CHAPTER I: MEASURING INTELLECTUAL PROPERTY ASSETS

Introduction

The 2008 SNA describes five categories of intellectual property assets:

- research and development;
- mineral exploration and evaluation;
- computer software and databases;
- entertainment, literary and artistic originals; and
- other IPPs.

It recommends that category (c) should be decomposed into two sub-categories: *computer software* and *databases*. Category (e), *other intellectual property products*, includes any such products that constitute fixed assets but are not captured in one of the specific items. As it does not comprise any defined items, it is ignored in this handbook. The remaining four categories are quite different in nature and the data available to estimate them vary considerably, too. Nevertheless, the same general principles apply for estimating their gross fixed capital formation (GFCF).

1. Intellectual property assets and gross fixed capital formation

1.1 Defining GFCF

The definition of an asset is given in paragraph 3.30 of the 2008 SNA as follows:

> *An asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of transferring value from one accounting period to another.*

This definition has a number of important implications for the measurement of intellectual property assets.

- First, the value of an intellectual property asset is determined by the benefits accruing to its economic owner. This implies that any benefits accruing to other units are not included in the value of the asset.

- Second, the definition refers to economic owner and not legal owner. In most cases the two are the same, but it is quite common for the legal owners of intellectual property assets to issue licences (or leases) that, in effect, transfer economic ownership.

- Third, assets are a means of transferring value from one accounting period to another. This is interpreted to mean that the product is expected to produce benefits for more than a year.

Fixed assets are produced assets that are used by their final users in production. It follows from the definition of an asset that fixed assets are to be used in production for more than a year. There are two exclusions, however; one based on concept and the other practice. The first is the exclusion of products, acquired by a household to provide services to the household, because the production of household services (with the exception of dwelling services) is outside the production boundary. Thus, IPPs, such as computer software, acquired by a household for the provision of services for itself is not regarded as

GFCF. The second exclusion concerns small tools. Paragraph 10.35 of the 2008 SNA describes the exclusion as such

> *10.35 The second exclusion is pragmatic rather than conceptual and concerns small tools. Some goods may be used repeatedly, or continuously, in production over many years but may nevertheless be small, inexpensive and used to perform relatively simple operations. Hand tools such as saws, spades, knives, axes, hammers, screwdrivers and spanners or wrenches are examples. If expenditures on such tools take place at a fairly steady rate and if their value is small compared with expenditures on more complex machinery and equipment, it may be appropriate to treat the tools as materials or supplies used for intermediate consumption. Some flexibility is needed, however, depending on the relative importance of such tools. In countries in which they account for a significant part of the value of the total stock of an industry's durable producers' goods, they may be treated as fixed assets and their acquisition and disposal by producers recorded under gross fixed capital formation.*

In concept, it is clearly preferable to record all expenditures on products that qualify as fixed assets as GFCF, irrespective of their size, and small expenditures should only be excluded when there are good practical reasons for doing so. Given the ways estimates of GFCF of intellectual products are derived in practice, however, there appears to be little occasion to make this exclusion.

Recommendation 1: Small expenditures should only be excluded from estimates of intellectual property products gross fixed capital formation if there are good practical reasons.

One of the difficulties to be overcome in measuring GFCF of IPPs is distinguishing between expenditures of a capital nature and intermediate consumption (IC). There are four particular cases that cause most of the difficulties: maintenance and repairs; licences to use; licences to reproduce; and IPP assets used in producing other IPP assets.

1.2 Maintenance and repairs

The SNA defines ordinary, regular, maintenance and repairs as IC, and major renovations, taken at any point in time not dictated by the condition of the asset, that increase the performance or expected service life of the asset as GFCF. IPPs are not subject to wear and tear, or any other form of physical deterioration[2], but for various reasons they can be amended or augmented. In principle, any amendments or augmentations that improve the performance of the asset or extend its expected service life should be recorded as GFCF. However, in practice, identifying these types of augmentations is not always clear cut. Paragraphs 10.45-10.47 of the 2008 SNA address this matter, and conclude with the recommendation that substantial, planned improvements should be recorded as GFCF, while minor, unplanned improvements are better recorded as IC.

Recommendation 2: Intellectual property products are not subject to wear and tear, but they can be subject to amendment and augmentation. Substantial, planned improvements should be recorded as gross fixed capital formation, while minor, unplanned improvements are better recorded as intermediate consumption.

1.3 Licences to use and reproduce

The circumstances under which expenditures on licences to use and reproduce should be recorded as GFCF are discussed in paragraphs 10.99 and 10.100 of the 2008 SNA, and they are reproduced here.

> *10.99 Some IPPs are used solely by the unit responsible for their development or by a single unit to whom the product is transferred. Mineral exploration and evaluation is an example. Other products, such as computer software and artistic originals, are used in two forms. The first is the original or "master copy". This is frequently controlled by a single unit but exceptions exist as explained below. The original is used to make copies that are in turn supplied to other units. The copies may be sold outright or made available under a licence.*
>
> *10.100 A copy sold outright may be treated as a fixed asset if it satisfies the necessary conditions, that is, it will be used in production for a period in excess of one year. A copy made available under a licence to use may also be treated as a fixed asset if it meets the necessary conditions, that is, it is expected to be used in production for more than one year and the licensee assumes all the risks and rewards of ownership. A good, but not necessary, indication is if the licence to use is purchased with a single payment for use over a multi-year period. If the acquisition of a copy with a licence to use is purchased with regular payments over a multi-year contract and the licensee is judged to have acquired economic ownership of the copy, then it should be regarded as the acquisition of an asset. If regular payments are made for a licence to use without a long-term contract, then the payments are treated as payments for a service. If there is a large initial payment followed by a series of smaller payments in succeeding years, the initial payment is recorded as gross fixed capital formation and the succeeding payments as payments for a service. If the licence allows the licensee to reproduce the original and subsequently assume responsibility for the distribution, support and maintenance of these copies, then this is described as a licence to reproduce and should be regarded as the sale of part or whole of the original to the unit holding the licence to reproduce.*

The importance of licences to use and reproduce varies by type of IPP and the application of the above recommendations is not straightforward. Therefore, it is best to consider them asset by asset.

1.4 IPP assets embodied or used in producing other IPP assets

The general principles that determine whether *purchased products* should be recorded as GFCF or IC are as follows:

(i) IC if it is expected to be used up in a year or less;

(ii) IC if it is to be completely embodied in part of a specific IPP; and

(iii) as the acquisition of a fixed asset if it is expected to be used repeatedly, or continuously, in production for over a year.

In case ii), the acquired product becomes a part of the new original being produced on own-account, even if the product could in isolation be treated as GFCF. For example, if a piece of software is acquired for the sole purpose of being incorporated in an own-account software original then, in principle, its

acquisition should be recorded as IC. Its cost should simply be included in the measurement of GFCF of the own-account software original. However, if the acquired software is used repeatedly, or continuously, in the production of the software original for more than a year then it should be recognised as a fixed asset in its own right and the value of the capital services it provides in each period should be used in measuring the GFCF of the original in each period; following the guidelines described later in this Handbook.

The same arguments apply to products *produced on own account* that are subsequently used to produce other products. For example, suppose in the staged production of own-account software there is an additional R&D stage. If the R&D output is used up in a year or less in the production of a software original then the costs of undertaking the R&D should, in principle, be included in the costs of producing the software original, and there should be no GFCF of an R&D asset. If the R&D is used up in a year or less to produce more than one software original then, in principle, its costs should be divided and included in the costs of creating each of the software originals. If, however, the R&D output is expected to be used in the development of one or more software originals for more than a year, then it should be recorded as a fixed asset and the value of the capital services it provides should be allocated to the costs of creating the various software originals in each period.

