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DRAFT

HANDBOOK ON DERIVING CAPITAL MEASURES OF INTELLECTUAL PROPERTY PRODUCTS

(SOFTWARE AND R&D COMPONENTS)

To be held on 3-5 October 2007
Tour Europe, Paris la Défense
Beginning at 9:30 a.m. on the firt day

This document has been prepared by Charles Aspden, Statistics Directorate - OECD and will presented under item 10 of the draft agenda

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NOTE BY THE SECRETARIAT

The Handbook on Deriving Capital Measures of Intellectual Property Products is intended to support the 1993 SNA Rev.1 by providing detailed guidance on how to compile capital measures of intellectual property products. This draft, prepared by the OECD Secretariat, is very much a "work in progress".

Chapter 2, which deals with software and databases, is largely based on the report of the OECD software task force (2003), but also reflects the changes made in the draft 1993 SNA Rev.1. An earlier version was presented at the meeting of the Canberra II Group on the Measurement of Non-financial Assets in April 2007, and account has been taken of the comments made. It is intended that the next draft will incorporate the recently revised industry and commodity codes.

Chapters 1 and 3 are new. Chapter 1 is intended to provide an overview of how capital measures can be derived for intellectual property products. Chapter 3 concerns research and experimental development (R&D). It describes how estimates of GFCF of R&D can be derived using data from R&D surveys conducted as per the Frascati Manual, and describes desirable changes to the surveys that would enable better estimates to be made. It is incomplete in a number of areas, such as determining which R&D expenditures should be recorded as capital and those which should be expensed, and the derivation of price indices, capital stock and depreciation. It is intended that these matters will be addressed by a new OECD task force.

Chapters 4 and 5, which will deal with mineral exploration and evaluation, and entertainment, literary or artistic orginals, are yet to be drafted.

Delegates are asked to provide any comments on the text: disagreements with recommendations, omissions, lack of clarity, layout, etc.

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HANDBOOK ON DERIVING CAPITAL MEASURES OF INTELLECTUAL PROPERTY

(SOFTWARE AND R&D COMPONENTS)

[N.B. The extracts from the 1993 SNA Rev.1 in this draft are still at the draft stage.]

1. General approach to measuring capital of intellectual property products

1.1 Introduction

1. The 1993 SNA Rev.1 describes five categories of intellectual property assets:

   a. research and development;

   b. mineral exploration and evaluation;

   c. computer software and databases;

   d. entertainment, literary or artistic originals; and

   e. other intellectual products.

2. 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 varies considerably, too. Nevertheless, the same general principles apply for estimating their gross fixed capital formation (GFCF).

1.2 Intellectual property assets and gross fixed capital formation

3. The definition of an asset is given in paragraph 3.29 of the 1993 SNA Rev.1 as follows

4. 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 give up their economic ownership by issuing licences. 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, and largely determines whether expenditures on intellectual property products should be recorded as capital formation or intermediate consumption.

5. Fixed assets are produced assets that are used by their final users in production. It follows from the definition of an asset, given above, that fixed assets are to be used in production for more than a year. There are two exclusions. The first is the exclusion of products, with the exception of dwellings, acquired by households to provide services for themselves because the production of household services is outside the production boundary. Thus, intellectual property products, such as computer software, acquired by a household for the provision of services for itself is not regarded as gross fixed capital formation (GFCF). The second exclusion is a pragmatic one rather than a conceptual one, and concerns small tools. Paragraph 10.32 of the 1993 SNA Rev. 1 describes the exclusion as such

> 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.

6. It can be argued that this exclusion could be applied to intellectual products if they are sufficiently inexpensive, are of minor importance in total and there is difficulty in obtaining sufficiently accurate data. But given the ways estimates of GFCF of intellectual products are derived in practice, there is little or no occasion to make this exclusion.

7. One of the difficulties to be overcome in measuring GFCF of intellectual products is distinguishing between expenditures of a capital nature and intermediate consumption. There are three particular cases that cause most of the difficulties: maintenance and repairs; licences to use; and licences to reproduce.

1.2.1 Maintenance and repairs

8. The SNA defines ordinary, regular, maintenance and repairs as intermediate consumption, 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. Those intellectual products that are knowledge-based, such as R&D, software and mineral exploration, are not subject to wear and tear, or any other form of physical deterioration[1], but they can be subject to amendment. In principle, any amendments that improve the performance of the asset or extend its expected service life should be recorded as GFCF. But paragraphs 10.42-10.44 of the 1993 SNA Rev.1 make it clear that it is not so straightforward to

[1] Intellectual products are also subject to obsolescence which leads to their consumption of fixed capital (i.e. depreciation) and decline in value.

discriminate between intermediate consumption and GFCF. Factors such as the magnitude of an improvement and whether it is has been planned need to be taken into account. Substantial, planned improvements should be recorded as GFCF, while minor, unplanned improvements are better recorded as intermediate consumption.

1.2.2 Licences to use and reproduce

9. Under what circumstances expenditures on licences to use and reproduce should be recorded as GFCF is discussed in paragraph 10.97 of the 1993 SNA Rev. 1, and it is reproduced here.

10. Some intellectual property products 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. A copy sold outright may be treated as a fixed asset if it satisfies the necessary condition that 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 the licence is 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 a licence to use which is purchased with regular payments over a multi-year contract is judged to meet the conditions of capital formation then it should be regarded as the acquisition of an asset under a financial lease. 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 under an operating lease. 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.

1.3 Summary of different approaches to estimating GFCF of intellectual products and pertinent issues

1.3.1 Purchased assets

11. Fixed assets can be acquired either by purchasing them or producing them on own account. If they are purchased, estimates of gross fixed capital formation (GFCF) can be obtained either by surveying businesses and government to ask for details of their expenditures (demand-side approach), or they can be obtained by estimating the supply of capital products (as output less exports plus imports less intermediate and final consumption less changes in inventories) and allocating it to different users (supply-side approach). The principal advantages of the demand-side approach are that it is a direct measure and provides estimates by sector or industry of activity. Its principal disadvantage is that it often leads to underestimates because respondents do not identify all their expenditures of a capital nature that correspond to the scope of the SNA. The principal advantage of the supply-side approach is that the major components of supply (output and imports less exports) are comparatively well measured at a detailed level of product. The principal disadvantages are that it is valued at basic prices, not purchasers' prices, and it does not provide estimates by 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. While it is not possible to use exactly the same process for own-account capital formation, it is possible, at least in principle, to mimic it.

1.3.2 Assets produced on own account

12. The 1993 SNA Rev.1 recommends (paragraphs 6.119-120) 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. Intellectual property products are generally unique and so they fail the condition of being sold in sufficient quantities to enable reliable market prices to be determined, and in practice the second best procedure is the only viable solution that can be applied on a macro scale. This implies that both demand- and supply-side approaches must value capital formation by summing the costs of production. Hence, the demand-side approach entails surveying businesses and government to obtain their estimates of the costs of producing their fixed assets. The same questions must be asked to get their estimates of output, and so the demand-side and supply-side approaches coincide.

13. Another way of getting "supply-side" estimates of own-account production and GFCF of intellectual capital products is to identify the number of people in those occupations that produce these products and how much time they spend doing so, and then multiply the quantum of labour input by wage rates and other labour costs, and the cost of all the overheads in undertaking such production. This gives an estimate of the total output of intellectual capital products from which an estimate of those produced for sale must be deducted. The resulting pseudo supply-side estimates can then be confronted with the demand-side estimates in a supply and use framework.

14. The "supply-side" estimation of own-account GFCF is, in effect, doing at a macro level what businesses are asked to do at the micro level in a survey or some other collection. So the two approaches can be considered to be micro and macro methods of summing costs to estimate GFCF, rather than supply- and demand-side methods.

1.3.3 Using business records

15. For some asset types, such as computer software[2], 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 less expenditure on experimental development than recommended by the SNA. In any case, businesses have a strong general tendency to minimise their recording of capital expenditures on intellectual products, particularly those produced on own account, to such an extent their estimates are useless for national accounts purposes. This is due to a number of factors, including a desire to be prudent and cautious as well as a desire to minimise tax payments by depreciating assets as quickly as possible. Hence, the use of business records to estimate the GFCF of intellectual products is not recommended.

1.3.4 Degree of product detail

16. The GFCF of intellectual capital products needs to be estimated for at least the first four broad category headings listed above. However, at least 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

[2] See annex 1 for details of the findings of the OECD software task force.

only the estimation of GFCF in current prices, but also 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 indexes 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 indexes). 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.

17. As already noted, the 1993 SNA Rev.1 has separate sub-categories for software and databases, but it is highly recommended that software be decomposed into packaged software, customised software and own-account software, at least for estimation purposes. The components of entertainment, literary or artistic originals are quite heterogeneous and lend themselves to separate estimation.

1.3.5 Time of recording

18. As explained in the 1993 SNA Rev. 1 (paragraphs 10.51-10.53), 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 as work-in-progress. Assets such as software that can be produced for sale can be either produced under contract or produced speculatively, with no particular purchaser in mind. When an asset is developed under a contract of sale the producer records work-in-progress until a payment is made, at which time a sale by the producer and the acquisition of an asset by the purchaser are recorded. If it is a stage payment then it is recorded as the purchase of part of a fixed asset or as a trade advance if the value of the stage payment exceeds the value of the work put in place. If the asset is produced on a speculative basis then it is recorded in the inventory of the producer until it is sold. In either case, the asset produced for sale that meets the definition of a fixed asset when acquired by the final user can be expected to be recorded as GFCF by the final user and be reported as such in capital expenditure surveys. Assets produced for own use should be recorded as GFCF as they are produced.

1.3.6 Unsuccessful developments

19. The SNA describes two different ways of dealing with unsuccessful developments. The general approach is to record the value of the asset either as work-in-progress or GFCF in the usual way whilst the development is going on, and then write it off when the project is abandoned (in the other changes in the volume of assets account, paragraph 12.60, 1993 SNA Rev. 1). This is consistent with business accounting procedures.

20. The general approach is inappropriate at the macro level when the production of a type of asset is inherently high risk and the values of the assets created are measured by summing costs. Mineral exploration and R&D are high risk activities, and those that undertake them expect that the benefits obtained from the few successes will more than compensate for the many failures. If only the costs of successful activities were used to value the assets produced, there would be a great understatement of GFCF and the value of assets on the balance sheet. 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 it happening. Furthermore, software developments are notorious for cost overruns and failure to meet all specifications. It seems reasonable to assume that units take these risks into account when they embark on software development, and, accordingly, their expectations of the benefits that the software will provide must exceed not only the anticipated costs but also an allowance for failures and cost overruns by a substantial margin. In these circumstances, it appears unlikely that total own-account GFCF of intellectual

[3] Capital stock, consumption of fixed capital and capital services

products would be overestimated by summing costs of both successful and unsuccessful development projects.

1.3.7 Spillovers

21. 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 10.98 of the 1993 SNA Rev.1 has this to say on the matter.

> 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 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.

1.4 Demand-side approach

22. Because of the quite different nature of the different categories of intellectual products it is not sensible to prescribe a generic survey form with a list of questions that could be asked of enterprises to obtain the various estimates of GFCF. But 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.

23. The scope of a survey should be all the units – private and public enterprises, government and NPISH – undertaking the GFCF of the particular category of intellectual asset. For software this should be the whole economy, but for other types of intellectual products the scope could be much narrower. 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. If the collection of intellectual product GFCF is part of an economy-wide survey then the questions should be tailored to particular industries to reflect the various scopes of different intellectual products.

24. The survey should distinguish between purchases of intellectual property products for own final use and the unit's estimates of the costs of producing intellectual property products for its own final use. It is imperative 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.

1.4.1 Purchases of intellectual property products

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

a. Outright purchases of complete products, such as a piece of software 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 that satisfy the asset criteria, such licences to use software, exhibit movies and use the output of R&D, and

d. Payments for licences to reproduce that satisfy the asset criteria, such as licences to reproduce software and artistic originals.

1.4.2 Own-account production of intellectual property products

1.4.2.1 Valuation concepts

26. The SNA recommends that 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 (paragraphs 6.119 and 6.120). If this is not possible, which is nearly always the case, then the basic price should be estimated by summing the costs of production, including the user cost of fixed assets.

27. Paragraph 6.119 of the 1993 SNA rev. 1 defines the valuation of output for own use as follows:

> 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. In the case of agricultural produce, for example, this does not necessarily equate to the prices in the local market where transportation costs and possibly wholesale margins may be included. The nearest equivalent price is likely to be the so-called "farm gate" price; that is, the price that the grower could receive by selling the produce to a purchaser who comes to the farm to collect the produce.

1.4.2.2 Costs to be included in own-account GFCF

28. Paragraph 6.120 of the 1993 SNA Rev. 1 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 return to fixed capital;
>
> v. Rent on land used in the production, if any; and
>
> vi. Other taxes (less subsidies) on production
>
> 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*.

29. Note that a return to fixed capital, item (iv), is only included when summing the costs of non-market producers.

30. Costs of developing in-house intellectual products whether for internal use or for which the unit intends to sell licences-to-use or reproduce should be included. It requires the calculation of total labour costs and other costs as follows:

Total labour costs:

a. The number of in-house staff involved in the development of the intellectual property asset;

b. Estimates of average percentage of time spent by in-house staff on intellectual property asset development, excluding maintenance and commercial tasks but including time spent on R&D;

c. Average compensation of staff engaged in asset development, including wages, salaries, bonuses, employer social contributions and other special benefits.

Other costs:

d. Overheads associated with employing the staff engaged on asset development[*], includes management costs, training, personnel management, office requisites, electricity, rent, etc. and the use of fixed assets owned by the enterprise;

e. Any other intermediate consumption associated with producing the asset;

f. Taxes associated with the cost of producing the asset, such as payroll taxes[*];

[*]In proportion to that spent on asset development.

31. While the cost of the capital services provided by assets used in any own-account production process should be included in the value of own-account production, the cost of the assets themselves should not be. Unfortunately, the boundary between "intermediate" and "asset" characteristics is sometimes blurred. This is partly a consequence of recording own-account production in its stages as and when it is produced. The general principles are that the purchased product should be recorded as:

(i) intermediate consumption if it is expected to be used up in less than a year;

(ii) intermediate consumption if is expected to be completely, or almost completely, embodied in the own-account production of a specific intellectual property product; and

(iii) as the acquisition of a fixed asset if it is expected to provide capital services for over a year in the production of a number of different products.

32. In case (ii), the acquired product in effect becomes a part of the new original being produced on own-account. For example, if a piece of software is acquired for the sole purpose of creating an enhanced

own-account software original then its acquisition should be recorded as intermediate consumption. Recording its acquisition as GFCF would lead to double counting if the cost of capital services provided by it were included in the measurement of GFCF of the own-account software original.

33. The same argument applies to products produced on own account that are subsequently embodied in a single new product. For example, suppose in the staged production of own-account software, there is an additional R&D stage. If the R&D output is to be used exclusively, or almost exclusively, in the production of a single, software original then the costs of undertaking the R&D should be included in the costs of producing the software original, and there should be no GFCF of an R&D asset. If, however, the R&D output is expected to be used in the development of other software originals for a year or more 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.

34. As a consequence, in principle, the costs of R&D should be recorded: as labour and overhead costs if the R&D is undertaken on own-account and completely, or almost completely, used up in producing a particular software original; in intermediate consumption if purchased and completely, or almost completely, used up in producing a particular software original; or in the user cost of fixed assets if the R&D is recognised as a fixed asset. In practice, this delineation would be too much to ask of many respondents, and so by convention it is recommended that the last category be ignored. Hence, respondents should be asked to include:

(i) the time spent on R&D in item (b), as shown; and

(ii) expenditures on the creation of the asset that have been expensed by the unit in intermediate consumption, item (e).

35. The inclusion of the costs of producing products that are then used up in the production of the final product raises the issue of double counting if the costs of producing the intermediate products are also recorded as GFCF elsewhere. This problem is likely to be most acute with respect to software and R&D, and is addressed in the R&D chapter of the handbook.

36. There several advantages in asking the respondent for estimates of each of the items to be included when summing costs. First, it encourages and supports the respondent in costing all the required items. Second, 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 fell 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.

37. 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 intellectual property asset. 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 intellectual property products.

38. 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 and the rent payable for the use of non-produced assets. When own assets are used these have to be imputed by estimating the cost of capital services (i.e. the consumption of fixed capital plus a return to capital). It is unrealistic to expect respondents to provide

reasonable estimates of the user cost of capital, and so it is recommended that this component of the costs of own account GFCF should be imputed by the 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 intellectual property product 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 intellectual property product 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.

39. Collecting detailed cost data for own-account GFCF of widespread intellectual property products, 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.

1.5 Supply-side approach

1.5.1 Purchases of intellectual property products

40. The underlying principle for estimating GFCF using a supply-side approach is simple. GFCF is calculated as:

Domestic supply + imports

minus

Exports, households' expenditure and exclusions to avoid double counting

41. Production on own account needs to be excluded from domestic supply. Both it 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.

42. Double counting occurs when one type of fixed asset is incorporated in the estimates of GFCF of another type, and then separately recorded as GFCF in its own right. One example where this can happen is pre-packaged software included with the sale of computer hardware. Another example, already discussed, is when R&D expenditures are included in expenditures on software and then again in their own right. Various strategies are available to avoid these pitfalls and are discussed elsewhere in the handbook.

1.5.2 Own-account production of intellectual property products

43. As already discussed, the demand and supply approaches for own account production of assets cannot be distinguished but there is a macro approach to estimating supply. It entails identifying the number of people in those occupations that produce the target intellectual property products and how much time they spend doing so, and then multiplying the quantum of labour input by wage rates and other labour costs, and the cost of all the overheads in undertaking such production. Naturally, the types of costs to be included are exactly the same as at the micro level.

Total number of employees working on own-account production

x

Average remuneration

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

44. For harmonisation and measurement purposes, 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) should be used.

45. Average remuneration, or compensation of employees, should include wages and salaries, social contributions (including imputed social contributions) and any related compensations-in-kind.

46. Not all of the time of each employee within the identified categories will be spent on own-account production of the target asset. Some of their time will be spent working on other tasks. However, the time spent on training by employees in the identified categories should be included proportionately. The same applies to managerial, supervisory, training, administrative and any other "overheads". The proportions may be obtained by referring to information gleaned from survey data, or failing that using rules of thumb based on international experience.

47. There are several ways of estimating non-labour intermediate input costs. One is to refer to data from demand-side surveys and another is to refer to the activity data of units specialising in the production of the target asset.

