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**1993 SNA UPDATE ISSUES**

**RESEARCH AND DEVELOPMENT**

# DERIVING ESTIMATES OF GROSS FIXED CAPITAL FORMATION OF RESEARCH AND DEVELOPMENT USING DATA FROM RESEARCH AND DEVELOPMENT SURVEYS

Note by the Organisation for Economic Co-operation and Development[1]

*Summary*

Expenditures on research and development (R&D) should, in principle, be treated as part of capital formation in the 1993 System of national Accounts (SNA) Rev.1. It is, however, recognized that many practical difficulties have to be overcome before the estimates reach sufficient level of international comparability. The paper presents an extract from a draft OECD Handbook on Deriving Capital Measures of Intellectual Property Products that aims to provide guidelines for the compilation of R&D satellite accounts. It focuses on the available data from R&D surveys as per the Frascati Manual and their transformation into national accounts estimates.

[1] Prepared by Charles Aspden (OECD) at the invitation of the UNECE secretariat.

## I. INTRODUCTION

1. This document is an extract from a draft of the OECD *Handbook on Deriving Capital Measures of Intellectual Property Products*, which is expected to be completed by the end of 2008. The handbook is being developed by the newly created OECD Task Force on research and development and other Intellectual Property Products, following on the work of the Canberra II Group.

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

3. The following was agreed by the United Nations Statistical Commission (UNSC) in 2007:

(a) Research and development should be treated as gross fixed capital formation in the SNA. It should be defined as in the *Frascati Manual*[2], namely "research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including the knowledge of man, culture and society and use of this stock of knowledge to devise new applications." This definition should not be interpreted as including human capital as capital formation within the SNA;

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

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

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

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

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

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

## II. QUANTITATIVE IMPACT

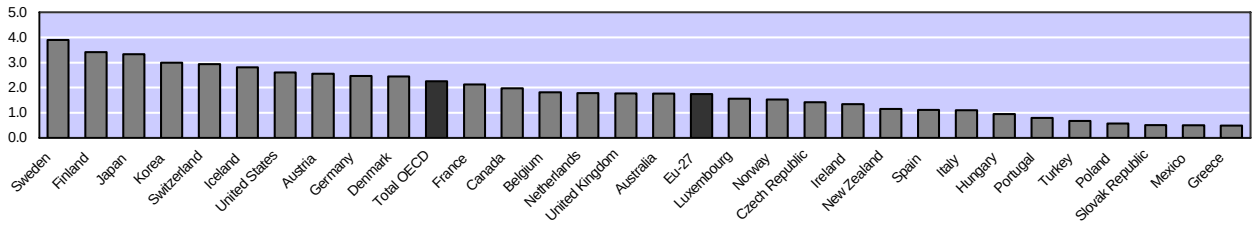
5. The impact on GDP of the capitalisation of R&D depends on the relative size of R&D production to GDP, if and when implemented. An approximate indicator of what this is likely to be is the ratio of gross domestic expenditures on research and development[3] (GERD) to GDP. This ratio varies considerably between OECD countries. Figure 1 presents the value of this ratio for OECD Member countries in 2006, or the latest year. The ratio varies from about 0.5% for Greece to a little under 4% for Sweden – with the OECD average being 2.3%. The ratios do not change very quickly over time, which suggests that the capitalisation of GDP will have little impact on GDP growth rates.

6. A word of caution is needed because the GERD to GDP ratio is only an approximate indicator of the impact of the capitalisation of R&D on GDP for three reasons. First, there are conceptual differences between GERD and the national accounts measure of R&D production. Second, expenditures on R&D are already included in the output of non-market producers because output is measured by summing costs. However, R&D assets will incur consumption of

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

fixed capital (depreciation) and so the gross value added, but not the net value added, of non-market producers will be boosted by the consumption of past R&D capital formation. In a growing economy the consumption of past R&D capital formation will be generally less than current expenditures on R&D and so the impact on GDP can be expected to be a little less than the GERD to GDP ratio suggests. Third, it is likely that some expenditure on R&D by government and non-profit institutions will not be recorded as capital formation.

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




a) Source: OECD, Main Science and Technology Indicators, May 2007
[1] 2006 or latest year.