Making such distinctions is difficult to do in practice, irrespective of whether the IPPs used in producing new IPPs are purchased or produced on own-account. Moreover, it is probably uncommon for purchased or own-account IPPs, such as software and R&D, to be completely used up in a year. It follows (see also below) that the cost of the capital services provided by these fixed assets should be included (when summing costs) if they contribute to subsequent own account GFCF. Only in cases where units specialise in producing an IPP for sale should acquisitions of that type of product be expensed, or if it is clear that they are completely embodied in another product: for example software copies purchased to be embedded in computers for sale.

Recommendation 3: As a general rule, all expenditures on intellectual property products, either purchased or produced on own account, should be recorded as gross fixed capital formation if they are expected to provide economic benefits for the owner. Only in cases where units specialise in producing a type of intellectual property product for sale should acquisitions of that type of product be expensed, or if it is clear that they are completely embodied in another product: for example software copies purchased to be embedded in computers for sale, or other specific information exists such as the existence of a license with a duration of one year or less.

Hence, in general, when R&D is undertaken to develop software on own account and the GFCF of software is estimated by summing costs, the costs should include the cost of the capital services provided by the R&D. Likewise, when summing costs to estimate the GFCF of R&D the cost of capital services provided by software developed to undertake the R&D should be included. This can be done either by applying the perpetual inventory method to past estimates of capital expenditures or by making an imputation based on data for units specialising in the production of the particular intellectual property product.

Box 1: Spillovers

As already noted, the value of an asset is determined by the benefits accruing to its economic owner. Benefits that accrue to other units are known as spillovers and they are not included in the value of the asset that produces them. Furthermore, the flows of spillovers are not recorded as transactions. Paragraph 10.101 of the 2008 SNA has this to say on the matter, (see also section 9.1 of this Handbook).

When copies are distributed by the owner free of charge then no flows between the owner and recipients are recorded in the System. If, despite making copies freely available, the owner still expects to obtain benefits then the present value of those benefits should be recorded in its balance sheet. It may be that when the information was distributed freely it was incomplete and the owner intends to make more detailed information available at a price later. Software distributed freely at the beta test stage is one example. Alternatively, the owner justifies the expenditure on the basis of the benefits to its own production and may make copies available for marketing purposes, generating goodwill or in cases it considers deserving.

Recommendation 4: Spillovers should not be considered in valuing fixed assets.

2. Estimating GFCF of intellectual property

All IPP assets can be split into two categories: *Purchased assets* and *Assets produced on own-account for own-use.* In practice the methods used to estimate the two classes are necessarily different and the distinguishing characteristics of each are described below.

Irrespective of whether the assets are purchased or produced on own-account however it is imperative that estimates of the GFCF of IPPs are produced at, at least, the first four broad category headings of IPPs in the 2008 SNA. Indeed, for some of the categories a more detailed compilation is desirable. Two things need to be taken into account: first, the needs of users and second, the needs of estimation. Regarding the latter, consideration needs to be given as to what level of detail best supports not only the estimation of GFCF in current prices, but also estimation in volume terms. If the price and volume elements of different components are growing at different rates then prima facie there is a need to have either price indices that take account of these changes (*i.e.* a Paasche price index to derive Laspeyres volume measures) or the volume estimation needs to be conducted at a sufficiently detailed level to allow satisfactory aggregate volume estimates to be derived (*i.e.* using Laspeyres price indices). Likewise, if components are growing at different rates and they have different service lives then there is good reason to derive the capital measures[3] at a sufficiently detailed level.

As already noted, the 2008 SNA has separate sub-categories for software and databases, but it is recommended that software be decomposed into *packaged software*, *customised software* and *own-account software*, at least for estimation purposes, because different deflators and service lives apply. In addition, the components of entertainment, literary or artistic originals are quite heterogeneous, and it is clearly preferable that these too are estimated separately.

Recommendation 5: In deriving estimates of GFCF, the degree of product detail should be determined by the needs of users, data availability and the heterogeneity of the products, taking account of the rate of price change and variation in service lives.

2.1 Purchased assets

Estimates of GFCF on purchased assets can be obtained either by surveying enterprises and government to ask for details of their expenditures, termed the demand-side approach, or they can be obtained by estimating the supply of capital products (as output plus imports) and allocating it to different uses. This is most often achieved by taking GFCF as the residual of supply and estimated expenditures on exports, intermediate and final consumption, and changes in inventories and is termed the supply-side or commodity flow approach.

The principal advantage of the demand-side approach is that it is a direct measure that provides estimates by sector or industry of activity. Its principal disadvantage however is that it often leads to underestimates because respondents do not typically identify all their expenditures on IPPs in a way that is consistent with the SNA definition of an IPP asset. The principal advantage of the supply-side approach is that the major components of supply and use for **capital products** (output, imports and exports) are comparatively well measured **at a detailed product level**, although there is considerable room for improvement[4] in respect of IPPs. The principal disadvantages are that the estimates of supply are valued at basic prices, not purchasers' prices, and the supply-side approach does not provide estimates by type of user. Given this situation, it is recommended that the two sets of estimates be confronted and reconciled using supply and use tables in such a way as to take account of their relative strengths and weaknesses. Even if one approach is considered to be markedly superior to the other for a particular type of asset, such a confrontation can still be informative if the estimates differ and re-assuring if they are similar.

Recommendation 6: Whenever possible, estimates of purchased fixed assets should be derived using both the demand and supply-side approaches, and then confronted and reconciled with each other.

2.2 Assets produced on own account

The 2008 SNA recommends (paragraph 6.124) that output for own use should be valued at the basic prices at which the goods and services could be sold if offered for sale on the market. In order to value them in this way, goods or services of the same kind must actually be bought and sold in sufficient quantities on the market to enable reliable market prices to be calculated for use for valuation purposes. The expression "on the market" means the price that would prevail between a willing buyer and willing seller at the time and place that the goods and services are produced. When reliable market prices cannot be obtained, a second best procedure must be used in which the value of the output of the goods or services produced for own use is deemed to be equal to the sum of their costs of production.

IPPs are generally unique, and so they fail the condition of being sold in sufficient quantities to enable reliable market prices to be determined. In such cases the usual approach is to estimate own account GFCF by summing costs. However, some IPPs, such as most entertainment, literary and artistic originals and packaged software, derive their value from sales of copies or licences to use them, which raises the possibility of estimating the value of the original as the net present value of the expected future sales. In practice, of course, only past sales are known – not future ones – and so certain assumptions have to be made to use this method. In some cases, such as original books and music, royalty data are often available but data relating to the costs of production are not, and so this method may offer the only viable way of making reasonable estimates.

Two different approaches are used to derive estimates of own account GFCF by summing costs. The first, commonly referred to as the 'micro-approach', entails surveying enterprises (or establishments) and government units to obtain their estimates of the costs of producing their fixed assets. The second is to adopt an approach based on labour-input, which requires estimates of the number of people in the occupations that produce these products and the proportion of time they spend doing so to obtain the

quantum of labour input. This is then multiplied by wage rates and other costs (non-wage labour and overheads that can be attributed to the costs of producing the asset) per unit of labour input. This gives an estimate of the total output of IPP originals from which an estimate of those produced for sale must be deducted to give estimates of IPP assets produced on own-account for own-use. This "macro" approach is commonly used to estimate own-account software GFCF.

Again, as was the case for purchased IPPs, it is best if two independent estimates of own-account GFCF are derived and compared. In this case, it is a matter of confronting estimates from surveys, *i.e.* the "micro" approach with estimates derived using the "macro" approach. For convenience of presentation, elsewhere in the Handbook, the micro approach is categorised as a demand-side approach and the macro approach is categorised as a supply-side approach.

