CHAPTER II: RESEARCH AND EXPERIMENTAL DEVELOPMENT

Introduction

One of the major innovations in the 2008 SNA, and, so, rationale for the development of this handbook, is the recognition of expenditures on research and experimental development (R&D) as capital formation. The following was agreed by the United Nations Statistical Commission in 2007:

> *Research and development should be treated as gross fixed capital formation in the SNA. It should be defined as in the Frascati Manual[9], 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.*
>
> *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.*
>
> *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.*
>
> *With the inclusion of R&D in the (fixed) 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 recognised, 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 2008 SNA 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.

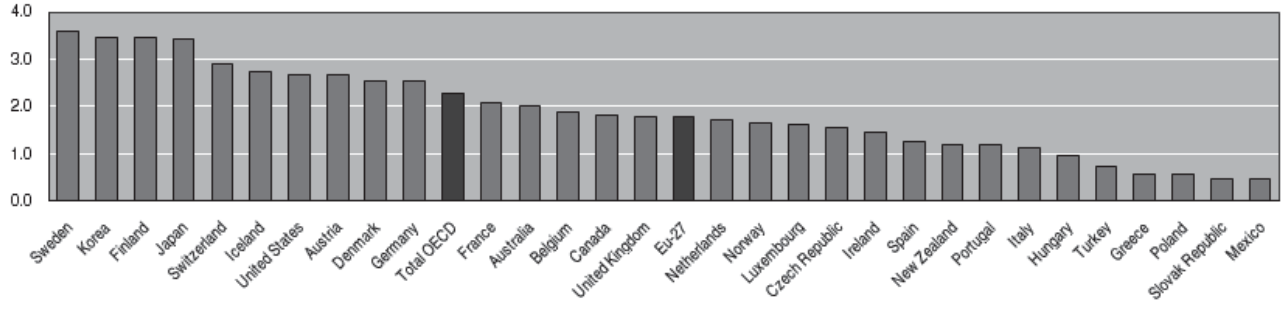
8. Quantitative impact

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[10] (GERD) to GDP. This ratio varies considerably between OECD countries. Figure 1 presents the value of this ratio for OECD Member countries in 2008. The ratio varies from about 0.5% for Mexico 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 R&D will have little impact on GDP growth rates for OECD countries.

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 two main 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.

Figure 1. Gross Domestic Expenditure on R&D as a percentage of GDP, 2008 or latest year



a) Source: OECD, *Main Science and Technology Indicators*, June 2009

9. Definition and scope of R&D GFCF in the 2008 SNA

The definition and scope of R&D GFCF read as follows in the 2008 SNA:

> *10.103 IPPs include the results of research and development (R&D).* ***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 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.*
>
> *10.105 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. The patent agreement is a form of licence to use which is treated as giving rise to payments for services or the acquisition of an asset.*

The criteria for determining whether expenditures on R&D should be recorded as GFCF are just the same as they are for any other product. Issues concerning maintenance and repair; licenses to use and

reproduce; the embodiment of IPP assets in other assets; and the treatment of unsuccessful developments apply to R&D, as they do other IPPs. The conceptual treatment of these issues is addressed in chapter I. This chapter simply addresses how to deal with them in practice. But there are two issues concerning the scope of GFCF that are of particular relevance to R&D, namely spillovers, which is addressed directly below, and some borderline issues between consumption and capital formation, which are discussed in the following section.

9.1 Spillovers

Spillovers are briefly discussed in chapter I (see Box 1), and a recommendation (4) is made that they should not contribute to the value of an asset. While spillovers can occur in respect of other IPPs, they are most relevant for R&D and a more detailed discussion is warranted here.

A feature of many R&D assets is that they can provide substantial benefits to units other than their owner without compensation – a characteristic they share to varying degrees with other IPPs. 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 economic owner 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 can also 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.

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 so, if, for example, a pharmaceutical company introduces a new type of important drug other 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.

The benefits that accrue to units other than the R&D owner without compensation 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.

10. Features of the FM data

Before describing in detail a set of guidelines that facilitate the measurement of R&D it is useful to first describe the information collected within the Frascati Manual framework as it is clear that these surveys provide a rich and readily available (in many countries) source of information on R&D.

The GERD data referred to above are obtained from R&D surveys conducted in accordance with the recommendations of the OECD's *Frascati Manual* (FM). Such surveys have been conducted by many countries for many years and they provide a wealth of information that can be used to compile R&D satellite accounts, including estimates of R&D GFCF. While the FM data fall short of what is ideal for national accounts purposes it has been shown (*e.g.* Mandler and Peleg (2004), ABS (2004), Robbins (2006), Galinda-Reuda (2007), and Tanriseven et al (2008)) that they can be successfully used to derive R&D satellite accounts and estimates of R&D GFCF.

The FM describes two types of expenditures 'intramural' and 'extramural'. The former relates to the expenditures a resident unit makes in producing R&D within the unit, whereas the latter measures the expenditures made by a unit in acquiring R&D produced by another unit and any grants provided to others for performing R&D. Additionally, the FM measures the sources of the funds used to perform intramural R&D, which provide an important mechanism to reconcile estimates by performers with those by funders.

10.1 Intramural expenditures

The FM recommends that intramural expenditures should be categorised in four independent ways (i.e. as single vectors and not as multi-dimensional arrays):

1. Three different kinds of R&D activity should be identified: basic research, applied research and experimental development.
2. Expenditures should be classified by socio-economic objective (SEO).
3. Expenditures should be classified by type: current costs and capital expenditure.
4. Expenditures should be classified according to the institutional sector of the reporting unit: business enterprise, government, private non-profit, higher education and abroad[11].

In addition, the FM prescribes the identification of supplementary extramural (see below) R&D expenditures[12].

Paragraphs 358 and 359 of the FM define intramural expenditures as:

a) All expenditures for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds.

b) 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.

The composition of intramural expenditures is described in paragraphs 361 to 388 of the FM. Current costs and capital expenditures are further subdivided, with current costs having 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 as 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.

Capital expenditures have three sub-categories:

a) *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;

b) *Instruments and equipment*, which includes embodied software; and

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

Of the three types of activity (*basic research, applied research* and *experimental development*), the FM recommends that basic research be further sub-divided into *pure basic research* and *oriented basic research*. But most OECD countries just make the primary division. Pure basic research is carried out for the

advancement of knowledge, without seeking long-term economic or social benefits or making any effort to apply the results to practical problems or to transfer the results to sectors responsible for their application. Oriented basic research is carried out with the expectation that it will produce a broad base of knowledge likely to form the basis of the solution to recognised or expected, current or future problems or possibilities.

The SEO categories recommended by the FM (see paragraph 286) are as follows:

1. Exploration and exploitation of the earth
2. Infrastructure and general planning of land use
3. Control and care of the environment
4. Protection and improvement of human health
5. Production, distribution and rational utilisation of energy
6. Agricultural production and technology
7. Industrial production and technology
8. Social structures and relationships
9. Exploration and exploitation of space
10. Non-oriented research
11. Other civil research
12. Defence

Less than half of OECD countries currently collect these data[13].

10.2 Sources of funds

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. These transfers may be measured in two ways. One is performer-based reporting of the sums which one unit, organisation or sector has received or will receive from another unit, organisation or sector for the performance of intramural R&D during a specific period, including R&D funded by the unit for itself. The second is source-based reporting of extramural expenditures, which are the sums a unit, organisation or sector reports having paid or committed itself to pay to another unit, organisation or sector for the performance of R&D during a specific period. It is important to note that "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.

These 'transfers' differ in meaning from those used in a national accounts context which do not include expenditures made to procure R&D. However in practice not all countries are currently able to provide the split between purchases and grants shown above. The FM does recommend however that, where possible, both categories of transfer should be identified for government funded R&D in the business enterprise sector and further encourages a similar breakdown for government funds to the higher education sector.

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

10.3 Extramural expenditures

The FM recommends the following breakdown of extramural expenditure:

- 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

11. Guidelines for measuring GFCF on R&D in practice

11.1 Reconciling Performer and Source based reporting

One might expect the estimated total of R&D expenditure within a country based on performers' reports of their sources of funds to equal the total based on the reported extramural expenditures of those providing funding. In practice, this does not normally occur for a number of reasons. One reason is measurement error due to such factors as sampling error and different interpretations of what constitutes R&D. An important, reason is that the scope of R&D surveys is generally confined to R&D performers in the country and excludes R&D non-performers who may purchase R&D. Hence, the estimates of extramural expenditures are likely to be understated. Furthermore, more accurate reports can be expected from those performing R&D than those who are providing the funding. Nevertheless, 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.

As already noted, sources of funds data reported by performers and extramural expenditures comprise grants and purchases of R&D, and only a few countries distinguish between them. For national accounts purposes this needs to be remedied. Until other countries make the split or have information that indicates otherwise, a reasonable 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. In addition, as with intramural expenditures, there is the problem of different sectoring, particularly in respect of higher education.

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 that 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.

