by producers.

18. Most countries follow the SNA in deciding which types of goods to include in GFCF. Thus goods are included where they are **tangible** (intangible assets such as artistic originals and computer software licences are excluded), **fixed** (inventories and work in progress are excluded, but not mobile equipment), **durable** (i.e. they last more than one year), and **reproducible** (goods such as land, natural forests and mineral deposits are excluded, but livestock for breeding/diary etc., and plantations of trees yielding repeat products are included). Assets used by the military are generally excluded. Although very few countries follow the SNA definitions exactly, it has been found that, for the OECD at least, deviations are quantitatively unimportant in most cases[5].

Service lives

19. The OECD Manual defines the **service lives** of capital assets as:

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[3] SNA 93, Para. 10.6
[4] SNA 93, Glossary, p.34.
[5] 'Methods used by OECD countries to measure stocks of fixed capital', OECD, 1992

"…the length of time that assets are retained in the capital stock, whether in the stock of the original purchaser or in the stocks of producers who purchase them as second hand assets."[6]

20. The set of assumptions regarding the service lives of different types of assets is one of the four crucial inputs to the PIM method of estimating capital stocks (along with the initial value of the stock, annual capital formation or GFCF, and price changes of assets). The service lives used in the PIM attempt to determine the total length of time from the initial installation of the asset to its final discard or scrapping by the producer. All assets have a finite life, which may range from say 4 to 5 years for computers to decades for roads and buildings. The problems of estimating the likely lengths of life of assets remain the main area of uncertainty in the PIM approach.

21. As mentioned above, capital assets can be either tangible or intangible. The measurement of intangibles is an area currently being developed and the SNA 93 specifies that they should be included in capital stock values, especially as they are becoming a more and more important part of the production process. Indeed, previous studies which have emphasised the dual roles of buildings and equipment in capital driven economic growth[7], may well have become quickly outdated. For the main part, however, **this paper will deal with issues regarding the service lives of fixed tangible assets - as they currently represent the main input into the calculation of GFCF in most countries**.

Mortality

22. The issue of **obsolescence** of assets and how it is measured is becoming more crucial as intangibles are included in capital stock values. This is still important however for some groups of tangible assets, such as computers. **Obsolescence is defined as occurring when an asset is retired before its physical capability is exhausted**, and should be included in capital stock data where the asset's owner can be expected to anticipate it[8]. The interaction between **planned obsolescence** and estimated service lives of tangible and intangible assets has become of major importance due to high and increasing rates of technological change.

23. Another crucial interaction in measuring capital stock is that between service lives and **mortality patterns** - i.e. assumptions made about the distribution of retirements of assets around the average service life. Within each of the various categories of asset, individual assets will clearly have varying life lengths and they could be exported, sold for scrapping, dismantled or abandoned - i.e. they become '**retirements**' (sometimes referred to as '**discards**'). Assumed mortality patterns may be referred to as **retirement distributions** or **mortality functions**. These functions show rates of retirement over the lifetimes of the longest-lived member of a group of assets of a particular type installed in a given year.[9]

24. This paper relies on the OECD Manual's definitions of mortality functions and their corresponding **survival functions** (these show what proportion of the original members of the group of assets are still in service at each point during the lifetime of the longest-lived member of the group)[10]. The four types of function discussed in the OECD Manual are:

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[6] OECD Manual, Para. 6.19
[7] see, for instance, O'Mahoney (1996)
[8] OECD Manual, box 1, p.31.
[9] OECD Manual, Para. 6.50.
[10] See OECD Manual, Para 6.50 to 6.54.

- The **simultaneous exit** mortality function assumes that all assets are retired from the capital stock at the moment they reach the average service life for the type of asset concerned.

- The **linear** function assumes assets are discarded at the same rate each year from the time of installation until twice the average service length.

- The **delayed linear** function however makes the more realistic assumption that that discards occur over a shorter period - retirements start later and finish sooner than in the simple linear case.

- The **bell-shaped** pattern of retirements assumes that retirements start gradually some time after the year of installation, build up to a peak around the average service life and then taper off in a similar gradual fashion some years after the average. Various mathematical functions are available to model the exact shape of the function's curve.

Categorisation

25. **Asset categories** are the groupings of types of assets to which average service life estimates are applied and should be sub-categorised by industry. This allows for variances in the actual service lives of diverse types of assets and of similar assets as they are applied across different economic activities. The definition and amount of categories used, and the level of variance by industry, may differ substantially from country to country. This may be due to a number of reasons but will be in large part determined by the amount of information available concerning asset service lives and asset use within a particular country, as well as particular conditions within a country.

26. There are three main asset categories used by most countries: *machinery and equipment*, *buildings and structures*, and *other assets* - which are broken down further by some countries following the SNA93 recommendations. There are three categorisations contained in the SNA93 which are relevant to determining the categories used, these are:

- the Classification of Assets,
- the Classification of Institutional Sectors,
- and the International Standard Classification of All Economic Activities (ISIC Rev.3).

27. The OECD Manual recommends that these categorisations are used for publishing capital stocks statistics[11]. The relevant tables are shown overleaf.

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[11] OECD Manual, Para.3.3

Table 1: SNA Classification of Produced Non-Financial Assets.

AN.1	**Produced Assets**			
AN.11	*Fixed Assets*			
	AN.111	**Tangible Fixed Assets**		
		AN.1111	Dwellings	
		AN.1112	Other buildings and structures	
			AN.11121	Non-residential buildings
			AN.11122	Other structures
		AN.1113	Machinery and equipment	
			AN.11131	Transport and equipment
			AN.11132	Other machinery and equipment
		AN.1114	Cultivated Assets	
			AN.11141	Livestock for breeding, diary, draught, etc…
			AN.11142	Vineyards, orchards and other plantations of trees yielding repeat products.
	AN.112	**Intangible fixed assets**		
		AN.1121	Mineral Exploration	
		AN.1122	Computer software	
		AN.1123	Entertainment, literary or artistic originals	
		AN:1129	Other intangible fixed assets	
AN.12	*Inventories*			
	AN. 121	**Material and supplies**		
	AN.122	**Work-in-progress**		
		AN.1221	Work-in-progress on cultivated assets	
		AN.1222	Other work-in-progress	
	AN.123	**Finished goods**		
	AN.124	**Goods for resale**		
AN.13	*Valuables*			
	AN.131	**Precious metals and stones**		
	AN.132	**Antiques and other art objects**		
	AN.139	**Other valuables**		

Table 2: SNA Classification of Institutional Sectors

Non-financial corporations	
Financial corporations	
General government:	
[can be sub-sectored into]	*Central*
	State
	Local
	Social security funds
Households	
Non-profit institutions serving households	

