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A RESEARCH AND DEVELOPMENT MODULE SUPPLEMENTING THE NATIONAL ACCOUNTS*)

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Abstract

This paper presents a modified national accounting system tailored to a description of the role of Research and Development (R&D) in the national economy. The main differences with the standard National Accounts are some changes in the basic concepts (e.g. own-account production of R&D is considered as work-in-progress, or as fixed capital formation if it is not intended to be patented) and the introduction of additional, more detailed, classifications (e.g. new subsectors).

Contents

1. Introduction

Most incomes and expenditures related to Research and Development (R&D) are not specified as such in the National Accounts. For example, own-account R&D production by establishments is not recorded as production and, as a consequence, the inputs in this R&D production are recorded as inputs into the producer's other production processes. Another case in point is that patents and licenses belong to an asset category called intangible non-produced assets, which also includes copyrights and trade marks. In order to provide a coherent description of R&D, a specific R&D-module that is linked to the National Accounts should be designed. In this paper, an outline of such a module is presented.

The notion of modules supplementing the National Accounts has been advocated for many years by various authors from the Netherlands Central Bureau of Statistics. They have argued that a flexible national accounting system, containing a core and modules is the 'ideal' NA system (see e.g. van Bochove and van Tuinen, 1986). The core should consist of a basic set of accounts for general purposes. In Gorter (1988) and Gorter and van der Laan (1992), the concept of the core has been elaborated. The modules should meet more specific data needs. At present, four modules have already been worked out:

- a socio-economic accounts module (Gorter and van der Laan, 1992);
- an environmental module (de Boo et al., 1991);
- a module on the allocation of time (Kazemier and Exel, 1992);
- a module in use as data set for a specific general equilibrium model (Zeelenberg et al., 1989).

The need for an R&D module stems from the important role that is attached to R&D by economists and politicians (see Mowery and Rosenberg, 1989). Innovations and inventions have greatly contributed to spurring economic growth. Governments have stimulated and subsidized many R&D-projects in order to maintain and improve the competitiveness of their national economies. A similar policy is also followed by international organizations like the EC and the OECD.

The importance of R&D for the national economy is further reflected in the statistical programmes of many countries and international organizations, like the EC and the OECD.

Since the 1960s, most industrialized countries collect statistical data on R&D. In 1963, international guidelines on R&D statistics were issued for the first time: the Frascati Manual. It was meant to harmonize the national R&D-statistics and to stimulate national statistical offices in setting up such statistics.

In the mid 1970s, the French statistical office -in cooperation with the French Ministry of Research and Technology- started to draw up a research satellite account(/module[1]) linked to the national accounts. This account describes "the circuits of funding and performance of research and development in a manner rendered compatible with the methods and concepts of national accounting" (Minder et al., 1989, p. 9).

Some years ago, a research satellite account has also been developed for Japan. It describes "the income and cost structure of R&D activities and ... the sources of funds for [these] activities" (Kurabayashi and Matsuda, 1989, p. 5). The concept of R&D activities and the sector classification are based on the Frascati Manual (OECD, 1981). This satellite account focuses on the R&D activities of academic institutions and pays special attention to the age structure of researchers and its changes over time.

In 1988, the OECD started the Structural Analysis (STAN) database project. The STAN database is a large database "which combines industrial and technological data for all OECD countries and, where data is available, for a number of non-OECD countries ... STAN has been designed specifically to underpin OECD and Member country studies of the role of technology in international competitiveness, structural change

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[1] The terms 'module' and 'satellite account' could be used interchangeably (see also Gorter and van der Laan, 1992, p. 4). In both cases, they refer to a structured set of information which is linked to the standard national accounts.

and economic growth ... Though a number of disaggregated databases exist ..., none is sufficiently complete to support the desired quantitative analysis. To overcome this problem, STAN 'patches' these and other source databases together to form the most comprehensive, disaggregated, technology/industry database available" (OECD, 1990, p. 1).

In this paper, a R&D module that supplements the national accounts is presented. In common with the French satellite account, a major purpose is to establish a linkage between R&D statistics and the national accounts. However, in addition, the module aims at providing a general perspective on the role of R&D in the national economy, e.g. by also paying attention to the role of multinationals and patents. In this respect, it has more in common with a report by the Dutch Advisory Board on on Science and Technology (van Heeringen and Langendorff, 1988) or the extensive R&D statistics of Canada (Statistics Canada, 1989). Furthermore, unlike all the above mentioned accounts, reports and statistics, several standard national accounting concepts are also modified in order to provide a better account of R&D.

Amending the concepts and classifications in the standard national accounts for the purposes of the R&D module is described in section 2. The design of the R&D module is the topic of section 3. Conclusions are drawn in section 4. R&D statistics will serve as a major data source for compiling the R&D module. Appendix A therefore provides a discussion of the international guideline on R&D statistics, the Frascati Manual. In Appendix B the relationship between figures in the R&D module and those standard national accounts is made explicit for the major aggregates.

2. Amending the standard accounts in the R&D module

2.1 Introduction

The concepts and classifications in the standard system of national accounts are not tailored to a description of the role of R&D in a national economy. Therefore, concepts and classifications in the R&D module must differ in some respects from those in the standard system. In subsection 2.2, the concepts proposed for the module are discussed. The classifications are the topic of subsection 2.3.

2.2 Concepts in the module

A discussion of alternative accounting procedures for R&D can be found in Muller (1990), OECD (1989b) and Harrison (1990). We restrict ourselves to explaining the basic logic of the accounting conventions adopted in our R&D module. Of course, our discussion of concepts in the module starts with the concept of R&D employed in the module.

In the module, the concept of R&D follows its definition by the Frascati Manual: "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications" (OECD, 1981, p. 25; see also Appendix A in this paper). The categories Research and Development in the International Standard Industrial Classification (ISIC: UN, 1990b), the Central Product Classification (CPC: UN, 1991), the Classification of the Purposes of Private Non-Profit Institutions (COPNI: UN, 1968, table 14, p. 185) and the Classification of Outlays of Producers by Purpose (COIP: UN, 1975) are also based on the Frascati concept. So, this concept is also employed in most R&D statistics.

A drawback of the rather narrow R&D concept in the Frascati Manual, is that it ignores many activities that are crucial to its commercial success, like product design and marketing. Furthermore, it includes R&D

which will never be a commercial success, e.g. basic research performed at universities (see also OECD, 1989b, paras 30 and 31). As a consequence, there is frequently no direct causal link between production of 'Frascati-R&D' and changes in value added and economic growth. A broader concept of R&D with respect to e.g. product engineering is nevertheless not adopted for the module, because that would imply almost insurmountable data problems (all relevant data sources employ a Frascati-type concept).