11.2 Determining which R&D expenditures should be recorded as GFCF

Ownership of an R&D asset can be legally established by a patent or by some other means, such as by publishing the results of R&D in a scientific journal. However, much R&D output is not legally protected because the owners do not think it is in their best interests to do so. Legal protection can be expensive and it requires making the R&D output publicly known. Also, if the time period over which the owner expects to obtain economic benefits is relatively short, there may be little point in seeking legal protection. Therefore, in the absence of legal protection, it seems reasonable that the owner should be deemed to be the purchaser of the R&D output, or in the case of own-account R&D, the owner is deemed to be the producer.

It is not uncommon for the owners of R&D output, particularly the output of basic research, to make it freely available to others. This may be due to a desire to benefit society, a common objective for government and NPISHs, or it may be that the owner expects to benefit as a result. The owner may expect benefits from being the first to publish, thereby enhancing their reputation, or from the activity that is stimulated by making the knowledge available to others, or it may be that researchers have simply 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 owner still expects to obtain economic benefits. 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. Market producers are generally not altruistic, and it seems reasonable to assume that they expect to obtain economic benefits from all, or nearly all, of their R&D. But, for non-market producers, determining whether the owner is able to extract economic benefits can be a non-trivial matter. If government, for example, 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) or by reducing its costs (*e.g.* by supplying for free the output of its medical research to private medical providers that it pays to provide services to the public) then it is acquiring an R&D asset equal to the expected economic benefits. But if it undertakes or funds R&D in areas in which it will not be involved in direct production or in which it does not pay the eventual recipients of the knowledge to provide services to the public, it has been argued that this expenditure should not be treated as investment. As described in section 2.2, this corresponds to a more narrow view of the role of government and the meaning of economic benefits. An alternative view is that such expenditures should be recorded as investment as they serve a public good and the fact that government does or does not pay producers who use the knowledge to provide services to the public is not a relevant criterion.

Fortunately, resolving what is ultimately a philosophical discussion about the role of government is not necessary, as the Handbook takes a more pragmatic view on the two different approaches. In coming to its conclusion, the Task Force on IPPs considered whether the data sources available could support the measurement of non-market GFCF based on the more strict interpretation of economic benefits (and which is described in more detail in Box 3). Because only half of OECD countries currently have such data sources, the upshot of this assessment was to recommend a pragmatic approach; namely that most R&D expenditures by the non-market sector should be recorded as GFCF.

Recommendation 16: Ownership of an asset exists when the owner has effective management and control of the R&D output in order to ensure the expected benefits are obtained. There are more ways of ensuring this than patenting the R&D, for example by publishing R&D in a scientific journal. By doing this, others are prevented from claiming ownership**.**

Recommendation 17: As a practical solution, when the rights to benefit from the results of R&D are not clearly assigned by intellectual property protection, the owner should be deemed to be the purchaser or, in the case of own account R&D, the owner is deemed to be the producer.

Recommendation 18: When ownership is deemed to exist, the only relevant question for determining whether R&D should be capitalised is whether it is expected to provide economic benefits for its owner. - When it produces economic benefits for its owner, such as by increasing its productivity or reducing its costs, it should be capitalised.

In practice, the following is recommended for both market and non-market producers:

Recommendation 19: As a general rule, all R&D purchased or produced on own account should be treated as gross fixed capital formation, except when the R&D original is produced for sale (in which case it should be recorded as GFCF of the acquiring unit).

Box 3: Earlier views on R&D produced by non-market producers

The decision to record, in practice, all expenditures on R&D by non-market producers as GFCF was contentious, and ultimately driven by pragmatism. In its earlier deliberations the OECD Task Force (TF) on R&D arrived at an initial preference for not treating all R&D expenditures by the non-market sector as GFCF and developed an approach based on Socio-Economic Objective data that could support measurement. The approach provided relatively robust results but ultimately two factors led to the OECD Task Force reviewing its initial conceptual preference: the first was the continuing contention vis-a-vis the conceptual treatment, and by extension the interpretation of economic benefits for the non-market sector; the second, perhaps most important reason, was that half the OECD countries do not have the data needed to makes such estimates. Despite this decision however it is instructive to describe the approach in this Handbook, if only for posterity.

The TF investigated whether expenditures recorded according to classifications by Socio-Economic Objective (SEO) or by type (basic research, applied research and experimental development) from R&D surveys could be to allocated to GFCF, based on the stricter interpretation of economic benefits. Investigations revealed that 'type' was not a particularly useful source because some basic research, applied research and experimental development meet the stricter criteria and some do not. However, data based on SEO categories did provide meaningful results.

The TF concluded that government/NPISH could obtain economic benefits (based on a strict interpretation) for expenditures undertaken in SEOs 2 to 4, 8 and 12, (their principal activities) and SEOs 1 and 5 (via royalties arising from the exploitation of mineral discoveries). By contrast, government/NPISHs are not commonly engaged in agricultural or industrial production, SEOs 6 and 7, and so the TF concluded that related expenditures were not GFCF. Similar conclusions were drawn for SEOs 9 and 10, with a recommendation that the miscellaneous category, SEO 11, was reallocated as much as possible to the other 11 SEOs as appropriate.

Two sources of SEO data were considered: surveys of R&D performers and government budget appropriations or outlays for R&D by socio-economic objective (GBAORD). The former are regarded by the FM as being of higher quality than the latter, and are consistent with other performer data. When collected, there are separate SEO data for higher education and other general government. By contrast, GBAORD has an additional SEO category "research financed from general university funds" that comprises the bulk of funding by government for R&D undertaken by higher education units, and for many countries there is no further breakdown by SEO. GBAORD as a source of SEO is commonly only available for central government. Investigations have also revealed that SEO data from GBAORD are often not well allocated by SEO. However nearly all OECD countries have GBAORD data (whilst performer data are available for less than half of OECD countries). And the data are usually more timely than the performer data. Finally, the data are on a funder rather than a performer basis.

Moreover further adjustments are needed with the performer data, which relate to intramural expenditures, and so combine purchases and sales of R&D by the government and NPISH sectors. The TF concluded that extramural expenditures, preferably with a breakdown between grants and purchases, could be used to make the first adjustment but extramural expenditures are unavailable by SOE, and it was further assumed that purchases of R&D output are most likely to be for the purchaser's own benefit (GFCF). Sources of funds, preferably with a breakdown between grants and purchases, were identified for the second adjustment. The TF assumed that sales of R&D output made by the government and NPISH sectors are predominantly associated with those SEOs which are of primary interest to market producers, namely SEOs 6 and 7, and so the recommendation was to create two sub-totals for intramural expenditures by SEO: one relating to those SEOs that are candidates for GFCF (1-5, 8, 11 and 12) and those that are candidates for final consumption expenditure (6, 7, 9 and 10), with the value of sales of R&D being subtracted from the second sub-total (or the first sub-total if the value of sales exceeds the second sub-total). The TF further concluded that in the absence of performer data by SEO, GBAORD should be used for the government sector. GBAORD data are usually inconsistent with performer data and so the proportions of GBAORD data by SEO are used to allocate the aggregate of intramural and extramural expenditures by government to obtain expenditures by SEO. The adjustment for sales of R&D output by government was made in the same way as it was for performer data by SEO. As noted earlier, one of the shortcomings of GBAORD data is that most of the government funding for universities is commonly lumped into one category "research finance from general university funds" with no further breakdown by SEO. In these cases a breakdown by SEO can be imputed using the best available data. One possibility identified was to use a breakdown into field of science categories of R&D expenditures by performers. Another possibility was to use information from annual reports. In the absence of performer data by SEO for the NPISH sector it was recommended that a breakdown by SEO should be imputed using the best available data.

11.3 Duplication and omission with respect to other fixed assets

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 that 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 raises the level of GDP and why estimates net of consumption of fixed capital are preferred.

From a national accounts perspective, acquisitions of R&D performed by another unit should be recorded as either GFCF or consumption depending on the circumstances. But as discussed in chapter I, and concluded in recommendation 3: *As a general rule, all expenditures on intellectual property products, either purchased or produced on own account, should be recorded as gross fixed capital formation if they are expected to provide economic benefits for the owner. Only in cases where units specialise in producing a type of intellectual property product for sale should acquisitions of that type of product be expensed, or if it is clear that they are completely embodied in another product: for example software copies purchased to be embedded in computers for sale or other specific information exists such as the existence of a license with a duration of one year or less.*

Following this recommendation, all expenditures on R&D should be recorded as GFCF if they are expected to provide economic benefits for the owner unless the R&D is purchased or produced with the intention of future sale. This is most likely to occur in respect of market producers classified to the Scientific Research and Development industry (Division 72 ISIC Rev. 4). However this is not always the case. Start-ups in the R&D sector may for example develop R&D, before any sales have occurred, in anticipation of producing future products and sales, and in these cases the R&D should be capitalised. It follows therefore that unless specific information is available to the contrary, acquisitions of R&D should not be recorded as GFCF by units in this industry, such as cases when a unit takes out a patent and sells licences to use.

Recommendation 20: *Unless specific information to the contrary exists, all* expenditures on purchases of R&D or on R&D production by market producers in the Scientific Research and Development industry (Division 72 ISIC Rev. 4) should be recorded as intermediate consumption, or otherwise expensed, on the presumption that such units produce R&D for sale, and any purchases are incorporated in products for sale. Only when specific information is available to the contrary should acquisitions of R&D be recorded as gross fixed capital formation, such as R&D performed by start-ups that do not yet have sales or cases when a unit takes out a patent and sells licences to use.