Recommendation 7: Whenever possible, estimates of own-account gross fixed capital formation should be derived using both micro and macro approaches, and then confronted and reconciled with each other.

An additional point concerning the time of recording assets produced on own-account for own-use is also important. As explained in the 2008 SNA (paragraphs 10.53-10.55), the general principle for the time of recording of acquisitions and disposals of fixed assets is when the ownership is transferred to the institutional unit that intends to use them in production. Until then assets under production are generally recorded in inventories as work-in-progress, and when completed they are re-classified as inventories of finished goods. However, assets produced for own use should be recorded as GFCF as they are produced, (see paragraph 10.54 of the 2008 SNA).

Unsuccessful developments

The fact that expenditures on assets produced for own use are recorded as GFCF at the time they are occur has important implications for the treatment of unsuccessful developments. Two options merit consideration. The first is to record the value of the asset as GFCF in the usual way during development, and then write it off when the project is abandoned (in the other changes in the volume of assets account, paragraph 12.55, 2008 SNA). This is consistent with business accounting procedures. This, general, approach is, however, less appropriate when dealing with IPPs especially when one takes into consideration the methods used to value successful IPPs in practice – namely by summing costs.

For a start the concept of an unsuccessful IPP is itself contentious. The realisation that a particular drug may not work, for example, is often a central part of the experimentation process that results in the development of a successful drug, and so these costs could legitimately be viewed as forming part of the costs of the successful drug. Indeed, even if it were possible to determine that expenditures resulting in an unsuccessful IPP were not part of a continuous process that would eventually lead to a successful IPP, if only the costs of successful activities were used to value the assets produced there would be a potentially significant understatement of GFCF and the value of assets on the balance sheet. This is because the development of IPP products, such as mineral exploration and R&D, are inherently high risk, and those that undertake them expect that the benefits obtained from the few successes will more than compensate for the cost of the many failures. While the risk of complete failure with software development is less than it is for either mineral exploration or R&D, there are well known cases of failures occurring, and the same argument applies. In these circumstances, it appears unlikely that total own-account GFCF of IPPs would be overestimated by summing costs of both successful and unsuccessful development projects.

Recommendation 8: When summing costs to estimate gross fixed capital formation of intellectual property products, all costs should be included, irrespective of whether the activity is eventually successful or not. Values of assets that subsequently prove unsuccessful should not be written off in the other changes

in volume account. Instead they should be depreciated in the same way as similar classes of assets that prove successful.

Freely available IPPs

A feature of IPPs is that they can be physically reproduced at minimal or zero cost. This characteristic means that their dissemination is often widespread. Market producers often sell copies or rights to use IPP originals that have been developed in-house, even if they were originally only developed for in-house use. But occasionally copies, or the right to use the original without restriction, are distributed for free. Typically this coincides with the expiry of patent rights or the expected service life of the asset, in which case the value of the original becomes zero. But this is not always the case. Occasionally market producers make their originals available for free before the end of their physical and economic service life. But the fact that the IPPs are made freely available does not of itself exclude the IPPs from being recorded as assets. As long as the original producer still expects to obtain economic benefits from the IPP an asset remains.

A complication arises however when market producers produce IPPs that are intended, **at the outset**, only for free dissemination and never for own-use. In these circumstances the economic benefits to the owner/producer are less obvious but that is not to say impossible. A market producer may choose to make IPPs freely available for a number of reasons that still provide economic benefits, for example to increase the goodwill of the company, or to develop a presence in a new market.

This suggests that information on own-account production of IPPs not intended for own-use by market providers is also required, as in some cases the expenditures could conceivably not satisfy asset requirements. However, to do so would be unnecessarily complicated. Especially when one considers the very likely insignificant size of such transactions – market producers are not generally altruistic. As such the Handbook recommends that no such distinction is needed in the case of market-producers.

Although such a pragmatic approach holds for market providers on the grounds that the size of such transactions is likely to be minimal, the same arguments, relating to size and, indeed, a lack of altruism, cannot be applied in the case of government. Two points of view exist in considering the treatment of IPPs produced by government but not intended for own-use by government. The first is to simply treat such expenditures as intermediate consumption on the grounds that government itself gains no direct economic benefits from the development of the asset.

The second point of view takes a more holistic perspective on the role of government. An, albeit imperfect, analogy can be used to illustrate the underlying philosophy of the argument. Roads, which in many countries are made freely available for use are still recorded as assets of government. The analogy is only imperfect because the roads retain a potential value to government which can be realised by eventual charging for use or through their sale but, typically, when governments make IPPs freely available they forfeit all subsequent ownership rights. However the point is that government is in the business of producing assets that it itself may not use in its own production but make freely available because it invests for the overall public good.

The crux of the argument revolves around the role of government and so the delineation between government and non-government sectors. Consider, for example, the case where government invests in medical research for use in hospitals classified within the government sector. Such expenditures should be recorded as investment, even if the same knowledge (the research IPP) is made freely available to hospitals in the non-government sector (be they public or private), because government will directly obtain benefits in its production of hospital services. But if all of the hospitals were outside of the government sector, and so the asset was not used directly by government but indirectly via purchasing services from the hospital

sector, the counter-argument to the recording of the medical research as an asset results in an asymmetric treatment of the related expenditure, depending on whether the hospitals are inside or outside of the government sector. This is somewhat incongruous. Indeed, it is important to note that the argument extends beyond hospitals, or indeed other activities traditionally viewed as being within the scope of government, as the government sector can, in theory and in practice, even if rare, subsume many other activities such as agriculture and industrial production. The argument holds even if one considers drawing the line between 'assets' provided freely to market producers from whom government purchase services and those that it does not: (the grounds being that for the former group government receives economic benefits through reducing its costs whereas for the latter group this is not so obvious). This is because one could argue that by providing assets that reduce the costs of production to market producers government reduces costs to the general public (so providing a public service), or even to itself if the alternative to the asset was an on-going subsidy or grant say.

Notwithstanding the conceptual arguments, nor the arguments related to the role and delineation of the government sector, other practical considerations argue in favour of the treatment of all expenditures by government on IPPs as GFCF. In practice very few countries collect information that would allow expenditures on IPPs by government to be broken down into the categories of 'to be used by government' and 'not intended for use by government'. The OECD Task Force on R&D investigated the use of expenditures recorded according to Socio-Economic Objective (SEO) data, as recommended by the FM as proxy indicators, but only half of OECD countries currently collect this information in their R&D surveys. The Task Force also considered the use of SEO data from government budget appropriations, which are also described in the FM. While these data are available for nearly all countries, the Task Force found that there were substantial difficulties in using them for this purpose. As a result, the Task Force came to the conclusion that while it may be possible to use SEO data, from one source or another, to determine which government R&D expenditures should be recorded as GFCF and which should not, accurate measurement is problematic and there is a real risk of significantly reducing international and temporal comparability. Therefore, the recommendation of this Handbook is that all expenditures by government on IPPs, including R&D, should be recorded as GFCF, if they satisfy the requirement that the IPP is intended for use in production for more than one year.

Recommendation 9: All expenditures by government on IPPs, including R&D, should be recorded as GFCF, if they satisfy the requirement that the IPP is intended for use in production, whether directly by government or by another user, for more than one year.

3. Demand and Supply side approaches

The following sections provide a more detailed description of demand and supply side approaches in practice.

3.1 Demand Side

As noted above, the demand side approach is based on using surveys in which enterprises and government are asked to provide details of their expenditures on, or own-account production of, IPPs. While it is not sensible to prescribe a generic survey form because of the quite different nature of IPPs, it is possible to identify some general principles that can be used to develop specific surveys. In what follows, the term "survey" is used to cover all forms of data collection, including censuses and administrative sources.