In the System of National Accounts (SNA: UN, 1992), production of R&D by enterprises is limited to R&D sold on contract[2]. In the module, production of R&D by establishments encompasses also their own-account production. Furthermore, selling patents is regarded as a trade activity and as a desinvestment, and not as the sale of a non-produced asset. Similarly, the rental of patents by means of licenses is registered as a production activity generating value added and not as a transaction that generates property income. These modifications imply an extension of the standard production boundary. It should be noted that own-account production of R&D by the government and non-profit institutions was already recorded as output (due to the convention that their output equals the costs of production).

R&D production differs in two important respects from most other types of production. Firstly, as R&D production is no routine activity (by definition), it is always uncertain whether and to what extent the inputs will indeed result in outputs, e.g. an increase in knowledge. Secondly, even if the inputs lead to the expected outputs, it is usually uncertain what the revenues will be; this uncertainty may prolong for many years after the R&D has been produced. This also applies to R&D production that explicitly aims at obtaining revenues from patents and licenses. In the module, R&D production not sold on contract is valued at costs, whether it is successful or not, and independent of what the expected revenues from patents and licenses are. As stated above, the

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2) In earlier Draft chapters for the revised SNA (UN, 1990a), also own-account production of R&D by enterprises is regarded as production and fixed capital formation. However, it has been decided that in the final version of the revised SNA, the 1968 SNA's conventions are retained.

actual revenues from patents and licenses are recorded as revenues from trade and rental activities respectively.

Extending the scope of production in the module is accommodated by changes in the concepts of intermediate consumption, changes in stocks, fixed capital formation and capital consumption. In our modified concepts it plays the central role whether or not the R&D production is patented:

1. R&D output which is intended to be patented, should be recorded as work-in-progress, i.e. a change in stocks. At the time it is patented, the stocks of the R&D producer are then reduced and fixed capital formation is recorded. Subsequently, this asset is written off, whereby its length-of-life is equal to the number of years for which the patent is granted. When the patent is sold, negative fixed capital formation should be recorded for the producer by amount of the production costs not yet written off. The difference between the patent's selling price and these costs is registered as a revenue from trade in patents. For the purchaser, positive fixed capital formation is registered by amount of the price paid for the patent plus the other acquisition costs for the patent. This implies that part of his investment consists of transfer costs, analogously to the case of trade in other existing capital goods.

Of course, it is also possible that the R&D output is unsuccessful, because it does not result in a patent. At the time this becomes clear, the stocks of the R&D producer are reduced and his fixed capital formation is increased; this fixed capital formation is then immediately written off for the full amount.

Like all rental of capital goods (cf. operational leasing) in the standard national accounts, rental of patents (licensing) does not diminish the capital stock of the owner. In the module, renting patents is to be recorded as intermediate or final consumption, depending on the buyer.

2. R&D production which is not intended to be patented, should be directly recorded as fixed capital formation and depreciated for 100% in the same year. This pertains to e.g. most R&D in the social sciences and humanities and to R&D which is in the public domain (e.g. through a publication in scientific journals). The reason for this accounting procedure is that R&D is very difficult to sell after it is produced unless it is patented.

Recording expenditure on R&D production as capital formation implies that this expenditure is no longer recorded as intermediate or final consumption. So, enlarging the concept of capital formation in this way entails a concomitant narrowing of the concepts of intermediate and final consumption.

Capital consumption of R&D assets should be calculated in the same way as capital consumption on tangible assets: straight-line depreciation on the assumption of expected economic life times (see Bos, 1990 and Ward, 1976). The latter can be determined on the basis of expert knowledge, practice in the business accounts that have capitalized R&D expenditure, dates of expiry of patents, etc.

Governments stimulate R&D production not only by direct subsidies, but also by all kinds of implicit or indirect subsidies. Examples given in the Frascati Manual are "the remission of income taxes for industrial R&D, the payment by a government, on demand and after audit, of a certain portion of some or all of firms' R&D expenditures, bonuses added to R&D contracts to encourage a firm in its own R&D, remission of taxes and tariffs on R&D equipment and the reimbursement of part of a firm's costs if it hires more R&D staff" (OECD, 1981, p. 77). Such subsidies are ignored or not accounted for explicitly in the standard national accounts. According to the Frascati Manual, they should also not be accounted for (explicitly). However, compiling such information seems crucial for analyzing the role of the government and comparing subsidies on R&D among countries. Therefore, such information should, as far as possible, be included in the R&D module; its concept of subsidies should be adjusted accordingly. If the subsidy consists of a rebate on income

taxes, this implies that the subsidies as well as the income taxes are larger in the module than in the standard national accounts.

Enlarging the concept of fixed capital formation also entails a shift in the demarcation between current and capital transfers. All subsidies received by "investors" in R&D, i.e. that serve to finance purchases of R&D work or own-account R&D production, should now be recorded as capital transfers and not as operating subsidies. This is in accordance with (Muller, 1990, p. 12): "[G]rants received by firms undertaking R&D on behalf of other firms remain classified as operating subsidies ... This remark obviously does not concern capital-goods subsidies received by these R&D contractors"

By recording revenues from the sale or rental of patents as revenues from the sale of goods and services, establishments that formerly were regarded as non-market may become market producers. The reason is that by taking these revenues into account, some establishments may now be mainly financed by revenues from the sale of goods and services.

The consequences of these changes in concepts for balancing items like Domestic Product, National Income and Net Lending is discussed in Appendix B.

2.3 Classifications in the module

The module should focus on a description of the role of R&D. On the one hand, some details in the standard classifications are superfluous and can be left out. On the other hand, various categories that are important in a description of the role of R&D tend to be absent and should thus be included. We will subsequently discuss the main taxonomies in the national accounts and present the classifications proposed for the R&D module. Attention is restricted to those classifications that deviate from the standard ones.

The classification by industries in the module should show the major producers and users of R&D and be based on ISIC (UN, 1990b). In the module, a high level of aggregation could be employed for most industries. Exceptions are only made for the division "Research and Development" and the subdivision "Defence activities" (see table 1). The latter should be shown separately in order to distinguish military R&D by the government from non-military R&D. It may be useful to subdivide Manufacturing, as this is in most countries relatively large. However, the level of detail recommended in some cases by the Frascati-Manual, e.g. including a separate category Aerospace, is not always appropriate, if only for reasons of secrecy.