A separate issue concerns what to do about double counting costs incurred in producing two or more types of asset when summing costs to estimate GFCF. This can easily happen when software is developed in-house to undertake R&D and vice versa. The issue is addressed in section 1.4.

11.4 Licences to use

Data to estimate the sale of licences to use R&D are not currently available from FM surveys because funding is restricted to payments for the performance of current R&D. One way of getting such data would be to ask R&D performers for details of the licences they sell to determine whether they satisfy the SNA requirements for GFCF by the licensee, and to obtain the income received from such licences. While such data could be expected to give reasonable estimates of total GFCF on licences to use R&D from domestic sources (assuming foreign sales could be excluded) it would exclude GFCF of foreign-sourced licences and there would be no industry (and possibly sector) breakdown. Another way would be to obtain details of expenditures in economy-wide surveys, as for software. It would be best to use both approaches and reconcile the results. However, before embarking on them it would be sensible to get some idea of the magnitude of GFCF by licensees by obtaining information from major R&D performers.

11.5 Licences to reproduce

The 2008 SNA recommends that if a licence allows the licensee to reproduce the original and subsequently assume responsibility for the distribution, support and maintenance of the 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. However, if the licensee simply reproduces and distributes copies without taking responsibility for support and maintenance then there is no change of ownership and the payments the licensee makes to the licensor should be recorded as IC rather than GFCF.

The FM does not cover payments and receipts for licences to reproduce, and the solutions suggested for licences to use could be applied to licenses to reproduce. However, before embarking on them, as for licences to use, it would be sensible to get some idea of the magnitude of the GFCF of licences to reproduce by contacting major R&D performers.

12. The bridge between FM and SNA sectors

Table 1 below 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 can be overcome by making a subdivision of the FM data for the higher education sector between:

a. Corporations and quasi corporations (including market NPIs);
b. General government units (including NPIs controlled by government); and
c. NPISHs

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[14]
	Non-financial corporations
	Financial corporations
Higher education sector	Corporations and quasi corporations
	General government
	NPISH
Abroad	Rest of world

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.

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

13.1 Deriving estimates of R&D output

As stated in chapter I, the SNA recommends that own-account capital formation should be estimated at the basic price it could be sold on the market, or at its basic price (estimated by summing costs) if the former is not possible.

Fortunately, the FM-based R&D surveys provide much of the data required to compile estimates of own-account capital formation for each of the key components needed in the summing costs approach, as shown below. But R&D output in a Frascati sense, reflects the development of 'new' R&D, and so does not include output related to the production of sales of licenses to use or reproduce; which are included in the SNA definition of output (all licences to use and non-GFCF licenses to reproduce).

Intermediate consumption of goods and services

The scope of intermediate consumption and the FM's *other current costs* are quite similar, but the accounting principles differ. When measuring output by summing costs, the SNA recommends summing the costs of the inputs actually used in the period. 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.

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 of employees and value added. But where they are included in the sum of costs has no bearing on the measurement of output and GFCF.

The FM recommends that R&D expenditures should be recorded at factor cost[15], and VAT and similar sales taxes should be excluded. But estimates of intermediate consumption are at purchasers' prices and so any taxes *less* subsidies on products omitted from the R&D survey data but that are applicable to the unit's intermediate expenditure need to be added.

Other current costs include payments for licences to use intellectual property other than software licence fees that satisfy GFCF criteria. The 2008 SNA, however, recognizes that some of these payments for licenses to use should be recorded as GFCF and not as intermediate consumption. Ideally, R&D surveys should be amended to separately identify these expenditures and collect information that would enable the determination of whether licenses to use IPPs should be treated as GFCF, bearing in mind recommendation 20 concerning R&D purchased by market producers in the Scientific, Research and Development Industry. However, before embarking on such a change it would be worthwhile conducting a pilot survey to determine how significant the estimates of GFCF are likely to be.

Acquisition of R&D output for use in R&D production

GERD is derived by adding the intramural expenditures of all resident R&D performers. Since intramural expenditures exclude purchases of FM R&D output performed in the same reporting period, GERD avoids "double counting" expenditures. Likewise, imported R&D used as an input by an R&D performer is excluded from GERD[16].

However, in the SNA, when output is measured by summing costs, all costs are included. Recommendations 19 and 20 are that acquisitions of R&D performed by another unit should be recorded as GFCF, except those by market producers in the Scientific Research and Development industry. Hence, when measuring output by summing costs, the costs of capital services provided by purchased R&D should be included, except for those purchases of R&D by market producers in the Scientific Research and Development industry, which should be recorded as IC.

Compensation of employees

Post graduate students who are either on the payroll of R&D performers and/or receive external funds (such as research scholarships) are included in those directly employed in R&D surveys in the FM. But the external funding component is not included in compensation of employees. To include it in compensation of employees requires re-routing the external funding received by the student and recording it as a current transfer from the funder to the R&D performer.

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

The user cost of capital[17] (*i.e.* the value of capital services provided by fixed assets) is equal to the consumption of fixed capital and a net return to capital. As noted, above, the 2008 SNA 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 net return to capital is set to zero, and the value of capital services is equal to the consumption of fixed capital.

In measuring GERD, the FM includes capital expenditures on fixed assets (other than R&D and own-account software) and land. These expenditures should not be included when summing costs to measure output, but the cost of the capital services the fixed assets provide should be included. One way of estimating the value of capital services they provide is to apply the perpetual inventory method (PIM) to the capital expenditures for previous periods as reported by FM surveys. In order to do this a breakdown below the level that is recommended by the FM is needed - one sufficient to distinguish between major components that have different long-term price changes and service lives. At a minimum 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. Purchases of R&D are separately identified, as described earlier.

Other ways of estimating the value of capital services are by making an imputation using the ratio of 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) to labour input or output. Alternatively, a

hybrid measure could be used, with consumption of fixed capital derived using data for the R&D performer and net capital services or net operating surplus imputed from an industry specialising in R&D.

Factors to consider in choosing between the various methods include:

a. The capital intensity of Division 72 may differ from that of other R&D performers and so the ratio of capital services or GOS to output or labour costs for Division 72 may not be appropriate.

b. The ratio of operating surplus to labour or output could vary considerably from year to year and, in addition, may 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 to 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. However, for practical reasons, it is recommended that the same rate is used as for other fixed assets.

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.

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.

In principle, past R&D can contribute to future R&D, and so these assets should also be included in estimating capital services but in practice it is generally difficult to measure this. Therefore, by convention, it is acceptable to ignore these expenditures unless specific information is available.

Other taxes less subsidies on production

Any other taxes less subsidies on production not already included in intramural expenditures need to be added to bring the value of output to basic prices. The FM recommends that expenditures on R&D should be recorded at factor cost, and so VAT and other similar sales taxes are excluded, irrespective of whether they are refundable or not. Nevertheless, some taxes on production are included in current expenditures. For example, payroll taxes are included in labour costs. On the other hand, other subsidies on production (i.e. subsidies on production other than subsidies on products) are not deducted from expenditure, but are shown as a financing source. Subsidies on R&D production may be quite substantial, and it is important to take them into account. Note that payable tax credits (see chapter 22 of the 2008 SNA) should also be recorded as subsidies.

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 unavailable then national accounts data on subsidies may be used to estimate these flows.

Taxes less subsidies on products

That part of R&D output produced for sale should be recorded at purchasers' prices. Hence, any taxes less subsidies payable on R&D products need to be added to this component.

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

14.1 Supply of R&D

Supply and use tables provide the means to estimate the GFCF of R&D using the commodity flow approach. However, for most countries a more realistic portrayal of the estimation process is that of making adjustments to the R&D survey estimates of intramural expenditures on R&D, because they usually dwarf the other components of supply and use. Detailed FM data on expenditure and funding provide the major part of the data needed for supply and use tables for R&D.

Output of R&D

Total supply of R&D is obtained by summing output and imports. R&D output can be classified in three different categories consistent with both FM and SNA-based terminology and data collection (Moris 2008). The three types are:

- own account,
- custom-made, and
- speculative production.

Own account R&D is produced ('performed' in FM terminology) and used internally, regardless of funding source (internal or external). Custom-made R&D is produced on behalf of another unit, usually under contract. Speculative R&D[18] refers to self-funded production not intended for internal use and with no advanced, secured buyer.[19] [20]This is exemplified by commercial R&D service providers (the latter, of course, also perform custom-made R&D under contract). For intramural expenditures, speculative R&D will include the creation of an original designed to be used solely for the purpose of producing licenses to use and licenses to reproduce. Intramural expenditure will not however include the value of any copies in addition to the value of the underlying original. Speculative production in an SNA sense will however include the value of any such copies (licences to use and non-GFCF licenses to reproduce) produced in the reporting period as well as the value of the original (or costs incurred in the period relating to its production).

In principle the output of speculative and custom-made R&D should be recorded in inventories (finished or work-in-progress R&D) until it is disposed of to a final user. But in practice the difficulty of implementation will generally outweigh the benefits.