Table 3: SNA suggested activity classification for capital stock statistics

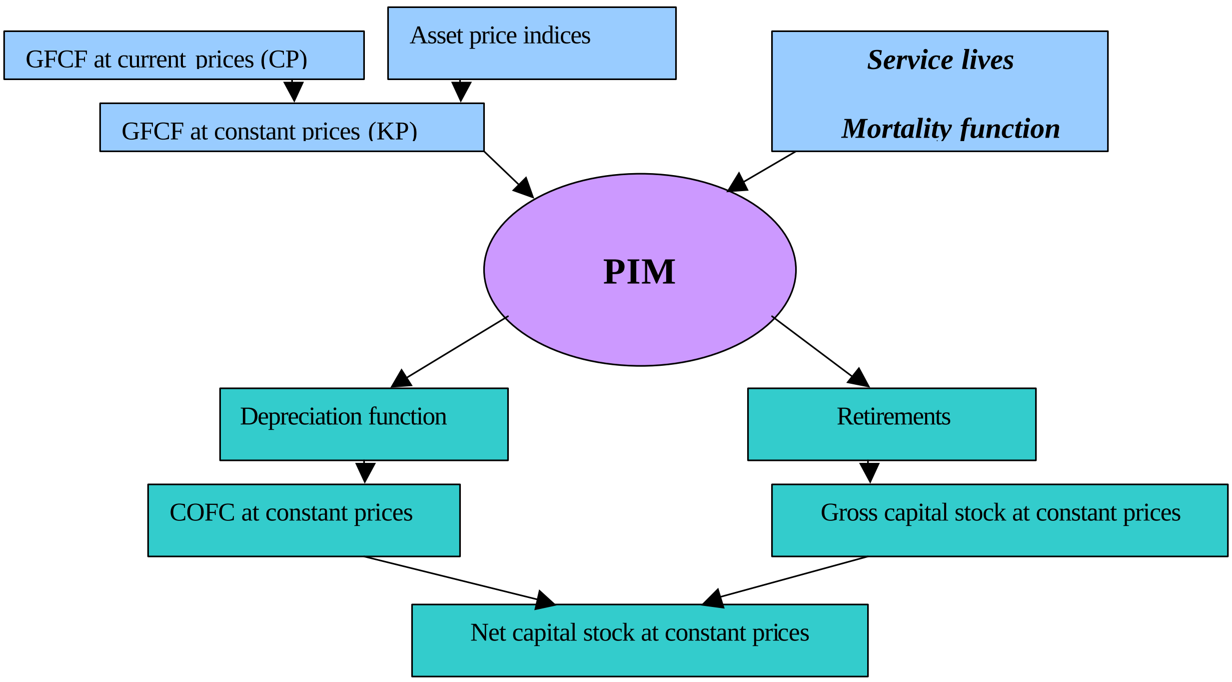
ISIC Tabulation Categories	Description
A + B	Agriculture, hunting, forestry and fishing
C	Mining and Quarrying
D	Manufacturing *(with 4 or 5 important activities separately identified)*
E	Electricity, gas and water supply
F	Construction
G + H	Wholesale and retail trade, repair of vehicles and household goods, hotels and restaurants
I	Transport, storage and communications
J + K	Financial intermediation, real estate, renting and business activities
L	Public administration, defence and social security
M,N +O	Education, health and social work, other community, social and personal service activities

Consumption of fixed capital

28. **Consumption of fixed capital (or COFC)**, sometimes called **capital consumption,** and capital stock are generally measured simultaneously as part of the same estimation procedure. The SNA 93 states that capital consumption represents the reduction in value of the fixed assets used in production during the accounting period resulting from physical deterioration, normal obsolescence ('planned obsolescence' as defined above) or normal accidental damage[12] - determined using a set of assumed **depreciation rates**. When COFC is subtracted from the gross capital stock figure a measure of **net capital stock** is obtained. It should be noted that references to capital stock in this paper relate to the concept of gross capital stock, rather than net capital stock**.**

29. Although this report is not specifically concerned with COFC, it is important to note that COFC is one of the principle measures to emerge from the PIM and as such relies heavily on the accuracy of service life data and mortality functions inputted into the model. This can be seen from diagram of the PIM shown below[13]. Note that accurate asset price indices are also an important input into the model.

The Perpetual Inventory Method



30. The OECD Manual describes how the PIM works in practice[14]. In basic terms the model involves 3 main stages of calculation:

- New capital investment is added to the existing capital stock (GFCF at constant prices,

[12] a definition can be found in the SNA93 Glossary p.10
[13] Derived from the diagram shown in the OECD Manual, Page 56.
[14] Chapter 6.

KP, is added to the gross capital stock from the previous period).

- Assets are subtracted which have reached the end of their lives (through the application of service lives, mortality functions and, theoretically, premature scrapping rates).

- The results are placed onto a common price basis

31. This paper is concerned primarily with the second stage described above, which is largely determined by a set of assumptions made concerning the retirement of assets from the capital stock. The other stages of the PIM, however, may be less based on assumptions but rather on recent data collection exercises.

32. The assumptions made should include an assessment of the level of **premature scrapping** which has occurred in the economy over the most recent time period. Premature scrapping refers to fixed assets which have been scrapped by creditors dealing with liquidated companies. The best price for an asset will of course be sought but in practice assets will often have to be sold for scrap and they will be removed from the capital stock *prematurely*, i.e. before the end of the normal service life of the asset assumed in the PIM. The rate of premature scrapping should be applied by type of asset and industry, corresponding to the asset categories used in the PIM.

33. The **Balance of Fixed Assets (BFA)** approach to measuring capital stocks was the standard method used in the Material Product System (MPS) of centrally planned economies. The BFA approach is no longer implemented in a systematic way in the transition economies and the amount and type of information now available differs from country to country[15]. The method involves undertaking annual surveys of the fixed assets recorded in the balance sheets of enterprises. These surveys are exhaustive and record information disaggregated by type of asset, utilising stock data directly as recorded in balance sheets. A table can thus be created which contains the value, composition, and change in value of fixed assets for the economy as a whole, by industry and form of ownership. Thus the following can be identified:

- The stock of fixed assets at the beginning of the year.

- The acquisitions during the year (separately identifying new assets).

- Withdrawals (separately identifying new assets).

- The value of the stock of fixed assets at the end of the year.

34. Essentially, the system is not dissimilar to the PIM in that it adds the value of *'inflows'* of assets during the year to the gross value of the stock at the start of the year, and then

[15] For more details see the UNECE survey (1997) 'Methods used to estimate stocks of fixed assets and COFC in transition countries'

subtracts *'outflows'*[16]. Service lives in this system are not relevant to estimating withdrawals from the stock of assets as these are measured directly. Service lives are used however to calculate the loss in value of fixed assets through the application of depreciation rates (it should be noted that this concept differs from that of COFC as defined in the SNA 93).

[16] For a fuller explanation of how the BFA is compiled see Chapter 3 of UNECE 'Measurement of capital stock in transition economies' (2003).

CHAPTER 3: ASSET SERVICE LIVES - THE PROBLEMS

Effect of errors in estimating service lives

35. If average service lives of fixed assets are under or overestimated this has considerable implications for the accuracy of the estimates of capital stock and capital consumption resulting from the PIM. The OECD Manual refers to the results of two 'sensitivity studies' carried out by Canada and the Netherlands that investigated the impact of errors in service lives, and thus suggests that:[17]

Longer service lives,

- always increase the size of the gross capital stock
- usually reduce consumption of fixed capital
- usually increase the size of the net capital stock and by relatively more than in the case of gross capital stock
- have an unpredictable effect on growth rates
- reduce the volatility over time in the growth of stocks and capital consumption

36. There are various sources of error in determining estimates of service lives. These are discussed below.

Sources of data on the average service lives of assets

37. For the PIM to produce accurate capital stock estimates two things are required: good quality data concerning capital investment and good quality information about the service lives of the assets invested in (it is also necessary to have long-run information on prices so that historic costs can be converted into current or constant values). It is possible to collect reasonable data on capital expenditure in the economy through surveys (although obviously the more comprehensive the survey the better the data), but obtaining and keeping up to date information on the service lives of assets presents substantial difficulties.