Table 1. The classification by industry in the R&D module

1. Agriculture, hunting, forestry and fishing (01, 02, 05)[a)]
2. Mining and quarrying (10-14)
3. Manufacturing (15-37)
4. Electricity, gas and water supply (40-41)
5. Construction (45)
6. Transport, storage and communications (60-64)
7. Research and development (73)
8. Defence activities (7522)
9. Other public administration (75 with the exc. of 7522)
10. Education (80)
11. Other services and n.e.c. (50-52, 55, 65-72, 74, 85, 90-93, 95, 99)

[a)] The codes between brackets refer to the ISIC Divisions and Classes (UN, 1990b).

The classification by institutional sectors in the module differs in several respects from that in the standard national accounts (UN, 1992, Chapter IV). The "Non-financial corporate sector" and "Financial corporate sector" are grouped together in a new sector "Business" (see table 2). This sector is subdivided into "Foreign-controlled corporations", "Domestic multinationals" and "Other business". In this way, one can account for the specific role played by multinationals. In fact, Foreign-controlled corporations are also distinguished as a subsector in the standard classification. Our subsector Domestic multinationals must still be defined. The most logical option is to define it as the mirror-image of Foreign controlled corporations, that is 'those domestic corporations that control foreign corporations'.

The "Government sector" is subdivided into "Public universities and other public higher education institutions" and "Other government". It

should be realized that universities that are not mainly financed by the government, are not recorded in this sector (see also our appendix on the Frascati Manual). The Household sector and the Private non-profit institutions serving households sector are similar to those in the standard national accounts.

Table 2. The classification by institutional sectors in the R&D module

Business (Non-financial corporate sector + Financial corporate sector)
Foreign controlled corporations
Domestic multinationals
Other business
Government (General government sector)
Public universities and other public higher education institutions
Other government
Households (Household sector)
Private non-profit institutions serving households
Rest of the World
International organizations
Other

The "Rest of the World"-account is included as a separate 'sector', as this is very convenient when presenting the tables in the module. For this account/sector, a new distinction is introduced: namely that between International organizations and rest of the Rest of the World. This distinction reflects the special role that is frequently played by international organizations in stimulating R&D, think of subsidies provided to R&D projects by the EC.

The commodity classification is based on the Central Product Classification of the UN (1991). The CPC is a classification of goods, services and assets. For our purpose, the categories Research and development services and Patents are the most relevant ones. In the module, Research and development services will be subdivided into Natural sciences and engineering and Social sciences and humanities (see table 3). The third CPC subclass Interdisciplinary is left out, as this subclass is also absent in the product classification of the EC, the NACE (Eurostat, 1991), and in the Frascati-Manual (OECD, 1981). A further subdivision of market services/non-market services is made in order to distinguish between R&D for sale on the one hand, and, own-account and non-profit production of R&D on the other. It should be noticed that in this way it is very well possible that market enter-

prises produce non-market R&D, e.g. if it is for use in their own organization.

In our modified concepts (see subsection 2.2) payments for patents and licenses are regarded as payments for goods and services. A new distinction is introduced between (the annual payments for) licenses and (the payments for) patents. The reason is that the purchase of patents is recorded as capital formation in the module, while the payments for licences are registered as (intermediate or final) consumption of the purchaser.

Table 3. R&D commodity classification

Research and development services (85)[a)]
Market services
Natural sciences and engineering (8510)
Social sciences and humanities (8520)
Non-market services
Natural sciences and engineering (8510)
Social sciences and humanities (8520)
Licenses (89210)
Patents (89210)

a) The codes between brackets refer to CPC groups/(sub)classes (UN, 1991).

In the classification by categories of value added (see table 4), compensation of employees is subdivided into high and low skilled labour income. This distinction is introduced because a specific feature of R&D production is that it requires relatively much high-skilled labour. In addition to the classification by level of education, classifications by type of education (e.g. a simple dichotomy between natural sciences and engineering versus social sciences and humanities) and by occupation (on the basis of the International Standard Classification of Occupation, ILO, 1990) could be introduced. By linking data on the volume of labour employed in R&D production to other data on the employed population and labour force, the (mis)matching of supply and demand in the labour market can be described. This issue may also be relevant in the context of developing a R&D policy, e.g. if a shortage of technically skilled labour hampers R&D production.

In the tables of the module, the categories of value added are not only classified by industry, but also subdivided into: a) related to R&D

production and b) related to other types of production. This functional split could also be regarded as a sub-classification of the categories of value added. If information on implicit or indirect subsidies can be obtained, these subsidies should be shown separately.

Table 4. The R&D module's classification by category of value added (gross, at market prices)

Compensation of employees
High skilled (University or Other post Secondary)[a]
Low skilled (Secondary or Other)[a]
Net operating surplus/mixed income
Consumption of fixed capital
Indirect taxes and subsidies
Taxes on production and imports
Subsidies (-)

[a] The categories between brackets refer to the International Standard Classification of Education (ISCED; UNESCO, 1976).

In the classification of current taxes and transfers (table 5), a subcategory for gifts and donations for R&D is introduced in order to take account of this way of financing R&D production or purchases. In practice, these gifts and donations may frequently be so small that they can be ignored in the R&D module. For the other current transfers, making a functional split on the basis of whether it is related to R&D production or purchases does not seem very useful. A possible exception are current taxes on income, wealth, etc., which could single out taxes on compensation of employees in R&D production. However, most other current taxes on income, wealth, etc. can only (and best) be split by introducing simple assumptions (e.g. about the ratio of tax to income). Such information could be shown in a separate table.

Table 5. The classification of current taxes and transfers in the R&D module

Current gifts and donations for R&D
Current taxes and other transfers (like other gifts, current taxes on income, wealth, etc., social contributions and benefits, casualty insurance premiums and claims or current transfers within government)

In the classification of capital transfers (table 6), a category for gifts and donations for R&D is also introduced. In practice, this subcategory will probably be more important than its current counterpart. Gifts and donations usually occur for specific types of R&D, e.g. for medical research. For some types of R&D, it may even be a major source

of finance. In case of investment grants, it may be possible to collect information on the amount related to R&D. This is therefore shown as a separate category. Taxes related to R&D are incorporated as a separate category. For the other capital transfers, such a functional split seems less feasible and is therefore left out. Perhaps, in some cases, it may also be possible to single out some taxes on capital related to R&D.

Table 6. The classification of capital taxes and transfers in the R&D module

Taxes on capital related to R&D production, purchases or sales
Investment grants for R&D production
Legacies, large gifts or exceptionally large donations for R&D production
Other capital transfers (like other investment grants, other taxes on capital, transfers within the government)

R&D production or purchases can also be stimulated by granting loans at non-market conditions, like interest rates clearly below market interest rates or with non-commercial repayment conditions. Therefore, in the classification of transactions in financial instruments (table 7), we have introduced a category Loans at non-market conditions for financing R&D expenditure[3)].