All three categories are principally derived from FM-based R&D survey data. Transactions in custom-made and speculative R&D are also expected to be reported in general economic surveys and in the export figures from surveys of international trade in services (SITS). The values reported for custom-made R&D in a general survey or SITS should, in principle, correspond to the funding data reported in FM-based R&D surveys, but this need not be so for speculative R&D. The costs of undertaking speculative R&D are reported in R&D surveys while the values reported in general surveys or SITS will be the sales price. Funding data reported in FM-based R&D surveys is for the performance of present or future R&D – not past R&D. So the sale of speculative R&D should not be included in the funding data reported by the R&D performer, but it should be included in the extramural expenditures of the purchaser, if the purchaser is also a performer and in scope of the R&D survey. Ideally, the sales price should be used to measure the output of speculative R&D, but marrying the data from the different data sources to achieve this is likely to be very difficult. In any case, care needs to be taken to avoid double counting.

Imports of R&D

As noted in the paragraph above, there are three types of output from R&D services. Only two of these outputs relate to imports in the form of purchase, transfer (gift), or license transactions: custom-made and speculative R&D. More specifically, custom made R&D imports involve purchase of an original, whereas speculative R&D (which for the SNA includes: purchased, licensed to use or reproduction, or received as a gift) may involve originals or copies. Some of these import transactions, especially those between affiliated companies and/or involving transfers or gifts may not be recorded or may not be easily separated from other activities in company, administrative (e.g., tax, customs), or statistical survey records. Lastly, outputs from current and prior R&D involved in import transactions may be protected by several forms intellectual property protection such as patents, copyrights, or secrecy. Table 2 summarizes these categories."

Table 2 R&D imports by type of transaction and IP protection

R&D Imports	**R&D Services (Originals)**	**IP (Original or Copies)**		
	(BPM 6 EBOPS 10.1.1.1)	**Purchases (BPM6 EBOPS 10.1.1.2)**	**Transfers (BPM6 EBOPS 10.1.1.2)**	**License to Use or Reproduce (BPM6 EBOPS 8.3)**
From speculative production by seller	X	X	X	X
From custom R&D services	X	X		

Extramural expenditures from R&D surveys comprise purchases and grants for the performance of R&D. Hence, they only include purchases of custom-made R&D (but only for R&D performers). SITS include data for R&D services and IP transactions but perhaps not with the desired detail or frequency, although it may be possible to supplement them with data from innovation surveys. Transfers and unrecorded transactions are unlikely to be available from SITS or foreign affiliates trade in services statistics (FATS), unless special steps are taken to collect or impute them.

Purchasers' prices

Supply-Use tables record output at basic prices. However consumption is measured at purchasers' prices. In theory therefore any trade margins and taxes/subsidies on products that might be applicable on R&D products should be included when sold. In practice these items are likely to be zero, certainly for margins but they are included in Table 4 below for comprehensiveness.

14.2 Uses of R&D

Uses of a product typically comprise final consumption, intermediate consumption, exports, GFCF and changes in inventories. In order to derive GFCF as a residual by sector, all purchases of R&D output between domestic sectors need to be recorded, too. Any capital transfers of R&D output should be recorded subsequently in the capital account.

Final consumption of R&D

Final consumption of R&D comprises household consumption, which is expected to be negligible, and any expenditures by government and NPISH on R&D that are not recorded as GFCF (nor as intermediate consumption, depending on how countries present their supply-use tables[21]. It is recommended that this item is shown separately, to satisfy the needs of users who are interested in a measure of total final expenditures on R&D.

Intermediate consumption of R&D services used in R&D production

This has already been dealt with above.

Net purchases of R&D between domestic sectors

The net purchases of R&D output between domestic sectors that constitute R&D GFCF need to be recorded in order to show uses, as opposed to output, by sector. If a split of the funding data is unavailable, then a practical solution is to assume that non-government R&D performers mainly make outlays to acquire R&D, while government R&D performers make almost none.

Inventories of finished R&D and work in progress

Since production of R&D generally takes longer than one year, whether own account, custom, or speculative, there will also be work in progress until the R&D is finished. The 2008 SNA 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 as work in progress. This is particularly important for R&D produced by affiliates of multinational firms, which may be ultimately be exported.

Exports of R&D

Exports may be classified as cross-border sales of custom-made and speculative R&D and outbound R&D transfers (Moris 2008). However, similar to the case for imports, exports of custom and speculative R&D are likely to be included as a whole in international transactions surveys that provide data on R&D services, whereas outbound transfers are not available from either R&D or trade surveys.

Alternatively, some export data may be obtained from R&D surveys. 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 both payments for purchases and **funding grants** (**cash** transfers in the national accounts sense) and at best only a partial decomposition may be 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 – see annex D *Additional Data Requirements*. (At the time of writing the NESTI group was 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 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 no 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.

Gross fixed capital formation in R&D

GFCF is derived as the residual between supply and the above uses. While it is possible to derive estimates of R&D GFCF using data collected as per the FM, the quality of the estimates could be significantly improved with the collection of additional data. In 2005, the Canberra II Group composed a list of additional data required from R&D surveys to better meet national accounts requirements (also sent to the OECD's NESTI Group, which is responsible for the FM). This is presented in annex C. The most important improvements are to obtain funding and extramural expenditures that are sufficiently classified.

The FM does not provide all the required data to estimate imports and alternative data sources need to be used, such as trade surveys or specialized business surveys, including innovation surveys. Further guidance on the estimation of exports and imports using commonly available current data sources is provided in annex E. Pointers for future development of trade data sources are described in annex F.

Table 3 summarises the steps needed to derive an estimate of R&D output and table 4 summarises the remaining steps to derive GFCF of R&D.

Table 3 Summary of steps to derive output of R&D

Starting point: FM Intramural expenditures on R&D for each sector	
1. Output of licences to use and non-GFCF licences to reproduce	Add sales from licenses to use and non-GFCF licenses to reproduce (i.e. those not satisfying asset requirements).
2. Intermediate consumption of goods and services other than R&D	Subtract payments for licences to use intellectual products (principally R&D assets, such as patents) that should be recorded as GFCF. See item 6 below and item 7 of table 4.
3. Intramural expenditures on own-account production of software	Subtract intramural expenditures on own-account production of software that satisfies the requirements to be recorded as GFCF.
4. Intermediate consumption of R&D services used to produce R&D	Add extramural purchases of R&D that should be recorded as intermediate consumption, but not those that should be recorded as GFCF. Applies only to market producers in the Scientific R&D industry.
5. Compensation of employees	Add payments to postgraduate students not included in FM data.
6. Cost of capital services	Subtract capital expenditures Add cost of capital services (only CFC for non-market producers), including R&D assets specifically identified as contributing to R&D output.
7. Other taxes less subsidies on production	Add taxes not included in FM data Subtract subsidies
	Equals Output of R&D for each sector

Table 4 Summary steps to derive total supply, total use and GFCF of R&D

Starting point: R&D output for each sector	
1. Add Imports of R&D	Including all expenditures on licences to use and reproduce R&D.
2. Add trade margins	In practice this is likely to be zero
3. Add taxes and subtract subsidies on products	In practice this is likely to be zero
4. Equals Total supply and Use of R&D	
5. Subtract Intermediate consumption of R&D	Same as item 4 from table 3
6. Subtract Acquisitions of R&D not expected to provide a benefit	In practice this is likely to be zero but licenses to reproduce not satisfying GFCF requirements should be recorded here.
7. Subtract Exports of R&D	Do not include sales of licenses to reproduce that satisfy GFCF requirements and that relate to an original produced in an earlier period. These sales concern pre-existing assets and are not included in output.
8. Add Net purchases of R&D between domestic sectors	Net purchases that are R&D GFCF. As per funding data between domestic sectors, excluding data for items 5, 6, transfers and subsidies.
9. Subtract Changes in inventories of finished R&D and work in progress	
Equals Total GFCF of R&D for each sector	
Add/subtract capital transfers of R&D assets between sectors in capital account	

15. Impact on the accounts

Clearly, recognizing R&D as GFCF will increase estimates of GDP. But for non-market producers, where output is derived via the sum of costs, the overall impact will be smaller than the expenditures on R&D GFCF per se, and for this sector the increase in GDP will reflect only the CFC of R&D fixed assets, (since, ignoring the CFC component, the capitalization of R&D merely results in a shift of expenditures from general government final consumption to GFCF). In practice, changes to GDP may also arise from the introduction of FM-based R&D survey data replacing other data sources.

16. More on international trade

16.1 Data sources

Chapter I provided a detailed overview of the conventional approaches used to measure international trade in IPPs including R&D. This section provides commentary on some of the additional sources that can be used to complement the more traditional trade data sources.

R&D surveys

Data from R&D surveys are described at length earlier in the Handbook. Sources of funds data are a data source for exports and extramural expenditures are a data source for imports. Both have their strengths and weaknesses, as already described.

Other sources

Surveys not specifically designed for R&D purposes may provide useful indicators. For example, industry-specific surveys with data for Scientific R&D services ISIC 72 rev.4 (or NAICS 5417 for North America) may provide data on global or export revenues. However, data from this source should be viewed as providing a lower bound since they do not include R&D exports/imports by companies or establishments whose primary activity is not R&D. (In contrast, services trade surveys cover all services, including R&D services, as an activity for all companies regardless of company classification.) Innovation surveys are also a potential source. The further development of data sources for international trade for the measurement of IPPs is discussed in annex 4.