38. Enterprises are generally unable to provide information on the service lives of assets they have purchased so it would not be possible to get such information when enquiring about their capital expenditure i.e. by ***direct observation***. West (1998)[18] points out, for the UK at least, businesses see no need to retain detailed information on disposed assets, neither for their own purposes nor to comply with accounting regulations, nor for tax returns. Indeed, although many firms do record a breakdown of their assets in their annual reports, the details given are often insufficient for the purpose, and where overseas assets are held they may not be distinguished from assets held domestically[19].

[17] para.6.48
[18] 'The Direct Observation of Asset Lives', Paul West (1998).
[19] 'The use of the PIM in the UK; Practices and Problems': Capital Stock Conference 1997.

39. Even if businesses could provide appropriate information, other factors in the economy could make estimates based on this information invalid, for instance: the rate of technological change in the economy might mean that planned obsolescence rates are inaccurate, or economic flux might result in higher or lower than expected premature scrapping rates. In essence, it is in fact impossible to predict the exact length of service, or an average, that an enterprise can expect from any particular type of asset. Estimates of service lives can be obtained from a number of sources however, but each of these sources has drawbacks.

40. Some ***Company Accounts*** do include information on the service lives that they are using to depreciate assets and these could be used in the PIM. Although companies usually record stocks of assets at acquisition costs, presenting problems for the deflation and depreciation functions in the PIM, this does not prevent them from being used as the basis of service life estimates. There are a number of ways of doing this.

41. The Atkinson and Mairesse method[20] uses company accounts to construct time series of investment in fixed assets and gross capital stocks. Combinations of mortality functions and different service lives are then tested on the data to achieve the 'best fit' with this time series data. This method has the following advantages:

- Appropriate mortality functions can also be estimated.
- Inspection of the data for sub-periods may also indicate if service lives are changing.
- Atkinson and Mairesse found that the level of aggregation did not much affect the accuracy of the service life estimates, or mortality function, and therefore highly aggregated data on enterprises could be used, where it is available, so it is unnecessary to examine individual company accounts.

42. However,

- When companies merge, are taken over, or undergo financial restructuring, assets are often re-valued, but the stock and investment data required for this method to work must be consistently valued over the entire period considered.
- This method gives little detail regarding asset categorisation, as company accounts may not give much detail concerning the type of asset held or the kinds of economic activity engaged in.

43. The method developed by Tarafosky et al (1982)[21] uses company accounts to estimate service lives by dividing the gross annual stock at the end of a given year by estimated depreciation during that year. They showed that as long as depreciation is calculated using a straight-line method, then this ratio is the harmonic mean of asset service lives. This method has the following advantages:

- More simple than the Atkinson and Mairesse method.
- No time series are necessary (one year's data is enough to provide an estimate for that particular year).
- If more than one year's data is available then changes in asset lives can be determined.

[20] See 'Length of life of equipment in French manufacturing industries' (1978).
[21] 'Ex post aggregate real rates if return in Canada, 1947-76' (1982).

44. However,

- ❖ No information about mortality functions can be derived.
- ❖ It still cannot provide information on asset categorisation.

45. Asset service lives may also be derived from ***Tax Lives***. These are employed by most tax authorities in OECD countries to specify the number of years over which the depreciation of various types of assets may, *under normal circumstances*, be deducted from profits before charging taxes. The question here of course is how are these tax lives determined in the first instance? A variety of sources appear to be used by the tax authorities, including: expert opinion, advice from trade organisations, and ad hoc surveys of particular assets in particular industries. Therefore tax lives may present a useful summary of the information collected by tax authorities on service lives, but on the other hand these sources may be of differing reliability. Indeed, Hibbert et al (1977) found that in the UK, for instance, tax lives were based on "custom and practice rather than any scientific study of the longevity of assets"[22]. Moreover, Blades (1983) found that for the same country various systems of accelerated depreciation had been used to encourage investment: and therefore published tax lives became irrelevant to the calculation of tax liabilities and neither the authorities or businesses had any incentive to keep them up-to-date[23.]

46. It would therefore represent good practice for the sources of tax life data to be thoroughly investigated in order for service life estimates based on them to be credible. Rather, as in some countries, tax life data may be found to be most useful as a general credibility check on service life estimates obtained by other methods[24]. The OECD Manual points out, however, that in some countries tax lives are based on periodic investigations by tax authorities and could be assumed to be realistic. There may be tendency though for an overall bias in one or other direction, meaning that systematic upward or downward corrections to tax lives may be needed before using them in the PIM.

47. Producers themselves can be asked directly for information concerning the service lives of their assets which can then be used to derive estimates of average service lives for particular types of assets in particular industries. Such **statistical surveys** can be used in two ways: through enquiries about the discard of assets in a certain accounting period, or about the expected remaining lives of assets currently in use. As mentioned above, the problem with the former is that companies may not be able to provide reliable information on discarded assets. Enquiries to companies about the expected remaining lives of assets, however, may be more fruitful because businesses have an incentive to accurately forecast service lives - so investment flows can be managed.

48. In both instances, however, the carrying out of surveys of a large enough scale to produce accurate economy-wide estimates may be undesirable. As Meinen (1998) points out: "most statistical offices see as the main obstacles in determining asset lives the high costs and

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[22] Hibbert et al 'Development of Estimates of the Stock of Fixed Capital in the United Kingdom' (1977)
[23] OECD Working Paper No.4: Service Lives of Fixed Assets - D.Blades 1983
[24] see OECD Working Paper No.4: Service Lives of Fixed Assets - D.Blades 1983

respondent load associated with obtaining and maintaining good measures".[25] Indeed, past experience in some East European countries has demonstrated the enormous complexity and scale such surveys may necessitate[26]. Moreover, the transition economies today experience particular problems in obliging or convincing new private businesses to provide the resources needed to submit information on their assets to statistical agencies.[27]

49. Nevertheless, some small-scale surveys have been carried out in some OECD countries, and in some cases service life questions have been added to regular surveys, such as capital expenditures surveys. Statistical offices may not, however, have to carry out their own surveys as trade and technical publications may provide usable information, based on their own surveys.

50. Producers of capital goods need to accurately estimate the service lives of the assets they sell in order to forecast future demand. They can therefore provide a reliable source of **expert advice** on which to base service live estimates. Basing estimates on expert advice can also involve seeking advice from a panel of production engineers familiar with conditions in a representative cross-section of industries. However, as Blades (1983) points out, 'expert advice' may merely represent a euphemism for guesswork by capital stock statisticians. Thus, estimates derived from expert advice can vary substantially in their accuracy depending on the 'expertness' of that advice.

51. Some asset service lives can also be estimated by **administrative records** kept by government bodies. The OECD Manual points out that:

"In almost all countries registers are kept of construction and demolition of dwellings and commercial buildings and vehicle registration records track the service lives of road vehicles. Aircraft and ships are also subject to similar controls. Regulatory bodies in power industries, railways and telecommunications are also a possible source of information."[28]

52. Service life estimates can also be determined or influenced by **other countries' estimates**. Moreover, estimates used in other countries can be used to check the feasibility of a particular country's estimates (derived from other sources), particularly where the countries being compared have similar economic environments. The Manual underlines two significant dangers here however[29]:

- If countries systematically copy other countries' service lives, an impression is created that there is a well-based consensus on the matter when in fact few, if any countries, have actually investigated service lives in their own countries.
  And,
- Asset service lives must be strongly influenced by country-specific factors such as the relative prices of capital and labour, interest rates, climate and government investment policies.