Table 7. The classification of transactions in financial instruments in the R&D module.

Loans at non-market conditions for financing R&D expenditure
Other transactions in financial instruments (like other loans, transactions in securities, currency and trade credits)

3) In principle, the interest differential should be recorded as a gift or a subsidy.

3. The design of the R&D module

3.1 Introduction

In this section, the set of standard tables constituting the R&D module is presented. The R&D module consists of five types of tables:
- an overview matrix;
- tables which are magnified cells of the overview matrix;
- a table comparing major aggregates in the module with those in the standard national accounts;
- supplementary tables in non-monetary terms (e.g. number of employees or number of patents classified by subject);
- tables with figures for intertemporal and international comparisons.

In subsection 3.2, a National Accounting Matrix specially tailored to the R&D module is discussed. This matrix is the basic framework of the R&D module. In subsection 3.3, the other tables in the R&D module are presented. The module does not describe the external effects of R&D. Such limitations of the R&D module are shortly investigated in subsection 3.4.

3.2 Basic framework

In designing the national accounting framework for the R&D module, we start from the standard system of national accounts as described in the revised SNA (UN, 1990a, 1992). For our purposes, several modifications are introduced, in particular with respect to the concepts and classifications employed (see section 2). This modified accounting system is summarized in a matrix-format in table 8. It shows the accounts[4], the

[4] The accounts not shown are: II.3 Redistribution of income in kind account, II.4.2 Use of adjusted disposable income account, III.3 Other changes in assets accounts, IV.1 Opening balance sheet, IV.2 Changes in balance sheets and IV.3 Closing balance sheet. The last four accounts have been omitted in our matrix, because in many countries there will be serious difficulties in obtaining data for these accounts. The other two accounts are hardly relevant in describing the role of R&D in the national economy. Omitting these accounts therefore serves to keep the overview relatively simple and clear.

Table 8/R&D.1. A matrix showing the major accounts and aggregates in the R&D module (numerical example)

ACCOUNT (Classification)	codes	0. R&D Services (Commodities)	0. Other Goods & Services (Commodities)	I. R&D Production (Industries)	I. Other Production (Industries)	II.1.1 Generation of Income (Value-added Categories)	II.1.2 Allocation of Primary Income (Institutional Sectors)	II.2 Secondary Distribution of Income (Institutional Sectors)	II.4.1 Use of Income (Institutional Sectors)	Taxes on Production & Subsidies	III.1 Capital (Institutional Sectors)	Capital Formation in R&D Production (Industries)	Capital Formation in Other Production (Industries)	III.2 Financial (Financial Assets)	V. Rest of the World I./II. Current	V. Rest of the World III.1 Capital	TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
0. R&D Services (Commodities)	1			Intermediate Consumption 1	Intermediate Consumption 1				Final Consumption 1			Gross Capital Formation 1	Gross Capital Formation 9		Exports 2		15
0. Other Goods & Services (Commodities)	2	Trade & Transport Margins 2	Trade & Transport Margins -2	Intermediate Consumption 4	Intermediate Consumption 394				Final Consumption 340	Subsidies on Products 8		Gross Capital Formation 2	Gross Capital Formation 89		Exports 245		1082
I. R&D Production (Industries)	3	Output (basic prices) 9								Other Subsidies on Production 4							13
I. Other Production (Industries)	4		Output (basic prices) 834							Other Subsidies on Production 9							843
II.1.1 Generation of Income (Value-added Categories)	5			NET VALUE ADDED(factor costs) 3	NET VALUE ADDED(factor costs) 385										Compensation of Employees from ROW 1		389
II.1.2 Allocation of Primary Income (Inst. Sectors)	6					NET GENERATED INCOME (factor costs) 386	Property Income Flows 151			Net Indirect Taxes 22					Property Income from ROW 31		590
II.2 Secondary Distribution of Income (Inst. Sectors)	7						NET NATIONAL INCOME (market prices) 405	Current Taxes and Transfers 295							Current Transfers from ROW 11		711
II.4.1 Use of Income (Institutional Sectors)	8							NET DISPOSABLE INCOME 402									402
Taxes on Production and Subsidies	9	Taxes on Products 1	Taxes on Products 26	Other Taxes on Production 1	Other Taxes on Production 15												43
III.1 Capital (Institutional Sectors)	10			Consumption of Fixed Capital 4	Consumption of Fixed Capital 48				NET SAVING 61		Capital Taxes and Transfers 91			Borrowing 49		Capital Transfers from ROW 1	254
Capital Formation in R&D Production (Industries)	11										Investment Allocation 3						3
Capital Formation in Other Production (Industries)	12										Investment Allocation 98						98
III.2 Financial (Financial Assets)	13										Lending 58					NET LENDING OF ROW -9	49
V. Rest of the World Current	14	Imports 3	Imports 224			Compensation of Employees to ROW 3	Property Income to ROW 34	Current Transfers to ROW 14									278
V. Rest of the World Capital	15										Capital Transfers to ROW 4				CURRENT EXTERNAL BALANCE -12		-8
TOTAL		15	1082	13	843	389	590	711	402	43	254	3	98	49	278	-8	

type of classifications used per account and the major balancing items and aggregates. The rows describe the revenues and the columns are used for expenditure. Our R&D-matrix can be regarded as an extension and modification of the national accounting matrices presented by Keuning (1991a, 1991b)[5]. This matrix is also the first table in the R&D module (R&D.1). For explanatory purposes, a stylized numerical example is included in table 8.

In the R&D module, the Goods and Services Account is split in two parts: one pertaining to R&D commodities and the other pertaining to the other commodities. The first and second rows show the use of goods and services (intermediate consumption, final consumption, gross capital formation and exports) and the first and second columns describe the supply of goods and services (output and imports). The intermediate and final consumption of R&D commodities consist of the rental of patents (see subsection 2.2 above). In cells (2,1) and (2,2) trade and transport margins by residents on behalf of residents are registered. At the national level, supply of this trade and transport is by definition equal to its use and therefore these cells always add up to zero. This is accomplished by inserting the total trade margin as a negative item. In the aggregate matrix, only the trade and transport margins on R&D, i.e. the trade margins on patents, are shown.