48. 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 obtained from the demand-side surveys or from the activity data of units specialising in the production of the target asset. The first option is probably the best in the case of R&D, while the second is the probably the best for software.

49. Care needs to be taken to avoid double counting. First, production of the target asset for outright sale has to be excluded. How this is to be achieved varies from asset to asset. For example, in the case of software it is desirable to include the own-account production of software originals that are to be held by their developers and leased to users, but it is desirable to exclude the production of custom-made software. Second, it is necessary to avoid double counting the production of an asset that is incorporated in the GFCF of another asset.

1.6 Prices and volumes

1.6.1 General methodology when price data are available

50. The principles of compiling price indexes when products are sold on the market and price data are available are well understood. An overview is given section B of chapter 16 of the 1993 SNA Rev.1

and more thorough explanations are given in the Producer Price Index Manual[4] and the OECD's *Handbook on Hedonic Indexes and Quality Adjustments in Price Indexes* by Jack Triplett.

51. Here we give a brief introduction to the two prevailing methods used in measuring price changes: matched-model and hedonic pricing. Hedonic pricing is based on regression techniques and 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. However, 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.

1.6.2 Matched-model method

52. 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.

53. 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:

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

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

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

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

54. 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

[4] P*roducer Price Index Manual: Theory and Practice* (Washington: International Monetary Fund). http://www.imf.org/np/sta/tegppi/index.htm.). A further manual on export and import price indices is in draft in 2007 and due for publication in ????? (Available on the IMF web site: http://www.imf.org/external/np/sta/tegeipi/index.htm).

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 by accommodating the substitution effect.

55. 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.

1.6.3 Hedonic pricing

56. The technique of hedonic pricing assumes, in principle, that each product is made up of a multitude of definable characteristics, that for each characteristic a price can be estimated and that 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).

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

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

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.

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

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*.

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

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.

60. 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.

61. 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) $g_{i,t-1}^{t} = \dfrac{\hat{p}_{it}}{\hat{p}_{i,t-1}}$,

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

62. 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*.

63. 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.

64. A comparison of price index studies in computer software shows that hedonic price indexes 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 percent using hedonic pricing and of 4.4 percent using the matched-model method.

1.6.4 General method for products when price data are unavailable

65. A feature of intellectual property products is that they are commonly produced on own account, and no price data are observable. For products not sold on the market, the 1993 SNA Rev.1 provides the following advice in paragraph 16.104:

> 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.

66. The other two methods referred to in the paragraph 16.104 apply to the production of individual and collective services by non-market producers, and do not generally apply to the production of intellectual property products.

67. The possibilities for deriving pseudo output price indexes depend on whether suitable data are available for similar products or comparable production processes. When no such data are available there is little option but to compile input price indexes.

1.7 Capital measures

68. The capital measures referred to in the 1993 SNA Rev.1 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 19. Methods for estimating GFCF are discussed elsewhere in this handbook and methods for estimating the other three measures is the subject of the 2008 edition of the OECD manual *Measuring Capital*.

69. 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. 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. 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. 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 attention. There are several ways of obtaining estimates of service lives, they include: surveying users, surveying suppliers and consulting expertsSoftware

2. Software and databases

2.1 Changes and clarifications made in the 1993 SNA Rev. 1 concerning software and databases

70. Of the three new fixed asset categories introduced in the *System of National Accounts, 1993* (1993 SNA), by far and away the one with greatest impact on the magnitude of GDP in most countries was software (including databases). Most OECD countries had adopted the new standard by the year 2000, but it was not long after before it became apparent that country estimates of software gross fixed capital formation (GFCF) varied considerably not only in their size relative to GDP, but also in the growth rates of the volume estimates.

71. In October 2001 an OECD Task Force was set up to address the issue, and one of its first actions was to conduct a survey of member countries. The survey had several aims:

a. quantify the differences between estimates,

b. identify what the conceptual treatments were in countries and the rationale for them,

c. determine the different methods being used to quantify the various software flows (GFCF, trade in software, etc.) and what might constitute best practice, and

d. determine how countries compiled price indexes for deflating software and what might constitute best practice.

72. The OECD Task Force made a large number of recommendations covering the definition of software, the scope of software that should be recorded as GFCF, the treatment of originals and copies and how licences-to-use and licences-to-reproduce software should be dealt with, how to differentiate between

GFCF and maintenance, how to estimate the value of own-account GFCF of software and the derivation of appropriate price indexes to derive volume estimates of software GFCF.

73. In the course of its work the OECD Task Force found that some of the recommendations made in the 1993 SNA either required clarification or review, and so once the UNSC had decided that a revision of the SNA should be undertaken they were brought to the attention of the newly formed Canberra II Group. The Canberra II Group subsequently proposed to the ISWGNA that two issues concerning software and databases should be included in the SNA review, namely *Originals and copies* and *Databases*. These were then formally adopted by the UNSC as issues to be considered in the SNA review and the issue descriptions are as follows:

Originals and copies

Following the 1993 SNA's introduction of computer software as capital formation, it became more evident that the SNA does not provide guidance on the treatment of originals and copies as distinct products. Should expenditures on originals and copies both be recorded as expenditure (on new goods) on the basis that originals are distinct from copies, or should originals be considered as being analogous to a 'stock' of copies, and so expenditure on a copy partly (or mostly) reflects a sale of an existing good? How should the transactions in copies be recorded?

Databases

The 1993 SNA recommends that large databases should be capitalized. Should the SNA provide a clearer definition of databases to be capitalized covering characteristics such as size and marketability of the data as well as the database itself, or should all databases be capitalized? How should the value of a database be determined?

74. The outcomes of the SNA review of these two issues is described in detail in the relevant sections of this handbook, but a few key recommendations of the 1993 SNA Rev.1 deserve particular attention:

a. Originals and copies are recognised as independent fixed assets providing they meet the general definition of an asset;

b. If a licence to use a copy (e.g. software) is purchased with annual payments over a multi-year contract, and if the licencee assumes all the risks and rewards associated with economic ownership of the copy, this may be regarded as the acquisition of an asset under a financial lease;

c. If annual payments are made for a licence to use a copy without a long-term contract, the payments are treated as payments for a service under an operating lease;

d. If the terms under which a unit is given permission to reproduce copies resemble an operating lease, then the payments to the holder of the original are recorded as payments for a service. If the holder of the original divests itself of part or all of the responsibility to issue and service copies under licences to use, this constitutes the sale of part or all of the asset represented by the original;

e. All databases holding data with a useful life of more than one year are fixed assets;

f. In the absence of a more satisfactory alternative, the value of a database created on own account should be valued on a sum of cost basis, with the DBMS recorded separately as software. The costs of acquiring the data are not included in the value of the database; and

g. Databases for sale should be valued at their market price, which includes the value of the information content.

75. Recommendations (a) and (b) are consistent with the OECD Task Force's interpretation of the 1993 SNA, but recommendation (c) marks a change. The Task Force recommended that if the licensee has the intention to renew an annual licence-to-use then the expenditures should be recorded as GFCF, but the 1993 SNA Rev.1 says that the contract must be for more than a year for GFCF to occur. Recommendation (d) is a change to the SNA, because it explicitly allows for treating the sale of a licence-to-reproduce as the sale of the whole original, or part of it. While for databases, the recommendations mark a complete revamp in the 1993 SNA Rev. 1. With the exception of recommendation (c), all of these changes and clarifications are consistent with the recommendations made by the Canberra II Group (Ahmad 2004a, 2005 and 2004b).

76. The guidelines provided in this handbook largely reflect the recommendations made by the OECD Task Force in its report to OECD Working Party on National Accounts in 2002 (OECD 2002). Most, but not all, of the differences arise from SNA recommendations (c) to (g), above.

2.2 Software

2.2.1 Introduction

77. Software GFCF accounts for more than 1% of GDP in many OECD countries and its share is growing. It is also of special interest because investment in software and other ITC products have been found to be significant contributors to growth in output (Colecchia 2001). This makes it very important that software GFCF and related capital measures should be measured accurately and in an internationally comparable way.

78. In its survey of OECD countries in 2001-2, the OECD Task Force found a considerable variation in all aspects of the measurement of software: intermediate consumption, software GFCF, volume measures, consumption of fixed capital and capital stock. This part of the handbook focuses on the measurement of software GFCF.

79. Software GFCF generally takes one of three forms: the acquisition of licences to use software copies, the acquisition of custom-made software from a software development enterprise and the own-account creation of software originals. Separate estimates are commonly derived for each of the three, but some countries choose to obtain an aggregate of the first two. There are two ways of deriving GFCF estimates. The first is by surveying businesses and government and asking them to report their expenditures. The second is for the NSO to derive estimates at the macro-level by estimating the supply of software.

2.2.2 Definition and scope

80. In the 1993 SNA Rev. 1 computer software and databases are recognised as two sub-categories of the category "computer software and databases", and the SNA defines computer software as follows:

> 10.106 Computer software consists of computer programs, program descriptions and supporting materials for both systems and applications software. Gross fixed capital formation in computer software includes both the initial development and subsequent extensions of software as well as acquisition of copies that are classified as assets.

> 10.107 The development of computer software represents the development of an intellectual property product. It is treated as an asset if it is to be used in production by its developer for more than one year. The software may be intended only for own use or may be intended for sale by means of copies. If copies of the software are sold on the market, their treatment follows the principles described in paragraph 10.97. Software purchased on the market is valued at purchasers' prices, while software developed in-house is valued at its estimated basic price, or at its costs of production if it is not possible to estimate the basic price.

81. The act of creating an original piece of software leads to the acquisition of a fixed asset if the original satisfies the conditions of an asset, i.e. it is expected to be a source of economic benefits to the owner over a period of years. These benefits derive from allowing other units to use the content of the original by means of issuing licences for a fee and/or the owner using the original directly.

2.2.2.1 Licences to use and reproduce

82. Licences may be issued for use by one or a specified number of users, or may be issued with permission to reproduce copies. These are referred to as "licences-to-use" and "licences-to-reproduce" respectively.

83. It is useful to distinguish between the sub-categories "original software" and reproduced software, otherwise known as "software copies", in more detail. This should help to avoid mistakes made in the past by some national accountants in not valuing "originals" as fixed assets on the mistaken grounds that doing so resulted in double-counting.

a. Original software: Original software should be considered as machines used in the process of producing other products, and as such are considered as investment. Originals can be produced on own-account (they are then called an "own-account original software") or can be bought ("purchased original software"). This includes games' originals. Games software is treated in the same way as conventional software because of the similar production processes (and producers) for games and conventional software. There are two types of originals:

b. Originals for reproduction: Original software intended to be reproduced for sale or lease, which are generally produced by specialist software companies.

c. Other originals: Software intended to be used in the process of production of other products, and generally produced on own-account or acquired as custom-made software from a specialist software company.

d. Software copies: Software copies are reproductions of original software. They include software giving users the rights, or licence, to use, and software that gives the rights, or licences, to reproduce:

e. Licences-to-use: They are mostly marketed, and are referred to by a variety of names, including "pre-packaged software" "packaged software" or "off-the-shelf software". In general, they legally provide a licence to use the software. This category includes software copies for final use and software copies for bundling in hardware, other equipment or other software. This category also covers "multiple copy" licences-to-use and software "rented" for use, for which payments often take the form of "royalties". It excludes licences that permit copies to be made for sale.

f. Licences-to-reproduce: Licences-to-reproduce permit companies to make further software copies for subsequent sale. These copies can be sold via licences-to-use or as part of a

bundle, whether the bundled software is included separately or embedded directly onto hardware. Often, licences-to-reproduce are paid for as royalties.

84. The acquisition of a licence-to-use or a licence-to-reproduce may be recorded as either GFCF or intermediate input, depending on the circumstances – see 1.2.2. The acquisition of a licence to use is recorded as GFCF if the licence is for more than one year and the licensee assumes all the risks and rewards of ownership. A licence to reproduce is only an asset if the holder of the original divests itself of part, or all, of the asset represented by the original. This occurs usually when the holder of the original sells its rights to issue and service copies in a country or group of countries.

2.2.2.2 Bundled/embedded software

85. Bundling/embedding of software occurs when software copies are purchased or produced with the explicit intent of on-selling as part of, or within, another product – be it office machinery, other machinery, other software, etc. Bundled/embedded software can be created in one of two ways. First, when copies are purchased from a software producer and subsequently bundled and sold on to another consumer. Second, when a licence-to-reproduce has been acquired and (the value of) the copied software is embedded in another product which is then sold on. It is recommended to treat any software (including outsourced software) purchased for bundling or embedding into products to be sold on as intermediate consumption.

86. Bundled software can be invoiced separately to the customer, in which case the purchase of software can be treated like any other purchase of software by the final-use customer. It may, however, be included in the purchaser's price of the bundle in which case the software is included within the value of the bundled product, normally computers. The value of total investment is not affected by the difference in treatment.

2.2.2.3 Maintenance and repairs

87. According to the 1993 SNA Rev. 1 ordinary, regular maintenance and repairs of a fixed asset used in production should be recorded as intermediate consumption 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 should be recorded as GFCF. However, the SNA states also that the distinction between maintenance and repairs and gross fixed capital formation is not clear-cut (paragraph 10.42).

88. What makes the consideration of maintenance and repairs particularly problematic for software is that it is difficult to describe a software repair that is not an addition to an existing software system. For example, there are few equivalents to the replacement of a part, say, in conventional plant and machinery.

89. A repair to software systems involves a change in the configuration or code of any program, but not the replacement of a part, or repairing something that no longer works. In this way software repairs may largely be seen as improvements. Repairing "faults" introduced by bugs say, may be one example where an analogy can be made with replacements of defective parts. But other repairs or modifications, for example modifying software to provide protection from a bug, can be seen as analogous to giving a car a paint-job to protect it from unusually, but anticipated, wet weather.

90. Conventional maintenance (distinct from repairs) such as systems' checking, does not change the characteristics of the software and so is clearly intermediate consumption. Changes to software that extend its service life should be generally recorded as GFCF. For example, modifications to software to deal with the Y2K problem were an upgrade (involving changes to the code to record years using four digits rather than two), which extended the expected service lives of software. Modifications to software so that they can operate on a new operating system are part of the cost of adopting the latter and should be recorded as

GFCF. However, frequent changes to the software to accommodate changes to the format of input data are more in the way of intermediate consumption.

Note: the OECD Task Force recommended that Y2K expenditures should be treated as intermediate consumption. The change was agreed to at the Canberra II Group meeting in April 2007. But what about changes as a result of the introduction of a new operating system?

2.2.2.4 Upgrades and outright sales of original software

91. When a software original is updated or upgraded, for example the update of Word 5 to Word 6, GFCF occurs. If possible the value of the update, or upgrade, should be determined as the present value of the expected increase in income it will provide. If it is not possible to measure this, then the GFCF of the update, or upgrade, should be measured by summing the costs incurred in updating, or upgrading, the software original. This does not include the cost of creating the earlier software original (e.g. Word 5). The value of updated or upgrade software is equal to the GFCF plus the depreciated value of the software before the upgrade.

Own-account software updates or upgrades should not include the value of the "original" version, and instead should only reflect the increase in value. The value of the upgraded software on the balance sheet comprises the value of the upgrade plus the depreciated value of the original version.

92. When a software original is sold outright the sale is recorded at the value of the actual market transaction. Most software originals are either produced for own use or to be licenced to others to use, and unless it is possible to determine with reasonable certainty that the software original was produced with the intention of sale the transaction should be treated in the same way as sales of existing assets as specified in paragraph 10.35 of the 1993 SNA Rev. 1. In which case gross fixed capital formation of the seller of the original is negative and that of the new owner is positive.

Sales of "originals" should be treated as sales of pre-existing assets as specified in paragraph 10.35 of the 1993 Rev. 1, unless it can be determined that they were produced for sale.

2.2.3 Measurement of GFCF

2.2.3.1 Demand-side approach

93. The demand-side approach for software follows the generic demand-side approach outlined in section 1.4. This section covers things that are peculiar to software.

94. Software is ubiquitous and so the scope of a demand-side survey is the entire economy. While nearly all units purchase software a great many of them also undertake their own-account production - both components are substantial.

2.2.3.1.1 Purchased software

95. Software purchases come in a number of different forms, but it is necessary to distinguish between pre-packaged, or ready-made, software and customised software for a number of reasons that will become clear. Units may or may not record either type of software expenditure as capital formation, but under-reporting of capital formation – from an SNA point of view – is particularly prevalent for software services. Therefore, units should be requested to include all their expenditures made on software related services, including expenditures made on original software (on which the company retains all property

rights, and from which the company may make copies to be sold) but excluding all expenditures made on software to be re-sold, whether embedded in other software or in hardware.

96. External expenditures can be categorised as follows:

a. Purchases of pre-packaged software for own use recorded as capital expenditures by the enterprise. They should include single and multiple licences-to-use copies that meet the definition of an asset, i.e. they should include expenditures on software for which the licence agreement is for more than one year, but not for a year or less.

b. Payments and royalties for own use of pre-packaged software that are expensed by the enterprise. This sub-category includes all payments, including rentals and royalties for licences-to-use, for the use of pre-packaged software (including system software) inside the enterprise that have been expensed by the enterprise, excluding expenditures on software for which the licence agreement is for no more than one year. All payments made for licences and royalties to reproduce copies to be sold as such or embedded in hardware or a software original for which the company does not have all property rights should be excluded.

c. Payments for services related to the development of customised software for own use. They should comprise all external costs of developing customised software for own use of the enterprise, including payments for services such as R&D, analysis, design and programming or modifications to packaged software. A software original developed with a view to selling copies is considered here as "own use". Payments for outside consultants participating in the development of in-house software are to be included whereas payments related to development of custom software on which the company will not retain exclusive property rights should be excluded. This sub-category should not contain expenditures on software to be used for less than one year.

d. Purchases of all property rights of software originals. This sub-category covers the purchase of all ownership rights of a software original from another enterprise, whether by outright purchase or by the acquisition of a licence-to-reproduce.

e. Other software related expenditures for own use. They should exclude sub-contracted maintenance costs.

2.2.3.1.2 Own-account production of software

97. This category covers the costs of developing in-house software whether for internal use or for which the company intends to sell licences-to-use or reproduce. It includes internal costs of developing a software original for which the company retains all property rights and of which the unit will sell copies or embed copies in hardware or other material.

98. Own-account software production is usually undertaken in several stages. This production process can be outlined in the following way:

1. Feasibility analysis;
2. Functional analysis;
3. Detailed analysis;
4. Programming;
5. Tests;
6. Documentation;

7. Training; and
8. Maintenance.

99. Only the costs incurred in stages 2-6 should be summed to estimate the value of the GFCF of the creation of the software. The costs of the other three stages (feasibility analysis, training and maintenance) do not contribute to the basic price of the asset, and should be expensed. Note, however, that when summing costs to measure GFCF the costs of general staff training should be included. It is only the training in the use of the particular software asset that should be excluded from its GFCF.