## III. DEFINITION AND SCOPE

7. The criteria for determining whether an expenditure on R&D is GFCF are just the same as they are for any other product. The definition and scope of R&D GFCF read as follows in version 4 the 1993 SNA Rev. 1:

> 10.104 ***Research and [experimental] development consists of the value of expenditures on creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and use of this stock of knowledge to devise new applications. This does not extend to including human capital as assets within the System.*** The value of research and development (R&D) should be determined in terms of the economic benefits it is expected to provide in the future. This includes the provision of public services in the case of R&D acquired by government. In principle, R&D that does not provide an economic benefit to its owner does not constitute a fixed asset and should be treated as intermediate consumption. Unless the market value of the R&D is observed directly, it may, by convention, be valued at the sum of costs, including the cost of unsuccessful R&D.
>
> 10.105 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.

8. While in most respects R&D assets are no different from any other fixed assets, they do have certain characteristics that differ from most other fixed assets. One of the most important is that R&D assets can provide benefits to units other than their owner – a characteristic they share to varying degrees with other intellectual property products. When the knowledge gained from R&D is sold by its legal owner to other units, such as via a licence or the sale of a patent, the sale

is recorded like that for any other product. But it is in the nature of R&D that the knowledge gained often becomes available to units other than the legal owner[4] by means other than a transaction. This can happen because the owner knowingly makes the knowledge available to others by putting it in the public domain, such as by patenting the knowledge or by making the knowledge freely available. The knowledge also can be spread by the simple act of the legal owner, or a licensee, using the knowledge in their production and it being observed by others.

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

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

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

[4] Or the economic owner if a licence agreement has the appearance of a sale of the R&D

# IV. COMPILING R&D GFCF AND OTHER STATISTICS

## A. Introduction

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

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

## B. Features of the FM data

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

Intramural expenditures

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

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

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

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

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

17. Capital expenditures have three sub-categories:

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

(d) *Instruments and equipment*, which includes embodied software; and

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

Sources of funds

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

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

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

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

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

Government sector:
- Central or federal government (excluding general university funds)
- Provincial or state government (excluding general university funds)

- Public general university funds
- Private non-profit sector
- Higher education sector
- Abroad:
  - Business enterprise:
    - Enterprises within the same group
    - Other enterprises
  - Other national governments
  - Private non-profit
  - Higher education
  - EU
  - International organizations

Extramural expenditures

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

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

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

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

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

performers may not always accurately identify the ultimate source of their funds the extramural expenditure data may provide a useful check on the distribution of the source of funds.

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

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

(a) Between FM sectors and SNA sectors;

(b) Between FM's expenditures on R&D and SNA output;

(c) 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.

## C. Bridges between FM and SNA sectors

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

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

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

(c) non-profit institutions serving households (NPISHs).

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

relatively straightforward to produce this breakdown. For other countries some other means will be needed.

Table 1
**Linking FM and SNA Sectors**

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

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

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

Intermediate consumption

27. The accounting principles differ between the FM and SNA in two important respects. First, to measure output by summing costs, the SNA recommends summing the costs of the inputs actually used in the period plus other taxes payable less other subsidies receivable on production to obtain an estimate at basic prices. By contrast the FM recommends the measurement of all the expenditures made in the period. Thus, in principle, an adjustment is required to the FM data for the changes in inventories of inputs. In practice, it is very likely to be insignificant and can be ignored.

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

29. From a national accounts perspective, acquisitions of R&D performed by another unit should be recorded as either GFCF or intermediate consumption depending on the circumstances. (For the moment the other alternative of final consumption is ignored). If acquired R&D is to be either used up in a year or completely, or almost completely, used up in another asset then the acquisition should be recorded as intermediate consumption. Otherwise it

should be recorded as GFCF. Given the difficulty of making this distinction in practice it is recommended that by convention purchases of R&D by R&D performers should be recorded as intermediate consumption, while purchases of R&D by non-performers should be recorded as GFCF. Thus, the SNA measure of R&D output should be higher than the FM measure of GERD because of the double counting of some domestically produced and imported R&D.

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

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

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

Compensation of employees

33. Included in those directly employed on R&D are postgraduate students who are either on the payroll of R&D units and/or receive external funds (such as research scholarships). Although the external funding component is not included in the SNA measure of compensation of employees, the 1993 SNA Rev. 1 (chapter 10) prescribes that even labour provided free should be included at what it would have cost if it had been paid for when summing costs to measure own-account GFCF and output. Therefore, the payments made to postgraduate students, whether by pay or external funding, should be included when summing costs to measure output and GFCF[5] on the assumption that they are indicative of the students' contribution to R&D output.