The Production Account "is designed in order to put emphasis on value added as one of the main balancing items in the System. Consequently, it does not cover all transactions linked with the production process, but only the concrete result of production (output) and the using up of goods and services when producing this output (intermediate consumption)" (UN, 1990a, Chapter II, p. 27). At the national level, the balancing item is Net Domestic Product, i.e. the aggregate of the value added of all domestic producers. The producers are classified by industry in the Production Account. In our matrix, an additional functional split is made in the Production Account between R&D production on the one hand and other types of production on the other. This split is in fact only

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[5] Another extended matrix has been applied to the environment (de Boo et al., 1991).

relevant to establishments that partly produce R&D and partly produce other commodities. By means of the functional split, all the inputs and outputs of R&D production can be shown separately.

Governments frequently stimulate the production and dissemination of R&D-knowledge by means of subsidies. In order to show this important aspect of R&D, a separate account is introduced for Taxes on production and imports ('indirect taxes') and subsidies. The indirect taxes are recorded in the rows and the subsidies in the columns. Another advantage of this accounting procedure is that also the indirect tax revenues related to R&D production and consumption are explicitly shown. Taxes and subsidies on products are recorded in the Goods and Services Account and other taxes and subsidies on production are recorded in the Production Account[6]. As a consequence, Output in cells (3,1) and (4,2) is valued at basic prices. The balancing item of Indirect taxes and subsidies is recorded in the Allocation of Primary Income Account. This implies that Net Domestic Product and Net Generated Income are valued at factor costs.

The Primary Distribution of Income Account consists of two sub-accounts: the Generation of Income Account and the Allocation of Primary Income Account. The Generation of Income Account records "distributive transactions which are directly linked to the process of production" (UN, 1990a, Chapter II, p. 30). In order to establish a link to figures on the employed population (see subsection 2.3 on the classification of value added), also the compensation of employees paid to and received from the Rest of the World is included. At the national level, this results in the balancing item Net Generated Income.[7]

The Allocation of Primary Income Account shows the remaining part of the primary distribution of income, i.e. property income flows plus net primary income received by institutional sector. As a consequence of our

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6) It would have been possible to show the taxes on products that pertain to capital formation in cells (9,11) and (9,12) and not as part of cells (9,1) and (9,2). In order to keep the matrix as simple as possible, this more complicated accounting procedure was left out.

7) This is not one of the official aggregates in the standard national accounts; cf. Keuning (1991a).

modifications, property income does not anymore include the revenues from licenses for R&D. Net primary income for the nation as a whole is generally known as Net National Income. From a conceptual point of view, it seems appropriate to make a distinction between revenues from direct investment and revenues from portfolio-investment. For the purposes of the R&D module, we are particularly interested in the part of the revenues from direct investment that should be regarded as a payment for the use of R&D knowledge. However, for statistical reasons, such a subdivision of property income flows are left out.

The Secondary Distribution of Income Account covers redistribution of income through current taxes paid out of income (that is, excluding taxes on production) and other current transfers (in cash). Its balancing item is Net Disposable Income. The Use of Income Account describes how Net Disposable Income is allocated between final consumption expenditure and Net Saving (= the account's balancing item).

The Capital Account records "transactions linked to investment in non-financial assets and capital transfers involving the redistribution of wealth" (UN, 1990a, Chapter II, p. 42). Net lending links the Capital Account and the Financial Account: in both accounts it serves as the balancing item. The Financial Account shows the changes in financial assets, like borrowing and lending and the purchase and sale of equity.

In the standard national accounts, two different transactor-classifications are employed: the industry classification is used in describing production and supply and use of commodities and the institutional sector classification is used in describing income distribution and the financing of production, capital formation and final consumption. The R&D module aims at a simultaneous discription of:

- the production and consumption of R&D as well as income generated due to R&D on the one hand,
- and the income distribution and financing related to R&D production and consumption on the other hand.

Therefore, the linkage between these two parts of the national accounts

is very important for the R&D module. This linkage is established in various ways.

In cells (5,3) and (5,4) value added is cross-classified by industry and value-added category, while in cell (6,5) value added is cross-classified by value-added category and institutional sector. This information can be linked in a three-dimensional table that classifies value added simultaneously by industry and institutional sector. This could be shown explicitly in a more detailed matrix; refer to the supplementary table 11 below (R&D.4). A three-dimensional table of value added will also be included in the revised SNA.

In order to describe the financing of R&D production, also R&D output in cell (3,1) should be classified by institutional sector (see table 11). In this way, this information can be linked to the gifts in cells (7,7) and (7,14) that are used to finance R&D production. The latter are explicitly shown in table 12 below (R&D.5).

Furthermore, by introducing Capital Formation accounts in rows and columns 11 and 12 of the overview matrix, fixed capital formation and changes in stocks by industry are classified simultaneously by industry and by institutional sector in cells (11,10) and (12,10). In this way, a linkage is established with the accounts that describe the financing of capital formation, i.e. the Capital and Financial Account. It is particularly important to link capital formation with the taxes on capital and investment grants in cells (10,10) and (10,15) (e.g. investment grants by the EC).

The Rest of the World Account describes transactions between resident and non-resident institutional units and related changes in assets and liabilities. "As the Rest of the World plays in the accounting structure a role similar to the one of an institutional sector, the Rest of the World Account is established from the point of view of the Rest of the World. A resource for the Rest of the World is a use for the Nation and vice versa. When looking at a balancing item, if it is positive it means a surplus of the Rest of the World and a deficit of the Nation, and vice

versa if it is negative" (UN, 1990a, Chapter II, p. 56). In our matrix, we have distinguished a current account and a capital account.

The Current Account shows imports and exports and compensation of employees, property income and current transfers to and from abroad. The Capital Account corresponds to those for the domestic sectors. Its balancing item is Net Lending of the Rest of the World.

3.3 Other tables in the module

In this subsection, we will present the other tables in the R&D module.

In the second table of the R&D module (table 9), the major aggregates in the R&D module are compared to those in the core (standard national accounts). How the aggregates in the module can be derived from those in the core, is explicitly shown in Appendix B.

Table 9 (=R&D.2). A comparison of major aggregates in the core and the R&D module

	NDP Abs.	NDP Growth	NNI Abs.	NNI Growth	Gross Fixed Capital Formation	Consumption of Capital	Final Consumption	Current External Balance
Core								
R&D module								

The third table in the module (R&D.3 = table 10) describes the supply and use of R&D production. In the first column the supply of R&D goods and services is presented. Submatrix (3,1) shows the R&D output by industry and in row vector (14,1) R&D imports are recorded. Similarly, in the second column the supply of other goods and services is recorded.