The value of own-account software GFCF should include the costs of all expenditures on stages 2-6, above.

100. The calculation of total labour costs and other costs within stages 2-6 should be derived as follows:

Total labour costs:

a. The number of in-house staff involved in the development of software;
b. Estimate of average percentage of time spent by in-house staff on software development, excluding maintenance and commercial tasks but including time spent on software R&D;
c. Average compensation of staff engaged in software development, including wages, salaries, bonuses, employer social contributions and other special benefits.
d. Other costs
e. Overheads associated with employing the staff engaged on software development*, includes management costs, training, personnel management, office requisites, electricity, rent, etc. and the use of fixed assets owned by the enterprise;
f. Any other intermediate consumption associated with producing the software, including the costs of software not recognised as a fixed asset;
g. Taxes associated with the cost of producing the software, such as payroll taxes*;

*In proportion to the spent on software development.

101. As noted in section 1.4.2.2, the costs of software R&D should be recorded: as labour and overhead costs if the R&D is undertaken on own-account and completely, or almost completely, used up in producing a particular software original; in intermediate consumption if purchased and completely, or almost completely, used up in producing a particular software original; or in the user cost of fixed assets if the R&D is recognised as a fixed asset. But in practice, this would be too much to ask of many respondents, and so an alternative strategy is proposed, namely to ask respondents to include:

(i) the time spent on software R&D in item (b), as shown;

(ii) software that has been expensed by the enterprise in intermediate consumption, item (e).

2.2.3.2 Supply-side approach

102. The main difficulty in applying the supply-side approach to software is to avoid the double-counting of some flows, including sub-contracts. The method is two-fold. For purchased software (including licences to use that qualify as assets) the commodity flow method, starting with sales statistics,

is used to derive a figure for purchased GFCF as a residual. For own-account software (absent by definition from sales statistics) the method is based on a macro-estimate of the cost of inputs.

2.2.3.2.1 Purchased software

General principles

103. The recommended commodity flow method for an estimate of gross fixed capital formation in purchased software is a multi-stage approach which can be outlined as follows.

Estimated total gross fixed capital formation of purchased software
equals
Value of domestic supply of software
plus
Imports
plus
Trade margins and taxes on domestic supply and imports
minus
Software embedded by hardware industry
minus
Sub-contracting flows between software companies
minus
Software purchases that do not qualify as GFCF
minus
Household consumption of games and other pre-packaged software
minus
Exports
minus
Maintenance expenditures

Step-by-step implementation

104. The departure point in the commodity flow method is sales. To be fully applicable, sales statistics should be available in a quite detailed classification. In a European context, a four-digit breakdown of the "2002 Statistical Classification of Products by Activity in the European Economic Community" (CPA-2002) is a minimum. If available sales data are classified by activity (main activity of the business), a preliminary step is necessary to reclassify it to obtain sales data of software products. When implementing a supply approach from industry sales data, all sales of software products should be taken into account, even if relevant businesses may produce and sell software products as a secondary activity. For example, manufacturing businesses may produce and sell software products as a secondary activity. This is more likely to be an important issue if the survey data relate to enterprises and there are establishments producing software products for sale that are included in enterprises allocated to industries other than computer services. Concordance tables which apply the principles described in section 2.3.1.1 to the relevant industry and commodity classifications to which software sales relate are given in Annex 2.

Step 1a: from industry data to product data

The references to industry codes below need to be amended to be consistent with ISIC Rev. 4.

105. If sales data originate from statistics based on business receipts classified by activity (main activity of the business), a preliminary step is necessary to reclassify the sales data to obtain sales data of *software products*. Indeed, the commodity flow approach is based on resources of the product, even if it is sold as a secondary activity. US experience (see the Task Force Report) shows that *Computer programming services* (US SIC 73.71) and *Software publishers* (US SIC 73.72) dominate domestic supply, as might be expected. US experience is that 73.71 is the predominant supplier of customised software and 73.72 is the predominant supplier of pre-packaged software.

106. This step should also include another important verification for the consistency of the method: sales data should include revenues classified by businesses as *royalties*.

Step 1b: starting with CPA data

107. The CPA-2002 distinguishes between software services at a fine level of detail. 72.21.1 *Packaged software products* and 72.22.1 *Software consultancy and other supply services n.e.c.,* which comprises sub-categories that mostly concern the provision of customised software.

Industry sales data can only be used if they are sufficiently detailed. When implementing a supply approach from industry sales data, all sales of software products should be taken into account, even if relevant businesses are not classified under the category "computer services".

Step 2: inclusion of imports to obtain total resources

108. For many countries imports are the major source of pre-packaged software, and it is useful at this point to consider how the importation occurs. The Australian Bureau of Statistics (ABS) identifies a three stage process (ABS 2006). The process begins with the production of an original piece of software in country A.

109. The second stage can take one of two forms:

a. the original is copied in A and exported in a 'boxed' format (i.e. disk(s), manuals and packaging) to country B, or

b. and becoming increasingly common, a copy is sent over the Internet or on a disk to country B. A wholesaler then makes as many copies as required.

110. The third stage involves the distribution of the software copies through licences-to-use. In the case of 2(a), this can occur directly between a distributor in country A and the final customer in country B, or it can occur indirectly through a distributor in country B. In some instances the third stage involves the export of software copies from a distributor in country B to customers in country C.

111. The case of 2(b) generally takes the form of the wholesaler in country B making payments to the software owner in country A for a licence-to-reproduce. The 1993 SNA Rev. 1 recommends that payments such as these should be treated as intermediate consumption if the licence has the appearance of an operating lease. However, the SNA also recommends that if the holder of the original divests itself of part or all of the responsibility to issue and service copies under licences to use, then this constitutes the sale of part, or all, of the asset represented by the original. In which case, the payment(s) by the wholesaler represent GFCF.

112. Measuring international trade in software is not easy, and it is likely that Balance of Payments data will be insufficiently detailed (see section 4) and will have to be supplemented by data from other sources. For example, royalties and licence fees in the BOP are generally not distinguished by type of product. Statistics Canada uses its annual survey on software development and computer services to derive figures for exports of computer services and exports of royalties and licence fees. A significant amount of imported royalties and licence fees are added to goods and services data to obtain an estimate of software imports.

Canada: imports and exports of software, 1998

	Imports	Exports
Merchandise trade	1003	107
Software services	314	731
Royalties and licence fees	685	1311
Total	2002	2150

In the supply approach, imports and exports definitions have to be consistent with definitions of domestic supply. Both should include royalty payments and licence fees.

Step 3: inclusion of trade margins and taxes

113. Sales data are valued at basic prices and imports at either their f.o.b. or c.i.f. prices. To be comparable with estimates of GFCF they need to be expressed at purchasers' prices. This is achieved by adding trade margins and taxes *less* subsidies on products (including VAT for household consumption). Only after this adjustment can the commodity-flow method (on which the supply-side approach is based) function properly. For example, in Canada, trade margins and taxes on resources (sales and imports) account for 17% of the value of total supply of software products.

Step 4: avoiding double counting and exclusion of intermediate consumption

Exclusion of intermediate consumption

114. Refer to the concordance tables in Annex 2 to see the exclusions of intermediate consumption.

115. As described earlier, the 1993 SNA Rev.1 has introduced two significant changes regarding licences to use software. First, the acquisition of a licence-to-reproduce may be GFCF, whereas before it was always intermediate consumption. Second, the acquisition of a licence-to-use a software copy can only be GFCF if the contract is for more than a year. The concordance tables in Annex 2 reflect these changes and strategies need to be developed to take account of them.

116. There are three types of double counting to be avoided: sub-contracting, embedding of pre-packaged software and own-account production.

Exclusion of subcontracting

117. Because the domestic supply of software is obtained using output data there is an inherent risk of double counting. For example, software product sales corresponding to the main activity of US SIC 73.71 are to be classified as GFCF except for those corresponding to purchases by a non-final user of the software (see Annex 2). Let us assume that company U, the final user of the software, orders a software product from company A, a software consultancy company. The software will cost 100. Suppose A sub-contracts 25% of the costs of the software to company B, another software consultancy company. Then

total sales of software would be equal to 125, while the value of capitalisable software is 100. The 25 subcontracted to B by A is an intermediate consumption of A, and should not be capitalised.

118. Problems also arise for US SIC 73.72 "software publishers", for which the concordance table distinguishes three cases for which sales should not be considered as GFCF: (1) when the software product is purchased by a bundler to be included into hardware or some other equipment, (2) when the software product is purchased by another software company to be embedded in another reproduced software for resale, (3) when the software is purchased by final user households or exported.

Exclusion of pre-packaged software purchased by hardware and software bundlers

119. Pre-packaged software is bought by the hardware computer industry to be embedded in the hardware they sell. To the extent it cannot be excluded from estimates of GFCF of computer hardware, then it must be excluded from the estimates of software GFCF. If no data are available as to what proportion of pre-packaged software is included in hardware GFCF, the OECD Task Force suggested that it be assumed that it was 50%.

Exclusion of own-account production of software

120. Expenditures on software originals that are expected to be used repeatedly to produce copies for more than a year should be recorded as GFCF. In addition, the acquisition of software copies that meet the definition of an asset is also to be treated as GFCF. Hence, in such cases, both the own-account creation of the original and the acquisition of the copies should be recorded as GFCF. Customised software by its nature is not generally reproduced and so only the acquisition of an original is to be recorded as GFCF. This implies that double counting can only arise with respect to customised software. Hence, double counting can be avoided by excluding customised software production from the estimates of own-account GFCF.

In the supply approach, double-counting of investment can be avoided by (1)) by excluding flows corresponding to sub-contracts, (2) excluding 50% (if no specific data) of purchased pre-packaged software by the computer hardware industry, and (3) by excluding, in the macro-estimate of own-account production, costs of analysts and programmers corresponding to sales of custom computer programming services that have already been accounted for using the sales data.

Step 5: Maintenance

121. As explained earlier, maintenance is not GFCF. There is thus the need to exclude from sales data those sales corresponding to maintenance in order to derive GFCF.

122. Countries that have implemented the supply approach have excluded in-house maintenance costs, when building their macro-estimate of own account production. However, businesses also use external services to maintain and repair their software. There is thus also the need to estimate external costs of maintenance.

123. In the private study of the software industry used by the US BEA to estimate the "maintenance" part of in-house software analysts and programmers, maintenance is estimated at 38% of the working hours. BEA chose to use a prudent, rough estimate of 50%. But the Task Force concluded that this was a very high estimate to apply to sales data because maintenance is more characteristic of in-house programmers than of externalized services, an amount of 10 to 15% could be more realistic. It seems that a 1997 US survey showed that only 12.5% of expenditures on customised software have maintenance characteristics.

124. Regarding the European case, there is a special category for *systems maintenance services*, CPA 72.22.14. As recommended in the concordance table in CPA, these flows should be treated as intermediate consumption. The ratio of sales of 72.22.14 to total *software consultancy and other supply services n.e.c.* (CPA 72.22.1) could be used to obtain a better estimate the proportion of programmer time spent on maintenance than the 10 to 15% proposed above for SIC 73.71. However, evidence from the SBS pilot survey on the computer services industry suggests that the 10-15% figure is in the right ballpark.

In the supply approach, external costs of maintenance are to be excluded. In the US SIC classification, these costs could be estimated on the basis of 10 to 15% of external sales of SIC 73.71 or using a ratio derived from other sources. In the CPA classification, a special category is representative of these costs (72.22.14), and they can thus be estimated directly. These flows are to be treated as intermediate consumption.

The text and recommendation on maintenance are slightly modified versions of those appearing in the Task Force report. Given that software is not subject to deterioration, only obsolescence, is it too extreme to exclude all maintenance services? Note that CPA 72.22.14 includes modifications.

Step 6: Exclusion of household purchases and exports.

Exclusion of household purchase

125. An estimate should be made of household purchases using household budget surveys or other relevant statistics.

126. Games are an important part of software expenditures by households and need to be excluded if they are included in the supply estimates, above. The CPA software classifications appear to include them and so does US SIC 73.72. Households also buy non-games software. That part used by individuals acting as own account workers should be recorded as GFCF, but the rest should be excluded.

127. Data obtained from Australia and USA seem to converge to an amount of 4 to 5% of total supply being assigned to household consumption. It is not clear, however, if the data include games or not.

128. Canada has a similar figure with a methodological note stating that its figures exclude spending on games. France has a smaller amount (2.1%).

In the supply approach, consumption by households should be estimated through household budget surveys or other equivalent sources and excluded from sales (adjusted for trade margins and indirect taxes).

Exclusion of exports

129. A previous paragraph has already discussed issues regarding external flows.

Summary of recommendations for implementation the supply approach for purchased software

130. The following table summarises the different steps to derive software GFCF, including specific parameter settings.

Value of sales of capitalisable software services (SIC 73.71 + SIC 73.72; CPA 72.21+ 72.22), including royalties and licence fees, and games	A
Inclusion of imports (including royalties and licence fees and games)	B
Inclusion of trade margins and taxes on domestic supply and imports	C
Exclusion of software embedded by hardware industry (50% of purchases of pre-packaged software by hardware industry), treated as intermediate consumption	D
Exclusion of sub-contracting flows between "software companies"	E
Exclusion of household consumption of pre-packaged software and games if included above	F
Exclusion of exports (including royalties and licence fees and games)	G
Exclusion of maintenance (CPA 72.22.14, 10-15% of SIC 73.71)	H
Total GFCF in purchased software	A+B+C-D-E-F-G-H

131. It is very important to note that the total value for GFCF in software should be adjusted if software already capitalised by businesses is included in total GFCF independently from this process. This adjustment is described at the end of this section.

Introduction of new classifications

132. In 2006 revised industry and commodity classifications were introduced, namely the *International Standard Industrial Classification of All Economic Activities, Revision 4* (ISIC Rev. 4) and the *Central Product Classification, Version* 2 (CPC version 2). As a result, the concordances and transformations described above will have to be modified when these revised classifications are adopted by NSO's.

133. The major software sales are likely to come from ISIC Rev. 4 5820 ("Software Publishing") which relates to CPC version 2 code 83143 ("Software originals"), ISIC 6201 ("Computer programming activities") which relates to CPC 83141 ("IT design and development services for applications"), and ISIC 6202 ("Computer consultancy and computer facilities management") which relates to CPC 83142 ("IT design and development services for networks and systems"), CPC 83161 ("Network management services") and CPC 83162 ("Computer systems management services").

2.2.3.2.2 Own-account original software

General principles

134. The OECD Task Force found that the GFCF of own-account original software accounted for about a third of total software GFCF. This implies that it cannot be ignored and a reasonable amount of care should be taken in estimating it. In broad terms, own-account software GFCF can be estimated as follows:

Estimated value of own-account software production
equals
Labour costs of software personnel (i.e. compensation of employees)
plus
Non-labour costs of own-account software production
(intermediate consumption, administrative overheads.)
plus
User cost of fixed capital or gross operating surplus
minus
Costs linked to other activities
(maintenance, etc.)
minus
Costs linked to the production of original custom-made software and reproduction software to be sold

Explanations

135. To understand the estimation process used by individual countries at the macro level, the difference between *production of software personnel* and *own-account software production* needs to be clarified. Software production of software personnel refers to the total amount of software produced by all the software personnel, which includes both software to be used internally (own-account software) and software to be sold. Own-account software production refers to the total amount of software produced in-house by software personnel for internal use. It thus excludes the software production linked to software to be sold. It is important to note here that original software for reproduction (such as Windows for Microsoft) corresponds to software to be used internally. Only reproductions of Windows are sold, not the original.

136. Therefore, in order to estimate own-account software production carried out by software personnel, a "sales adjustment" needs to be made to exclude market activities (i.e. sale of original custom-made software and sale of reproductions). This adjustment allows that no double counting is recorded under the supply approach, because software sold has been already accounted for using sales data.

137. The production of own-account software is measured as the sum of production costs. These costs consist of compensation of employees, administrative overheads, intermediate inputs, indirect business taxes (e.g. payroll tax), user cost of capital, etc.

Labour costs

138. The labour compensation costs of software personnel can be measured by multiplying the number of the relevant labour force by their average compensation. Average compensation should be derived using the national accounts measure of compensation of employees. It is recommended that the number of software personnel should be broken down by group of economic activity, including the government sector, and particularly ISIC sub-division 62 ("Computer programming, consultancy and related activities").

139. The number of software personnel can be estimated either by direct business surveys or employment data by occupation, but most countries do the latter. The appropriate identification of software personnel is not straightforward, however. The OECD Task Force recommended that in the absence of direct survey data on the number of software personnel employment data by occupation should be used and limited to the number of computing services department managers and computing

professionals according to International Standard Classification of Occupations 1988 (ISCO-88), codes 213 (computing professionals), in the hope that the contribution of other occupation codes associated with computer programming was insignificant. The reason for this assumption was that there was a lack of information as to how much time other software personnel spent on software development and the belief that it was not substantial.

140. A more recent consultation of key firms and institutions in the software industry by the Office for National Statistics (ONS), United Kingdom, has found that a wider range of occupations should be considered. Although software professionals constitute the most important occupational group, significant contributions are also made by computing services managers (ISCO-88, code 1236), computer assistants (code 3121), computer equipment operators (code 3122) and data entry operators (code 4113). Since this study included discussions with important firms in the software industry, e.g. CISCO Systems and IBM UK, and the broadening of the scope was found by the ONS to increase estimates of own-account software GFCF by about 20%, the broadened scope is recommended.

141. As the multiplication of the number of software personnel by their average compensation provides their total compensation, adjustments have to be made to obtain the labour costs of own-account software production. This can be done by subtracting the labour compensation that is not linked to own-account software production from the total labour compensation of software personnel. These adjustments are made based on data on the working time of the labour force classified by industry of activity by ISCO code. In a first step, the working time of the software personnel that is spent on the production of original custom-made software and reproduction software that are to be sold should be excluded, leaving the working time for the production of own-account software and of originals for reproduction. A second adjustment has to be made for the working time of software personnel linked to other activities such as system repair, maintenance of computer systems, etc. This part of their working time has to be estimated and deducted from their total working time. The UK ONS survey found the following approximate percentages of time spent on software development by software personnel occupation group. The data are reported in terms of the UK Standard Occupational Classification, along with closest ISCO-88 equivalents. The respondents to the UK survey reported that about 70% of the time of software professionals (213) was spent on software development, but the UK decided to adopt 50%, in line with the recommendations of the report of 2002 OECD Task Force.