Capital services, consumption of fixed capital and return to capital

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

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

35. In measuring GERD, the FM includes capital expenditures both on fixed assets and land. Neither of these should be included when summing costs to measure of output. One way of estimating the value of capital services is to apply the perpetual inventory method (PIM) to the estimates of GFCF for previous periods as reported by FM surveys plus any purchases of R&D of a capital nature. Little is known about the composition of capital expenditures of R&D performers collected by countries below the level that is recommended by the FM. But it is very likely that it does not sufficiently distinguish between major components that have different long-term price changes and service lives. If so, a more detailed breakdown by type of asset is required by future FM surveys that would also allow land to be excluded. The following breakdown is suggested as a minimum:

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.

36. Other ways of estimating the value of capital services are by making an imputation using either the estimated value of capital services (using the PIM) or simply taking the gross operating surplus of an industry specialising in R&D (i.e. Scientific Research and Development, Division 72 of the International Standard Industrial Classification of all economic activities (ISIC) Rev. 4).

37. Factors to consider in choosing between the three methods include:

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

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

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

38. 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.

39. 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.

Rent on land

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

Other taxes less subsidies on production

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

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

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

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

Supply including imports of R&D

44.

45. Total supply of R&D is obtained by summing output and imports. The FM can provide estimates of imported R&D for use by R&D performers, but imports of R&D for final use by non-R&D performers must be obtained through other sources – for example in economic surveys or in surveys of exports and imports, which are becoming more common in recent years. Another source of data that could possibly also provide information on R&D transactions of producers that are not themselves performing any R&D, are innovation surveys. This is one of the issues being addressed by the OECD task force.

Uses of R&D

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

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

**At purchaser's prices**

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

**Uses for final consumption assumed neglible**

Intermediate consumption of R&D

47. This has already been dealt with above.

Exports of R&D

48. As described above, the FM recommends that R&D performers should be asked to provide details of their sources of funds. Unfortunately, these funds include payments for purchases and transfers (in the national accounts sense) and at best only a partial decomposition may 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. (The OECD National Experts on Science and Technology Indicators (NESTI) group is currently reviewing the issue of internationalization of R&D performance, and a task force has undertaken work to improve measures of international transactions of R&D.) Until such data are available from R&D surveys, in the short run it should be possible to prepare reasonable estimates of uses of R&D by subdividing data on funding of business R&D using balance of payments data on exports of R&D. Such a subdivision can be made under the assumption that funding from the business sector to the business sector is only received to make a purchase (that there are not any transfers – i.e. with no quid pro quo - between business enterprises) and that exports of R&D by producers that do not engage in R&D may be ignored.

Inventories of finished R&D and work in progress

49. Since production of R&D mostly takes longer than one year, there will also be work in progress until the R&D is finished. If the R&D is produced on own account, then the 1993 SNA rev. 1 recommends that the production of assets on own account should be recorded as GFCF as it occurs. If there is significant production of R&D for sale (as is the case for exporting countries such as Israel), then it should be recorded in inventories of work in progress. This is particularly

important for the R&D produced by affiliates of multinational firms, which will ultimately be exported. Present R&D surveys do not support this.

Gross fixed capital formation in R&D

50. In the framework of FM R&D statistics it will be possible to estimate R&D output, imports and intermediate consumption once funding and extramural expenditures are sufficiently classified. Imports of R&D for GFCF will have to be obtained, as explained above, either in exports-imports surveys or in specialized business surveys, including innovation surveys. Until additional data are available, estimates of GFCF can be derived using certain assumptions.

## F. Additional data requirements

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

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

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

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

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

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

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

(iii) Private NPISHs.

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

(d) Other taxes on production less other subsidies on production: The SNA defines the other taxes on production as part of the taxes on production, "consisting mainly of taxes on the ownership or use of land, building or other assets used in production or on the labour employed,

or compensation of employees paid". Other subsidies on production includes mainly subsidies in payroll or workforce. The FM does not show the flow of other taxes on production explicitly, but the flows are included, at least partially, in the current expenditures, e.g. payroll taxes are part of the labour costs. However, the flow of other subsidies on production is not accounted for in intramural expenditures, but as a financing source of them. In the interim, until data become available from R&D surveys, national accounts data on subsidies may be used to estimate these flows;

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

Items demanding data collection outside R&D surveys

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

## V. INTERNATIONAL TRADE BETWEEN AFFILIATED ENTERPRISES

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

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

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