The use of R&D goods and services (intermediate consumption, final consumption, capital formation and exports) can be found in the first row. In cells (1,3) and (1,4) intermediate consumption by industry is registered. As a major part of the purchase and own-account production

	codes	Goods & Services — R&D services: Total	Market NSE	Market SSH	Non-market NSE	Non-market SSH	Licenses	Patents	Other Goods & Services	R&D Production (Industries): Total	1	...	11	Other Production (Industries): Total	1	...	11	Use of income Final consumption: Gov.	HH.	PNP's	Subsidies on Products	Subsidies on Production	Changes in Stocks in R&D Production (Industries): Total	1	...	11	Gross Fixed Capital Formation in R&D Production (Industries): Total	1	...	11	Changes in Stocks in Other Production (Industries): Total	1	...	11	Gross Fixed Capital Formation in Other Production (Industries): Total	1	...	11	ROW Exports	Total
		1							2	3				4				8			9		11a				11b				12a				12b				14	
R&D services, total Market services Nat. sciences and eng. Soc. sciences and hum. Non-market services Nat. sciences and eng. Soc. sciences and hum. Licenses Patents	1																																							
Other goods and services	2																																							
Total 1. Agric. and fishing 2. Mining and quarrying 3. Manufacturing 4. Electr., gas and water 5. Construction 6. Transp., storage & comm. 7. Research and development 8. Defence activities 9. Other public adm. 10. Education 11. Other serv. and n.e.c.	3																																							
Total 1. Agric. and fishing 2. Mining and quarrying 3. Manufacturing 4. Electr., gas and water 5. Construction 6. Transp., storage & comm. 7. Research and development 8. Defence activities 9. Other public adm. 10. Education 11. Other serv. and n.e.c.	4																																							
Net value added Compensation of employees High skilled Low skilled Net oper. surp./mixed inc.	5																																							
Taxes on products Other taxes on production	9																																							
Consump. of fixed capital	10																																							
Imports	14																																							

of R&D is included in gross fixed capital formation, most rows are empty in this block. The exception is the expenditure on licenses. In submatrices (1,11a), (1,11b), (1,12a) and (1,12b) gross capital formation is shown; with the exception of the row for the expenditure on licenses, all rows could be non-zero here. Exports of R&D commodities can be found in vector (1,14). Analogously, the second row shows the use of other goods and services. In row vector (2,1), the trade and transport margins on patents are presented. In order to balance the totals, these margins are also entered in cell (2,2), but now with a negative sign.

In columns 3 and 4 the inputs into production are recorded: intermediate consumption in submatrices (1,3), (1,4), (2,3) and (2,4) and the various categories of value added in submatrices (5,3) and (5,4).

Table R&D.4 (= table 11) serves to establish a linkage between table R&D.3 (= table 10) on the supply and use of R&D production and other tables on the financing of R&D production (R&D.5; = table 12). In terms of the overview matrix, it contains information from the third row and column. The table is three-dimensional, as it cross-classifies the various costs of production by industry and by institutional sector. For the subsectors of Business, no cross-classification is made for reasons of secrecy. Subsidies are subdivided into those received from the national government and those from international organizations, in order to show the funding sectors as well.

The fifth table of the R&D module (table 12), describes the Current gifts and donations for R&D purposes. In order to add up to the totals in cells (7,7), (7,14) and (14,7) of the overview matrix, also the category Net other current transfers is entered. For our purposes, it is not necessary to show these flows by institutional sector of origin.

The sixth table in the R&D module (table 13), cross-classifies gross capital formation for R&D production by industry and institutional sectors. This table corresponds to cell (11,10) in the overview matrix.

Table 11/R&D.4. Production and generation of income by sectors and industries

	codes	Total domestic production	R&D production by industries Total	1	2	3	4	5	6	7	8	9	10	11
		I.	II.											
I. Business Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net operating surplus Taxes on production (-) Subsidies National government International organizations Total output	I.													
I.1 Foreign controlled corporations Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net operating surplus Taxes on production (-) Subsidies National government International organizations Total output	I.a													
I.2 Domestic multinationals Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net operating surplus Taxes on production (-) Subsidies National government International organizations Total output	I.b													
I.3 Other business Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net operating surplus Taxes on production (-) Subsidies National government International organizations Total output	I.c													
II.1 Public universities Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net operating surplus Taxes on production (-) Subsidies National government International organizations Total output	II.a													
II.2 Other government Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net operating surplus Taxes on production (-) Subsidies National government International organizations Total output	II.b													
III.1 Households Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net oper. surp./mixed income Taxes on production (-) Subsidies National government International organizations Total output	III.a													
III.2 PNP's serving households Intermediate consumption Consumption of fixed capital Net value added Compensation of employees Net oper. surp./mixed income Taxes on production (-) Subsidies National government International organizations Total output	III.b													
Total Domestic Sectors Net value added Total output	IV.													

Table 12/R&D.5. Current taxes and transfers

	codes	Institutional sectors I.	I.1	I.2	I.3	II.1	II.2	III.1	III.2	Total	ROW Int.org.	Other
		7									14	
I. Business Current gifts and donations related to R&D Net other current transfers	7											
I.1 Foreign controlled corporations Current gifts and donations related to R&D Net other current transfers												
I.2 Domestic multinationals Current gifts and donations related to R&D Net other current transfers												
I.3 Other business Current gifts and donations related to R&D Net other current transfers												
II.1 Public universities Current gifts and donations related to R&D Net other current transfers												
II.2 Other government Current gifts and donations related to R&D Net other current transfers												
III.1 Households Current gifts and donations related to R&D Net other current transfers												
III.2 PNP's serving households Current gifts and donations related to R&D Net other current transfers												
Total Domestic Sectors Current gifts and donations related to R&D Net other current transfers												
Rest of the World Current gifts and donations related to R&D Net other current transfers	14											

Table 13/R&D.6. Gross capital formation related to R&D production by sectors and industries

	codes	Gross capital formation in R&D production (sectors) Total	I.	I.1	I.2	I.3	II.1	II.2	III.1	III.2
		10								
1. Agriculture and fishing Gross fixed capital formation Changes in stocks	11									
2. Mining and quarrying Gross fixed capital formation Changes in stocks										
3. Manufacturing Gross fixed capital formation Changes in stocks										
4. Electricity, gas and water Gross fixed capital formation Changes in stocks										
5. Construction Gross fixed capital formation Changes in stocks										
6. Transport,storage & communication Gross fixed capital formation Changes in stocks										
7. Research and development Gross fixed capital formation Changes in stocks										
8. Defence activities Gross fixed capital formation Changes in stocks										
9. Other public administration Gross fixed capital formation Changes in stocks										
10. Education Gross fixed capital formation Changes in stocks										
11. Other services and n.e.c. Gross fixed capital formation Changes in stocks										
Total Domestic Industries Gross fixed capital formation Changes in stocks										