ISCO-88	UK SOC	Occupation	Proportion (%)
1236	1136	Information and communication technology managers	15
213	2131	IT strategy and planning professionals	35
213	2132	Software professionals	70 (50)
3121	3131	IT operations technicians	20
3122	3132	It user support technicians	15
4113	4136	Database assistants/clerks	5
213	5245	Computer engineers, installation and maintenance	5

142. The recommendations of the OECD Task Force were based on US experience. The US has adopted a 50% deduction rule for the time spent by software professionals on tasks other than software development. The 50% share originates from a 20-year old study on the share of software development and maintenance costs in 487 business organizations reported by Barry Boehm (Boehm 1981). The detailed shares are shown in the box. The categories that are classified as software investment are in bold italics.

Development	49 per cent
Maintenance	*43 per cent*
a) Emergency program fixes	6 per cent
b) Routine debugging	4 per cent
c) Accommodate changes to input data, files	8 per cent
d) ***Accommodate changes to hardware, operating systems***	***3 per cent***
e) Enhancements for users:	
New reports	***8 per cent***
Added data for existing reports	***6 per cent***
Other	7 per cent
f) Improve documentation	3 per cent
g) ***Improve code efficiency***	***2 per cent***
h) Other	8 per cent
Other	2 per cent

143. Although the result of the study shows that 62% of time spent is on investment, a 50% share was chosen to emphasize the approximate nature of the estimate. The 50% share is also based on anecdotal evidence that the share has diminished with the growing importance of personal computer and prepackaged software. So far, no recent study on the matter has been identified. The 50% deduction rule is also adopted in Canada, France and Italy.

144. Statistics Netherlands conducted an analysis in order to compare the result of the labour costs of own-account software production derived from two different data sources: direct survey (Automation Survey) and a labour survey (employment and wages by occupation). The main conclusion is that the correction factor of 50% leads to an overestimate of the labour cost of own account software production.

If a country does not have reliable data on the share of time spent on the various tasks of computer professionals, the 50% deduction rule can be applied as an upper limit of the labour cost of own-account software production.

Non-labour costs

145. As direct data on non-labour costs of own-account software production is hardly available, it has generally to be estimated based on the relationship between labour costs and non-labour costs of relevant industries. The data for the relationship should generally be derived by survey or census data for computer services industries (if possible, custom software developers would be preferable). The calculated ratio of non-labour costs to labour costs is quite different across countries. This is mainly due to the availability of data on cost structure of related industries. Some countries have data at a detailed level of computer services industries, but others might have only data on service industry as a whole.

146. It is reasonable to assume that the cost structure of own-account software production is similar to custom software development or contract software programming industries. These industries tend to be more labour intensive than the service industry as a whole. However calculated, the ratio should be adjusted to exclude any double-counting of external costs that would have been already recorded in the other branch of the supply method, covering purchases. This is due to the fact that sales of programmer services included in the process of production of a final user's in-house software are to be recorded directly as investment. At the same time, the above process of estimating non-labour costs using the structure of the computer software industry, implicitly includes a mark-up for these external costs, because the computer software industry also purchases software services for its own use. There would therefore be a double-

counting element if these costs were included both as purchases and, implicitly, in the mark-up process used in adding in non-labour costs. That is why a downwards adjustment of the ratio is recommended.

147. Furthermore, it is recommended that allowances for administrative overheads should be included to take account of their contribution to the process of software production.

Cost of capital services

148. The cost of the capital services provided all the non-financial assets used in the production of own-account software should be included. It is recommended that the ratio of the gross operating surplus to labour costs in the custom software development or contract software programming industries be used to make the imputation.

Sales adjustment

149. As described above, it is necessary to make an adjustment to exclude the costs of producing custom software to be sold, as not all software personnel produce own-account software. Many of them, especially in the computer services industry, are involved in the production of software to be sold, and this activity should not be included in the estimation of own-account software production. Ideally, surveys of the computer services industry should be undertaken to determine what proportion of their software personnel are used to produce custom software and what proportion is used to produce originals for producing copies and originals for internal use. In the absence of actual data, it is worth noting the experience and practice of the US (reference) and UK.

150. In the US, a sales adjustment is made in industries where software professionals constitute more than 2 per cent of total employment. In any industry where more than 2 per cent of those employed are software professionals (ISCO-88 codes 2131 and 2132) a sales adjustment is made of 2/(proportion of software professionals to total employment x 100)*.

*Needs to be confirmed by BEA.

Multiplicative model

151. The additive model described above for deriving supply-side estimates of own-account software GFCF may not be the best way of deriving estimates in practice. It may well be reasonable to assume that direct labour costs (i.e. compensation of employees) are directly proportional to some of the other factors in the model, e.g. costs other than direct labour costs (such as management, taxes, intermediate inputs, and the capital services from fixed assets) and the sales adjustment. If so, a multiplicative model, as shown below, or a mixed multiplicative- additive model should be used.

Model with multiplicative relationships between components

Own-account software GFCF
equals
Wages and salaries of software personnel
multiplied by
Mark-up to take account of other labour costs
multiplied by
Adjustments for time spent on other activities
multiplied by
All overheads (management overheads, intermediate inputs, user cost of fixed capital)
multiplied by
Sales adjustment

R&D and software

152. The 1993 SNA Rev.1 recognises R&D expenditures that meet the general definition of an asset as fixed assets. This change occurred after the 2003 OECD Task Force report and after the UK study described above. Nevertheless, the OECD Task Force was concerned that all costs associated with software R&D should be included in estimates of own-account software GFCF, and recommended that they should be capitalised as they occurred. With the recognition of R&D assets this recommendation needs to be modified to ensure that the capital services provided by R&D assets are correctly included in estimates of own-account software GFCF and to avoid double-counting R&D and software GFCF. This matter is addressed in R&D chapter of the handbook.

Further adjustments ensuring consistency of national accounts

153. When the estimates of gross domestic product using the income approach are based directly or indirectly on business reports, an adjustment has to be made when compiling gross operating surplus to ensure consistency of the national accounts because the "supply approach" leads to a significantly different breakdown between current expenses (intermediate consumption) and investment (gross fixed capital formation) than in the business reports. These adjustments should be based on the difference between the independent "supply approach" estimate of gross fixed capital formation and what is declared capitalised by businesses. In order to compile this difference, surveys should continue to monitor capitalised software investment as they are recorded in business accounts.

154. Prior to the decision to implement the SNA recommendation on capitalising software, and in order to be fully consistent with SNA, all software expenses should have been treated fully as intermediate consumption and not gross fixed capital formation. As a result, the above adjustment to corporate profits should not be a new feature in the process of compilation of the national accounts. In other words, before the implementation of 1993 SNA, corporate profits should have been adjusted by adding to intermediate consumption the software "wrongly" classified as investment in the business accounts. In parallel, gross fixed capital formation reported by businesses should have been diminished by the same amount.

155. Another source of double-counting of software capitalisation is the use of specific business reports. In applying the supply-side approach, double-counting of software investment already included in national accounts (sometimes under "hardware") occurs when the general process of estimation of gross fixed capital formation uses business reports which include software capitalised by business since sometimes this software, even bought separately from hardware, is included as hardware. That is why the built-in capitalised software already included as hardware in business reports has to be deducted from

hardware investment. A possibility to do this is to compare the reports from respondents to the relevant survey (e.g. on capital expenditures) who declared software capitalisation to the software investment resulting from the commodity flow method. The resulting ratios can be applied to adjust the hardware data in order to avoid this kind of double-counting.

2.3 Databases

2.3.1 Introduction

156. The 1993 SNA described the treatment and measurement of databases as a special case of software and recommended that only large databases should be capitalised. There was a good deal of difficulty in implementing this recommendation for a number of reasons: there was no precise definition of what a database was, how should the qualification "large" be interpreted, should the value of information stored on a database be included in its value or not and, hence, how should a database be valued in general. As a result, many countries did not capitalise databases at all or not in an internationally comparable way. An OECD survey of Member countries in 2004 (OECD 2004) found that of the 13 countries who responded 5 said they excluded databases from their estimates of GFCF and the remaining 8 said that they included them in principle, but the values were not separately identifiable.

157. All of these issues were addressed by the Canberra II Group, and its proposals for addressing the above deficiencies led to changes reflected in the 1993 SNA Rev. 1.

2.3.2 Definition and treatment

158. The 1993 SNA Rev. 1 identifies databases as a separate sub-category of the asset category "software and databases", and in paragraphs 10.108 to 10.110 clarifies what databases are and how their value should be determined.

> 10.108 ***A database consists of files of data organised in such a way as to permit resource-effective access and use of the data.*** Databases may be developed exclusively for own use or for sale as an entity or for sale by means of a licence to access the information contained. The standard conditions for when an own-use database or a purchased database or the licence to access a database constitutes an asset apply.
>
> 10.109 The creation of a database will generally have to be estimated by a sum-of-costs approach. The cost of the DBMS used should not be included in the costs but be treated as a computer software asset unless it is used under an operating lease. The cost of preparing data in the appropriate format is included in the cost of the database but not the cost of acquiring or producing the data initially. Other costs will include staff time estimated on the basis of the amount of time spent in developing the database, an estimate of the capital services of the assets used in developing the database and costs of items used as intermediate consumption.
>
> 10.110 Databases for sale should be valued at their market price, which includes the value of the information content. If the value of a software component is available separately, it should be recorded as the sale of software.

159. This definition implies that all databases holding data with a useful life of more than one year should be recorded as fixed assets providing they meet the general definition of an asset (i.e. are expected provide benefits to their owners and over which ownership rights are exercised). Databases created on own-account and those for sale are included in the asset boundary if they meet this criterion notwithstanding their size or their type. The value of the DBMS will normally be recorded elsewhere as software. The definition also implies that the scope of databases should not be limited to specific types of

databases nor to databases created by specific activities and that the reference to "large" mentioned in 1993 SNA no longer applies.

160. Databases produced for outright sale should be valued at their market prices. Likewise, expenditures on licences to use databases should be recorded at their market prices and recorded as GFCF if the licences meet the definition of an asset, or as intermediate consumption if they do not, in the same way as software licences, see above.

161. Most databases are produced on own-account, either for internal use only or for distribution via licences-to-use or reproduce. The GFCF of those databases that satisfy the definition of an asset has to be estimated by summing costs in the same way as software. However, there is one important difference between a piece of software and a database (excluding the DBMS); unlike software, the data on a database that meets the definition of an asset does not require maintenance. The value of data may decline over time due to obsolescence but it does not decline due deterioration, and the cost of updating a database that qualifies as a fixed asset should be recorded as GFCF.

162. The recommendation in the 1993 SNA Rev.1 not to include the cost of obtaining information when summing costs to value database GFCF was made for measurement reasons and because otherwise the door to the capitalisation of knowledge in general would have been opened indirectly. In addition, the capitalisation of knowledge would create an inconsistency in the SNA, because its capitalisation would depend on how it was stored. If the knowledge was stored and embodied in a database it would be capitalised, however, if it was stored elsewhere, e.g. on paper files, it would not be capitalised. In addition, the data/information may already be recorded in the accounts as fixed assets, in the category "entertainment, artistic or literary originals", or they may not be, e.g. paper records.

163. A key question is which information provides services for more than one year since it is the length of the expected working life of the data/knowledge that determines whether the database should be recorded as a fixed asset. A good indication that it should, is if either of the following two conditions is met:

a. a typical datum is expected to be stored on the database for more than a year, or

b. if a typical datum is expected to be updated and replaced within a year on the principal database, then it will be archived on a secondary database.

Recommendation 3.1: a database should be recorded as a fixed asset if a typical datum is expected to be stored on the database, or archived on a secondary database, for more than a year.

2.3.3 Measurement

164. Most creation of databases occurs on own-account, either for internal use or for sale via licences-to-use. The rules for determining whether the purchase of a licence should be treated as GFCF or intermediate consumption are the same as those for software (see section 1.2.2).

165. A feature of most, but not all, databases is that they are frequently updated, and external users of a database pay for a copy that is frequently replaced with an updated version. This is the case for many statistical databases, for example. Access to frequently updated databases is generally obtained by annual subscription and users are undertaking consumption of database services rather than fixed capital formation. There are exceptions, such as the sale of population census data on a CD-ROM by a national statistical office and for which the database may be used for five or ten years. However, there is a dearth of information as to how significant the GFCF of databases by purchase is.

166. As for software, estimates of database GFCF can be derived using the demand-side and/or supply-side approaches, at least in concept. But unlike software, purchases of databases or database services that qualify as GFCF is thought to be very minor, with examples such as population census data being very much the exception. It is therefore recommended that the focus should be on measuring own-account database GFCF and that purchases of databases or database services only be recorded as GFCF on an exceptional basis, if and when such sales come to light.

167. It has been difficult to determine how great expenditures on database creation are. There is no particular database industry and CPC version 1.1 did not provide an adequate set of categories that covers databases without including too many other things besides. With the introduction of CPC version 2, this has changed and now there is a single category "Original compilations of facts/information" (83940) that relates to databases. How well data can be collected for this category remains to be seen.

2.3.3.1 Demand-side approach

168. The scope of an "ideal" survey should be all units in the economy. There would be considerable advantage in combining it with a software survey or more general survey, as this could minimise costs and may help avoid including the value of a DBMS in the value of a database created on own account. As for software, the survey should distinguish between external costs (expenditures) related to databases for own final use and internal costs of in-house database creation. In addition, the survey should ask for the company's own estimate of its capitalised databases, if any.

169. Concerning external costs (expenditures), businesses should be requested to include expenditures made on original databases (on which the company retains all property rights, and from which the company may make copies to be sold) but excluding all expenditures made on databases to be re-sold and all payments for data base management software. External costs should exclude all payments for data or other information to be incorporated in a database, but include the cost of any services entailed in preparing or loading the data into a database.

2.3.3.1.1 Costs of in-house database creation

170. This category covers the internal costs of developing a database original on which the company retains all property rights and of which the company will sell copies or embed copies in hardware or other material. It also covers databases developed for internal use. But it does not include the costs of creating databases intended for outright sale. It comprises the costs of utilising a DBMS (but not the cost of the DBMS itself) and loading data/information into a database, including updates. It requires the calculation of total labour costs and other costs as follows:

Total labour costs:

a. The number of in-house staff involved in the specification of the DBMS and loading data/information into it, including updates;

b. Estimate of average percentage of time spent by in-house staff on database tasks;

c. Average compensation of the staff engaged in database creation, including wages, salaries, bonuses, employer social contributions and other special benefits.

Other costs:

d. Overheads associated with employing the staff engaged on database creation and updating*, includes management costs, training, personnel management, office requisites, electricity, rent, etc. and the cost of using the enterprise's fixed assets;

e. Any other intermediate consumption associated with database creation, including the costs of software not recognised as a fixed asset;

f. Taxes associated with the cost of database creation, such as payroll taxes*;

*In proportion to the spent on database creation.

2.3.3.2 Supply-side approach

171. The method to be used is the same as that for own-account original software (section 2.3.2). In the absence of any data on the proportions of time spent by occupation groups on database creation, it is recommended that the direct labour costs be determined by the time spent by database assistants/clerks (ISCO-88 4113) not allocated to software production. Non-labour costs, the user cost of fixed assets should be derived in the same way as for software.

172. Not all database creation qualifies as GFCF. In the absence of any information on the proportion that does, it is recommended that it be assumed to be 50%.

2.3.4 International trade in software and databases

2.3.4.1 Introduction

173. The need for valid, detailed and international comparable data on trade in services has increased as its share in international trade volumes has augmented over the last years. The key interest focuses especially on data on trade in software since this is assumed to be extensive and very dynamic.

174. However, measuring international trade flows of software can be very difficult. These difficulties result from the fact that software may be traded on a variety of media, both tangible and intangible, and by a variety of means. Moreover, software sales may take the form of licences to use or reproduce software, which may or may not be accompanied by a physical supply of software.

175. Software is often bundled with hardware or other computer or consultancy services. Computer software is only one of a number of so called digitized products along with, for example music, film, data, TV programmes, news and literature that may be regarded as presenting analogous measurement problems regarding international trade.

176. International trade is for practical reasons partitioned into goods and services more rigidly than production. Eight examples of ways in which software can be traded as goods or services internationally are distinguished in the following (there may be more).

a. The most straightforward case is where packaged software is traded with manuals on a physical disk, e.g. a CD-ROM. However, valuation is sometimes a problem here, if it is based on the medium rather than the software content and/or the extent of the user licence.

b. Software may be installed on equipment or machinery, e.g. a PC. The software traded then may be counted simply as trade in that type of equipment. Both case (1) and (2) are treated as trade in goods.

c. A single (physical or online) copy of some software may be sold to a foreign firm which pays a licence fee to make further use of it. The licence payments are counted in trade in services but will not be separately identified as software in the current international classifications. It should be noticed that it is not uncommon for large firms/organisations to

renegotiate the licence-to-use agreements and ensuing payments can be divorced from any physical supply of software.

d. A single (physical or online) copy of some software may be sold to a foreign firm, possibly an affiliated firm, under licence to reproduce/sell further copies within certain (geographical/numerical) limits or bundle the software with hardware or software for resale. The royalty payments are counted in trade in services but again will not be separately identified as software in the current international classifications.

e. Traded customised software, if sold in physical format, is likely to be counted as trade in goods in the Customs reports, but may transferred to trade in computer services, following BPM5 guidelines or possibly to purchase of assets depending on the nature of the transaction. No change is expected in BPM6.

f. Software may be traded internationally online and in such a case it will by default not be counted in Customs reports. BPM6 will recommend that downloaded software should be treated as computer services.

g. Customers can subscribe to software services where the software is frequently updated, e.g. anti-virus software or databases, and access updates online (possibly downloading all or part).

h. Finally, software may be sold internationally from one firm to an affiliated firm within the same multinational. This is likely to form a significant part of trade in software. Here, there is no guarantee of uniform treatment and although this may be treated as in the cases above another possibility is that such transactions maybe treated as internal computer services, royalties, classified as miscellaneous management charges, trade in services with related enterprises, goods trade, or in extremis not recorded at all. There is also no guarantee of a market price valuation.

177. This section gives a definition of international trade in software and addresses its measurement whether or not particular sets of transactions are regarded as part of capital formation. The aim is to identify areas where measurement could be improved and to make recommendations on improvements to classifications, reporting practice and further work, in particular on the measurement of trade in software goods, of computer services and of software royalty payments. Furthermore, it addresses both specific problems concerning software delivered online and the borderline between merchandise trade and trade in services.