[25] 'Lives of Capital goods', OECD 1998
[26] See, for instance, 'Organisation of Statistics in the USSR', A. Yezhov (1987)
[27] 'Measurement of Capital Stock in Transition Countries', UNECE
[28] Para. 6.30
[29] Para. 6.32

53. Information on service lives in the former centrally planned economies was available from central government estimates. The number of years over which depreciation rates should be applied was 'prescribed' centrally (for the purposes of making depreciation allowances). As a UNECE report (2003)[30] points out, however, these prescribed service lives could be irrelevant to calculating capital stocks as they could be substantially shorter than the actual service lives of assets: companies would keep assets in service for some years after they had been fully depreciated for tax purposes, while various systems of accelerated depreciation would be recommended to encourage investment.

54. The BFA system does however allow for information on service lives to be derived from the information on the age structure of the capital stock and data on retirements or scrapings contained within the BFA. So where the BFA structure, or elements of it, are still in place fairly reliable estimates of service lives may therefore still be possible and separate investigations of company accounts or statistical surveys, which would otherwise be necessary to obtain this data, may not be necessary.

Changes in service lives

55. The Capital Stock Conference of 1997 noted that:

'In an ideal situation of a totally stable economy, and limited technological change, provided the initial estimate of life spans was reasonably accurate, there would be no problem with PIM. But, that type of industrial environment does not exist, and never will. In practice actual asset lives change over time, and sometimes very rapidly.'[31]

56. Therefore, even if satisfactory service lives can be estimated, accurate capital stock measurements would need to take into account changes in the actual service lives of existing and new assets. However, service lives are rarely updated in most countries. This 'fixity' of service lives fails to capture real changes in the capital stock - service lives can either fall or increase over time due to a number of factors. Such changes in service lives are in fact becoming more and more disruptive to the accuracy of capital stock measurements for the following reasons[32]:

- ❖ "Product cycles" are becoming shorter. Rapidly changing consumer tastes force manufacturers to retool their production lines more frequently. The development of "flexible" production systems, however, which allow manufacturers to rapidly switch between alternative models without any need to retool, presents an added complication.

- ❖ The increasing use of computer technology means that obsolescence rates are much higher than in the past.

- ❖ Some assets are becoming more durable over time, e.g., road vehicles and commercial aircraft.

57. Thus there is a need to deal with the inherent and increasing discrepancies between the

[30] 'Measurement of Capital Stock in Transition Economies' (para. 5.4)
[31] see 'The use of the PIM in the UK; Practices and Problems', Agenda Item V.
[32] para. 6.33 and 6.34 of the OECD Manual.

expected and real service lives of assets. This implies that, at least, either a regular review of service lives is required, or assumptions concerning the overall annual level of change in the original estimates should be built into the PIM.

58. A previous OECD study on capital stock measurement concluded that although service lives can be expected to vary over time (and between firms) there is no reason to expect any long-term tendency for the service life of a given type of asset to become shorter or longer[33]. The factors identified which cause variations in service lives may be just as likely to increase service lives as decrease them: demand for the asset's output, labour and input prices, effective tax rates, expenditure on asset maintenance, and the efficiency with which management uses factor and non-factor inputs can all go up or down.

59. Where assumptions are used to adjust for changes over time, however, the Manual points out that even without information concerning the asset lives of specific assets it may be right to assume declining service lives for groups of assets[34]. Indeed, it may well be the case that the asset groups identified in a PIM may contain increasing *shares* of shorter-lived assets (e.g. those with computerised components) rather than having a homogenous set of assets with equally decreasing service lives.

60. It would therefore seem necessary, if assumptions concerning the decrease (or increase) of asset service lives were to be applied within the PIM, that these assumptions are based on empirical evidence. Such evidence should determine the direction and magnitude of changes in service lives specific to certain industries or types of assets[35].

Asset Categorisation

61. Asset categorisation is a crucial factor in determining the effectiveness of service life estimates in the PIM. Without appropriate groupings of types of assets accurate estimates of the service lives of particular assets would do little to improve the overall accuracy of the capital stock measurement. Homogeneity in the service lives of assets within a category (whether by type, institution, or industry) is required for the PIM to produce accurate estimates.

62. Theoretically, the most accurate PIM would use different service lives for each individual fixed asset in the economy, rather than grouping them under broad criteria which may exaggerate commonalities in the life lengths of assets within that group. It therefore follows that greater numbers of categories (by type of asset, institution or industry) should produce more reliable estimates of capital stock from the PIM (as long as categories are designed to reflect the homogeneity of the assets within them and service life estimates are reasonable).

63. Homogeneity is also a key to achieving accurate deflation when applying price indices to groups of assets. The Eurostat Handbook on Price and Volume suggests the use of a categorisation by asset which is thought to be relatively homogenous concerning price movements[36] (for the purposes of deflation).

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[33] 'Methods used by OECD countries to measure stocks of fixed capital' (1992), P.27.
[34] Para. 6.37
[35] For details of national studies see 35 'Methods used by OECD countries to measure stocks of fixed capital' (1992), P.27-30.
[36] A breakdown can be found in the OECD Manual, Para. 3.8

A note on mortality and depreciation functions

64. Questions on mortality and depreciation functions were included in the questionnaire for the survey. Service life estimates and mortality functions both involve making assumptions about the nature of the retirement of assets from the capital stock. The choice of mortality function employed can similarly bring about errors in the capital stock estimate.

65. Where a 'bell-shaped' mortality function is used, different mathematical functions are used to determine the exact shape of the curve. The choice of curve can be determined on the basis of how well it fits in with the information available in different countries concerning the actual retirements of various kinds of assets. Given the general lack of empirical evidence regarding retirements, Blades (1983) points out that the selection of a particular function in most countries is based on the retirement patterns of only a few types of assets - notably transport equipment[37]. ***Winfrey functions*** were however developed with a good empirical base in the USA in the 1930s, but given the differences between the fixed assets of 70 years ago and today their appropriateness must be called into question.

66. While 'linear' mortality functions may be assumed to be too unrealistic, 'delayed linear' functions may give a more accurate picture of actual retirements with a similar computational simplicity. It has been found though that delayed linear functions may reflect the mortality patterns of particular groups of assets rather than the whole capital stock (see Barna, 1961[38]).

67. The 'simultaneous exit' function may also seem unrealistic as it suggests that all assets of a given age disappear from the capital stock simultaneously. Different companies and different industries will use particular assets differently and the retirement ages may thus differ significantly. However, like the delayed linear function, this function may be used because of its computational simplicity and little information may be available concerning the pattern of actual retirements.

68. The success of depreciation functions in accurately estimating COFC will depend to some extent on the accuracy of the service lives they are applied to. Various depreciation functions have inherent problems, however, and these are discussed in the OECD Manual[39].

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[37] Para. 34.
[38] 'On Measuring Capital', in The Theory of Capital, Lutz & Hague, 1961
[39] Chapter 7.

CHAPTER 4: CONCLUSIONS FROM PREVIOUS SURVEYS ON NATIONAL PRACTICES IN ESTIMATING SERVICE LIVES

OECD Studies

69. A report was prepared in 1983[40] on capital stock statistics for 13 OECD countries (Canada, USA, Japan, Australia, New Zealand, Austria, Finland, France, Germany, Italy, Norway, Sweden, and the UK) which detailed the wide variety of methodologies for dealing with service lives across those countries. The box below summarises the findings at that time:

Table 4: Summary of results from the 1983 OECD report on service lives

Data sources: Most countries were making some use of *tax lives*, either to estimate the service lives of assets for which no other sources were available, or to provide a general credibility check on service life estimates obtained by other methods. These tax lives were based on a variety of sources of differing reliability.