The scope of a survey should be all the units – private and public enterprises, government and NPISHs – undertaking GFCF in any particular category of IPP. The scope for software should be the whole economy, given the fact that many production units produce some form of own-account software.

However, for other types of IPPs, keeping in mind the constant desire to minimise reporting burdens, a more selective approach is encouraged. For example, the scope of a mineral exploration survey may be restricted to units classified to mining or units providing relevant supporting services to mining. This general principle should guide the development of surveys related to other IPPs.

In addition, the survey should distinguish between purchases of IPPs for own final use and the unit's estimates of the costs of producing IPPs for its own final use. It is important that clear and comprehensive guidelines be given as to how each of these two types of expenditures should be estimated. It will almost certainly require the intensive and iterative use of pilot surveys to hone the questionnaire, supporting material and edits to achieve good results. Given the substantial possibilities for error due to understatement and to a lesser extent double counting, it is recommended that the questionnaire should lead the respondent through all the items that are required to obtain estimates of purchased assets and assets produced on own account, and ask for intermediate estimates along the way.

Purchases of intellectual property products

Units should be requested to include all their purchases of IPPs intended for own final use, including complete products, such as software, and services. They should be categorised by each type of expenditure. This varies according to the type of IPP, but should cover the following where appropriate:

a. Outright purchases of complete products, such as a software original or a patent, for own use;

b. Payments for services that constitute fixed assets, such as the development of customised software or aerial and satellite imaging services to locate mineral deposits;

c. Payments for licences to use (*e.g*. software, the output of R&D, to exhibit movies) that satisfy the asset criteria; and

d. Payments for licences to reproduce (*e.g*. software and artistic originals) that satisfy the asset criteria.

Own-account production of intellectual property products

An important point to note in the estimation of own-account production of IPPs is that an original asset is created whether it is designed to produce internal services or made available to other users via licenses to use (including copies) or licenses to reproduce, so long as it satisfies the standard asset criteria.

As described earlier, own-account GFCF should be valued at the basic prices at which the goods and services could be sold if offered for sale on the market. If this is not possible, which is nearly always the case, then the basic price should be estimated as either the net present value of future royalties or, more commonly, by summing the costs of production, including the user cost of fixed assets.

Paragraph 6.125 of the 2008 SNA defines how estimates should be obtained when reliable market prices are unavailable.

> *When reliable market prices cannot be obtained, a second best procedure must be used in which the value of the output of the goods or services produced for own use is deemed to be equal to the sum of their costs of production: that is, as the sum of:*
>
> *i. Intermediate consumption;*
> *ii. Compensation of employees;*

iii. Consumption of fixed capital;
iv. A net return to fixed capital; and
v. Other taxes (less subsidies) on production

By convention, no net return to capital is included when own-account production is undertaken by non-market producers

Where the following items should be recorded under each category:

i) *Intermediate consumption* - includes overheads associated with employing the staff engaged on asset development (in proportion to the time spent by employees on asset development), such as management costs, training, personnel management, office requisites, electricity, rent, etc., and the use of fixed assets owned by the enterprise and any other intermediate consumption associated with producing the asset.

ii) *Compensation of employees* – which should reflect the number of in-house staff involved in the development of the IPP multiplied by the average percentage of time they spend on own-account intellectual property asset development, excluding maintenance and commercial tasks, but including time spent on R&D, multiplied by their average compensation.

iii) *Consumption of fixed capital* – which should include the depreciation of all fixed assets when used in producing the own-account IPP.

iv) *A net return to fixed capital:* reflecting all fixed assets used in producing the own-account IPP, in proportion to the amount of time spent on asset development, see Box 2 below.

v) *Other taxes (less subsidies) on production*: reflecting all taxes/subsidies associated with the cost of producing the asset, such as payroll taxes.

Survey respondents should be asked to itemise their expenditures, including purchases of R&D and software and other fixed assets needed to produce the asset. There are several advantages in doing so. First, it encourages and supports the respondent in costing all the required items. Second, data pertaining to purchases of fixed assets can be used to estimate the value of the capital services they provide. Third, it supports editing of the response by survey statisticians that could lead to substantially better estimates. For instance, there could be an edit that compares the reported staff hours spent on asset development with other costs. If one or more of these relationships were to fall outside certain bounds then follow-up action could be taken. For major respondents it may justify a query with the respondent, but for minor respondents it may initiate replacement of the reported values with imputed values.

Box 2: User Costs of Capital

When a producer hires a fixed asset (such as a building or a piece of equipment) to use in production, the rental is included in intermediate consumption, but when the producer owns the fixed asset it is necessary to impute the rental. In some instances it may be possible to do this by observing market rentals, but in practice it is usually estimated by summing the costs of owning the asset, *i.e.* the *user cost*. The user cost has two principal components: consumption of fixed capital and a return to capital. The second component comprises two sub-components: the interest cost of owning the capital (the cost of financing the asset or the opportunity cost of the financial capital tied up in owning the asset) and the expected holding gains and losses of owning this type of asset. In addition, government taxes, such as the tax deductibility of interest or accelerated depreciation allowances also influence the user cost of capital. For a full discussion as to how it can be estimated, refer to the OECD's revised *Measuring Capital*.

R&D surveys conducted as per the Frascati Manual are an example of surveys designed to measure the total in-house costs of developing an IPP. Although not entirely consistent with national accounts requirements they provide a useful guide as to how to conduct surveys of this type. For many countries these surveys have been conducted over a long period of time and the experience gained could be exploited in developing surveys to obtain data for other types of IPPs.

The Frascati Manual recommends that capital costs should be measured by expenditures on capital products (including land); whereas for national accounting purposes, capital costs should be measured as the rental payable for the use of fixed assets. When own assets are used these have to be imputed by estimating the cost of capital services. It is probably unrealistic to expect respondents to provide reasonable estimates of these costs and so it is recommended that this component is imputed by the national statistical office (NSO). There are several ways of making this imputation.

a. If it is known what the past expenditures have been on fixed assets to be used exclusively for the production of the IPP then the perpetual inventory method (PIM) can be used to estimate the cost of capital services. This is a possibility for R&D.

b. If sufficiently accurate and detailed data are available for units specialising in the production of the IPP then the ratio of the cost of capital services to labour input can be calculated for this activity and used to make the imputation. Another possibility is to use the ratio of gross operating surplus to labour input.

Collecting detailed cost data for own-account GFCF of widespread IPPs, such as software, imposes a considerable respondent burden and substantial costs for the NSO. One way to reduce the costs is to collect the full set of cost data from only a sub-sample of units, collect only labour costs for the remaining units in the sample and impute the total costs using a regression model, or by some other means.

Recommendation 10: When asking units to estimate the costs of producing assets on own account they should be asked to itemize their costs, separately identifying purchases of fixed assets. The latter should not be included in the sum of costs. But estimates of the user cost of capital should be (but only the depreciation component for non-market producers). This can be done either by applying the perpetual inventory method to past estimates of capital expenditures or by making an imputation based on data for units specialising in the production of the particular intellectual property product.

Using business records

For some types of asset, such as computer software, business and national accounting standards are quite similar, but for others, such as research and development, they differ substantially. Businesses do not record any research expenditures as GFCF and record less expenditure on experimental development than recommended by the SNA (IAS 38). In any case, businesses have a strong general tendency to minimise their recording of capital expenditures on IPPs, particularly those produced on own account, to such an extent that their estimates are often inappropriate for national accounts purposes. This is due to a number of factors, including a desire to be prudent (to meet the requirements of accounting standards, which stress prudence) as well as a desire to minimise tax payments by depreciating assets as quickly as possible or not recognising them as assets in the first place. Hence, the use of business records to estimate the GFCF of IPPs is not generally recommended.