178. It seems probable that nearly all expenditures on database services are consumption and not capital formation.

2.3.4.2 Concepts and classification issues

179. The product “computer software” is not well identified in current international trade codes or balance of payments (BOP) items, but a number of items in the goods and services classifications are relevant.

180. The international standard for recording merchandise trade is set out in the United Nation’s publication “International Merchandise Trade Statistics: Concepts and Definitions” (IMTS, Rev. 2), edited in 1998. There, trade is classified into detailed products based on the “Harmonized Commodity Description and Coding System, 1996 version” (Harmonized System 1996 or HS96). Meanwhile, a third and a fourth edition of the “Harmonized Commodity Description and Coding System”, the HS02 and HS07, have been published. For trade in services the international standard is the International Monetary Fund’s “Balance of Payments Manual” in its fifth edition (BPM5), which also sets out a classification of

services. In certain countries the BPM5 categories are further disaggregated according to the "Joint OECD/Eurostat Trade in Services Classification". In order to obtain more detailed, more comparable and more comprehensive statistics, six international organisations[5] jointly compiled a new "Manual on Statistics of International Trade in Services" where an "Extended Balance of Payments Services" (EBOPS) classification was introduced. The EBOPS classification is a disaggregation of the BPM5. EBOPS is being updated in parallel with BPM6.

181. For merchandise trade there are a number of categories of HS products which may approximately relate to trade in software goods. The IMTS in its paragraph 27 sets out guidelines for the recording of software goods in international trade. It describes goods that are carriers of software within HS heading 85.24. "This category includes, for example, ... packaged sets containing diskettes or CD-ROMs with stored computer software and/or data developed for general or commercial use (not to order), with or without a users' manual. ..... However ... diskettes or CD-ROMs with stored computer software and/or data developed to order .... are to be excluded from international merchandise trade statistics." IMTS goes on to add that where these goods are carrying software and/or data developed to order they should be treated as part of trade in services. It should be noted that the HS codes do not distinguish media carrying customised software from packaged software. In the 2007 update of the HS, HS07, 85.24 is replaced by 85.23 and the situation is even worse, as there is no distinction between media with and without anything recorded on them.

182. On valuation of trade in software goods IMTS paragraph 123(b) states "Goods used as carriers of information and software, such as packaged sets containing diskettes or CD-ROMS with stored computer software and/or data developed for general or commercial use (not to order) be valued at their full transaction value (not at the value of the empty diskettes or CD-ROMS, paper or other materials)".

183. IMTS paragraph 48 (c) says that software goods purchased by travellers, including non-resident workers, or by foreign governments through their embassies or foreign military or other installations located in the host country are to be recorded as trade in services (such transactions would not normally separately identify software).

184. For online delivery of standard (i.e. packaged, not customised) software or databases no clear classification guidance currently exists as is the case for some other digitized products. However, BPM6 will recommend that downloaded software be recorded as computer services.

185. Software related royalty payments, which are counted in trade in services, are not at present separately identifiable from other royalty and licence fee payments in the international classifications. BPM6 will recommend that royalty and licence payments should be included in either *computer services* or *fees for franchises and other proprietary rights*, but at present it is unclear which.

186. There are some points of difference between the basic trade data and the basis on which investment assets are measured in the SNA. First, the BOP trade series make no distinction as to the length of time traded goods or services are used, whereas the SNA recommends that only software for use in production for more than one year should be recorded as a fixed asset. Second, the BOP records by exception repairs in computer services rather than in goods without clearly demarcating the extensiveness of the repair, whereas the SNA includes improvements to existing fixed assets that go beyond ordinary maintenance and repair. This difference is expected to be remedied in BPM6.

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[5] The United Nations (UN), the Statistical Office of the European Communities (Eurostat), the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD), the World Trade Organisation (WTO) and the United Nations Conference on Trade and Development (UNCTAD).

Conclusions and recommendations

187. Current international trade and balance of payments classifications and statistics are not as helpful as they could be in identifying international trade in computer software. Only a few countries appear to have access to a satisfactory set of data concerning trade in software. Supply-use tables should be made more consistent with trade flows in software.

188. The following four measures in trade and balance of payments are proposed. Their combined realisation would mark an important advance in effectively assessing international trade in computer software and their incorporation in the product balances of the national accounts in a more internationally comparable way.

a. the product "computer software" in international trade statistics and in national accounts should be regarded as having broadly three main trade components. These are software goods, computer services and software royalty and licence fee payments. This would clarify trade flows of software and increase international comparability.

b. the separate identification of trade in computer services (BOP code 263, see Box below) from computer and information services where this is not already done should be implemented.

c. it is recommended that software royalty and licence fee payments in the balance of payments services classification (part of BOPS code 266 at present) and in country reporting should be separately identified.

d. standard international grouping of Harmonized System codes that represents trade in software goods to improve international comparability is desirable and the following are proposed: HS96 codes 8524.31; 8524.40; 8524.91 and 8524.99. However, this has not been implemented in HS 2007.

189. In addition, two main areas for follow up work are identified where questions are unanswered and it appears premature to make any specific recommendations is needed. First, research should be undertaken into how software goods are valued and whether and how countries coordinate software measurement (valuation) in trade in goods and services to ensure a standard allocation, full coverage and avoid double-counting. Second, the online sale/purchase and delivery of software to/from other countries needs to be further investigated, probably through Internet use and e-commerce surveys. A further task is to identify the "Central Product Classification" (CPC) Version 2 codes associated with the relevant HS and BOP codes mentioned above and to clarify the link with output products as expressed in the main National Accounts paper in terms of CPA and North American Industry Classification System (NAICS).

Box 1. Relevant International BOP Codes

262 Computer and information services, includes 263 and 264

263 Computer services

EBOPS Description: Computer services consist of hardware and software related services and data processing services. Included are hardware and software consultancy and implementation services; maintenance and repair of computers and peripheral equipment; disaster recovery services; provision of advice and assistance on matters related to the management of computer resources; analysis, design and programming of systems ready to use (including web page development and design) and technical consultancy related to software; development, production, supply and documentation of customised software, including operating systems made on order for specific users; systems maintenance and other support services such as training provided as part of consultancy; data processing services such as data entry, tabulation, and processing on a time-sharing basis; web page hosting services (i.e., the provision of server space on the Internet to host clients' web pages); and computer facilities management.

Excluded from computer services are the provision of packaged (non-customised) software (classified as goods and therefore not included in EBOPS) and non-specific computer training courses (included in other personal, cultural, and recreational services).

264 Information services

EBOPS description:

a) News agency services which include the provision of news, photographs, and feature articles to the media. In the GNS/W/120 list of services that was a basis for the GATS commitments in the Uruguay Round, these services are a part of "recreational, cultural and sporting services" rather than computer and information services in the case of BPM5. These services are therefore separately identified in the EBOPS classification, thus facilitating a linkage with GNS/W/120.

b) Other information provision services which include database services – database conception, data storage and the dissemination of data and databases (including directories and mailing lists), both online and through magnetic, optical or printed media; and web search portals (search engine services that find Internet addresses for clients who input keyword queries). Also included are direct, non-bulk subscriptions to newspapers and periodicals, whether by mail, electronic transmission or other means.

266 Royalties and licence fees

EBOPS description: This Manual recommends a disaggregation of the BPM5 component into franchises and similar rights and other royalties and licence fees. Franchises and similar rights comprise international payments and receipts of franchising fees and the royalties paid for the use of registered trademarks. Other royalties and licence fees include international payments and receipts for the authorised use of intangible, non-produced, non-financial assets and proprietary rights (such as patents, copyrights and industrial processes and designs) and with the use, through licensing agreements, of produced originals or prototypes (such as manuscripts, computer programs, and cinematographic works and sound recordings). Payments and receipts for the outright purchase or sale of these assets and rights are excluded (following BPM5, these are recorded as capital account transactions, not as services). Excluded also are distributive rights for audiovisual products for a limited period or a limited area; these are included in audiovisual and related services.

2.4 Prices and volumes

2.4.1 Introduction

190. When deriving volume estimates of software and databases it is advisable to decompose software into three components: pre-packaged (or off-the-shelf), custom-made and own account, and to deflate them and databases separately. There are several reasons for doing this. First, the three components of software and databases vary in the extent to which price data are available to compile price indexes. Second, it is likely that their prices and volumes grow at different rates, particularly between pre-packaged, the other two software components and databases. Third, despite the previous point, price indexes for packaged software may be used to construct price indexes for the other two software components if more appropriate price indexes are unavailable. Fourth, volume estimates of the items are useful indicators in their own right.

191. Pre-packaged software is purchased on a very large scale, generally via licences-to-use, and there is an abundance of price data available. The challenge is to construct price indexes free of the effects of changing specifications and any other aspects of quality change. With ever larger numbers of copies of popular software being sold, growing economies of scale allow prices to fall. Custom-made software is also sold on the market, but each custom-made software product is a one-off, which presents an obvious problem for compiling price indexes. Although each custom-made product is different, different products may share common components, or a strategy used to develop one product may be able to be used for another. This not only suggests a possible way of compiling a price index, but also suggests means by which productivity gains could be made that would put downward pressure on prices.

192. The 2002 OECD Task Force found that the deflators used to derive volume estimates of software GFCF varied enormously between Member countries. This largely reflected the fact that many countries did not have suitable price indexes and used the price indexes of other goods and services as proxies. Partly as a result of the OECD Task Force's report and partly as a result of the EU decision to make it mandatory for its members to adopt more appropriate deflators those differences are being reduced. In making its decision, the EU provided indications of what form suitable price indexes might take. But these are of a general nature, and reflect the fact that there is still more work to be done in determining the best way to derive suitable price indexes for these products in practice.

193. One thing that is clear is that best results can be achieved in an input-output framework. This ensures that solutions made in the deflation are internally consistent. For many countries a significant share of purchased software is imported. If prices and volumes on the use side are consistent with imports, then errors, at least at the GDP level, will not be very significant.

194. There are two particular features of software GFCF that make the derivation of suitable price indexes challenging. First, there are rapid quality and specification changes, and, second, price data are only readily available for purchases of pre-packaged software. This section begins by giving an outline of the two main methods used for measuring price changes when quality changes occur frequently and price data are available. It then goes on to describe how price indexes for software and databases should or could be compiled. The recommendations distinguish between pre-packaged software, customised software, own-account software and databases. When the most desirable way of compiling price indexes may only be possible in the long term, then recommendations for second-best, short-term solutions are given.

2.4.2 Recommendations

2.4.2.1 Pre-packaged software deflators

195. Generally, all OECD member countries should develop price indexes for pre-packaged software in the long term. These should cover software acquired by both businesses and households (including games) and adequately take into account qualitative changes of software. As shown above, developing an unbiased index is difficult and adjustments might still be needed. If that is the case, adjustments should be based on available objective data and made transparent to users. Improvement of the comparability with other countries is an important criterion in the adjustment procedure.

196. The US has been the leader in developing price indexes for pre-packaged software. The US producer price index for pre-packaged software is compiled by the Bureau of Labor Statistics (BLS) and was first published in December 1997. It is based on a survey of producer selling prices, i.e. at the first line of distribution, collected from a sample of manufacturers of pre-packaged software. The BLS collects price quotes from both the Original Equipment Manufacturer (OEM) and finished goods channels, and for full versions and upgrades.

197. The methodology of the BLS price index for pre-packaged software is a fixed basket matched-model Laspeyres price index, with plans to update the weights every five to seven years. Because of the bias in price changes measured by matched-model price indexes, the US Bureau of Economic Analysis (BEA) began, in 2000, to make an adjustment to the BLS pre-packaged software price index. This adjustment is based both on a matched-model price index for spreadsheets, word processors, and databases (Oliner 1994) and on a BEA hedonic price index for spreadsheets and word processors. The average annual difference between these two sets of price indexes over the 1985 to 1993 time period is – 6.3 percent. The BEA calculates its bias adjustment as one-half of this difference, or – 3.15 percent. Self-evidently, use of mechanically adjusted price index is not an acceptable solution in the long term.

198. Nevertheless, the BEA's price index is recommended for use in the short term, because on the one hand the US has a dominant share in the market and on the other hand the use of the same index ensures the best comparability between countries. For use outside the USA, the US price index could be adjusted on the basis of either changes in exchange rates or purchasing power parities (PPPs) and it should reflect different timings of releases of new software in the USA and in the country where the modified US price index is used. The problem with using exchange rates is that they can be volatile, and the software supplier may not adjust the prices of imported software in accordance with them for practical as well as competitive reasons. The problem with PPPs is that they are unlikely to be available in sufficient detail and they are only collected at infrequent intervals. In between times they are extrapolated using GDP IPDs.

199. One possibility is to contact major software importers and ask them how they set and adjust their prices, and at the same time ask them what the usual lag is between software released in the US and software released in the home country.

200. Although prices for domestically-produced software do probably not develop in the same way as prices for imported software, it is better to use the US BEA price index, appropriately adjusted, than a price index not directly related to software. It is suggested here that the BEA index be adjusted by the relative inflation rate between the home country and the US (preferably producer price index for the home country vis-à-vis producer price index for the US).

2.4.2.2 Customised software deflators

201. The standard price index techniques described above cannot be applied to customised software, at least not in a straightforward way, because each product is unique. Methods for constructing price indexes for unique products are described in the *2004 Producer Price Index Manual*. They include model pricing, repeat recent real sale, specification pricing and component pricing. Of these possibly the first, model pricing, is the best possibility. Model pricing involves asking a producer to specify a notional product,

based on recent orders. For each period the respondent is asked to supply a hypothetical price. Model specifications need to be changed over time to reflect changes in the market.

202. However, for customised and own-account software the PPI Manual suggests function point analysis as a potential means of constructing price indexes. The function point metric was devised as a means of measuring software size and productivity. It uses functional, logical entities such as inputs, outputs, and inquiries that tend to relate more closely to the functions performed by the software as compared to other measures, such as lines of code. Basic function points are categorized into five groups: outputs, inquiries, inputs, files, and interfaces. A function point is defined as one end-user business function, such as a query for an input. Determining the size of a software product involves counting the number of each type of function point and weighting them. This is a time-consuming business and there is the question of whether two trained analysts would make the same count for a software product. Nevertheless, there is a large number of software enterprises and others engaged in function point analysis and efforts are being made to address the difficulties just described (Carnegie Mellon Software Engineering Institute 2007).

203. At the time of writing we are unaware of any satisfactory price index that has been compiled for customised software, and so it is premature to make a recommendation as to how such price indexes should be compiled, but model pricing and function point analysis look to be the best prospects.

204. The US derives its price index for customised software as a weighted average of its pre-packaged software index and an input price index based on the costs of producing software (wage rate indexes, PPIs for intermediate inputs, etc.). Weights of the two indices are arbitrarily defined, for pre-packaged software 25% and input price index 75%. The rationale is that some productivity growth can be expected in the production of customised software, but not at the same rate as for the production of pre-packaged software. At least two other countries (Australia and Canada) have adopted the US approach. To do so, countries should take a weighted average of the US pre-packaged index, adjusted for differential inflation rates (see above), and an input cost index compiled for their own country.

205. Another second-best approach is to adjust the input price index for customised software using estimates of multi-factor productivity growth in related industries where it is observable.

2.4.2.3 Own-account software deflators

206. In the long term, when price indexes for customised software become available, it would be reasonable to use them for own-account software production. In the interim, countries could follow the same approach they use for customised software.

2.4.2.4 Database deflators

207. Databases are generally heterogeneous products with a small market since most databases are made for in-house purposes. This makes it difficult, if not impossible, to develop a true output price index. We must therefore consider second-best alternatives; there appear to be three. The first is to compile an input price index, but this would imply zero productivity growth. The second is to adjust the input price index by assuming MFP growth in database production is similar to some other industries. The third is to use a price index of some related activity for which there is a price index of reasonable quality.

2.5 Capital measures

2.5.1 Introduction

208. The capital measures referred to in the 1993 SNA Rev.1 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 there. Methods for estimating GFCF are discussed in previous chapters of this handbook and methods for estimating the other three measures is the subject of the 2008 edition of the OECD manual *Measuring Capital*.

209. 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.

210. 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. 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. This chapter addresses the matter of setting values for these parameters for software and databases.

2.5.2 Service lives

211. 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 attention. There are several ways of obtaining estimates of service lives, they include: surveying software users, surveying software suppliers and consulting software consultants.

Surveying software users

212. This could entail asking software users what their expectations are of the service lives of the different forms of software they have acquired in the latest year, i.e. pre-packaged, customised and own-account. Alternatively, they could be asked what the service lives have been of recently retired software products. A natural place to pose such questions would be in a demand-side survey (section 2.4.1).

Surveying software suppliers

213. Most pre-packaged software is acquired by licences-to-use. Software suppliers can be expected to have records that may indicate the length of time of licences. But can they differentiate between business and household users?

Consulting software consultants

214. There are many IT consultancy firms, and some may have conducted studies into this matter. They generally do not provide such information free of charge, but it could still be a cost-effective solution. They may also be able to supply information on databases.

2.5.3 Country practices

215. Many countries currently do not derive estimates for capital services and they do not specify an age-efficiency function. But they do specify an age-price function which determines how the value of an asset, or group of assets, declines as it ages. The 2002 OECD software task asked Member countries to report the service life assumptions they used, and the functional forms of the age-price function and the retirement distribution function they use. Table 1 presents the results.

Table 1: Estimating the capital stock of software, PIM parameters
Responses to Questionnaire, 2002

Country	Service lives		Age-efficiency or age-price function	Retirement distribution function
	Own-acc't & Customised	Pre-recorded/ packaged		
Australia	Pre 89/90 - 8 Post 89/90 6	6 4	Hyperbolic for age efficiency function	Skewed retirement for packaged & other
Canada	5	3	Straight line	Truncated normal
Czech Republic	5		Business accounts	Any
Denmark	6[a]	4[b]	Straight line	Winfrey S3
Finland	5		Straight line	Skewed Weibull
France	5		Straight line	Lognormal.
Italy	5		Straight line	Truncated normal
Japan	5		Straight line	None
Netherlands	3		Straight Line	Weibull
Spain	4		Straight Line	Delayed linear
Sweden	10[a]	5[b]	Geometric	None
United Kingdom	5		Straight Line	Normal
United States	5	3	Geometric	None

(a) Own-account software only; (b) all purchased software.