Company accounts were being used in two countries.

Japan was found to be the only country to have used a large-scale *asset survey*, in 1970, to estimate service lives. Respondents were required to give expected life-times for a very detailed list of fixed assets along with other information relating to their capital stock - this established a benchmark figure for capital stock which was subsequently updated by the PIM. A smaller scale enquiry had been carried out in the UK within the manufacturing sector only, while Italy had included questions on the service lives of machinery in its annual survey of industrial production.

Most countries were found to base at least some of their asset lives on *expert advice*, and Sweden and Italy almost exclusively relied on this source.

Although relatively few countries specifically mentioned *other countries* as a source for estimating asset lives, it was found to be probable that most countries periodically review estimates used by other countries to ensure their own estimates are not too far out of line with those of neighbouring similar countries.

Dealing with changes to service lives: Although it was found to be generally accepted that average service lives change over time, only three countries made allowance for this. Sweden assumed declining service lives for certain assets, while both Germany and Australia maintained models which provided for variation in asset lives where information became available to warrant such changes.

The report did not investigate asset categorisation.

[40] OECD Working Paper No.4: 'Service Lives of Fixed Assets' - Derek Blades, 1983.

70. The OECD produced a second report on service lives in 1992, updating the information from the 1983 report. This time 15 OECD countries were investigated. Little had appeared to change in terms of the data sources being used to estimate service lives by the countries investigated. The paper was however able to report on the impact of some important studies on service lives which had been conducted in the meantime.

71. The report concluded that there is no long-term tendency for a service life of a given asset to become shorter or longer. Numerous studies in different countries however (e.g. Smith 1987, Halstrick 1986/87, 1985 Capital Expenditure Survey - Canada) reaffirmed the idea that overestimation had become a significant problem, for some types of assets at least. In the case of the UK and Australia both countries were therefore assuming that there was an underlying tendency for all capital assets to remain in use for shorter and shorter periods. Germany was assuming that the lives of certain assets had fallen. Most other countries, however, were found to be still assuming that service lives remain constant over time. A lot of countries were found to be using the same service life length to cover all manufacturing equipment and only one for all building and construction.

72. The report states, however, that declining average service lives should be assumed where the asset mix of capital stocks is changing to include relatively more short-life assets (if the service lives used are 'overall averages' each covering several different types of assets).[41] Thus countries such as Belgium, Iceland and Norway, who were found to be using fixed service lives that are averaged over many different types of assets, were considered to be overstating the size and growth of their capital stocks.

Transition economies

73. The transition economies have experienced particular problems concerning the estimation of service lives. Under centrally planned economies exhaustive annual surveys of fixed assets were conducted to compile the BFA. Currently, however, different countries are at different stages in their transition to new statistical and accounting systems. All the countries in this group started to implement the SNA93 in the early 1990s. This adaptation was a challenging exercise and the estimation of fixed capital stocks is one of the most demanding aspects of this transition.

74. A comprehensive investigation into capital stock measurement in transition economies was carried out by the UNECE between 1998 and 2000[42]. It was found that there were two groups of countries, one who had discontinued annual surveys (mainly Central and Eastern Europe) and the other who were still compiling some of the information required by the BFA (CIS countries plus the Baltic States). It was concluded that the past experience of all these countries could form a good basis for the implementation of new methods that conform to international standards.

75. The study found that information on service lives was not available in most of the countries. While data on the service lives of machinery and equipment may be available in some, it is not available for buildings and structures. The comparability of data over time was also found to be a problem, i.e. before 1990 and after, with respect to the coverage of GFCF,

[41] Para.88
[42] Measurement of Capital Stock in Transition Economies - UNECE (2003)

details by type of asset and the definitions of assets. There was also found to be very little knowledge about the use of mortality functions and retirement patterns, as the usual practice has been to collect data on actual retirements.

76. There is also evidence that, like OECD countries, the composition of the capital stock is shifting more towards assets with shorter lives.

77. The transition economies were found to be facing serious budget restrictions during the transition period, which makes it quite difficult to continue the practice of annual capital stock surveys. It was concluded, however, that, despite the difficulties of data collection, periodical surveys of selected large enterprises were the only way to collect data about the value and service lives of assets in some transition economies.

CHAPTER 5: SUMMARY OF RESULTS

Survey Design and presentation of the results

78. The survey questionnaire used for the purposes of this report (see Annex 1) was designed in order to collect information from each country concerning the problem areas in estimating asset service lives identified in Chapter 3.

79. To understand the context of each country's response, countries were asked to describe their method of capital stock estimation. Questions were asked about the three main problem areas in estimating service lives: data sources, asset categorisation, and dealing with changes to service lives over time. Countries were also asked to provide lists of asset groups and service lives in use. Additionally, it was felt important to discern what plans each country had for the future, and in this way determine how each country perceives the development of best practice within the context of their particular statistical environments.

80. Additional questions were added concerning the related topics of mortality and depreciation functions. This meant that, in some way, continuity could be maintained between this survey and previous studies of service lives, which have included information about mortality functions. This also meant capitalising on an opportunity to gather information on related practices within capital stock measurement, like depreciation. Countries were also requested to provide details of relevant national documentation so the survey results could provide a comprehensive reference point for analysts seeking a broad range of information on estimating service lives in particular and capital stock estimation in general.

81. This chapter gives a summary of all 41 national responses to the survey. Each country's response to each question is given in detail in Annexes 2-7, which follow the order of the questions in the questionnaire. Where future plans for estimating service lives were given by respondents these have been incorporated into the 'notes' column of the relevant annex. The following table however gives an overall summary of the responses to some of the main questions:

Table 5: Summary of the results of the survey of national practices in estimating service lives

Country	Number of asset categories (inc. sub-categories)*	Capital stock estimation method				Sources used for estimating service lives								Do assumed asset lives vary over time?	Notes
		PIM	Administrative records	Survey or census	Other	Expert Advice	Other countries' estimates	Tax Lives	Administrative records	Company Accounts	Direct observation/Survey	Government stipulated	Other		
Armenia	-				y										
Australia	22	y				y	y	y						y	
Austria	7	y				y	y								
Azerbaijan	-			y											
Belarus	12	y				y		y			y				
Belgium	7	y				y	y							y	
Canada	155	y									y			y	
Croatia	*16**	*y**	y	y		y									used in pilot survey
Czech Republic	6	y			y	y					y			y	
Denmark	12	y	y			y	y		y						
Estonia	12		y	y	y	y	y			y		y			
Finland	11	y				y			y		y			y	
France	21	y				y									
Germany	27	y			y	y		y	y		y			y	
Greece	4	y													
Hungary	4	y*										y	y		Inverted PIM
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Capital stock estimates are not currently made
Israel	8	y					y								
Italy	4	y				y									
Japan	13	y			y			y							
Korea (Rep.of)	5			y				y							
Kyrgyzstan	8			y											
Latvia	5			y											
Lithuania	21			y							y				
Mexico	7	y						y							
Moldova	14			y							y				
Netherlands	15	y			y						y			y*	May be changed during revisions
New Zealand	19	y					y	y	y	y	y				
Norway	19	y	y			y	y							y*	May be changed during revisions
Poland	8	*y**	y	y							y				Data from other surveys inputted into a simplified PIM
Russian Fed.	1			y	y						y		y	y	
Serbia & Montene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Capital stock estimates are not currently made
Slovakia	4		y								y				
Slovenia	44	y	y	y		y	y		y	y					
Spain	10	y						y						y	
Sweden	10	y				y	y								
Switzerland	*11**	y					y								planned
The FYROM	13		y						y						
Turkey	2	y				y	y								
UK	5	y											y		

Nb: The 'number of asset categories' is a count of the number of categories for which each country declared that individual average service lives are available and applied, it does not indicate variations by industry used in each country.