Table 14/R&D.7. Capital taxes and transfers

	codes	Institutional sectors I.	I.1	I.2	I.3	II.1	II.2	III.1	III.2	Total	ROW Int.org.	Other
		10									15	
I. Business Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
I.1 Foreign controlled corporations Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
I.2 Domestic multinationals Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
I.3 Other business Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
II.1 Public universities Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
II.2 Other government Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
III.1 Households Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
III.2 PNP's serving households Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
Total Domestic Sectors Taxes on capital related to R&D Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	10											
Rest of the World Investment grants related to R&D Legacies, large gifts, etc., for R&D Net other capital transfers	15											

Table 15/R&D.8 Transactions in financial instruments

	codes	Institutional sectors I.	I.1	I.2	I.3	II.1	II.2	III.1	III.2	Total	ROW Int.org.	Other	Loans at non-market conditions	Other financial trans.
		10									15		13	
I. Business I.1 Foreign controlled corporations I.2 Domestic multinationals I.3 Other business II.1 Public universities II.2 Other government III.1 Households III.2 PNP's serving households Total Domestic Sectors	10													
Rest of the World International organizations Other	15													
Loans at non-market conditions for R&D Other financial transactions	13													

In the seventh table (table 14/R&D.7), Taxes on capital, Investment grants and Legacies, large gifts etc. related to R&D production are shown. Just as in table 12, a category Net other (capital transfers) is included, in order to add up to the total capital transfers in cells (10,10), (10,15) and (15,10) of the overview matrix.

The eighth table (table 15/R&D.8), describes the non-market loans with the specific purpose of financing R&D. The table corresponds to cells (13,10) and (10,13) in the overview matrix.

This standard set of tables can be supplemented by tables in non-monetary terms or tables which focus on intertemporal or international comparisons. Examples are:

- tables on the size of domestic R&D production (as a percentage of Domestic Product);
- tables on the financing of R&D production (showing the relative importance of direct and indirect subsidies);
- tables on the volume of labour inputs in R&D production by quality of labour;
- a table on the number of patents owned and licences used classified by economic activity and subject of the patent/license;
- tables on the relation between R&D-intensity and indexes of productivity or
- a table on the sensitivity of the measurement of output to our alternative accounting procedures.

3.4 Limitations

In designing our module, some problems of data compilation have been explicitly taken into account, e.g. when choosing the R&D concept. Nevertheless, it may not yet be possible to compile all the necessary data. R&D statistics, which are generally based on the guidelines in the Frascati Manual, should serve as a principal data source for compiling the R&D module. Unfortunately, the Frascati Manual deviates in scope as well as in concepts from the national accounts. These differences are

discussed in Appendix A. Another data problem is that our module starts from the revised SNA, but in most countries national accounts are based on the 1968 SNA. Finally, information on the new subsectors as defined in the module may not be readily available.

In drawing conclusions about the role of R&D in the national economy, it is important to realize which aspects of R&D are not described by the standard set of tables. We will list four of such analytical limitations.

First, as already remarked in subsection 2.2, the concept of R&D employed in the module focuses on creative and innovative work. The limitations of this concept have already been noted above. For example, it ignores many activities that are crucial to commercial success, such as marketing and product design.

Secondly, in the case of joint ventures or multinationals, it frequently occurs that use is made of R&D output, but that accomodating payments -e.g. in the form of license payments- are absent or not recognizable as such. Such flows are neglected in the module for measurement reasons. In fact, this is a transfer pricing problem.

Thirdly, in the module, R&D production is generally valued at costs. Exceptions are only made for R&D on contract and the revenues from the trade in patents. This valuation at costs implies that gains in efficiency and effectiveness due to the use of R&D are not incorporated in the valuation of R&D production. These gains are also not shown elsewhere in the module, because they are merely analytical constructs[8]. This statement holds for R&D which leads to new products (changes in outputs) as well as for R&D that only changes the inputs for production.

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[8] Productivity analysis and growth accounting try to estimate and analyze the relative contribution of various inputs to changes in productivity and growth. The results obtained are subject to a lot of discussion (see Maddison, 1987 and van der Wee, 1987, pp. 138-149). Accounting for the depreciation of patents as an extra capital input, like in our module, decreases total factor productivity, but this probably hardly contributes to an explanation of the residual.

For example, for individual enterprises, it may be possible to calculate the (expected) savings on the costs of producing due to a concrete invention or innovation. However, even if such a calculation is possible, a problem for the statistician is that enterprises often do not make such calculations: enterprises only have to decide on whether it is profitable to make use of the invention or innovation or not; for this decision, it is not necessary to know how much more profitable it is. Another problem with calculating the benefits from R&D as input is that, if the simple criterium of cost reduction is used, innovations and inventions that do not lead to cost reductions are not regarded as benefits from R&D. Examples are innovations that improve the safety of employees or that lead to less pollution.

Calculating the benefits of R&D that changes outputs is even more difficult. For the individual enterprise, innovation of its products may be necessary to survive national and international competition. From this point of view, even all its profits and value added could be regarded as the benefit from innovation. In the long term, this reasoning applies to nearly all output, and the calculation would clearly be nonsensical. However, taking a more modest view on the benefits of R&D is equally problematic as clear criteria for delineating these benefits are absent.

Furthermore, new or improved products, e.g. computers, can be used as inputs for producing other goods and services. So, the macro-economic benefits from this R&D activity include the savings due to this change in inputs. This external effect is very important, but also very difficult to quantify.

As a final limitation, we mention that the module also does not present specific information on the supply and use of R&D-intensive commodities, because the concept of R&D-intensive is problematic.

A solid operationalization of the concept of R&D-intensive is difficult even when it is narrowed down to technology-intensive (thus excluding commercial and managerial knowledge). Eurostat (1989, Appendix B)

has published a list of 130 high-tech commodities. This list comprises commodities in aerospace, automatic data processing machines, electronic equipment, telecommunications equipment, drugs, scientific instruments, electrical machinery, non-electrical machinery and chemicals. How heterogeneous this list may seem, it nevertheless excludes e.g. some R&D intensive commodities for which the Netherlands are world famous, like flowers, breeding-cattle and seeds.

Furthermore, for analyzing international competitiveness, the absolute R&D intensity of a commodity can be very misleading. A R&D extensive commodity can be very successful as long as it is more R&D intensive than competing products. A similar remark applies to unsuccessful R&D-intensive commodities. For that purpose, a classification by relative R&D intensity is preferable. However, such a classification is outside the scope of the R&D module as it would constitute an extensive analysis of international flows in goods and services.