216. With the exception of Sweden, most respondent countries reported service lives of approximately 5 years. A few countries specify service lives for customised and own-account separately from pre-packaged, and invariably specify a shorter life for the latter. Given the high cost and specialised nature of customised and own-account software this is only to be expected. One country, Australia, indicated that it had found that service lives had declined over time, and had set shorter service lives from 1989-90.

217. Australia uses a hyperbolic age-efficiency function and derives corresponding age-price function by assuming a real 4% per annum discount rate. The other responding countries mostly reported using

straight line depreciation, i.e. the age-price function is assumed to decline linearly. Two exceptions were Sweden and the US who reported using a geometric age-price function.

218. Nearly all those countries who did not report using a geometric age-price function reported using a retirement distribution function, but with little commonality.

Annexes

Annex 1: Lessons from business accounting

Even before the introduction of the 1993 SNA, business accountants recognised that software whether purchased or produced in-house had asset characteristics. Generally, business accounting standards recommend the capitalisation of software as long as technical feasibility is established. In this section, three accounting standards will be described in more detail: The US Generally Accepted Accounting Principles, the International Financial Reporting Standards and the French business accounting recommendations. Finally, some problems of identifying software costs due to their ways of reporting in business accounts are mentioned.

The US Generally Accepted Accounting Principles

Forerunner for other national accounting standards of software was in many ways the US accounting system GAAP (Generally Accepted Accounting Principles). Financial Accounting Standards Board (FASB) Statement No. 86 was the first statement to address a standard method for accounting for software. Although this statement did not cover software developed in-house, for internal use, clear guidance was given for software to be sold or leased (including "originals" produced for reproduction). According to this statement all costs of the software to be sold or leased during the research and development stage are to be expensed. At the point in time that the software becomes technologically feasible for use the costs should be capitalised and treated as a product master copy with subsequent costs capitalised as an intangible asset. After a clarification by the FASB which became effective in December 1998 guidance was also given for software developed or purchased for internal use. It was stated that the costs of that software should also be capitalised but not the costs in the final stage of implementation/operation such as training and maintenance which were to be expensed.

The International Financial Reporting Standards

The International Financial Reporting Standards (IFRS) announce in statement # 38 that an enterprise should recognise an intangible asset (at cost) only if it is probable that the future economic benefits that are attributable to the asset will flow to the enterprise and that the cost of the asset can be measured reliably. Furthermore, it is stated that during the research phase all costs should be expensed as incurred. In the development phase costs are to be capitalised if the enterprise can demonstrate all of the following requirements: Technical feasibility; intent to complete the asset for use or for sale; ability to use or sell the asset; record of the way how future economic benefits of the intangible asset can be generated; availability of adequate resources to complete the process for sale or use and ability to measure expenditures during the development stage. The value of the intangible asset should be based on the accumulated costs of development. Costs of internally generated software would include expenditures on materials and services used in production; salaries, wages and other employment related costs of personnel directly engaged in production; any expenditure directly attributable to generating the asset; overheads that can be allocated on a reasonable and consistent basis. Software costs should not include selling, administrative and other general overhead expenditure nor should they include training costs for staff.

The French business accounting system

The French business accounting recommendations split an in-house software project in eight stages:

i. Pre-analysis of feasibility;
ii. Functional analysis;
iii. Detailed analysis;
iv. Programming;
v. Tests;
vi. Documentation;
vii. Training;
viii. Maintenance.

According to the recommendations only costs of stages (2) to (6) should be included in the valuation of the in-house software. The objective is to make a fair estimate of the market price of the intangible asset thus created. Since the first stage is to precise the demand for the software it is not to be taken into account. Stages (7) and (8) should be excluded because training costs and maintenance are not embedded in the asset.

Identification of software costs in business accounts

Proper identification of software costs can be a problem due to the accepted ways accounting information is reported in business accounts. For capitalised software, costs are grouped under the general heading "intangible costs". Intangible costs can include scientific or technical knowledge, design and implementation of new processes or systems, licences, intellectual property, trademarks (including brand names and publishing titles). Examples include computer software, patents, copyrights, motion picture films, customer lists, mortgage servicing rights, import quotas and marketing rights. In addition, the amortisation of intangible costs may include any or all of the above intangible assets without any specific identification of software related items.

Expensed software can also be problematic since the actual costs are often split among multiple accounts, which include consultancy expenses, research and development costs, computer expenses, labour costs, payroll costs, equipment depreciation, software amortisation, office supplies, direct manufacturing costs, miscellaneous accounts, utility costs, and other expense accounts. This heterogeneity makes it particularly difficult to have a comprehensive picture of the total costs on software. The expenditure problem can be particularly difficult related to product enhancements and updated versions (compared to original development costs).

Annex 2: CPA and US SIC concordance tables (2002)

Introduction

The following concordance tables were included in the report of the report of OECD Task Force, and, with one exception, they relate to the classifications that existed at that time. The exception is that the CPA 2007 is used here. With the introduction of ISIC Rev. 4 and the revised CPC (version 2) in 2006, they will all be superseded as countries adopt the new classifications.

CPA Concordance Table

What follows are concordance tables based on the European product classification system (CPA 2007). Where the treatment is non-contentious (and evident) no further explanation is given.

The first table considers purchases of software and the second own-account production. That is, where software is intended for final-use by the purchaser and not intended for further processing nor for bundling/embedding (including outsourced purchases) in a subsequent sale, nor where the software is purchased as part of own-account production.

Table 1 – Purchases of Software

CPA Code	Product Description	Intermediate or Investment
72.21.1	Packaged software products. Our understanding is that this category includes sales of originals (including games) and software copies (on-the-shelf software, whatever the media). This includes licences to use and licences to reproduce and rentals.	
	Original software – (purchases of pre-existing software originals)	GFCF
	Other reproduced purchased, rented, leased or licenced software with a contract for more than one year. Including payments for "multiple-copy" licences. (*Payment can include, royalties, commissions, fees etc).*	GFCF excluding games[6]
	Other reproduced purchased, rented, leased or licenced software, with a contract for no more than one year. (*Payment can include, royalties, commissions, fees etc).*	IC
	When purchased for bundling/embedding into products for subsequent sale (whether the products are hardware, other equipment (chips on planes, cars, boats etc) or other software products or just sold-on.	IC
	Payments for licences-to-reproduce software for subsequent sale.	
	If there the licence has the appearance of a change of economic ownership of part or a whole of the software original	GFCF
	If the licence has the appearance of an operating lease	IC
72.22.1	Software consultancy and other supply services nec	
72.22.11	Systems and technical consulting services (includes advice and assistance on technical matters, (equivalent to stage 1 of the production process – see sub-section 1.3.2, above)	IC

[6] Unless purchased by games arcades, game rental companies etc

72.22.12	Custom software development services (Includes development (analysis, design and programming) of software for, and to meet the requirements of, a specific client (including self) and – modification of packaged software).	
	Software expected to be used in production for more than one year. (including -embedding in an own-account 'original')	GFCF
	Software expected to be used in production for less than one year, (This includes "customised" software purchased to be sold-on to another user/client.)	IC
72.22.13	Systems analysis and programming services (Includes provision of systems analysts' and/or programmers' services on a per diem basis to participate in one of the phases of the development of a system. The client supervises and retains the right to their work.)	
	Software expected to be used in production for more than one year For inclusion/embedding in an own-account 'original' – the value of own-account production should not include these costs if they are directly capitalised. If the software is purchased by a final-user for inclusion in an own-account "original" the expenditure may also be treated as intermediate consumption as long as its value is included in own-account production	GFCF
	Software expected to be used in production for less than one year. (This includes "customised" software purchased to be sold-on to another user/client.)	IC
72.22.14	Systems maintenance services (Includes provision of assistance to keep computer systems (software) in good working condition. The maintenance may be corrective or preventive).	IC
72.20.35	Other professional computer-related services	IC
72.4.1	Database services	
	Where exclusive ownership rights are transferred	GFCF
72.4.11	On-line publishing services	IC
72.4.12	Web search portal services	IC
72.4.13	Other database services (includes technical support such as: database development services: assembly of data from one or more sources and data storage services: preparation of a computer record for such information in a predetermined format	
	For inclusion/embedding in an own-account 'original' that meets the definition of an asset – the value of own-account production should not include these costs if they are directly capitalised. If the database services are purchased by a final-user for inclusion in an own-account "original" the expenditure may also be treated as intermediate consumption as long as its value is included in own-account production	GFCF
	If the database services are not contributing to the creation of an asset	IC

The Table below describes the treatment of own-account production of software.

Table 2 - Own-account production		
CPA Code	Product Description	Intermediate or Investment
72	Own-account produced software In practice the following should be capitalised: Compensation of staff and all internal overhead costs involved in the strict development of in-house software and databases. This includes the development of in-house originals destined for reproduction. In other words, the internal costs of software editing and database creation companies incurred in this production should also be capitalised. Costs should only include those strictly related to the creation of the software or database. Costs related to the first phase of the software (Stage 1 above) or to the last phases (stages 7 and 8) should be excluded.	GFCF

US SIC Concordance Table

Similar concordance tables are shown below (Table 1a and 2a) using the US SIC classification[7]. NAICS codes and amounts of sales (in millions of US dollars for the US for the year 97) have been added for information and clarification.

Creating a concordance for the US SIC based on the CPA table is, in most cases, relatively easy given the similarity in classification descriptions. However there is one area where there is some ambiguity: NAICS 541512 (SIC 7373 and part of SIC 7379), computer systems design services. The exact definition of this activity is the following: *activity of establishments primarily engaged in planning and designing computer systems that integrate computer hardware, software, and communication technologies. The hardware and the software components of the system may be provided by this establishment or company as part of the integrated services or may be provided by third parties or vendors. These establishments often install the system and train and support users of the system.*

There could be various interpretations of this activity. One interpretation is that it relates only to the integration of the various hardware components. In that case, costs linked to these services are not to be included in the value of the software asset in itself. However, another interpretation is that the software cannot function without these integration services. In that case, these costs should be included in the value of the software.

[7] The SIC was used rather than the more recent NAICS because of its similarity with the NACE/CPA classification. SIC and NAICS are industry and not product classifications but used here as if they were a product classification.

Table 1a – Purchases of Software		
US SIC Code	"Product" Description	Intermediate or Investment
73.71	Computer programming services NAICS 541511, 38,300 US$: Custom computer programming services: services of writing, modifying, testing, and supporting software to meet the needs of a particular customer. This category is similar to CPA 72.20.32 Custom software development services and CPA 72.20.33.	
	Software expected to be used in production for more than one year (Including – embedding in an own-account 'original). If the software is purchased by a final-user for inclusion in an own-account "original" the expenditure may also be treated as intermediate consumption as long as its value is included in own-account production	GFCF
	Software expected to be used in production for less than one year, including expenditure on maintenance and repair (see Section 1.6) and "customised" software purchased to be sold-on to another user/client.	IC
73.72	Software publishers NAICS 5112, 61,700 US$: establishments in this industry produce and distribute software (design, documentation, assisting in installation, provide support services to software publishers). This category seems similar to CPA 72.21.1 Packaged software products.	
	Payments for licences-to-reproduce software for subsequent sale.	
	If there the licence has the appearance of a change of economic ownership of part or a whole of the software original	GFCF
	If the licence has the appearance of an operating lease	IC
	Original software – (purchases of pre-existing software originals; and originals)	GFCF
	Other reproduced purchased, rented, leased or licenced software with a contract for more than one year. (*Payment can include, royalties, commissions, fees etc).*	GFCF excluding games[4]
	When purchased for bundling/embedding into products for subsequent sale (whether the products are hardware, other equipment (chips on planes, cars, boats etc) or other software products or just sold-on.	IC
	Other reproduced purchased, rented, leased or licenced software, expected to be used in production for less than one year. (*Payment can include, royalties, commissions, fees etc).*	IC
72.73	Computer systems integrators and consultants "This category covers approx. 70% of NAICS 541512 Computer systems design services, (US$ 51200, 70% =US$ 35,800). This industry comprises establishments engaged in planning and designing computer systems that integrate computer hardware, software, and communication technology". This category is related to CPA 72.22.11 Systems and technical consulting services. The definition of this category explicitly says that sales can include hardware. If hardware is included, this should be classified as GFCF in hardware. If not, under the point of view of this table which is to treat software services, these transactions seem to relate to intermediate consumption, because these costs do not relate to the asset software itself, but to its installation.	IC

73.74	Data processing services NAICS 5142, 30,840 US$.	
	For inclusion/embedding in an own-account database that meets the definition of an asset – the value of own-account production should not include these costs if they are directly capitalised. If the database services are purchased by a final-user for inclusion in an own-account "original" the expenditure may also be treated as intermediate consumption as long as its value is included in own-account production	GFCF
	If the database services are not contributing to the creation of an asset	IC
73.75	On-line information systems NAICS 5114191, 8,000 US$	IC
73.76	Computer facilities management services NAICS 541513, 15,100 US$: provision of on-site management and operation of clients computer systems.	IC
73.77	Computer rental or leasing NAICS 532420, 5,700 US$: not related to software	IC
73.78	Computer maintenance or repair NAICS 811212, 7,600 US$: not related to software	IC
73.79	Other computer services This category contains NAICS 334611 Software reproducing (US$ 1,300), 30% of NAICS 541512 computer systems consultant (US$ 51200, 30% = US$ 15,900), and NAICS 541519 Other computer related services (US$4400). Except for the small flow of NAICS 334611, these services seem to be classified as intermediate consumption (considering "computer systems consultant', see classification of 73.73)	IC

Table 2a - Own-account production		
US SIC Code	Product Description	Intermediate or Investment
73.7	Own-account produced software and databases expected to be used for more than one year. In practice the following should be capitalised: Compensation of staff and all internal overhead costs involved in the strict development of in-house software. This includes the development of in-house originals destined for reproduction. In other words, the internal costs of software editing companies incurred in this production should also be capitalised. Costs should only include those strictly related to the software and databases. Costs related to the first phase of the software (Stage 1 above) or to the last phases (stages 7 and 8) should be excluded.	GFCF

Appendix: Broad Concordance Table between CPA 2007/ISIC rev. 3 and CPC 1.1

CPA	ISIC	CPC	
72.2	72.2		
72.21.1		83142	part
72.22.11		83142	part
72.22.12		83142	part
72.22.13		83142	part
72.22.14		83160	
72.4	72.4	84300	part

3. Research and experimental development

3.1 Introduction

219. The 1993 SNA does not recognize research and experimental development (R&D) as capital formation, despite the fact that it is thought to be a major contributor to future economic growth. Instead, R&D is not recorded as output and expenditures on R&D are recorded as consumption, with the result that GDP is understated. Stocks of R&D assets are not recorded in the balance sheet, and hence the net worth of a country is also understated. Furthermore, the capital services provided by R&D assets are not recognised as an input in productivity estimation. None of this is an oversight. In fact, it was proposed to include the "capitalisation" of R&D in the 1993 SNA, and it was only late in the piece that the proposal was aborted because agreement could not be reached on how it should be implemented. There is no doubt that this is a difficult issue and history almost repeated itself in the development of the 1993 SNA Rev. 1, but not quite.

220. The following was agreed by the United Nations Statistical Commission in 2007:

a. Research and development should be treated as gross fixed capital formation in the SNA. It should be defined as in the *Frascati Manual*[8], namely "research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including the knowledge of man, culture and society and use of this stock of knowledge to devise new applications." This definition should not be interpreted as including human capital as capital formation within the SNA.

b. By convention, since much R&D is carried out on own account, it should be valued at cost. In practice, the information collected in accordance with the *Frascati Manual* will provide estimates of R&D expenditure; discussion is ongoing to make adjustments to this Manual to meet the needs of the SNA more closely. It is recognised that a detailed guide to implementation will be desirable to assist implementation of this recommendation.

c. All R&D expenditure that is sold or is expected to bring a benefit in the future to its owner (including for the provision of public services in the case of R&D undertaken by government) is included within the asset boundary. Only R&D that brings no economic benefit discernable at the time of its completion is excluded.

[8] OECD *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*

d. With the inclusion of R&D in the asset boundary, patented entities will no longer be separately identified as such in the system, but they will be subsumed into R&D assets.

While there is strong support by countries for adopting these recommendations in the SNA, there is also considerable concern that it is premature to do so because of technical difficulties that have yet to be overcome. In conclusion, R&D expenditure should be recognized, in principle, as part of capital formation. However, recognising the difficulties to be overcome before this objective can be reached, satellite accounts will provide a useful way of working towards solutions that give the appropriate level of confidence in the resulting measures and practical guidance on implementation will help to ensure international comparability. Therefore, the 1993 SNA Rev.1 will describe the objective and its conceptual underpinnings, note the difficulties and provide links to work underway to overcome them and recognize that for many countries implementation will take some time. The ISWGNA will report periodically to the UNSC on progress and signal when widely accepted implementation guidelines are available.

221. To further the objective of introducing capital measures of R&D in the core accounts as quickly as possible the OECD and Eurostat are forming task forces that will work closely together to develop guidelines for the compilation of R&D satellite accounts. A considerable amount of work has already been undertaken by Canberra II Group members and several have already compiled R&D satellite accounts. The draft guidelines and recommendations provided here are based on country experiences and the views of the Canberra II Group. It is expected that they will be refined and extended over the coming year to reflect the findings of the task forces. Some components of this draft, such as transforming FM survey data to SNA estimates, are well understood and do not appear to be controversial, but there are a number of things that are not settled. These include measuring international trade in R&D, price indexes, service lives (or depreciation rates) and practical guidelines for identifying those expenditures by non-business units that should be recorded as GFCF and those that should be recorded as intermediate consumption.

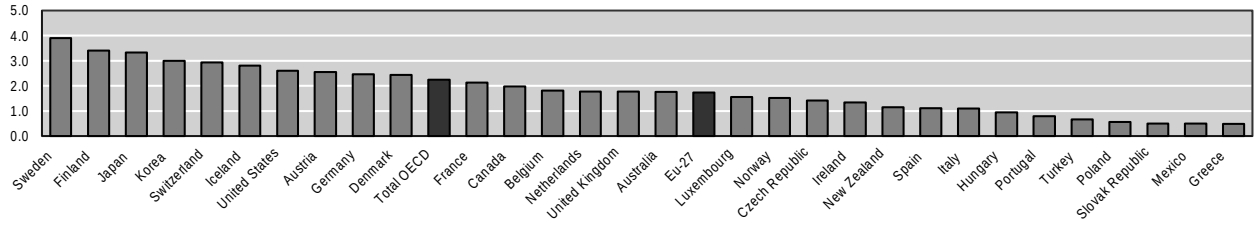
3.2 Quantitative impact

222. The impact on GDP of the capitalisation of R&D depends on the relative size of R&D production to GDP, if and when implemented. An approximate indicator of what this is likely to be is the ratio of gross domestic expenditures on research and development[9] (GERD) to GDP. This ratio varies considerably between OECD countries. Figure 1 presents the value of this ratio for OECD Member countries in 2006, or the latest year. The ratio varies from about 0.5% for Greece to a little under 4% for Sweden – with the OECD average being 2.3%. The ratios do not change very quickly over time, which suggests that the capitalisation of GDP will have little impact on GDP growth rates.