Asset Categorisation

82. The results of the survey show that the average number of asset categories used by the countries surveyed (counted at the lowest level, i.e. excluding categories that contained sub-categories for which service lives were applied) is approximately 15. If the outliers of Canada and the USA are removed from this calculation, as they both utilise unusually large numbers of asset categories (see table 5, above), the average is approximately 10.

83. If variations by industry and institutional sectors are considered then some countries are using hundreds of service lives as applied to different groups of assets in different parts of the economy. In this context, France uses over 300 different service lives while countries such as Australia, Canada, Belgium, Finland, Hungary, Italy, New Zealand and the USA use individual service lives for over 100 different assets by industry. There is much variation however and other countries only utilise a dozen or so, but in some cases this may be determined by the needs of their system of capital stock estimation (e.g. Japan) as much as by the availability of data .

84. The detailed results of the survey, moreover, illustrate the wide variety of asset categorisations in use but also show a great deal of commonality in the reasons for choosing a particular set of categories. This commonality in reasoning has however also led to some broad similarities in categorisation between countries with similar statistical environments, and especially where countries have attempted to follow the definitions set out in the SNA.

Use of SNA93 recommendations

85. One of the main considerations of many countries when determining asset categories has been to follow the guidelines set out in the SNA93, and for European countries the ESA95. These classifications provide categories that have been found to be more or less homogenous over a broad range of economies and are seen to provide a good basis for applying the PIM successfully. France, for example, categorises assets in exact accordance with SNA93 (while being able to provide separate details for computer and communications equipment). In most cases, however, this is not possible and the exact nature, and number, of the categories used is determined by the availability of data within a particular country.

86. The availability of data on which to base asset categorisations is in large part determined by processes elsewhere in the statistical system. The methodological development of such processes may well have preceded the development of asset categories and may have an a priori significance in the statistical system. Thus asset categories are determined in many cases by the level of detail provided in the GFCF series in the National Accounts, the availability of data for constructing accurate price indices, or the level of detail available for estimating service lives themselves.

Countries not using the PIM

87. Where the PIM has not been applied traditionally as a method of capital stock estimation, such as in the transition economies, or is not used at present, asset categories may diverge significantly from the SNA guidelines. Where administrative records are used to calculate capital stocks those asset categories which are currently available may follow the

purposes for which the records were originally intended, e.g. those used for tax calculations as in The former Yugoslav Republic of Macedonia.

88. Where the PIM is not used however, the categorisation of assets, if there is any, may have little impact on the accuracy of the capital stock estimate. The existing categorisation may however influence the formation of asset categories for input to the PIM, where there are plans to implement it in the future, and in this scenario it should be thoroughly scrutinised beforehand.

User needs

89. In at least two cases, France and Norway, countries have adjusted their categorisations in order to satisfy user needs. This is an important consideration because accurate data on capital stocks is of no use to policy analysts and economists if it is not relevant. In the French case, although the SNA93 recommendations are followed extra details are given for computer and communications equipment, two increasingly important areas of the economy. In Norway the asset breakdown is based on both relevant differences in asset lives and identified user needs for data on particular asset types.

Matching categories to national economic characteristics

90. In other countries assets are categorised, in full or part, in order to reflect the peculiarities of a particular economy, and thus may satisfy user needs implicitly. This can be seen in the Mexican classification which includes a distinction between dwellings made from bricks, adobe (bricks made from dried clay), and from other materials. Australia identifies 'timber, fibro and other' houses as a separate asset category. Whereas in other countries the materials used for dwellings may well be more or less homogenous and in many cases brick-based only.

91. In the USA, the variation by industrial sector in the asset categorisation, which follows the investment categories used in the National Income and Production Accounts (NIPA), reflects the particularities of the US economy. Indeed, the relatively high investment in defence by the US government is even reflected in the inclusion of military weapons systems as a fixed asset in their national accounts, whereas the SNA93 recommends they should be treated as intermediate consumption (note that they are treated as IC in data submissions to international organisations). Asset categorisations may thus be most effective when they not only represent homogeneous groups of assets but also represent distinct groups of assets of particular importance to a particular economy.

Variation by industry

92. To achieve both accurate stock estimations and useful data for analysis an appropriate variation of the asset categories by industry is necessary. The level and exact nature of variation by industry applied in each country is largely determined by the availability of investment data. Usually, this means the available level of breakdown of data by industry and sector found within a country's GFCF data or input-output tables.

93. Where data is available, it is possible to attempt to capture not only the effect of differences in the intensity of use of the same assets in different industries but also the changing composition of capital formation. This is achieved through appropriate asset categorisation and

variation by industry. Australia, for example, splits the 'machinery and equipment' category into six sub-classes. This includes a separation between 'computers and peripherals' and 'road vehicles'. This recognises that computers have a relatively short life compared to road vehicles, whose lives have been steadily increasing. Accompanied by an appropriate variation by industry, this attempts to reflect the fact that in industries where motor vehicles form a high proportion of machinery and equipment expenditure, such as agriculture, lives have increased, while for industries such as finance and insurance, where computers form a relatively high proportion of capital formation, average equipment lives have fallen.

Asset categories: conclusions

94. The results of the survey show that, on the whole, countries are trying to both achieve homogeneity in their asset categories, with the SNA93 recommendations as a template in many cases, and to apply variations by industry in their service life estimates for each category. On a theoretical level the greater the number of homogenous categories (by type of asset, industry, or institution) the more reliable the resulting estimates of capital stock from the PIM. There is however a correlation in the survey results between the level of detail of asset categories provided and the level of data available to the national statistical office providing them. The breadth of data available is therefore a key determinant in achieving an effective categorisation of fixed assets. Equally as important is the matching of categories to the national economic context and to user needs, on a national and international level.

95. In most cases, however, the data available on which to base asset categorisation is a by-product of other, possibly related, statistical processes. This implies that one way to improve the quality of capital stock estimates, through better asset categorisation at least, is to ensure that the homogeneity and relevance of asset categories needs to be considered when developing the data sources which define the ultimate boundaries of these categories.

<u>Sources of data for estimating service lives</u>

96. The survey results showed that a wide variety of practices are in place to estimate survey lives both across countries and within countries (where different sources are often combined). It is perhaps no surprise that many countries should have a multiplicious approach to estimating service lives given the inherent difficulty of the task. Indeed, combining numerous data sources, which may be available either nationally or some times internationally, seems to be a common means of ensuring reliability in the estimates.

Expert advice

97. Significant use of 'expert advice' is made across many of the countries surveyed. It was explicitly identified by 17 countries. A popular form of advice is that given from industry bodies and production engineers, while in some cases a working group of experts may be assembled for the task of deciding all estimates (e.g. Italy and Belarus). In other cases, the advice may involve less formal contacts between statisticians and industry experts, such as in Norway. The informal approach however may lead to problems. In the UK, where the origin of historical service life estimates are unknown, a review of the capital stock estimation system is underway as service life estimates cannot be considered reliable.