Recommendation 11: Business records of asset acquisitions should only be used to derive estimates of gross fixed capital formation of intellectual property products with extreme caution.

4. Supply-side approach

4.1 Purchases of intellectual property products

The underlying principle for estimating GFCF of purchased IPPs using the supply-side approach is simple. GFCF is calculated as:

Domestic output + imports

minus

Exports, households' expenditure and exclusions to avoid double counting

Production on own account needs to be excluded from domestic supply to avoid the possibility of double counting. Both domestic supply and imports are valued at basic prices, and so transport costs, wholesale and retail margins and taxes less subsidies on products need to be added to obtain values at purchasers' prices.

4.2 Own-account production of intellectual property products

As already discussed, the underlying approach for demand and supply estimates of own account production of assets cannot be distinguished. Like the demand-side micro-approach the supply-side macro-approach entails identifying the number of people in those occupations that produce the target IPPs and the proportion of their time spent undertaking this production to derive the quantum of labour input. This is then multiplied by wage rates and other labour costs, and the cost of all the overheads in undertaking the production of the IPP. Naturally, the types of costs to be included at the macro level are exactly the same as at the micro level. The only difference between the two approaches relates to the source information. The micro-approach is based on detailed survey response information whilst the macro-approach is based on more aggregated information, often from a variety of sources. For example, estimates of the proportion of time that employees spend working on own-account production, can often be based on information gleaned from survey data, or failing that using rules of thumb based on international experience.

The equation for estimating the value of own-account IPP production can be presented as follows:

Value of own-account production =

Total number of employees working on own-account production

x

Average compensation of employees

x

Proportion of time spent on own-account production

+

Other intermediate costs used in own-account production

+

Notional operating surplus related to own-account production (capital services) (only depreciation for non-market producers)

+

Other taxes (less subsidies) on production

Clearly, especially for software, the occupation category of individuals working on own-account IPP developments can be very varied, with the average proportion of time spent on own-account production also varying significantly by occupation. For harmonisation and measurement purposes therefore, it is sensible to restrict the employee categories included in the calculations to those that make a significant contribution. Where this information is not separately collected, estimates based on the relevant categories as per the International Standard Classification of Occupations 88 (ISCO 88) should be used.

There are several ways of estimating non-labour intermediate input costs. One is to refer to data from demand-side surveys, but the more likely option when using the macro approach is to refer to the activity data of units specialising in the production of the target asset.

The same kinds of choices apply to estimating the operating surplus. That is, by assuming that the ratio of operating surplus to compensation of employees is the same as that of the industry in question or from the activity data of units specialising in the production of the target asset. Because own-account software is more typically produced across a range of industrial sectors (and not just the software producing industry) than own-account R&D, the first option is probably the best in the case of R&D, while the second is probably the best for software.

Care needs to be taken to ensure that only production for own-use is included. Production of the target asset for outright sale, such as custom-made software, should not be included.

5. International trade in intellectual property products

5.1 International Trade, GFCF, and supply-based methods

With the exception of mineral exploration and evaluation, IPPs are subject to substantial international trade. Commonly the trade relates to copies of IPPs, such as packaged software, and musical and film recordings, or the services provided by them, but trade in originals, such as R&D, can be important. Given their importance, and the widespread use of the supply-side approach to estimating GFCF, ensuring the accurate measurement of exports and imports of IPPs is essential.

Transactions in originals and copies of IPPs and IPP services are recorded in the goods and services account of the balance of payments (BOP) and Chapter 10 of the *Sixth Edition of the IMF's Balance of Payments and International Investment Position Manual* (BPM6) describes the categories in which they are recorded. Unfortunately, the level of detail that is, at present, typically collected on international transactions in IPPs is less than ideal for the purposes described in this Handbook.

This situation is further complicated by the fact that IPPs can have a dual categorisation – both as goods or services, depending on the mode with which they are transported, which means that, in practice, the information required to compile total imports of a particular IPP category, in particular software, comes from two different sources.

One of the most important sources for estimating international trade in services are surveys conducted in accordance with the *Manual on Statistics of International Trade in Services* (MSITS). The 2002 edition of this manual, which is consistent with both the 1993 SNA and BPM5, includes the *Extended Balance of Payments Services Classification* (EBOPS). The text below, which looks at the three main types of IPP that are internationally traded, describes why the breakdown into product groups currently defined in this classification systems, is often not sufficient for national accounts purposes However, revisions to both EBOPS and the MSITS have recently been agreed, which should improve the situation in the future, and these changes are also described.

Computer software and databases

The effective use of a supply-side approach to estimating GFCF requires that a breakdown of products purchased by producers allows for a robust delineation between intermediate consumption and GFCF: both from a conceptual and a collection perspective. For the former, as described in more detail later in this manual, such a breakdown has been developed; and is shown in summary detail below with the corresponding entry (in brackets) for the treatment in the accounts of purchases by producers.

- Customized software and non-customized originals (GFCF)
- Non-customized software – outright sales of copies and long-term (more than one year) licences to use (GFCF)
- Non-customized software – short-term (one year or less) licences to use (IC)
- Non-customized software - licences to reproduce (resembling an operating lease) (IC)
- Non-customized software - licences to reproduce (not resembling an operating lease) (GFCF)
- Hardware and software consultancy, implementation and installation services; analysis, design and programming of systems ready to use (GFCF)
- Repairs and maintenance of computers and peripherals; data recovery services, provision of advice on matters related to management of computer resources; systems maintenance and other support services, such as training; data processing; web page hosting services; provision of applications, hosting clients' applications, and computer facilities management (IC).

However, the product breakdown currently provided in the MSITS (2002) is considerably more aggregated. The current (2002) version of the EBOPS classification contains a specific classification for *Computer Services* but with no further breakdown. Moreover, it does not capture trade in *Licences to use non-customised products provided on disks, etc. and which convey perpetual use,* which are instead recorded as trade in goods rather than trade in services. Neither does it capture *licenses to reproduce* software, which although captured under *Royalties and License fees*[5]*,* includes other IPPs which are not separately identified.

However, partly in response to the work of the OECD Task Force on Intellectual Property Products, the new MSITS (2010), and corresponding EBOPS, have been developed to better accommodate the needs of the national accounts in this regard. At its March 2009 meeting, the Interagency Task Force on Statistics of International Trade (TFSITS) approved a number of changes to the EBOPS classification. Those affecting the measurement of software are as follows:

- A separate category, *Licenses to reproduce and/or distribute software*, within *Charges for the use of intellectual property (previously referred to as Royalties and License fees).*

- A breakdown of *Computer Services* into *Computer software* and *Other computer services,* with a further *of-which* item for the former, reflecting *software originals.*

- The inclusion of a supplementary item *Computer Software Transactions* (which includes *licenses to reproduce/distribute software*, *computer software* and importantly, transactions in *computer software goods*).

- The inclusion of a further supplementary item *licenses to use computer software* (which includes all licenses to use computer software, irrespective of whether they are classified as goods or services).

Such a breakdown will provide considerable scope for improvement in the quality of supply-based methods of GFCF.

Entertainment, literary and artistic originals (Audiovisual products)

The national accounts requirements for audiovisual products, vis-à-vis the type of product breakdown required, are essentially the same as they are for computer software. Moreover, like software, MSITS (2002) contains two product categories within which audiovisual products might be found *Audiovisual and related services* and *Royalties and License fees*.