223. A word of caution is needed because the GERD to GDP ratio is only an approximate indicator of the impact of the capitalisation of R&D on GDP for three reasons. First, there are conceptual differences between GERD and the national accounts measure of R&D production. Second, expenditures on R&D are already included in the output of non-market producers because output is measured by summing costs. However, R&D assets will incur consumption of fixed capital (depreciation) and so the gross value added, but not the net value added, of non-market producers will be boosted by the consumption of past R&D capital formation. In a growing economy the consumption of past R&D capital formation will be generally less than current expenditures on R&D and so the impact on GDP can be expected to be a little less than the GERD to GDP ratio suggests. Third, it is likely that some expenditure on R&D by government and non-profit institutions will not be recorded as capital formation.

[9] One of the principal aggregates obtained from R&D surveys conducted as per the *Frascati Manual*.

Figure 1. Gross Domestic Expenditure on R&D as a percentage of GDP, 2006[1]



a) Source: OECD, Main Science and Technology Indicators, May 2007

1. 2006 or latest year.

3.3 Definition and scope

224. The criteria for determining whether an expenditure on R&D is GFCF are just the same as they are for any other product. The definition and scope of R&D GFCF read as follows in the 1993 SNA Rev. 1:

> 10.100 ***Research and [experimental] development consists of the value of expenditures on creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and use of this stock of knowledge to devise new applications. This does not extend to including human capital as assets within the System.*** The value of research and development (R&D) should be determined in terms of the economic benefits it is expected to provide in the future. This includes the provision of public services in the case of R&D acquired by government. In principle, R&D that does not provide an economic benefit to its owner does not constitute a fixed asset and should be treated as intermediate consumption. Unless the market value of the R&D is observed directly, it may, by convention be valued at the sum of costs, including the cost of unsuccessful R&D.
>
> 10.101 With the inclusion of R&D expenditure as capital formation, patented entities no longer feature as assets in the System. The patent agreement is to be seen instead as the legal agreement concerning the terms on which access to the R&D is granted.

225. While in most respects R&D assets are no different from any other fixed assets, they do have certain characteristics that differ from most other fixed assets. One of the most important is that R&D assets can provide benefits to units other than their owner – a characteristic they share to varying degrees with other intellectual property products. When the knowledge gained from R&D is sold by its legal owner to other units, such as via a licence or the sale of a patent, the sale is recorded like that for any other product. But it is in the nature of R&D that the knowledge gained often becomes available to units other than the legal owner[10] by means other than a transaction. This can happen because the owner knowingly makes the knowledge available to others by putting it in the public domain, such as by patenting the knowledge or by making the knowledge freely available. The knowledge also can be spread by the simple act of the legal owner, or a licensee, using the knowledge in their production and it being observed by others.

226. Once the knowledge has been leaked it can become valuable to other units in a number of ways. First, there is considerable variation between countries in the extent that they recognise and uphold the rights of units with patents; knowledge that is well protected by a patent in one country may not be so well protected in another. Second, most new knowledge is gained by extending or synthesising existing knowledge, and if a pharmaceutical company introduces a new type of important drug, for example, other

10 Or the economic owner if a licence agreement has the appearance of a sale of the R&D

pharmaceutical companies often endeavour to build on this knowledge and develop related, but more effective varieties. Third, when a patent expires other units are free to use the patented knowledge and produce products that compete with those of the owner of the R&D, and this is also a common occurrence in the pharmaceutical industry.

227. The benefits that accrue to units other than the R&D owner are commonly referred to as spillovers, and it is common for the owner to obtain only a portion of the total economic benefits provided by the knowledge gained from its R&D, but it is only that portion that is recorded as an asset in the System. Spillovers are not attributed to any asset in the System.

228. It is common for the owners of R&D knowledge, particularly the output of basic research, to make it freely available to others. This may be due altruism or it may be that the owner expects to benefit as a result. The owner may expect benefits to arise from the activity that is stimulated by making its knowledge available to others, or it may be that researchers simply have found that if they do not share their knowledge other researchers will not either, and so it is in their best interests to collaborate. In any case, making knowledge freely available does not exclude the knowledge from being an asset provided the expected benefits for the owner are not diminished. What matters is the effective management and control of the knowledge asset in order to ensure the expected benefits are obtained. Knowledge is not recognised as an asset in the System if it is made freely available and leaves the owner with no expected economic benefits. Hence, if government undertakes or funds R&D (e.g. medical research) with the intention of using the knowledge it hopes to gain in its own production (e.g. the production of hospital or medical services) then it is acquiring an R&D asset equal to the expected economic benefits reflected in its future production. If, however, it undertakes or funds the R&D with no intention of using the knowledge in its own production then it is not an asset.

3.4 Compiling R&D GFCF and other statistics

3.4.1 Introduction

229. As for other fixed assets, estimates of GFCF of R&D can be derived using either the supply- or demand-side approaches. It is best to use both approaches and confront them in a supply and use framework. There are, however, two special features of R&D that need to be recognised. First, the great bulk of R&D is conducted for own use, if not within the unit conducting it then within associated units. Second, in many countries there are well established surveys of R&D performers conducted as per the Frascati Manual (FM) that are considered to produce satisfactory estimates of expenditures on R&D. This is in stark contrast to the situation with regard to software, for instance. Moreover, the 1993 SNA Rev.1 has adopted the FM definition of R&D. Thus, there is not the strong need for supply-side estimates as there has been for software, which in the case of R&D would largely entail using a macro approach to estimate the own account component. Nevertheless, such estimates could serve as a useful check on the FM-based surveys for R&D.

230. Over the years the FM has become more consistent with the SNA, and in the 2002 edition only relatively few differences remain. It has been shown by members of the Canberra II Group that it is possible to develop bridges between FM data and the SNA using existing data. Because the exiting data are incomplete for this purpose, these bridges have required some assumptions to be made, and while the estimates derived are considered to be of reasonable quality (probably better than current estimates of software GFCF), it is expected that significant improvements could be made with additional data.

3.4.2 Features of the FM data

231. The principal aims of FM-based surveys are to estimate how much is being spent on undertaking R&D by resident units, i.e. the amount spent on the inputs to R&D, which are referred to as intramural expenditures, and to identify the sources of the funds used. There are several dimensions to the data collected. First, three different kinds of R&D activity are identified: basic research, applied research and experimental development. Second, the expenditures are classified by type: current and capital. Third, there is a sectoral dimension: business enterprise, government, private non-profit, higher education and abroad. The data are compiled as a single vector in each dimension, with no three dimensional matrix. In addition, the FM prescribes the identification of supplementary extramural R&D expenditures.

3.4.2.1 Intramural expenditures

232. Paragraphs 358 and 359 of the FM define intramural expenditures as

> All expenditures for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds.
>
> Expenditures made outside the statistical unit or sector but in support of intramural R&D (e.g. purchase of supplies for R&D are included. Both current and capital expenditures are included.

233. The composition of intramural expenditures is described in paragraphs 361 to 388 of the FM. Current costs have two sub-categories:

a. *The labour costs of R&D personnel*, which comprises all persons employed directly on R&D including those providing direct services such R&D managers, administrators and clerical staff.

b. *Other current costs*, which includes intermediate expenditures to support R&D, administrative overheads and on-site consultants.

234. Capital expenditures have three sub-categories:

c. *Land and buildings*, which comprises the share of these assets used for R&D. Land includes that under buildings and any other land used for R&D, such as testing sites;

d. *Instruments and equipment*, which includes embodied software; and

e. *Computer software*, which includes purchases as well as annual licence fees.

3.4.2.2 Sources of funds

235. Sources of funds are described in paragraphs 389 to 407 of the FM. The aim is to identify all direct transfers of resources both intended and used for the performance of R&D, and to attribute them to their ultimate source. “Transfers” has a much broader meaning in the FM than it does in the SNA and comprises two categories:

a. Those that are specifically for the procurement of R&D, i.e. the results of the R&D belong to the recipient of the output or product of the R&D, which is not necessarily the funder of the R&D; and

b. Those that are provided to the performers of R&D in the form of grants or other financial incentives, with the results of the R&D becoming the property of the R&D performers.

236. The FM recommends that, where possible, both categories of transfer of government R&D funds should be identified in the R&D data of the business enterprise sector. It also suggests that, if possible, a similar breakdown should be made for government funds to the higher education sector. Because transfers (the national accounts meaning) are treated quite differently from purchases in the national accounts it is highly desirable that they be distinguished. The FM recommends that, as far as possible, the following breakdown of sources of funds should be obtained from R&D performers:

- Business enterprise sector:
  - Own enterprise
  - Other enterprise in the same group
  - Other enterprise
- Government sector:
  - Central or federal government (excluding general university funds)
  - Provincial or state government (excluding general university funds)
  - Public general university funds
- Private non-profit sector
- Higher education sector
- Abroad:
  - Business enterprise:
    - Enterprises within the same group
    - Other enterprises
  - Other national governments
  - Private non-profit
  - Higher education
  - EU
  - International organisations

3.4.2.3 Extramural expenditures

237. Extramural expenditures are defined in paragraph 408 of the FM as:

> the sums a unit, organisation or sector reports having paid or committed themselves to pay to another unit, organisation or sector for the performance of R&D during a specific period. This includes acquisition of R&D performed by other units and grants given to others for performing R&D.

238. It is recommended in the FM that the following breakdown of extramural expenditure be obtained:

- Business enterprise sector:
  - Other enterprise in the same group
  - Other enterprise

- Government sector
- Private non-profit sector
- Higher education sector
- Abroad:
    - Business enterprise:
        - Enterprises within the same group
        - Other enterprises
    - Other national governments
    - Private non-profit
    - Higher education
    - International organisations

239. In principle, the estimated total of R&D expenditure within a country based on performers' reports of their sources of funds should equal the total based on the reported extramural expenditures of those providing funding. In practice, this does not normally occur due to such factors as sampling error and different interpretations of what constitutes R&D. Given that it is the performers who are actually undertaking the R&D, greater confidence should be put in their reports of expenditures on R&D than those who are providing the funding. However, given that performers may not always accurately identify the ultimate source of their funds the extramural expenditure data may provide a useful check on the distribution of the source of funds.

240. Note that extramural expenditures comprise grants and purchases of R&D, but the FM makes no recommendation to distinguish between them. For national accounts purposes this needs to be remedied. In addition, as with intramural expenditures, there is the problem of different sectoring, particularly in respect of higher education.

241. The expenditures on the inputs used to undertake R&D reported by performers provide much of the data required to estimate the output of R&D in a country by summing costs. Combining an estimate of R&D output with imports gives an estimate of the total supply of R&D, which can then be allocated to the using categories, including GFCF, using the commodity flow approach. To accomplish all of this requires three kinds of bridges between the FM and SNA data:

- Between FM sectors and SNA sectors
- Between FM's expenditures on R&D and SNA output
- Between FM's classifications of expenditures and funding and the SNA supply and use tables.

Annex 3 of the FM describes the differences and similarities in the SNA and FM treatments of R&D. This includes a discussion of the differences in sectoring and the differences between SNA output and total intramural R&D.

3.4.3 Bridges between FM and SNA data

3.4.3.1 The bridge between FM and SNA sectors

242. Table 1 depicts the relationship between FM and SNA sectors. As can be seen from the table, there are several instances where FM sectors correspond to more than one SNA sector. The most important case concerns the higher education sector. This difference may be overcome by making a subdivision of the FM data for the higher education sector between:

a. Corporations and quasi corporations (including NPIs serving them)

b. General government units (including NPIs controlled and mainly financed by government)

c. NPISHs

243. In fact the FM already recommends a step in this direction in paragraphs 227 and 228: *"For some countries, it may be helpful, for the purposes of international comparison, to know the breakdown between public and private universities"*. Since data in R&D surveys are mostly collected for each institution, it seems feasible to make the necessary sub-classification for most countries. For those countries with sector codes recorded in their business register it may be relatively straightforward to produce this breakdown. For other countries some other means will be needed.

Table 1: Linking FM and SNA Sectors

OECD Frascati Manual	**SNA**
Business enterprise sector	Non-financial corporations
	Financial corporations
Government sector	General government
Private non-profit sector	NPISH
	Households
Higher education sector	Corporations and quasi corporations
	General government
	NPISH
Abroad	Rest of world

3.4.3.2 The bridge between FM's intramural expenditures on R&D and SNA output

244. When summing costs to measure output, the SNA identifies six principal components to be included (see paragraph 28). The use of FM intramural expenditure data is considered for each of the six in turn.

3.4.3.2.1 Intermediate consumption

245. The accounting principles differ between the FM and SNA in two important respects. First, to measure output by summing costs, the SNA recommends summing the costs of the inputs actually used in the period plus other taxes payable less other subsidies receivable on production to obtain an estimate at basic prices. By contrast the FM recommends the measurement of all the expenditures made in the period.

Thus, in principle, an adjustment is required to the FM data for the changes in inventories of inputs. In practice, it is very likely to be insignificant and can be ignored.

246. Second, the FM excludes transactions in R&D between producers to avoid double counting. Gross expenditures on R&D (GERD) are estimated by adding the intramural expenditures of all resident producers; consequently the R&D performed by one resident unit should not be included in the intramural expenditure of another resident unit (e.g. the outsourcing of part of an R&D contract that is a component of the R&D project to be performed). For the same reason, imported R&D used as intermediate input by an R&D producer should be excluded from GERD. Acquisitions of R&D are registered by the FM as extramural expenditures, which provide a financing source for the costs of the R&D produced by the seller.

247. From a national accounts perspective, acquisitions of R&D performed by another unit should be recorded as either GFCF or intermediate consumption depending on the circumstances. (For the moment the other alternative of final consumption is ignored, but is addressed in paragraph 272). As discussed in paragraphs 31-34, if acquired R&D is to be either used up in a year or completely, or almost completely, embodied in another asset then the acquisition should be recorded as intermediate consumption. Otherwise it should be recorded as GFCF. Given the difficulty of making this distinction in practice it is recommended that by convention purchases of R&D by R&D performers should be recorded as intermediate consumption, while purchases of R&D by non-performers should be recorded as GFCF. Thus, the SNA measure of R&D output should be higher than the FM measure of GERD because of the double counting of some domestically produced and imported R&D.

248. As already noted, the FM does not prescribe classifying extramural expenditures to grants or acquisitions. Many countries do it anyway and the data available from these countries show that the amount of acquisitions is quite large and growing. Until other countries make the split, then probably their best option is to assume that non-government R&D performers mainly make outlays to acquire R&D, while government R&D performers make almost none.

249. Other current costs include intermediate inputs as well as the labour costs provided by staff providing indirect services, such as security and canteen staff. For national accounts purposes these costs should be included in compensation employees and value added. But where they are included in the sum of costs has no bearing on the measurement of output and GFCF.

250. In summary, intermediate consumption, derived with the ultimate objective of estimating GFCF, can be measured by summing the FM data for other current costs and the purchases component of extramural expenditures. If the purchases split is unavailable then it is suggested that it should be assumed that non-government R&D performers mainly make outlays to acquire R&D, while government R&D performers make almost none.

3.4.3.2.2 *Compensation of employees*

251. Included in those directly employed on R&D are postgraduate students who are either on the payroll of R&D units and/or receive external funds (such as research scholarships). Although the external funding component is not included in the SNA measure of compensation of employees, the 1993 SNA Rev. 1 (paragraph 10.61) prescribes that even labour provided free should be included at what it would have cost if it had been paid for when summing costs to measure own-account GFCF and output. Therefore, the payments made to postgraduate students, whether by pay or external funding, should be

included when summing costs to measure output and GFCF[11] on the assumption that they are indicative of the students' contribution to R&D output.

3.4.3.2.3 Capital services, consumption of fixed capital and return to capital

252. The value of capital services provided by fixed assets is equal to the consumption of fixed and a return to capital. The 1993 SNA Rev. 1 recommends that when summing costs to measure the output of market producers the value of capital services should be included, but when measuring the output of non-market producers the return to capital is set to zero, and the value of capital services is equal to the consumption of fixed capital.

253. In measuring GERD, the FM includes capital expenditures both on fixed assets and land. Neither of these should be included when summing costs to measure of output. But one way of estimating the value of capital services is to apply the perpetual inventory method (PIM) to the estimates of GFCF for previous periods as reported by FM surveys plus any purchases of R&D of a capital nature. Little is known about the composition of capital expenditures of R&D performers below the level that is recommended by the FM. But it is very likely that it does not sufficiently distinguish between major components that have different long-term price changes and service lives. If so, a more detailed breakdown by type of asset is required by future FM surveys that would also allow land to be excluded. If no additional information is available about the composition of capital expenditure then the following breakdown is suggested:

- Land and buildings
    - Land
    - Buildings
- Instruments and equipment
    - Transport equipment
    - Office machinery and equipment
    - Radio, TV and communication
    - Other machinery and equipment
- Software

Breakdowns of past capital expenditures would need to be imputed.

254. Other ways of estimating the value of capital services are by making an imputation using the estimated value of capital services or gross operating surplus of an industry specialising in R&D (i.e. Scientific Research and Development, Division 72, ISIC Rev. 4) – see paragraph 37.

255. Other factors to consider in choosing between the three methods include:

[11] As a result, the external funding component should, in principle be included in the operating surplus, but this is irrelevant for measuring output and GFCF.

a. The capital intensity of Division 72 might be quite different to that of other R&D performers, particularly non-market producers, and so the ratio of capital services or GOS to output or labour costs for Division 72 might be quite inappropriate.

b. The ratio of GOS to output could vary a good deal from year to year and, in any case, might not be indicative of R&D activity undertaken by other industries.

c. R&D is a high risk activity, and one would expect those engaging in it would demand a high rate of return. This implies that if the first method is to be used a relatively high interest rate should be used in determining the return to capital for market producers.

256. On balance it would seem that using the PIM on GFCF data collected via FM surveys is to be preferred, providing a sufficiently detailed breakdown of GFCF can be obtained.

257. There is another issue regarding the FM capital expenditure data: sales of fixed capital and land are ignored. There is reason to believe this is insignificant, but it should be taken account of if possible.