Data adjustments

In the light of current shortcomings from known sources on R&D trade, countries may leverage existing data from different sources by cross-survey comparative or benchmarking studies (Schellings, 2004) and microdata-linking exercises. Bilateral statistical studies represent another tool already exploited for comparisons of overall exports and imports across countries. Data quality studies on exports and imports of IPPs may be included in such bilateral projects or be designed as stand-alone exercises, at least on a one-off basis.

16.2 Scope of R&D

As described earlier the scope of BPM5 includes development and testing activities, which go beyond the scope of R&D defined in the 2008 SNA. Thus, until countries begin to provide data on the basis of the 2010 EBOPS classification system which resolves this issue, transactions data obtained from services surveys will need to be adjusted down to correct for non-R&D components.

17. Quarterly estimates of R&D

Until now R&D surveys have been conducted annually, or less frequently, and there is a need to both interpolate existing annual data and to extend the latest annual data one or more years to meet the needs of quarterly national accounts.

This type of problem is commonplace for national accounts compilers and the usual practice is to derive a quarterly indicator that is then benchmarked to the annual estimates[22]. Ideally, the quarterly indicator should be highly correlated with the annual data to minimise revisions, and it is best to have quarterly data from the same source as the annual data. This is generally not possible and so national accountants have to use quarterly indicators that are generally, but not always, inferior to their annual counterparts. In the case of R&D, there appear to be five options:

a. A quarterly R&D survey on a smaller scale than its annual counterpart
b. Annual intention data
c. Proxy indicators
d. An econometric or mathematical model
e. Administrative data

17.1 A quarterly R&D survey on a smaller scale than its annual counterpart

It may be feasible to conduct a quarterly R&D survey that collects less detailed data and from a smaller sample than its annual counterpart. A substantial part of the sample may be common with the annual survey, but probably not completely because of the births and deaths of units since the latest annual sample was taken. The most important data item is expenditure on wages and salaries. Intermediate inputs are probably minor and highly correlated with labour input, while capital services will be dominated by capital goods acquired in previous periods. Data to support the estimation of international trade in R&D may also be a high priority.

If this option is taken the quarterly survey should be started as soon as possible in order to provide as long a time series as possible at the time the new treatment of R&D is introduced. The time taken for a new survey to settle down and the need for sufficient data for seasonal adjustment purposes should be taken into account.

17.2 Annual intention data

Some countries ask R&D performers in their FM surveys what their R&D expenditure intentions are for the coming year. The actual annual data and the intention data for the latest year can then be interpolated by employment data relating to categories prevalent in R&D. Canadian data reveals a high correlation between the intention data and actual ex post data reported by respondents.

17.3 Proxy indicators

A third option could be along the lines of the macro approach for estimating own account capital formation of software recommended by the OECD task force on software[23]. This involves summing costs, as in the first approach, but with the labour cost component being derived from quarterly employment data multiplied by a suitable average compensation rate. This approach requires reasonable quality quarterly employment data for a sufficiently fine level of employment categories. If these data are available it may be possible to construct a long time series of quarterly estimates of R&D expenditures quickly. This would allow an assessment of how good an indicator it is and permit seasonal adjustment. Data for estimating international trade in R&D would have to come from quarterly trade in services surveys.

17.4 Administrative data

Some countries may have administrative sources that provide indicators of R&D activity.

17.5 An econometric or mathematical model

The fifth approach is to either use some indicators that have a relationship to expenditure on R&D or to simply use a mathematical procedure to interpolate and extrapolate the annual estimates. Clearly, this is the least desirable option.

17.6 Conclusion

It is important to develop quarterly indicators for R&D GFCF to both interpolate and extrapolate annual estimates. Potentially at least, the best estimates will probably come from a quarterly R&D survey.

If there is an existing source of sufficiently detailed employment data then a satisfactory solution would be to use a macro approach akin to the one recommended for software. This could be implemented more quickly and produce a long time series, which, amongst other things, would allow an evaluation of its performance in the past.

Collecting estimates of expenditure intentions from R&D performers and interpolating with a suitable employment indicator is low cost and, based on the Canadian experience, discussed above, produces good results. This could well be the most cost-effective solution.

18. Prices and volumes

Two features of R&D make it difficult to compile output price indices. First, it is very heterogeneous and second, most of it is produced on own account. Recommendations 12 to 14 describe the approaches that should be undertaken in creating price indices for IPP assets in general, which hold equally for R&D. Recommendation 14, in particular, relates to own-account production which is especially relevant for R&D and is restated below for comprehensiveness. This is consistent with the FM that also recommends the use of, and detailed advice on how to build, input-cost price indices. An alternative approach to a comprehensive input-cost price index is to use a single price index for one of the inputs. This approach is not uncommon for measuring the volume of output in the service sector where many countries typically use a measure of average earnings or equivalent for deflation. However, the cost structure of R&D, provided by R&D surveys, show that no single input represents more than 50% of output and so such an approach is generally not recommended for deflating R&D output.

Recommendation 21: In principle, output, or pseudo output, price indices should be derived for R&D. But at the present time no consensus has been reached on how such price indices could be derived. Until that time input-cost price indices should be used.

In practice the use of input-cost indices for R&D is likely to be widespread in the short to medium term at least, and so it is instructive to say a few additional words on the subject here.

Methods for deflating estimates of compensation of employees, an important input-cost, should ensure adequate splits of the quantity and price components. So, for example, average earnings per week indices, should be adjusted before use to ensure that changes in the compensation paid per hour are included in the price components but that changes in the index driven by changes in the number of hours worked, or say, qualifications/experience are included in the quantity component. It also follows that estimates of compensation of employees should be broken down as far as possible by employee-type, such that the disaggregation results in groups that are as homogeneous as possible. The FM for example breaks down R&D

personnel into three categories, Researchers, Technicians and equivalent staff, and other supporting staff. Ideally this split should serve as a minimum (with corresponding average compensation indices also available). The UK R&D satellite account uses hourly wage information for 12 detailed occupational groups from the Annual Survey of Hours and Earnings (Galino-Rueda 2007). Useful information on other national approaches is also available, for example: for the United States (Copeland, Medeiros and Robbins, 2007) and for Denmark (Gysting 2006).

19. Capital measures

Typically, researchers have derived estimates of R&D capital stock using econometric methods or the perpetual inventory method (PIM). The PIM method is most commonly used to derive capital stock estimates of fixed assets for national accounts purposes, and therefore has the advantages of being well understood and having computer systems in place to employ it. These are some of the reasons why, as described in Chapter I, the PIM method is the recommended approach for deriving capital measures for R&D.

The choice of PIM notwithstanding an important area where guidance is still required concerns the assumptions and/or sources that should be used to estimate depreciation rates and asset service lives for R&D. Two key approaches have generally been used in practice: the patent renewal method and econometric methods. While both approaches have serious shortcomings[24], they generally indicate that service lives lie between 10 and 20 years, but vary considerably between industries.

Given these shortcomings, the joint meeting of Canberra II and NESTI in 2006, encouraged the adoption of survey based approaches, particularly those that could target major R&D performers in various industries to test whether they were able to provide expectations of the service lives of R&D. In response, a number of statistical agencies (including Israel, Germany and the UK) undertook exploratory pilot surveys which are described below.

19.1 The pilot survey conducted by ICBS

The pilot survey conducted by ICBS (Israeli Central Bureau of Statistics) covered a small number of enterprises (about 30), operating in the most important industrial sectors engaged in R&D – software, pharmaceuticals, semiconductors, monitoring equipment, chemicals. Experts on R&D such as representatives of venture capital funds were also interviewed. Respondents were asked about the length of service life, and also about their views on ways to collect data, the relevant contact persons, etc. In almost all cases respondents were able to provide firm estimates of the average length of service lives of R&D, and when data for more than one enterprise in a certain industry were collected, the length reported was similar for similar types of R&D.

In almost all cases respondents explained that they undertook more than one kind of R&D, each with its own specific service life. The enterprises distinguished mainly between R&D that involves major innovation and R&D that involves minor innovation, and they reported significant differences in service lives between the two. This meant that it was important to collect data on the composition of R&D in some industries and, after a few interviews were conducted, a shorter questionnaire was developed that included questions about the length of service lives by type of R&D broken down by different stages in the R&D development/use process namely: the gestation lag, the application lag and the length of time used in production (see below).

Some of the major findings are as follows:

- Some respondents explained that the length of service lives has changed in recent years, and become shorter in some industries. This implies that data on the length of service lives need to be collected regularly (at least every few years).

- The length of service lives appeared partly to be connected to the duration and difficulty of R&D projects. Data on the duration of R&D projects were easy to obtain – the enterprises had structured working programs for R&D projects.

- The length of the application lag was quite short in many cases. The enterprises reported that they work simultaneously on the R&D and on the designs for use of the R&D in production, so that implementation takes place as quickly as possible.

- The respondents reported that they had detailed work programs for a number of years ahead, and were well able to respond to questions on the lengths of the three stages.

The results of the pilot survey are presented in table 5, below, and given the size of the sample, are intended for illustrative purposes only.