As was the case for software, a product breakdown that facilitates supply-based estimates of GFCF, is also essential. Fortunately, like software, planned and agreed revisions to the EBOPS will also improve the situation here. Those affecting the measurement of audiovisual products are as follows:

- A separate category, *Licenses to reproduce and/or distribute audiovisual and related services*, within *Charges for the use of intellectual property.*

- A breakdown of *Audiovisual services* into *Audiovisual products* and *Other audiovisual services,* with a further *of-which* item for the former, reflecting *Audiovisual originals.*

- The inclusion of a supplementary item *Audiovisual transactions*

- The inclusion of a further supplementary item *Licenses to use audiovisual products.*

This new product classification will significantly improve the quality of GFCF, supply-based, estimates. The supplementary item L*icenses to use audiovisual products* will, for example, include transactions in audiovisual 'goods' (CDs, DVDs etc), and *Other audiovisual services* will separately record those transactions in audiovisual products, such as fees to actors, payments to encrypted television channels etc that should not be recorded as GFCF.

R&D

In the 2002 MSITS, R&D transactions fall into three categories: Other royalties and licence fees, Research and development services and Acquisition or disposal of non produced, nonfinancial assets. The first two of these categories are in the current account and the third is in the capital account. In BPM6 R&D transactions fall into two categories: Charges for the use of intellectual property and R&D services. As far as R&D is concerned, the major change in categorization is that payments for the acquisition of patents have been moved from Acquisition or disposal of non produced, nonfinancial assets in the capital account to R&D services in the current account.

The definition of *R&D services* in BPM6 is wider than that in the 2008 SNA and the FM because it includes testing and other product development activities that may give rise to patents (see BPM6 paragraph 10.148). The planned revision to EBOPS, however, has been designed to separately identify this component of R&D services, as shown below:

10.1.1 Creative work undertaken on a systematic basis to increase the stock of knowledge
10.1.1.1 Provision of customized and non-customized R&D services
10.1.1.2 Sale of proprietary rights arising from R&D (patents, copyrights, etc.)
10.1.1.2.1 Patents
10.1.1.2.2 Copyrights
10.1.1.2.3 Industrial processes and designs (including trade secrets)
10.1.1.2.4 Other

10.1.2 Other R&D services (testing and other product/process development activities)

5.2 Movement of IPPs between affiliated enterprises

One of the areas presenting considerable statistical challenges concerns 'transactions' in IPPs between affiliated enterprises located in different countries. The key difficulty reflects the fact that monetary transactions, implicit or otherwise, that are explicitly identifiable with the IPP are rarely recorded by either party. When an IPP is provided by one affiliated enterprise to another, either in its entirety or via a license to use or reproduce, a number of possibilities for recording the transaction arise:

a. *There is either a sale or licence agreement* between the provider and the recipient: the provider provides access to the IPP in exchange for a fee that is observable and should be recorded in the BOP and SNA goods and services accounts.

b. *There is a capital transfer* from the provider to the recipient, i.e. the IPP is a gift. This should be recorded in the BOP and SNA capital accounts, but it is very likely to go unrecorded.

c. *The IPP is provided by the parent to a foreign subsidiary without a fee* but with the expectation of receiving property income in the future. In effect, the parent is providing the IPP for a fee and then using the fee to increase its foreign direct investment in the subsidiary. This, too, is likely to go unrecorded. Both this and the case below include access related to reproduction rights without explicit observable fees charged.

d. *The IPP is provided to the parent by the foreign subsidiary without a fee* but in response to previous foreign direct investment. In effect, the parent is receiving the IPP in lieu of property income. This, also, is likely to go unrecorded unless steps are taken to monitor what is happening to the output of foreign-owned units created to undertake the production of IPPs.

Transactions between affiliates also impact on the valuation of the original IPP. In effect, there are two possibilities, when transactions occur:

e. The aggregate value of the asset has increased within the multinational: in other words the expected present value of future benefits has increased, as could occur, for example, if the multinational acquired a new affiliate and so obtained economic rights within a country that were not expected at the time of the original valuation. This would be recorded in the other changes in the volume of assets account of the provider. Such recordings have been rare in practice. A consequential difficulty is related to the split, if any, of the asset across the different countries where economic rights exist.

f. The aggregate value of the asset has not changed: the provider expected to share the asset in some way at the time it was acquired. In other words the original valuation reflected the scope for its use across different countries.

Clearly significant problems related to these flows implicit or otherwise exist. Moreover, the current scope for fully articulating such flows in the accounts is restricted by the sources of information available to measure them.

The MSITS identifies four different modes of trading in services within the General Agreement on Trade in Services (GATS) between economies. The two modes most relevant for measuring cross border trade in IPPs are mode 1, "cross border supply [which] takes place when the consumer remains in [the] home territory while the service crosses national borders" (MSITS 2.16) and mode 3, "commercial presence" where services are provided within an economy by a foreign owned enterprise, and which are usually associated with foreign direct investment (FDI) (2.18, 2.59). Statistics relating to these modes are therefore important for the measurement of cross-border IPP transactions, in particular between affiliates.

Mode 1 transactions are captured by conventional cross-border trade statistics and are reflected in exports and imports of goods and services, where the major problems, in a statistical sense, relate to the ability to differentiate between the different types of IPPs; as described above. Mode 3, on the other hand, as its title suggests is concerned with foreign-owned subsidiaries, where data are provided by Foreign Affiliates Trade in Services (FATS) statistics (MSITS 1.21, 1.24, 2.64, 2.65) and FDI statistics (MSITS 1.20, 2.46, 2.59).

Although both sources provide potential for recording the movements of IPPs between affiliated enterprises, considerable care needs to be taken. For example, just because a parent enterprise funds IPP production of a subsidiary in another country does not mean that the IPP is intended for use back in the parent country – this may be the case but funding or FDI data by themselves do not suffice to reach such a conclusion.

An important first step in addressing problems with properly recording movements of IPPs between affiliated enterprises is to separately identify transactions between them in surveys of trade in services. This provides a starting point for valuing flows which otherwise go unreported.

Statistics on transactions of international services associated with IPPs are difficult to separate from other activities, especially for intra-group services. Indeed, intra-group arrangements for rendering services are sometimes linked to arrangements for transferring goods or intangible property (or the licensing thereof). In some cases, such as know-how contracts containing a service element, it may be very difficult to determine where the exact border lies between the transfer or licensing of property and the transfer of services (OECD 2001: 1.42-1.44, 7.3).

Evidently the national accounts should reflect economic reality, and changes in ownership of IPP assets and the associated transactions should be recorded. However, current data sources generally do not identify transactions such as (b), (c), or (d), above, and, so, it is generally not possible to record them in the accounts. Further research is needed to identify ways of obtaining the values of transactions between affiliated units and their nature. Likewise, if the aggregate value of the asset has changed it should, in principle, be recorded in the accounts but this too is stymied by a lack of information and so is also a matter for further research.

6. Prices and volumes

Determining prices and volumes is probably one of the most difficult measurement issues related to the measurement of IPPs. Essentially, there are three cases to consider:

a. The IPP original is sold. This is the case for a minority of all types of IPPs.

b. Copies of the IPP are sold. This is the case for a substantial portion of software and most of entertainment, literary and artistic originals.

c. The IPP is produced on own account. This is commonly the case for R&D, mineral exploration and evaluation, databases, and also, to a substantial degree, software.

Each case raises different issues for measuring volumes and prices. The following briefly considers each case, but the particulars for each type of IPP are addressed as they are presented later in the Handbook.

6.1 Intellectual property product originals for sale

In this case market prices are available, at least in principle, but there is a difficulty in separately identifying the price and volume components because originals are unique by definition. How to derive price indices of unique manufactured products is addressed in paragraphs 6.83 to 6.86 of the *Producer Price Index Manual*[6], and it may be possible to use one or more of the approaches described for types of IPP originals that have well defined means of production, or a limited number of means of production. However, the collection of price data is not costless to either the NSO or respondents.