3.4.3.2.4 *Rent on land*

258. All rents and rentals actually paid are included in other current costs. To the extent that land under buildings is included in the capital expenditure on buildings then an estimate of imputed rent on land is included in the value of capital services provided by buildings. Thus, the only component of rent on land that is missing is the imputed part relating to land owned by the R&D performer that is not included with buildings. This could be dealt with at the same time estimates are made for rents that have to be imputed – see paragraphs 367 and 368 of the FM. In any case, it is probably very small and is probably not worth the effort. Peleg and Mandler (2005) report that the whole of capital expenditure on land and buildings is only about 2 per cent of R&D expenditure for those OECD countries that report these expenditures separately.

3.4.3.2.5 *Other taxes less subsidies on production*

259. The FM does not show the flows of taxes explicitly, but some taxes are included in current expenditures. For example, payroll taxes are included in labour costs. On the other hand, other subsidies on production are not deducted from expenditure, but are shown as a financing source. Subsidies on R&D production may be quite common, and it is important to take them into account.

260. Details on government funding of R&D performance in other sectors are already recommended in the FM for government budget appropriations or outlays for R&D by socio-economic objectives (GBOARD) (see chapter 8 of the FM), and include the data necessary for bridging between the two systems. In the short term, if such data are not collected in R&D surveys, national accounts data on subsidies may be used to estimate these flows.

3.4.3.3 The bridge between FM's classifications of expenditures and funding and the SNA supply and use tables

261. National accounts include tables on supply and uses, where flows of goods and services in the economy may be analyzed. But most importantly they provide the means to estimate the GFCF of R&D using the commodity flow approach. Detailed FM data on expenditure and funding provide the major part of the data needed for supply and use tables for R&D.

3.4.3.3.1 Supply including imports of R&D

262. Total supply of R&D is obtained by summing output and imports. The FM can provide estimates of imported R&D for use by R&D performers, but imports of R&D for final use by non-R&D performers must be obtained through other sources – for example in economic surveys or in surveys of exports and

imports, which are becoming more common in recent years. Another source of data that could possibly also provide information on R&D transactions of producers that are not themselves performing any R&D, are innovation surveys.

3.4.3.3.2 *Uses of R&D*

263. Uses of a product typically comprise final consumption, intermediate consumption, exports, GFCF and changes in inventories. For the moment, final consumption is ignored. A typical supply and use table for R&D is shown below in table 2.

Table 2. Supply and use of R&D, assuming R&D capitalized in national accounts

At purchaser's prices

	Supply			Use				
Period	Total R&D	Output of R&D	Imports of R&D	Total R&D	Intermediate consumption of R&D	Exports of R&D	Gross fixed capital formation in R&D	Increase in inventories of work in progress on R&D

Uses for final consumption assumed neglible

Intermediate consumption of R&D

264. This has already been dealt with above.

Exports of R&D

265. As described above, the FM recommends that R&D performers should be asked to provide details of their sources of funds. Unfortunately, these funds include payments for purchases and transfers (in the national accounts sense) and at best only a partial decomposition may available. But detailed data of funding from R&D surveys with appropriate sub-classifications by domestic and foreign sectors of origin (similar to the classification outlined above for extramural expenditure), and by economic kind (*sales, transfers and subsidies*) could provide a reliable source for estimating exports. (The NESTI group is currently reviewing the issue of internationalization of R&D performance, and a task force has undertaken work to improve measures of international transactions of R&D.) Until such data are available from R&D surveys, in the short run it should be possible to prepare reasonable estimates of uses of R&D by subdividing data on funding of business R&D using balance of payments data on exports of R&D. Such a subdivision can be made under the assumption that funding from the business sector to the business sector is only received to make a purchase (that there are not any transfers – i.e. with no quid pro quo - between business enterprises) and that exports of R&D by producers that do not engage in R&D may be ignored.

Inventories of finished R&D and work in progress

266. Since production of R&D mostly takes longer than one year, there will also be work in progress until the R&D is finished. If the R&D is produced on own account, then the 1993 SNA rev. 1 recommends that the production of assets on own account should be recorded as GFCF as it occurs. If there is significant production of R&D for sale (as is the case for exporting countries such as Israel), then it should be recorded in inventories of work in progress. This is particularly important for the R&D produced by affiliates of multinational firms, which will ultimately be exported. Present R&D surveys do not support this.

Gross fixed capital formation in R&D

267. In the framework of FM R&D statistics it will be possible to estimate R&D output, imports and intermediate consumption once funding and extramural expenditures are sufficiently classified. Imports of R&D for GFCF will have to be obtained, as explained above, either in exports-imports surveys or in specialized business surveys, including innovation surveys. Until additional data are available, estimates of GFCF can be derived using certain assumptions. Table 3 summarises the steps involved to derive an estimate of R&D output, and table 4 summarises the remaining steps to derive GFCF of R&D. **[To be inserted]**

268. There is one further step to obtain estimates of GFCF, which is to exclude from supply R&D expenditures that do not qualify as either intermediate consumption or GFCF. This has been ignored for the moment but is addressed below.

3.4.4 Additional data requirements

269. In summary, the additional data required are as follows:

Items to be estimated by using data from R&D surveys

a. R&D procured from other performers: Data on extramural expenditure from R&D surveys to be classified into R&D purchases from domestic performers, R&D imported from abroad and donations and other transfers. Such a classification would enable the addition of R&D acquired by domestic performers (assumed to be intermediate consumption) to be added to their intramural expenditures on R&D in order to arrive at a gross measure of domestic output of R&D. Total supply of R&D would equal domestic output of R&D plus imports of R&D.

b. Uses of R&D: A segregation of data on funding received between R&D sales to domestic producers and to other countries (R&D exports), and transfers received, would enable the measurement of uses of R&D output as required for a supply and use table. Such a classification already exists in R&D surveys for the government sector's funding of the higher education and business sectors.

c. Harmonisation of sectors: A breakdown of expenditure by the higher education sector is needed to get the institutional sector breakdown used in the national accounts. Hence the need for a classification of data for the higher education sector by sub-sector:

   i. Corporations and quasi-corporations (including non-profit institutions serving them)

   ii. General Government units (including non-profit institutions controlled and mainly financed by government), and

   iii. Private Non-profit Institutions serving households

Items to be estimated by combining R&D statistics with national accounts data

d. Other taxes on production less other subsidies on production: The SNA defines the other taxes on production as part of the taxes on production, "consisting mainly of taxes on the ownership or use of land, building or other assets used in production or on the labour employed, or compensation of employees paid". Other subsidies on production includes mainly subsidies in payroll or workforce. The FM does not show the flow of other taxes on production explicitly, but the flows are included, at least partially, in the current

expenditures, e.g. payroll taxes are part of the labour costs. However, the flow of other subsidies on production is not accounted for in intramural expenditures, but as a financing source of them. In the interim, until data become available from R&D surveys, national accounts data on subsidies may be used to estimate these flows.

e. Cost of capital services provided by own fixed assets: These estimates would best be obtained by applying the PIM to past GFCF. The FM breakdown of capital expenditures requires more detail to distinguish between asset types that have significantly different price growth and different service lives.

Items demanding data collection outside R&D surveys

f. Producer units other than R&D performers may also have external sales and purchases of R&D. In countries where such transactions are of importance, they will have to be covered through other types of sources – for example in economic surveys or in surveys of exports and imports, which are becoming more common in recent years, the latter providing data on R&D transactions with other countries. Another source of data that could possibly also provide information on R&D transactions of producers that are not themselves performing any R&D, are innovation surveys.

Editor's note - International trade between affiliated enterprises

270. As noted above, additional data relating to exports and imports of R&D are required to compile SNA aggregates. While some of the gap can be filled by obtaining additional data in the FM R&D surveys, the scope of these surveys is confined to R&D performers, and so other sources are needed, in particular, to obtain imports for final use by non-R&D performers. A major source of such imported R&D is likely to be affiliated enterprises. US data shows that investment by US parent companies in foreign affiliates and vice versa accounts for a modest but significant share of total R&D expenditures. Important questions are how well such flows are recorded in balance of payments statistics, and to what extent R&D trade flows can be separately identified. US experience is that it is worthwhile trying to marry data from the FM R&D survey with that from BOP surveys at the unit level.

271. Ideally, the Handbook should provide guidance on these matters and promote cost-effective strategies for measuring exports and imports of R&D between affiliated enterprises.

3.4.5 Discriminating between GFCF and intermediate consumption

272. R&D output that is not expected to provide future economic benefits for its owner is not regarded as an asset in the SNA. This means, for example, that expenditures on R&D by government and NPISHs with no intention of using the R&D output as an input in their own future production, but just making it freely available, should not be recorded as GFCF. Instead, it should be recorded as final consumption expenditure. The Handbook should provide guidance on how to discriminate between expenditures that qualify as GFCF and those that do not.

273. There seems to be agreement that all expenditures by businesses on R&D should be recorded as GFCF and the challenge of discriminating between GFCF and intermediate consumption is restricted to the government, higher education and NPI FM sectors. As they stand, R&D performer surveys do not provide the means to do this. The FM, however, does recommend the collection of *Government Budget Appropriations or Outlays for R&D by socio-economic objectives* (GBAORD) – see chapter 8 of the FM. These data indicate how much government funding is directed towards defence and civil objectives such as space R&D, health and environment, economic development, non-oriented R&D and general university funding. The data come from government budget documents and they are regarded as being less accurate

than the performer-based surveys, with which they are inconsistent. Nevertheless, GBAORD may have a role to play.

274. There appear to be only two other options: one is to introduce questions into the R&D performer survey forms sent to non-business units to determine whether their R&D expenditures are asset forming, and the other is something along the lines of the proposal I made last year, which is to simply exclude basic research by government and higher education. That proposal received a mixed response, with some members of the Canberra II Group expressing the view it was a robust method that could be readily applied and would preserve international comparability, but just as many members did not express support. Some felt that it is was too crude.

3.4.6 Avoiding duplication and omission with respect to other fixed assets

275. The SNA recommends that own-account capital formation should be estimated at market prices if possible, and when it is not, which is generally the case, its basic price should be estimated by summing costs. This means the costs of labour, capital and intermediate inputs and other taxes on (less subsidies) on production need to be added together. The cost of capital should be the value of the capital services provided by all the non-financial assets used during the period in producing the asset.

276. In a sense, all capital formation involves a form of double (or multiple) counting in the national accounts. The production of an asset is recorded in gross value added and GDP. In subsequent periods it can provide capital services which contribute to the production of goods and services, including other assets. Hence, over time there is a multiple counting. This is why the inclusion of R&D in the asset boundary will raise the level of GDP.

277. This kind of temporal double counting is an accepted feature of the national accounts. A problem arises in measuring own account GFCF by summing costs if the costs are counted twice – say in the GFCF of software and GFCF of R&D. As discussed in paragraphs 31-33, if an asset is completely, or almost completely, embodied in another asset then its acquisition should be recorded as intermediate consumption, rather than capital formation. If, however, R&D output, say, is used to produce a number of software originals over a number of years then it is correct to recognise the R&D as an asset, and the value of the capital services it produces should be included when summing costs to measure own account software GFCF. In this latter case, if the software GFCF is derived by including the R&D costs as they occur, rather than using the capital services from previous R&D, then software GFCF would be misrecorded between periods, but over time there would be no double counting.

3.4.6.1 R&D and software

278. R&D surveys conducted as per the Frascati Manual (FM) are the best available source of data for compiling estimates of R&D capital formation. Most R&D capital formation is produced on own account and in the absence of being able to observe prices for equivalent assets its value should be obtained by summing its cost of production. The expenditure data collected by R&D surveys require some adjustment for national accounts purposes, but having made them double counting can arise if the data are summed to obtain estimates of own account capital formation of R&D, while at the same time some, or all, of the same expenditures are also summed to obtain own account capital formation of some other asset. In the case of R&D and software some producers will have either:

a. undertaken R&D in the course of producing software, or

b. produced software in the course of undertaking R&D

279. An R&D survey adhering to the FM would record either some or all of the expenditure in case (a) and all of the expenditure in case (b) as expenditure on R&D. Whether estimates of software GFCF are

obtained either by demand-side surveys or by using the supply-side commodity flow approach it is likely that they will include the total value of the expenditure in case (a) and that part of the software component not expensed in case (b). Hence, if the data from the two surveys were added together there would be either a partial or complete double count of capital formation of R&D and software in both cases.

280. If R&D is not capitalised then there is no risk of double counting and all software R&D should be included in estimates of software GFCF. This will occur in own account software GFCF if purchased R&D output is included in the production costs as intermediate input and if the time spent by software personnel undertaking software R&D in-house is included in in-house costs, along with associated overheads.

3.4.6.2 R&D undertaken to produce software

281. If R&D is capitalised then it raises the issue of double counting. Consider the case of R&D undertaken in the production of software. The FM guidelines clearly state that certain software development projects may entirely fall under the FM definition of R&D (paragraphs 135 and further). "For a software development to be classified as R&D, its completion must be dependent on a scientific and/or technological advance, and the aim of the project must be the systematic resolution of a scientific and/or technological uncertainty", and, "The nature of software development is such as to make identifying its R&D component, if any, difficult".

282. In principle, if the software R&D is completely, or almost completely, embodied in one software original then the expenditures on the R&D should be incorporated in the GFCF of software and excluded from R&D GFCF. If this is not the case then the expenditures on the R&D should be recorded as GFCF and the cost of the capital services they produce should be included when summing costs to measure the value of future software GFCF. If it is possible for R&D surveys to differentiate between the two cases then the following adjustments can be made:

a. When the R&D is embodied in the software, the expenditures on the R&D should be excluded from estimates of R&D GFCF.

b. When the R&D is for producing more than one software original, the expenditures on the R&D should be recorded as GFCF and the services the R&D provides should be included in the costs of producing software in the future. This could be accomplished as follows:

    i. Subtract software R&D (collected as per the FM) from the estimates of own-account software GFCF, and

    ii. Estimate the value of capital services produced by software R&D fixed assets and add this back to the estimates of own account software GFCF.

283. If it is not possible for R&D surveys to differentiate between the two cases then a convention needs to be adopted. This could be to treat all expenditures on software R&D as (a), (b) or some combination of the two.

3.4.6.3 Software undertaken to produce R&D

284. This still leaves a possible double count of software GFCF undertaken as part of non-software R&D. One possible way of overcoming this would be to ask respondents to R&D surveys to separately identify expenditure on software development. Such estimates could then be deducted from the macro estimates of software GFCF.

Are the above guidelines considered practical? Would it be better to go for just one of the alternatives in paragraph 283? Is the suggestion in paragraph 284 practical?

3.4.6.4 R&D and mineral exploration

285. Another type of intellectual property asset that may be the subject of double counting is mineral exploration. GFCF of mineral exploration, like R&D, is a likely candidate to be estimated using a special survey, and although the FM indicates that "…surveying and prospecting activities of commercial companies will be almost entirely excluded from R&D", there is a possibility of overlap. According to the FM, R&D involved in "mining and prospecting" is restricted to the following two activities:

a. The development of new or substantially improved methods and equipment for data acquisition, processing and study of the data collected;

b. Surveying undertaken as an integral part of R&D project on geological phenomena per se.

286. These two activities may overlap with mineral exploration as defined in the SNA. In paragraph 10.102, the 1993 SNA Rev. 1 indicates that mineral exploration costs "..include the costs of actual drilling and boring, as well as the costs of aerial or other surveys, transportation costs, etc. incurred to make it possible to carry out the tests…". These additional costs seem to be related to the two activities described by the FM, above.

287. As for software, if mineral exploration R&D is considered to provide on-going capital services then only these capital services should be included in deriving estimates of own account GFCF of mineral exploration. If, however, it is considered that mineral exploration R&D is used up rapidly it would be best to record it as intermediate consumption when estimating own account mineral exploration GFCF and exclude it from R&D GFCF.

3.4.6.5 R&D and estimates of GFCF obtained directly from surveys

288. Capital expenditure or more general surveys are commonly used to obtain estimates of GFCF directly from units. Respondents are asked to report their purchasers (and may be sales) of fixed assets and the value of own account capital formation - estimated by summing costs. The same possibility of double counting R&D with assets other than software and mineral exploration therefore exists, although probably to a lesser extent. If the R&D is assumed to produce more than one fixed asset over more than a year, and given the nature of R&D the assumption seems reasonable for most fixed assets, then the only deficiency is that the costs of the R&D are not allocated to the correct period. In the whole scheme of things this is not likely to be a serious problem.

3.5 Prices and volumes

289. Two features of R&D make it difficult to compile output price indexes. First, it is very heterogeneous and second, most of it is produced on own account. Consequently, either proxy price indexes, such as the GDP IPD, or input-cost price indexes have been used to deflate current price estimates of R&D flows. Experience has shown that the GDP IPD is not a good proxy price index, particularly at the industry or sector level. Therefore, the FM recommends that input-cost price indexes should be compiled and it provides detailed advice on how it should be done.

290. Nevertheless, it is widely recognised that input-cost price indexes make unsatisfactory deflators because the resulting volume estimates show no growth in productivity. This could be a very serious deficiency for R&D, because there is reason to believe that there is actually significant growth in productivity occurring.

291. This issue is addressed in paragraphs 64-66. It is proposed that the Handbook should describe best practice in deriving input-cost price indexes, note their limitations, and then go on to describe ways of deriving pseudo output price indexes.

3.6 Capital measures

292. Researchers have derived estimates of the capital stock of R&D using econometric methods as well as the perpetual inventory method (PIM). The PIM is the method most commonly used to derive capital stock estimates of fixed assets for national accounts purposes, and it therefore has the advantages of being well understood and having computer systems in place to employ it. Hence, it is proposed that the Handbook should recommend the use of the PIM for R&D.

293. In equilibrium, the value of an asset is equal to the net present value of expected future benefits it will provide. Hence, the value of an asset declines over time unless the values of the benefits do not decline, such as can be the case for natural assets like land. Like other intellectual property assets, R&D is not subject to wear and tear but future benefits can decline due to obsolescence and if the level of protection (e.g. afforded by patents) falls or becomes more costly to maintain.

294. Researchers have employed two different approaches to estimating depreciation rates and asset service lives for R&D output: the patent renewal method and econometric methods. While both approaches have serious shortcomings they generally indicate that service lives lie between 10 and 20 years, but vary considerably between industries.

295. At the joint meeting of Canberra II and NESTI in 2006 it was proposed to approach major R&D performers in various industries to test whether they were able to provide expectations of the service lives of R&D that could be used with the PIM. If this proves to be viable then the HMIP should recommend this approach and, if possible, report on the findings of countries that have employed it.

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