Table 5 Average service lives reported by enterprises in selected industries in the pilot survey*

Industry	Type of R&D	Length of gestation lag in years	Length of application lag in years	Length of use in production in years	Total length in years
Pharmaceuticals	Major improvement - unique, original medicine	15	1	5	21
	Generic medicine	2	1	10	13
Chemicals	Major development	9	1	50	60
	Development on existing product	1	1	10	12
Semiconductors	For use in communication - appliances	2	0 to 1	3	5
	For use in communication - equipment for infrastructure	2	0 to 1	6	8
	For use in transportation equipment	2	1	10	13
Monitoring equipment	Original product	4	1	15	20
	Development on existing product	2	1	10	13
Software	Major improvement	3	Up to a year	5	9
	Minor improvement	2	Up to a year	2 to 3	5
Fabricated metal products, except machinery and equipment	Major development	2	1	15	18
	Development on existing product	Less than a year	1	10	12

* Since only a few enterprises in each industry were covered in the pilot survey, the length may not be representative, although the responses within industries were similar.

Further summary information from the pilot survey is provided below:

- Inclusion of unsuccessful R&D: Respondents were aware of the rates of success, and the fact that R&D can be unsuccessful was taken into account in work programs. Respondents also stated that revenues from successful R&D covered all R&D, including that which proved to be unsuccessful.

- The reason for ceasing to use an R&D asset: reflected the uptake of newer R&D which replaced and improved upon the former R&D asset. In most cases the old R&D asset is entirely abandoned but in some cases it continues to be used in production on a minor scale if remaining benefits can be gained.

- Factors that may lengthen the use of the R&D: lack of competition (niches) or cases where R&D is embedded in large-scale expensive equipment that is renewed infrequently.

- Framework for data collection: Respondents thought that service lives were similar for specific types of R&D, so that collection of information on service lives from experts could be sufficient.

- Contact persons within an enterprise: The preferred respondents to the questionnaire should be R&D managers or, for R&D enterprises, Product Managers. For face to face interviews however, a combination of R&D managers and financial managers should be encouraged.

19.2 Pilot survey conducted in Germany

The Federal Statistical Office of Germany has distributed a questionnaire to a number of industry associations and enterprises with the help of the umbrella organization of German Industry (BDI) in Germany to gain information on service lives, on the share of R&D patented, and on the shares of types of R&D (with significantly different service lives), within total R&D expenditure. Results from all 12 respondents showed that it is possible to obtain answers to questions on the length of service lives. Most respondents also gave information concerning the different types of R&D and some separated product and process development. Those who differentiated between several types of R&D were mostly also able to estimate their shares in total R&D.

On the basis of this experience one can conclude that it is important to obtain service lives broken down by type of project within each industry, and to have estimates of the relative magnitudes of the values of the different types of project so that a weighted average of service lives can be derived for each industry (but separate mortality functions for the difference service lives of projects within an industry can also be calculated). In addition, the reported shares of relating to the patenting of R&D ranged from between 1.5 to 90 per cent, indicating very strongly that considerable care is needed when using patent data to estimate the service lives of R&D.

19.3 Pilot survey conducted in UK

The UK Office for National Statistics undertook a pilot survey of 19 enterprises (nine face-to-face and ten telephone interviews) across various industries, using the questionnaire developed by the Israeli CBS. Unlike the other two pilot surveys, the UK survey covered R&D and other non-technical activities. However, it was found that this approach did not work very well and that the two types needed to be conducted separately with different interviewees. For R&D it is crucial that a technical person, familiar with R&D projects, be asked to complete the questionnaire. Other findings are as follows:

- The response from companies was extremely positive, as the overriding feeling of interviewees was that the R&D agenda had been neglected.

- The questionnaire needs to be amended; clearer definitions given, more examples provided, geography and timeframe specified, and questions clarified - a second round of testing will be required.

- Most of the companies undertook applied and experimental development research rather than basic research.

- The sources and structures of R&D production and management varied across companies.

- The concept of a three stage service life was said to be simplistic although companies were able to provide service life estimates within this framework.

- Typical service life lengths are difficult for companies to estimate – therefore the different types of R&D should be clearly defined within the questionnaire.

- To improve estimates of service lives an expenditure weighting should be collected.

19.4 Japanese and Korean surveys

Two earlier instances of data collection on service lives were conducted by Japan and Korea. Although the data collected were not explicitly on R&D, and covered intangibles in general, the results demonstrated that it was possible to obtain data on service lives.

The Japanese survey was conducted by the Japanese Science and Technology Agency. This survey concerned only patents and had a questionnaire with questions on length of time that a patent generated royalty revenues, or the average length of time the products that embodied patented technologies generated profits (the survey is mentioned in *Goto and Suzuki, 1989*).

Questions on service lives have also been included in Korean innovation surveys for manufacturing and for service industries. The questions concerned service lives of knowledge accumulated during innovation activities, and a distinction between product innovation and process innovation was made. The questions in the 2005 version of the survey for manufacturing were as follows:

- "For your innovation activities, how many years is the knowledge accumulated from your product innovation during the period 2002-2004 valid, on average?"

- "How many years is the knowledge accumulated from your process innovation during the period 2002-2004 valid, on average?"

Since the concept of innovation is wider than the definition of R&D, the results from the survey cannot be applied to the estimation of R&D service lives per se, unless R&D accounts for a large portion of innovation expenditures. However the number of responses to the survey – for example the 2005 survey for manufacturing had a 61% response rate out of a large sample (from the results the sample seems to be over 10,000 enterprises) - demonstrates that it is feasible to collect data on the service lives of intangibles in full-scale regular surveys.

19.5 Conclusion

The outcomes of all three pilot surveys and indeed the earlier surveys conducted by the Japanese and the Koreans are very encouraging, and it appears that obtaining service lives by surveying respondents is viable, but an assessment of full blown surveys by several countries are required to confirm this is so.

Based on the outcomes of the three pilot surveys described above, the original CBS questionnaire has been modified a little – see below. Service life surveys could be conducted as either as part of the regular R&D surveys or conducted independently. The three countries who have undertaken pilot surveys favour undertaking a separate survey of a sub-sample of the regular R&D survey sample. By linking data from the two surveys at the unit record level, it should be possible to use GERD data from the regular R&D surveys to weight service life information to obtain industry averages. It is envisaged that surveys could be conducted by mail, personal interview or telephone. But whichever mode is used, it is clear that contacting a technical expert with first-hand knowledge of the R&D being undertaken by an enterprise is critical.

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

10 One of the principal aggregates obtained from R&D surveys conducted as per the Frascati Manual.

11 There is a fourth dimension – product field - recommended for the business enterprise sector, which focuses on the actual industrial orientation of the R&D carried out

12 Some countries compile all, or nearly all, the data recommended by the FM. Some countries compile less detail and some countries collect extra detail

13 Data are now collected for the OECD based on the 2007 version of NABS (Nomenclature for the Analyses and Comparison of Scientific Programmes and Budgets). Previously, data were collected using Eurostat's 1992 version of NABS, see Eurostat: "Comparison between NABS 2007 and NABS 1992" October 2008.

14 Expenditures on R&D by the household sector are considered to be nil as there is no real survey coverage.

15 Estimates of national income and output at factor cost exclude taxes less subsidies on production and were recommended measures in the 1968 SNA. However, they are not recommended measures in either the 1993 or 2008 SNA.

16 For the acquisition of services closely related to intramural R&D activities, the borderline between intramural and extramural expenditures is not always clear. If these services are separate R&D projects, the expenditures can in most cases be regarded as extramural R&D. If they are certain tasks (not necessarily R&D as such) necessary for the intramural R&D of the unit but contracted out, they can generally be regarded as intramural R&D expenditure (other current costs).

17 Refer to the OECD manual *Measuring Capital* for a full explanation.

18 The label is consistent with the term used for construction of dwellings and other buildings and structures in the SNA

19 The 2008 SNA recognizes speculative production of assets (see for example paragraph 10.55). Mohr and Murphy (2002: 5) consider speculative IP production in the context of product classification systems.

20 R&D contracts where the buyer does not receive payments until the client successfully commercializes resulting knowledge could be classified as speculative R&D as defined here.

21 Some countries show expenditure by government and NPISH directly as final consumption, others however reflect the transactions as IC, forming parts of the costs of output, and instead record under final consumption the output produced and consumed by these sectors.

22 See Quarterly National Accounts Manual IMF 2001..

23 OECD Software Task Force Report on Software Measurement in the National Accounts (2002).

24 Econometric studies commonly make unrealistic assumptions, such as attributing all multifactor productivity growth to R&D. The major drawback with the patent-renewal approach is that much, probably most, of R&D output (by value) is not patented.

ANNEX B: QUESTIONS ON THE LENGTH OF THE SERVICE LIFE OF R&D

Recently the United Nations Statistical Commission approved the inclusion of expenditures on major parts of research and development (R&D) as fixed capital formation (i.e. investment) in the national accounts, after appropriate steps have been taken to ensure that the estimates are of acceptable quality.

One of the requirements is to record the value of the stock of R&D assets in the national balance sheet and another is to make estimates of the depreciation of these assets over time. In order to make such estimates, information on the length of the service life of R&D assets is required. You can help make this important improvement to national and international statistics by entering the required information in the following tables.