98. From those responses which elucidate the nature of the expert advice given, however, the concern that 'expert advice' may merely represent a euphemism for guesswork by capital stock statisticians is certainly not justified. The results of the survey also point to a wide range of types of 'expert advice' being sought. This goes beyond the advice from 'asset producers' identified in the OECD Manual. Some countries, Germany, Australia and USA, refer to academic or government studies, which in turn might rely on their own independent surveys or analysis of administrative records. In Germany, the service lives of outdoor facilities and parts of buildings are derived from the official guidelines for ascertaining the current market value of land, published by the Länder, which is neither quite 'expert advice' or the use of 'administrative records'.

Tax lives

99. 8 Countries declared the use of tax lives for deriving service lives. In most of these cases, however, tax lives are not taken at 'face value'. It is recognised that the best practice is to scrutinise their validity for statistical purposes and then to adjust them accordingly to suit economic realities based on other evidence. In general, there was a recognition that official tax lives need a systematic upward adjustment in order to reflect actual service lives.

100. In Australia for instance, tax lives are used as a basis for the service lives of machinery and equipment. Although the tax lives used here are industry based and comprehensive in coverage they have been found to be generally shorter than economic lives (a perception shared by Germany). Therefore additional sources, such as technical data and information collected from industry sources, have been used to adjust the tax lives to derive the service lives for input into the PIM. In Belgium, tax lives are used but they are first compared with the average service lives used by 13 OECD countries and when there are significant differences the mean of the two estimates is taken as an input to PIM. Elsewhere tax lives are adjusted based on information from enterprise and business associations (Germany) or from company accounts (Spain).

Statistical surveys

101. Only two of the countries surveyed with developed statistical systems (Canada and the Netherlands) rely entirely on statistical surveys to estimate service lives. This is perhaps unsurprising given that such surveys can place considerable costs on national statistical offices and burdens on respondents. The Netherlands performs a discard survey and from this indirectly estimates service lives (described in detail in the OECD Manual[43]). Canada on the other hand includes a question in its capital expenditure survey (CES) concerning the 'expected useful life' and the age at disposal of enterprises' assets. The Canadian method may not imply a high relative increase in costs to countries already performing capital expenditure surveys of their own but may be unacceptable to some countries as a creeping increase in the burden on respondents.

102. Of the non-transition economies, four countries however use statistical surveys in a limited ad hoc fashion, as practicalities allow (Finland, Germany, New Zealand and USA). These are often targeted at specific industries and may occur irregularly or infrequently. Thus surveys taking place for other purposes can be utilised to gain information on service lives and

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[43] Para. 6.27. See also: Meinen, Verbiest & de Wolf 'PIM: Service lives, Discard patterns and Depreciation methods' (1998)

thereby national statistical offices could economise on the resources that may otherwise be necessary.

103. In New Zealand, for example, a depreciation survey was conducted by Statistics New Zealand (SNZ) on behalf of the Inland Revenue Department (IRD) in 1992. The objective of the survey was to provide estimates of the mean depreciation rates, useful life, and residual value for a specified list of assets held by a selected group of industries. It was expected that the depreciation rates to be derived from the survey would be close to the true economic life of an asset. Using statistical surveys in this way to estimate service lives is intrinsically linked to the use of tax life data, but in this case concerns about both the quality of tax life data and the inefficient use of resources in large scale surveys may be overcome. It would therefore represent good practice for capital stock statisticians to seek out opportunities to work with tax authorities in data collection exercises, or for that matter with any other bodies requiring information that could be linked to the requirements of estimating service lives.

104. The transition economies, however, may already have infrastructures for conducting business surveys that lend themselves to more efficiently collecting service life data through statistical surveys. This method of estimating service lives is therefore still used by some countries; e.g., Lithuania, Slovakia, and the Russian Federation. In the Russian Federation, for instance, an annual questionnaire is submitted by all large and medium-sized enterprises, and information on fixed assets for non-market institutions is collected with the help of a shorter version of this questionnaire. In other cases, however, other factors have meant that past survey infrastructures have become obsolete. In Armenia, for example, the Balance of Fixed Assets is no longer compiled as it is impossible to ensure the required coverage due to changes both in forms of property and in regulations governing the collection of information.

105. Annual statistical surveys may give good information on service lives and may be supplemented, where practical, with ad hoc surveys. In the Czech Republic, for example, annual surveys give information on the service lives of transport equipment and other machinery and equipment, covering all sectors except the household sector, while a one-off survey in 2003 ascertained information about the average and expected service lives of computer software.

106. In other transition economies there is potential to use the existing statistical infrastructure to gather additional data. In Poland, the statistical surveys currently used to calculate capital stocks also collect data on completely depreciated assets so that depreciation rates can be verified. Moreover, in Lithuania, where capital stocks are also estimated using surveys rather than the PIM, questions concerning the service lives of assets were added to the capital stock survey questionnaire in 2002, albeit for the government and public corporations sectors only. This information will help Lithuania towards a successful introduction of the PIM, which is planned for 2004. Other transition economies moving towards the PIM could also benefit from utilising existing survey mechanisms to ascertain service life estimates while still possible.

Other countries' estimates

107. The use of other countries' estimates of service lives, in some form or another, is shown to be quite common by the survey results (reported by 11 countries). In most cases, countries have adapted their approach to the inherent risks of using such data outlined in the OECD

Manual, but this may or may not be adequate. Some countries choose to use averages of the service lives used by OECD countries: Turkey uses such averages directly, and Belgium as a check against its estimations by other means. Such techniques may well reduce the distortive effects of country specific factors in using other countries estimates

108. Where particular countries' estimates are used, there is a variety of criteria for selecting those deemed most appropriate. In Estonia, mainly those of neighbouring countries are selected. In Norway, other countries' estimates are used but only from those countries deemed 'similar' in terms of climate and/or having 'good data' (i.e. Sweden, Germany, UK, USA and Canada). Elsewhere, Israel prefers to use the estimates of the USA, and Sweden those of the USA and Canada combined. It may be argued though that more accurate and reliable estimates could be achieved by selecting a 'first-hand' method of estimation, where possible, or at least by performing some sort of check on the estimates.

109. Moreover, the purpose of this paper being to help establish 'best practice' in capital stock measurement, it could be suggested that countries should look to learn from the methodology of those countries with the 'best practices,' rather than simply utilising the results of this methodology.

Company accounts

110. Very few of the countries surveyed (three) are using **company accounts** to derive service lives. Estonia looks at companies' annual financial statements and makes some use of the service lives being used by enterprises' to depreciate their assets. It seems though that the methods for using company accounts developed by studies such as Atkinson and Mairesse and Tarafosky et al, outlined in the introduction, do not have a great appeal to statistical offices.

Administrative records

111. Administrative records are used in some countries but mainly in a limited capacity for specialised areas for which particular record sets are available. In quite a few cases information on service lives is garnered from **official records relating to transport**, especially for motor vehicles. For example, the Federal Office for Motor Traffic in Germany has detailed records on stocks and retirements of cars by age structure. In Australia also, service lives for road vehicles have been estimated from publicly available data. Furthermore, useful administrative records may be found outside the government domain, as in the USA where vehicle registration data from **a private industry source** provides enough data for capital stock estimation for the private motor vehicle asset category to be achieved outside the PIM.

112. It is probable that comparable records exist in many countries which are currently not using them, but they could provide reliable data for estimating the service lives - of motor vehicles at least. The OECD Manual suggests that in many countries usable records are also available for other transport assets and through the regulatory bodies of private industries. However, the results of this survey show that such sources are currently rarely used.