For types of IPP original that do not have a well defined production process, or where there are many production processes, other solutions can be considered. For example, revenue figures may be available from which price indices may be inferred - given adequate quantity indices. Such revenue data would need to relate to the production by market producers of a type of IPP, and there would need to be a corresponding volume indicator that adequately approximated the growth in volume of IPP output. In the US, revenue data are available for the industry "Scientific Research and Development Services" (North American Industrial Classification System 5417). Under ISIC Rev. 4, it would be market producers in "Scientific Research and Development", industry 72.

Recommendation 12: For Intellectual property product originals that have a well defined means of production, or a limited number of means of production, then the methods described for deriving price indices for unique manufactured products in the Producer Price Index Manual can be considered. Otherwise, other solutions should be considered. One possibility is to infer a price index using the revenue earned by market producers of original Intellectual property products and a satisfactory volume output indicator.

6.2 Copies of Intellectual property products for sale

The principles for compiling price indices for non-unique products whose price data are available are well understood. An overview is given section B of chapter 15 of the 2008 SNA and more thorough explanations are given in the *Producer Price Index Manual* and the OECD's *Handbook on Hedonic Indices and Quality Adjustments in Price Indices*. Section C of chapter 15 of the 2008 SNA addresses volume measurement, and paragraphs 15.149 to 15.156 address the volume measurement of IPPs.

Two prevailing methods exist for measuring quality-adjusted price changes in practice: matched-model and hedonic pricing. Hedonic pricing is based on regression techniques and is used for a wide range of products, but they are most widely used in the area of computers and peripheral equipment. The standard approach in matched-model methods is to choose a fixed reference period and to match prices of products in subsequent periods with prices of the same products in the reference period. This is difficult to establish in a fast changing market where old products disappear or new products are introduced with high frequency, which is typically the case for software, and R&D. Under these circumstances, matched-model methods are prone to not capturing quality changes.

Hedonic methods on the other hand assume that each product is made up of a multitude of definable characteristics whose implicit or shadow prices can be estimated, such that changes in the price of the overall product can be decomposed into a pure price change and a quality change (related to changes in the composition/quality of the components), making them more appropriate for IPP assets than matched-models, (more information on both methods is shown in Annex 1.1). As such, for products where price data are available and there is evidence of rapid quality change, as is the case for packaged software, then hedonic methods are the preferred approach for deriving volume estimates.

Recommendation 13: For products where price data are available and there is evidence of rapid quality change, as is the case for packaged software, then a method, such as the hedonic method, that takes account of quality change should be used to derive price indices.

6.3 Intellectual Property Products produced on own account

Many IPPs are produced on own account, and, so, no price data are observable. For non-market output, the 2008 SNA provides advice in paragraph 15.117. Some of this advice is often also applicable to the output of market producers not sold on the market.

> *15.117 In practice, there are three possible methods of compiling volume estimates of the output of non-market goods and services. The first is to derive a pseudo output price index such that when it is compared to the aggregate input price index the difference reflects the productivity growth thought to be occurring in the production process. Pseudo output price indices can be derived in various ways, such as by adjusting the input price index according to the observed productivity growth of a related production process or by basing the growth of the pseudo output price index on the observed output price indices of similar products. However, such data are rarely available for the goods and services produced by government and NPISHs.*

The second of the two methods referred to in paragraph 15.118 applies to the production of individual and collective services by non-market producers, and does not generally apply to the production of IPPs. The third method, (paragraph 15.119) the "input method", is applicable to IPPs when no satisfactory output or pseudo output price index is available.

The possibilities for deriving pseudo output price indices depend on whether suitable data are available for similar products or comparable production processes. When no measures of output are available, there is little option but to apply input price indices. If productivity is rising in a perfectly

competitive market then it is expected that the output prices of a unit, or an industry, will show lower growth than the input prices. Hence, the use of input prices, rather than output prices, will tend to reduce the growth rate of the volume measure of output. But if markets are imperfectly competitive, such as in the case of R&D, the relationship between input and output prices is less clear.

Recommendation 14: For products where price data are unavailable, pseudo output price indices should be derived if practicable, otherwise input price indices must be used.

7. Capital measures

The capital measures referred to in the 2008 SNA comprise gross fixed capital formation, capital services, net capital stock and consumption of fixed capital. Their definitions and the roles they play are all described in chapter 20. Methods for estimating GFCF are discussed elsewhere in this Handbook and methods for estimating the other three measures are the subject of a new edition of the OECD manual *Measuring Capital*.

Nearly all countries derive their estimates of capital services, net capital stock and consumption of fixed capital using the perpetual inventory method (PIM). As its name suggests, the PIM involves aggregating GFCF over time, but allowing for declines in efficiency and value until assets reach the end of their service lives and are retired. The PIM is applied to groups of assets, generally at the most detailed level at which GFCF data are available.

IPPs are not subject to wear and tear like most other fixed assets, such as motor vehicles and buildings, but their values do decline over time. First, they are subject to obsolescence. For example, in the case of R&D, more recent R&D may lead to new products or processes that displace those arising from previous R&D. Second, other units may be able to exploit the IPP without payment because the patent or copyright has expired, thereby leading to a reduction in the benefits accruing to the owner. This leads to reduced value and consumption of fixed capital (*i.e.* depreciation).

The key parameters in the PIM are the expected service life of a group of assets of a similar type, the rate at which its productive capacity, or efficiency, is expected to decline as it ages and the rate at which its value is expected to decline as it ages. The last two are interdependent and their relationship hinges on a discount rate[7]. Not all assets within a group can be expected to have exactly the same service life, and so a probability distribution function is usually specified[8]. The most important PIM parameter is the service life. Specifying a service life of 10 years rather than 5 years would make a huge difference to the estimates of the capital measures. Net capital stock would be approximately double, and with a typical scenario of strong growth, consumption of fixed capital would be appreciably smaller. It therefore deserves a good deal of attention. There are several ways of obtaining estimates of service lives, they include: surveying users, surveying suppliers and consulting experts.

The age-efficiency function is usually unobservable, but the age-price function is observable for some fixed assets, such as motor vehicles or buildings, and the corresponding age-efficiency can be determined. It is likely that this will need to be adjusted to be plausible and so an iterative procedure can be undertaken until a plausible age-efficiency is obtained such that the corresponding age-price function reasonably approximates the observed data. But an age-price function for IPPs is not readily observable. There are two reasons: many IPPs are produced on own account and aged IPPs are not commonly traded. In the absence of information of the functional forms of either the age-efficiency or the age-price function it is necessary to hypothesise as to what appears to be plausible.

It can be shown that no matter what the functional form of the age-efficiency function of individual assets is, once they are considered as a group with individual service lives subject to a probability

distribution, the functional forms of both the age-efficiency and age-price functions of the group will at least roughly approximate a geometric function with the same rate of decline, δ. Hence, the specification of a geometric function for the age-price and age-efficiency functions for a group of assets is attractive, particularly for assets, such as IPPs, for which the age-price function of an individual asset or a cohort of assets is unavailable. The geometric function also has the advantage that it is much easier to apply than any other functional form.

Another factor to consider in choosing a functional form for IPPs is what functional forms are used for other asset types when applying the PIM, as it may be judged impracticable to use geometric for IPPs and some other functional form for other asset types.

In practice, as for service lives, δ is rarely observable for IPPs and it has to be imputed by some means and, as for service lives, there are several ways that this can be approached. Whichever approach is taken, it is likely that respondents will find it easier to report what they think the service life of an asset will be rather than the rate of decline in its efficiency or value. Given the service life it is possible to determine a corresponding δ using the following formula:

$$\delta = X/N,$$

where X is the declining balance rate and N is the expected mean service life of the group of assets. See the OECD's *Measuring Capital* for advice on choosing a value for X.