Please provide information on the average length of service life for the R&D assets you have developed yourself in Table 1 and those you have purchased in Table 2.

If you have different types of R&D assets with different average service lives, please describe the types and the service lives for each type. Please provide an approximate proportion of the expenditure on each type in total expenditure.

Table 1: R&D projects for own use

No	Type of R&D project	Details on stages in the "life" of R&D				Comments
		Stage	Information needed	Time in years	Expenditure % of total projects	
1		Development	Average time of development			
		Transition from development to production/operation	Average length of time between end of development to start of use of the R&D asset in production/operation			
		Use in production/ operation	Average length of time from start of use of the R&D asset in production until end of use			
2		Development	Average length time of development			
		Transition from development to production/operation	Average length of time between end of development to start of use of the R&D asset in production/operation			
		Use in production/ operation	Average length of time from start of use of the R&D asset until end of use			

Table 2: R&D purchased from others

[2]No.	Type of R&D	Details on stages in the "life" of R&D				Comments
		Stage	Information needed	Time in years	Expenditure % of total	
1		Use in production/operation	Average length of time from start of use of the R&D asset purchased until end of use			
2		Use in production/operation	Average length of time from start of use of the R&D asset purchased until end of use			

ANNEX C: CONSOLIDATED SET OF QUESTIONS FOR R&D PERFORMERS[25]

Introduction

This document is a supplement to the progress report on the development of the OECD Handbook on Deriving Capital Measures of IPPs prepared by the OECD Secretariat.

At various times in the meeting of the OECD Task Force on R&D and Other IPPs (TFIPP) in April 2008, the matter of approaching major R&D and software performers for information was raised. As a result, it was agreed that it would be highly desirable for countries represented on the Task Force to consult major R&D and software performers using a standard set of questions, and that the development of these questions should be given a high priority.

Many of the questions are exploratory in nature. They are intended to help the TFIPP better understand how R&D performers do things and it is proposed that only major R&D performers be approached. They are not intended to be asked recurrently. Using a standard set of questions would facilitate country comparisons and if the questions are sufficiently exhaustive there will be no need to contact a performer more than once to obtain the information required by the Task Force.

There are some questions that would be recurrent and are intended to be incorporated in either a main stream R&D questionnaire or an auxiliary questionnaire. However, pilot surveys would be needed to develop these questions and these could be combined with the one-off questions.

Each sub-group of the TFIPP was asked to identify questions pertinent to its objectives. They are intended to determine the following:

I. R&D output service lives (recurrent).

II. Which R&D output should be recorded as gross fixed capital formation (GFCF) and which should not (one-off).

III. Data availability and data for international trade in R&D services and R&D output produced in the past (such as patents) between (i) affiliated enterprises and (ii) non-affiliated enterprises (recurrent, unless labelled otherwise).

IV. To what extent the acquisition of software and R&D licences to use should be recorded as GFCF (one-off).

Most questions are aimed specifically at R&D performers, but there are some aimed at software performers, who are likely to be R&D performers but may not be. Some of the questions regarding international trade have been designed to be included in surveys of trade services and foreign direct investment. Questions should apply to a given reference year (especially those intended as recurrent exercises).

Beyond the specific needs of the TFIPP it is hoped that this collection of questions will also serve to stimulate discussion and long-term data development on these intangibles.

I. Length of the service life of research and development

See Annex B

II. Which R&D output should be recorded as GFCF and which should not?

II. Which R&D output should be recorded as GFCF and which should not?

1. Questions for non-market performers of R&D

Objectives

To determine to what extent non-market performers (NMPs) of R&D expect to obtain economic benefits from undertaking R&D. These benefits can take several forms:

a) The NMP is paid to undertake R&D for another unit

b) The R&D output is sold outright

c) Licences to use the R&D output are sold

d) The NMP enters into a partnership or some other contract with a market producer, whereby the NMP gets some share of the profits

e) The R&D output is used by the NMP, or an affiliate, in its production

f) In cases (c), (d) and (e) the NMP is undertaking GFCF

Questions

A. In the survey form you completed for year xxxx, you indicated that you received yyyy funding from different sources. How much of these amounts were grants and how much were from sales?

B. How much of sales was from

   a. R&D undertaken under contract or outright sale

   b. From licence fees or royalties

   c. Share of profits from a business partner

C. Of the R&D you have undertaken paid for by grants, what proportion of the R&D do you expect to be used by your organisation, or an affiliated organisation, in its own production (other than in the production of other R&D)? This includes receiving payments for licensing R&D to others.

D. Of the R&D you have undertaken paid for by grants, what proportion of the R&D do you expect to be used *repeatedly* by your organisation, or an affiliated organisation, in the production of other R&D?

E. Could you answer these questions separately for basic research, applied research and experimental development?

2. Questions for non-market purchasers of R&D (outside the R&D industry)

Objective

To determine to what extent non-market units expect to obtain economic benefits from their purchases of R&D output

Enterprises in the R&D sector are explicitly excluded as unless specific information says otherwise, expenditures on R&D by the sector are treated as intermediate consumption (IC).

These questions should be asked of non-market purchasers or funders, whether they are R&D producers or not.

Questions

A. Do you (expect to) use all purchased R&D in a production process (other than in the production of other R&D)?

B. If not, what other reasons do you have for purchasing R&D?

C. If not, could you quantify which part of purchased R&D is used in a production process?

D. For R&D performed by others that you fund by a grant rather than make an outright purchase, do you expect to receive any R&D output that you could use in your own future production, *i.e.* of defence services, health services, policy development? If so, can you specify?

III. International trade in R&D services and R&D output produced in the past (such as patents) between (i) affiliated enterprises and (ii) non-affiliated enterprises (recurrent)

Questions for R&D survey respondents

1. *International R&D transactions within your company*

   A. Would your company be able to report payments for R&D performed for you by others within your company but located outside this country?

      i. transactions involving your foreign parent company

      ii. transactions involving other foreign members of your company

   B. Would your company be able to report revenues for R&D performed by you for others within your company but located outside this country?

      i. transactions involving your foreign parent company

      ii. transactions involving other foreign members of your company

2. *International R&D transactions with others outside your company*

   A. Would your company be able to report payments for R&D performed for you by others outside your company and also located outside this country?

B. Would your company be able to report revenues for R&D performed by you for others outside your company and also located outside this country?

C. Can you separate out R&D grants from contracts for R&D services?

3. International transfers of R&D or patents (inflow)

A. Have you received free transfers of R&D or patents from the following sources?

i. Your foreign parent company? (if applicable)

ii. Other foreign members of your company (if applicable)

iii. A foreign university or research institute?

iv. A foreign government unit or international organization?

B. Would you be able to estimate the production cost or value of these transfers?

4. International transfers of R&D or patents (outflow)

A. Have you donated R&D or patents to the following recipients?

i. Your foreign parent company? (if applicable)

ii. Other foreign members of your company (if applicable)

iii. A foreign university or research institute?

iv. A foreign government unit or international organization?

B. Would you be able to estimate the production cost or value of these transfers?

Questions for international services trade respondents

1. R&D services vs. other business and technical services - (one-off)

A. Have you reported R&D services exports/imports to include transactions in the following services? (this question assumes R&D services is a survey category in your survey, otherwise skip)

i. commercial testing services

ii. software development services

iii. engineering services

iv. design services

v. customer services (post-sales)

vi. royalties and license fees

B. Would you be able to separate out R&D services exports/imports from transactions involving the following services?

i. commercial testing services

ii. software development services

iii. engineering services

iv. design services

v. customer services (post-sales)

vi. royalties and license fees

2. *International R&D transactions within your company*

A. Would your company be able to report payments for R&D performed for you by others within your company but located outside this country?

i. transactions involving your foreign parent company

ii. transactions involving other foreign members of your company

B. Would your company be able to report revenues for R&D performed by you for others within your company but located outside this country?

i. transactions involving your foreign parent company

ii. transactions involving other foreign members of your company

3. *International R&D transactions with others outside your company*

A. Would your company be able to report payments for R&D performed for you by others outside your company and also located outside this country?

B. Would your company be able to report revenues for R&D performed by you for others outside your company and also located outside this country?

25 Supplementary paper presented by OECD Task Force on R&D and Other IPPs Working Party of National Experts on Science and Technology Indicators, 16-19 June 2008, Paris

4. International royalties, license fees for the use or sale of intangible property

Note: For the purposes of this question intangible property includes patents, trademarks, copyrights, and trade secrets.

A. Total royalties, license fees, and other fees for the use of intangible property (IP), EXCLUDING cross-licensing:

Payments

Receipts

of which:

Industrial processes and products (except software licensing)

Payments

Receipts

Software licensing

Payments

Receipts

B. Total royalties, license fees, and other fees for the use of intangible property (IP), in a CROSS-LICENSING arrangement:

Payments

Receipts

of which:

Industrial processes and products (except software licensing)

Payments

Receipts

Software licensing

Payments

Receipts

Are these cross-licensing measures net or gross transactions with respect to cross-licensing? If net, could you estimate the gross value of these transactions?