Other sources

113. Some countries report using estimation methods not described in the OECD Manual but

which are worth consideration here. In some transition economies service lives stipulated by central government departments are used, perhaps reflecting to some extent practises under the BFA system of capital stock estimation. For example, in the Czech Republic service lives of railways are determined by the Ministry of Transport while in Estonia the Ministry of Finance has stipulated service lives for 5 asset categories (buildings, structures, machinery and equipment, office appliances, and computers). It would seem good practice to scrutinise the reliability of such advice given that in the past government estimates of service lives in transition economies have been found to be substantially shorter than actual economic lives. In the absence of other sources however, this may be akin to estimating lives from expert advice but the purposes for which the lives have been determined must be examined to establish their reliability.

Sources for estimating service lives: conclusions

114. On the whole, the results of the survey show that many countries have adopted a practical approach to achieving reliable service live estimates based on the data available to a particular country. The use of "other countries' estimates" seems to be necessary only where other sources are unavailable or discovered to be unreliable, and should only then be used with caution. The best practice would seem to be to use a diverse range of methodologies that are able to reflect the peculiarities of particular asset categories or industrial sectors within a particular country. Furthermore, Meinen, Verbiest & de Wolf point out that:

> "One should try to avoid the increasing reliance on estimates which largely depend on 'second-hand' estimation methods. This inevitably affects the accuracy of the estimates of capital stock[44]."

115. Moreover, more reliable estimates emerge where one source is cross-checked with another or is adjusted to reflect economic realities; this is especially important when using information based on tax lives or other countries' estimates. Although comprehensive surveys or censuses may lead to good results they are too expensive and cumbersome for most countries.

<u>Dealing with changes to service lives</u>

116. A good majority of those countries surveyed who are currently using service lives in their capital stock estimation method reported using service lives that were, in general, assumed to be fixed. Of those assuming changes many only changed their service lives as a result of periodical system reviews. Very few countries are in fact systematically adjusting their capital stock estimates to reflect real changes in the service lives of fixed assets.

117. Given that industrial environments are unstable and technological change is rapid, then there is a possibility that capital stock estimates based on the PIM may fail to capture real changes in the stock if service lives are assumed to be stable. This problem is aggravated by two factors. Firstly, technological change is, currently at least, exponential in character, and, secondly, the transition economies' industrial environments are relatively highly unstable. In most cases then, capital stock estimates would only be considered reliable at the moment when periodical reviews have been implemented or new evidence has been uncovered. In fact many

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[44] 'PIM: Service lives, Discard patterns and Depreciation methods' (1998), Statistics Netherlands.

countries only change service lives when new evidence becomes available.

Ways to incorporate changes to service lives into the CS estimation method

118. The empirical evidence needed on which to base any assumptions about changing service lives is unavailable in many countries. Indeed, sources for estimating initial service lives, as well as being unreliable, may only provide data periodically and in most cases only provide data about the nature of capital stocks at one specific point in time. The countries surveyed are thus making use of two options to deal with changing service lives effectively:

a) to find data sources on service lives which provide regular updates, or

b) to incorporate assumptions about service lives into the capital stock estimation method.

119. The first option has been followed where regular statistical surveys are used to gather data on service lives (e.g. in Canada) and/or to estimate capital stocks (such as in many transition economies). As a result, estimates of service lives and capital stocks may be mostly reliable. In other cases it may be possible to find regular data sources which allow for service lives to change as the empirical data dictates. In Australia for instance, data is available on motor vehicles that allows for average service lives to be tracked annually for historical periods and to be estimated for more recent periods

120. The second option, of incorporating assumptions, is more common however due to the lack of regular empirical data. Assumptions concerning changing service lives are used for computers and computer software in Australia for example. Computer lives are assumed to have gradually declined from 8 years in 1960 to 5 years in 1997-98 based on the decline in the proportion of mainframe computers relative to PCs and the longer lives of the former. For computer software, average service lives were adjusted from 8 years (maximum 12) to 6 years (maximum 8) after 1989-90 due to the increased incidence of outsourcing and technological change. Both these assumptions seem credible and are based on some academic research, although the empirical evidence for the exact adjustment may be weak. Other countries also use what appear to be credible assumptions concerning particular asset categories or assets in certain industries, such as in Finland, the Czech Republic and Germany.

121. Although there may be a lack of empirical evidence within countries on which to base such adjustments or assumptions on service lives, the development of assumptions based on the evidence found in other countries has proved useful to some countries. Making credible assumptions based on both other countries' practices, where they are evidence based, and on general observations about the economy have proven more useful to some countries than making no assumptions at all. In particular this would seem to be especially true for computers, computer software, and motor vehicles - as it is generally accepted that their service lives are steadily changing in a well-defined direction. The need to make assumptions about other asset categories would seem less important as there is, in general, little evidence to suggest changes have taken or are taking place on a significant scale or in a particular direction.

Maintaining the continuity of the series

122. Those countries who apply changes to service lives maintain series continuity in a

number of ways. In Australia all mean service lives are stored as time series and so are free to vary over time - although most are fixed. Their system has been programmed to apply the service life of a particular asset, for a particular year, from that year on for the associated GFCF data. This means that for any particular year, the capital stock may represent GFCF of different vintages and different lives. By contrast, in other countries, such as Belgium and Germany, discontinuities in the series are avoided as service lives are adapted gradually, spreading the impact of the new service lives on the capital stock estimates over a long period of time. In other cases however, for example after Norway's last major revision of its National Accounts in 2002, no special adjustments may be deemed necessary as the resulting discontinuities may be considered relatively small.

Dealing with changes to service lives: conclusions

123. This survey shows that service lives for past periods are mostly only revised in the process of national accounts-wide reviews or when new information becomes available on service lives. Such a revision however may of course result in a level shift in the capital stock for the full time period considered and full historical revisions to COFC. As this is usually undesirable to both users and compilers it would be preferable to build in credible assumptions about asset life changes into the capital stock estimation method. Thus new evidence concerning asset lives might approximate the assumptions made and the resulting revisions would be minimal or even negligible. At the very least, it would seem good practice to ensure that national accounts revisions, which involve reviewing new information on service lives, or stand-alone reviews of new service life data take place on a regular basis over the shortest time intervals practicable.

Service lives

124. The OECD published an overview of the service lives applied in 15 member states in 1993[45]. The current service lives used for these countries (except Iceland) and the additional 23 respondents to this survey are shown in the 'detailed results' chapter in this paper.

Mortality functions

125. An OECD report in 1993 into the methods used by countries to measure capital stocks concluded that bell-shaped functions are the only plausible candidate for establishing discard patterns. It states that:

"The death of living things are known to follow a bell-shaped distribution. Both common sense and the small amount of empirical evidence on the matter - notably by the investigations by Winfrey (1935) - suggest that capital goods die off in a similar way."

126. The same report found that most OECD countries were at the time making use of some kind of bell-shaped function and those that were not were using one of two acceptable approximations - simultaneous exit or delayed linear. The UNECE's current survey results also show that this remains the case and is also true for non-OECD and transition countries - many of which plan to use, or have started to use, bell-shaped functions when the PIM has been

[45] 'Methods used by OECD countries to measure stocks of fixed capital' (1993).

implemented. There is substantial variation, however, in the exact shape of the function selected.

Depreciation functions

127. It has been suggested that in most cases a straight-line depreciation provides the best approximation of the 'actual depreciation'[46]. This is not however reflected in the survey results as there are as many countries using this method as use the linear option.

A copy of the questionnaire and summaries of individual country responses to the questions can be found in the annexes to this paper (CES/AC.68/18/Add.1 and CES/AC.68/18/Add.2)

[46] Blades (1998) Measuring Depreciation.