Recommendation 15: When using the perpetual inventory method, it is important to have reasonably accurate service lives. The geometric model has a number of advantages and should be used unless there are strong conceptual or practical objections.

Two issues merit particular discussion here: the treatment of unsuccessful developments and government produced IPPs made freely available and not used in direct production. Paragraph 12.55 of the 2008 SNA provides examples of types of 'unsuccessful assets' that could be written off in the other changes in volume of assets account, rather than depreciated like equivalent successful assets. As stated above however, IPP assets do not fall into this category of 'unsuccessful assets' and so this Handbook recommends an equivalent treatment for measuring successful and unsuccessful assets as GFCF (Recommendation 8); following the arguments provided in section 2.2. The same arguments imply that for the same class of IPP assets the same average service lives, age-efficiency and age-price functions should be used for both successful and unsuccessful assets.

One could argue that government produced IPPs made freely available and not intended for direct use in production should be re-valued to zero at the time they become freely available, on the grounds that that is their effective market price at the time. However the same arguments evoked in section 2.2, (defining the government sector, defining government services for the public good, and the practical measurement difficulties) suggest otherwise. As such, the Handbook recommends that IPP assets made freely available by and produced by government but not used in direct production should use the same average service lives, age-efficiency and age-price functions as similar IPP assets used by government in direct production.

---

2 Although they do decline in value for other reasons – see section 7.

3 Capital stock, consumption of fixed capital and capital services.

4 For example, in international trade statistics. See also section 5 for information on proposed changes to the Manual on Statistics of International Trade in Services and the Extended Balance of Payments Classification, scheduled for release in 2010, which should improve the situation.

5 Charges for the use of intellectual property in BPM6 replaces Royalties and licence fees in BPM5.

6 *Producer Price Index Manual: Theory and Practice* (Washington: International Monetary Fund). See also the OECD's M*ethodological Guide For Developing Producer Price Indices For Services* http://www.oecd.org/dataoecd/44/40/36274111.pdf. A further manual on export and import price indices is in draft (as of mid-2008) http://www.imf.org/external/np/sta/tegeipi/index.html).

7 In the case of a geometric model the age-efficiency and age-price functions are identical, irrespective of the discount rate.

8 If a geometric model is used this step is unnecessary.

ANNEX A: PRICE AND QUALITY CHANGE

Matched-model method

In a typical matched-model, the price of a product in the base period is compared with the price of the product with the identical attribute or characteristic in the comparison period. In this way the price difference is the pure price change not due to any quality improvement. In cases where an existing product disappears or is replaced by a new product with different characteristics, it has to be deleted from the sample and the new product must be included in the sample to be matched in the next period.

After matching the products in two adjacent periods, the Laspeyres price index, P_L, the Paasche price index, P_P, and the Fisher Ideal index, P_F, can be calculated as follows:

$$(1)\quad P_L = \frac{\sum_i p_i^2 q_i^1}{\sum_i p_i^1 q_i^1},$$

$$(2)\quad P_P = \frac{\sum_i p_i^2 q_i^2}{\sum_i p_i^1 q_i^2},$$

$$(3)\quad P_F = \sqrt{P_L P_P},$$

where p_i^t and q_i^t are the price and quantity of product *i* sold in period *t*, *t = 1,2*.

In the Laspeyres price index the first period quantities q_i^1 are used as weights for the prices in both periods, implying that the buyers do not adapt their purchasing patterns to price changes. Since this assumption does not match reality, the Laspeyres price index is generally biased upwards, *i.e.* true price changes are overstated. On the other hand, the Paasche index is downward biased as it is based on the second period purchases. The Fisher index, which is the geometric mean of P_L and P_P, is a good approximation of the "true" price change because it accommodates the substitution effect.

Problems with matched-model price indexes arise when old products disappear or new products are introduced with high frequency. An index based only on overlapping products in a few periods and ignoring new products means that products actually sold are not sufficiently represented in the index. A way to get around this problem is to calculate a chained index with frequent re-sampling and re-weighting.

Hedonic pricing

The technique of hedonic pricing assumes, in principle, each product is made up of a multitude of definable characteristics, for each characteristic a price can be estimated and quality changes in a product can be viewed as adding a new characteristic to the product. The resulting price change can then be divided between the change resulting from adding the better quality characteristic and from a more general price increase (or decrease). As such, a quality-adjusted or "pure" price can be calculated (Hollanders 2001).

In general, the following functional relation between the price of a product and its quality characteristics is assumed:

$$(1)\quad p_{it} = f_t\left(x_{1it}, x_{2it}, ..., x_{kit}, u_{it}\right), t \in [0, T],$$

where p_{it} is the price of variety *i* of a product at time *t*, x_{jit} the quality *j* of variety *i* at time *t* where there are *k* different product characteristics and u_{it} a disturbance term measuring all random factors.

There are several possible functional forms for this relation, *e.g.* semi-logarithmic, linear and linear in logarithms. Assuming the empirically most convenient semi-logarithmic functional form gives:

$$(2)\quad \log p_{it} = a_o + a_1 x_{1it} + a_2 x_{2it} + ... + a_k x_{kit} + u_{it},$$

where the a_j coefficient can now be interpreted as an estimate of the percentage increase in price due to a one-unit change in quality *j*.

Adding a time-dummy for each year except the base year, *i.e.* the dummy variable D_t takes the value one in year *t* and zero otherwise, gives:

$$(3)\quad \log p_{it} = a_o + a_1 x_{1it} + a_2 x_{2it} + ... + a_k x_{kit} + \sum_{t=1}^{T} a_{dt} D_t + u_{it},$$

where the coefficient a_{dt} provides with an estimate of the average percentage increase in price between year *t* and the previous year *t-1*, keeping the various qualities *j* constant.

The accumulation of these quality-adjusted price changes results in an estimate of the quality-adjusted price change between the base year and year *T* for any individual product.

A hedonic regression of equation (3) results in estimates for the a_k coefficients. Between period *t* and *t-1*, the quality change can then be calculated as:

$$(4)\quad g_{i,t-1}^{t} = \frac{\hat{p}_{it}}{\hat{p}_{i,t-1}},$$

where $\hat{p}_{it} = f_t\left(x_{1it}, x_{2it}, ..., x_{kit}, u_{it}\right)$ and $\hat{p}_{i,t-1} = f_{t-1}\left(x_{1i,t-1}, x_{2i,t-1}, ..., x_{ki,t-1}, u_{i,t-1}\right)$ are the predicted prices for each period based on the estimates for the a_k coefficients.

The observed price index between years *t* and *t-1* can then be adjusted for this quality change as follows:

$$\text{true price index} = \frac{\text{observed price index}}{\text{quality change index}} = \frac{p_t / p_{t-1}}{\hat{p}_t / \hat{p}_{t-1}} = \frac{p_t / \hat{p}_t}{p_{t-1} / \hat{p}_{t-1}},$$

where p_t is the price index for year *t* compiled out of the individual p_{it}'*s*.

Hedonic pricing requires a big and detailed data set, since details of characteristics for each product are needed. Moreover, some product knowledge is necessary so that a certain amount of research effort is required. These requirements make the compilation of a hedonic price index very resource consuming.

A comparison of price index studies in packaged computer software shows that hedonic price indices generally decline more rapidly than their matched-model counterparts. For example, a study (Hardoff 1997) of database prices in Germany show for the period 1986-1994 an annual average price decline of 7.4 per cent using hedonic pricing and of 4.4 per cent using the matched-model method. Intellectual Property Products produced on own account.