C. Total fees paid or received for the sale or purchase of intangible property (IP):

Payments

Receipts

of which: industrial processes and products (except software)

Payments

Receipts

Questions for FDI survey respondents: new investments

These questions should be directed to either –

a) a local business enterprise when a foreign parent company establishes or acquires directly, or indirectly through an existing affiliate, a 10 percent or more voting interest in that enterprise, or

b) existing affiliates of foreign parents when they acquire, or merge with, a local business enterprise, or a business segment or operating unit in the compiling country.

Have you or your foreign parent company engaged in the following investments in this country?

- Created a new legal entity, either incorporated or unincorporated, including a branch, which is organized and operating as a new business enterprise.

- Bought or secured a voting equity interest in a previously existing, separate legal entity that was already organized and operating as a business enterprise and it continued to operate as a separate legal entity, either incorporated or unincorporated, including a branch.

- Bought or secured a voting equity interest in a business segment or operating unit of an existing business enterprise, which is organized as a new separate legal entity, either incorporated or unincorporated, including a branch.

- Bought and merged another local business enterprise, or business segment or operating unit of a business enterprise, into your own operations rather than continuing or organizing it as a separate legal entity.

For M&As of existing businesses, would you be able to report the magnitude of the following items (where applicable) at the time of the M/A?

- employment
- R&D expenditures
- stock of patents issued
- stock of patent applications

For newly established businesses, would you be able to report: (one-off)

- if the new business is intended for R&D performance?
- if you plan to sell or license R&D to the new business?
- if you plan to sell or license patents to the new business?
- if you plan to transfer (for free) R&D or patents to the new business?

IV. Nature of software and R&D licences

Questions relate to licences to use and licences to reproduce software copies sold by large units in the Software publishing industry and licences to use sold by major R&D performers

Objective

1. To determine what proportion of expenditures on licences to use software and R&D output qualify as GFCF. To do so the licences must be for a multi-year period and the licensee must assume all the risks and rewards of ownership.

2. To determine the extent to which acquisitions of part, or the whole, of licences to reproduce software qualify as GFCF. To do so the licensee must assume the risks and rewards of ownership, which is evidenced by taking responsibility for the distribution, support and maintenance required for more than a year.

Questions

1. If you sell licences to use,

    a. what proportion of sales to business are for a period of:

        i. a year or less?

        ii. more than a year?

    b. what proportions of sales to government are for a period of:

        i. a year or less?

        ii. more than a year?

    c. for R&D licences to use ONLY

        i. do the payments give unlimited use?

        ii. are payments linked to use, *e.g.* a royalty per unit of product produced using the licence?

2. If you sell licences to reproduce software, under what terms are they sold and for what period of time? If for more than a year, is the licensee responsible for the distribution, support and maintenance required? If so, please indicate the value in each of the last three years of:

    a. domestic sales

    b. foreign sales

ANNEX D: ADDITIONAL DATA REQUIREMENTS

The following is a list sent by the Canberra II Group in 2005 to the OECD's NESTI Group.

Items to be estimated using data from R&D surveys

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.

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.

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:

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

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

c. Private Non-profit Institutions serving households

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

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 include 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.

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

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 international trade in services and foreign direct investment. 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.

ANNEX E: POINTERS ON DATA DEVELOPMENT FOR INTERNATIONAL TRANSACTIONS IN R&D

A. International transactions between affiliated enterprises

International transaction surveys collected for BOP purposes already cover both affiliated and unaffiliated transactions. National accountants, tax authorities, and researchers are aware of distortions, whatever the underlying causes, implied by transfer prices for fiscal matters (Hines 1996), national and international economic accounts (Landefeld et al. 2008), and more recently, measures of intangibles production and exploitation (Lipsey 2008).

The *IMF's BOP Compilation Guide* (IMF 1995) provides guidance on this issue from the perspective of international transactions (paragraphs 487-491). In particular, it recognizes misreporting issues (over- or under-reporting of quantities or values) for intra-company transactions and describes transfer prices for transactions "between enterprises in a direct investment relationship" as prices "significantly distorted from market values". Further, "an enterprise may sell goods to a related enterprise for prices unrelated to the cost of production or the acquisition cost of the goods. Such a sale might be made, for example, to transfer profits from one country to another for tax reasons or because the country of the direct investment enterprise imposes restrictions on the repatriation of income." The *OECD Transfer Prices Guidelines* (OECD 2001) recommends that internal transactions (prepared for tax administration purposes) should be reported as if they were performed by independent parties at arm's-length market prices. In particular, the arm's length principle seeks "to adjust profits by reference to the conditions which would have obtained between independent enterprises in comparable transactions and comparable circumstances, [thus] ….treating the members of an MNE group as [if] operating as separate entities…"

The IMF BOP Guide goes on with suggestions on adjustments to reported data but also cautions that "such adjustments should be made only when significant distortions are encountered" (paragraphs 487-491). Notably, adjustments recommended by either OECD or IMF guidelines are intended for tax authorities with access to taxpayer records. Some of this material *may* be applicable for surveys work (*e.g.*, microdata editing/processing, imputation, and further survey development). Alternatively, adjustments to aggregate data would have to be performed by national accountants. At the moment, however, generic guidance on possible transfer price adjustments to R&D export and import totals is hindered by data and metadata limitations. Further, given the relatively small share of IPPs in aggregate FDI and transactions data, new or improved data on transactions between affiliated enterprises should be designed and develop collaboratively by intangibles, trade, national accounts, and globalization experts and working groups (see for example *OECD 2007*).

B. Joint production and /or ownership of R&D and IP

Joint production, both within and across companies, is recognised in the *OECD Transfer Prices Guidelines* under the label of 'cost contribution arrangements'. The latter are defined as "contractual arrangement to share costs & risks of developing, producing, or obtaining assets, services, or rights" (8.3). The Guidelines note that these arrangements are conceptually different from licensing agreements and from exchanges or transfer of existing assets. Again, the goal is to apply the arm's length principle. Further, "for the conditions of a CCA to satisfy the arm's length principle, a participant's contributions must be consistent with what an independent enterprise would have agreed to contribute under comparable circumstances given the benefits it reasonably expects to derive from the arrangement" (8.8).

Within MNCs, joint production is entangled with joint ownership, which highlights the need to distinguish between legal vs. economic ownership and sort out implications for asset boundary issues in terms of who benefits from what and where. The Guidelines note that "…legal ownership of developed intangible property [may be] vested in only one of [the arrangement parties] but all of them have effective ownership interests." (8.4). These issues go to the core of properly defining the direction of trade flows not only for R&D (*Yorgason 2007*: 14-18) but also for other IPPs in the Handbook.

C. Merchanting and "fabless" production

Merchanting is the purchase of a good by a resident of the compiling economy from a non-resident and the subsequent resale of the good to another non-resident, *without* the goods entering or leaving the compiling economy (BMP5 and BMP6 draft [10.42]). Thus, with respect to the compiling economy, there is a change in ownership affecting a resident although there is no entry or exit of goods. However, "[t]he physical form of the goods may be changed during the period the goods are under merchanting, as a result of manufacturing services performed by other entities. In these cases, the enterprise that owns the goods makes contributions to the manufacturing process, such as providing planning, management, patents and other know-how, marketing, and financing, but without physically possessing the goods. Particularly for high-technology goods, these non-physical contributions may be large in relation to the value of materials and assembly." These transactions are particularly important given global and contract manufacturing, services outsourcing and subcontracting (BMP6 10.145), and within-MNCs transactions (*Connolly 2008; Takeda 2006)*, including so called fabless companies (*Peleg 2008*).

D. Non-R&D testing services

CPC v.1 does not provide a separate code for commercial non-R&D testing services. Such a category is contemplated in the North American Product Classification System (NAPCS) categories for NAICS 5417.[26] In addition to categories similar to the CPC code, NAPCS includes 'Testing laboratory services', defined as services "Providing various conformity assessment services such as testing, instrument calibration, product certification, management system registration and commercial inspection services, and other related services such as sale of standards information, consulting, and training."[27] Data linking exercises involving trade and R&D surveys may provide additional tools to separate out non-R&D testing.

E. R&D transfers

A possible future source for statistics on transfer of (completed or in-progress) R&D is FM-based surveys, assuming the definition of transfers in the FM and SNA are reconciled in the future. R&D surveys could ask for the cost of producing R&D that is subsequently transferred outside the performing unit (output could then be estimated by methodology similar to other R&D expenditures).

F. IP sales/purchases

In addition to flows of current production of R&D, a full account of R&D trade needs to incorporate sales/purchases of past R&D captured in patents and other forms of legally protected (or secret) intellectual property. These flows are separate from licensing and royalty fee statistics (for use and/or reproduction) already recognised in services trade statistics. However, information on outright sales/purchases of IP assets is very limited. A related indicator is cross-border mergers and acquisitions (M&As) of R&D-performing or IP-holding companies. *Peleg (2008)* developed an experimental 'decision tree' to identify M&A transactions involving IP. Alternatively, surveys on new FDI investments[28] may be further developed to accommodate some of these issues.

26 Both NAICS and NAPCS support economic statistics in NAFTA countries.

27 http://www.census.gov/eos/www/napcs/napcs.htm

28 http://www.bea.gov/surveys/pdf/be13.pdf.