4. Conclusions

The role of Research and Development (R&D) in the national economy is not described as such by the national accounts. By means of a set of tables linked to the national accounts, the various aspects of R&D (production, consumption, income, financing) can be described in relation to the national economy. Linkage to the national accounts implies that the same statistical units, concepts, classifications and accounts are used as in the national accounts. Only some specific modifications in concepts and classifications are allowed in order to improve the description of the role of R&D.

The modifications with respect to the basic accounting concepts are:

- Production of R&D by market producers not sold on contract, e.g. their own-account production, is also recorded as output;
- R&D output which is intended to be patented, should be recorded as work-in-progress, i.e. a change in stocks. At the time it is patented, the stocks of the R&D producer are then reduced and fixed capital formation is recorded. Subsequently, this asset is written off, whereby its length-of-life is equal to the number of years for which the patent is granted. For the purchaser, positive fixed capital formation is registered by amount of the price paid for the patent plus the other acquisition costs for the patent. This implies that part of his investment consists of transfer costs, analogously to the case of trade in other existing capital goods.
- R&D output which is not intended to be patented, is recorded as fixed capital formation and immediately written off;
- Revenues from the sale of patents are recorded as revenues from trade and thus not recorded as revenues from the sale of a non-produced asset;
- Revenues from licenses are recorded as the output of a business activity rental of patents and not as property income;
- The purchase of a license is recorded as intermediate or final consumption, the purchase of a patent is always recorded as fixed capital formation; the sale of a patent is recorded as negative fixed capital formation;
- Indirect subsidies, like the remission of income taxes for industrial

R&D, are also recorded as subsidies;
- Subsidies received by "investors" in R&D should be recorded as capital transfers and not as operating subsidies.

As a consequence of these changes, Fixed Capital Formation, Final Consumption, Value Added, Domestic Product and National Income change as well.

The major changes in the classifications are:
- Intermediate consumption, value added categories and fixed capital formation are cross-classified by economic activity and institutional sectors;
- In classifying R&D output, a distinction is made between market and non-market services (e.g. own-account);
- New subsectors are introduced: Domestic Multinationals and International Organizations;
- Compensation of employees is also classified by quality of labour.

Although the concepts and classifications for the R&D module have been selected with the possibilities of data compilation in mind, it may not yet be possible to compile all the necessary data. Statistics on R&D, based on the guidelines in the Frascati Manual, have to serve as a major data source for compiling the R&D module. However, the Frascati Manual has some clear limitations in scope and concepts:
- The focus is on measuring R&D expenditure and R&D employment; income from and expenditure on patents and licenses are ignored;
- The distinction between current and capital expenditure does not coincide with that in the national accounts and in our module;
- No distinction is made between subsidies for R&D and the purchase of R&D by the government;
- Linkage with national accounts tables that are classified by economic activity (like the supply and use tables and the production accounts) is problematic, because a different statistical unit is employed.

So, for the purposes of the R&D module, supplementary information is to be used. Part of this information should preferably be obtained by extending and modifying the (annual surveys for the) R&D statistics.

Appendix A. The Frascati Manual and the National Accounts

In this section, the Frascati Manual, the international guideline on R&D statistics, is discussed. We start by taking a short look at its historical roots and then continue by discussing the R&D-concepts, the statistical units, the sector classification and the classification of transactions employed.

Most OECD countries started the collection of R&D data in the early sixties, following pioneering countries as the United States and the Netherlands (OECD, 1981, Annex I, pp. 122-126). Two main problems called for the standardization of the measurement techniques used in the R&D surveys. First, among the pioneering countries there were differences in scope, methods and concepts, obstructing an international comparison of their R&D statistics. Secondly, several other countries were facing theoretical difficulties in starting R&D surveys. International guidelines regarding these measurement techniques were thus needed.

The OECD tried to meet these needs by setting up studies on the technical problems of measuring R&D, culminating in 1963 in the publication of the Frascati Manual - a 'Proposed Standard Practice for Surveys of Research and Development' -. Improved versions of this Manual were published in 1970, 1976 and 1981. A supplement on the specific problems of measuring R&D in the Higher education sector was published in 1989. Presently, a new revision of the Manual is in preparation. The success of the Frascati concept is evidenced by its use by nearly all OECD countries. This significantly increased the comparability of R&D statistics among these countries.

The main objective of the Manual is to present guidelines on the measurement of two variables: R&D expenditures and R&D manpower. Over the years, these data have been used in a wide range of studies, e.g. productivity-analyses and studies on economic growth.

The Frascati Manual defines Research and Experimental Development (R&D) as "creative work undertaken on a systematic basis in order to

increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications" (OECD, 1981, p. 25). R&D covers three activities: basic research, applied research and experimental development. "Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed" (OECD, 1981, p. 25).

In order to sharper the notion of its R&D concept, the Manual distinguishes three types of related activities which are to be excluded from R&D.

The first type of activities which is to be excluded, is education and training taking place at universities and other institutions of post-secondary education. The research performed by post-graduate students at universities however, should be included in R&D as this research is not part of their formal education.

Secondly, all activities classified as other related scientific and technological activities are not to be treated as R&D. Examples of these activities, are:

- the translation and collection of already established research;
- the bibliographic activities supporting R&D;
- all data collected for general purposes;
- the testing and standardization of R&D inputs and outputs;
- feasibility studies to the successful implementation of the outcomes of R&D;
- specialised medical care based on routine activities;

- and policy related studies.

The last type of activities to be excluded from R&D is other industrial activities. It comprises all those steps in the innovation process, except R&D, executed to increase the successful development and marketing of the output of R&D. If further technical progress is not the central objective, these activities should not be included. Examples are design engineering, market research and patent filing and licensing.

In table A.1 the sector classification in the Frascati Manual is presented. The Frascati sector classification differs in several respects from the institutional sector classification in the National Accounts. The major difference is that Higher Education has been established as a separate sector. In this sector, privately-funded profit-making universities, privately funded non-profit universities as well as universities funded by the government are incorporated. In the standard national accounts, these are classified in respectively the Non-financial (or financial) Corporate sector, the Private non-profit institutions serving households sector and the General government sector.

Table A.1. Sector classifications in the Frascati Manual and the revised SNA

Frascati Manual	Revised SNA
Business enterprise sector	1. Non-financial corporate sector
- private enterprises	
- public 'market' enterprises	2. Financial corporate sector
- PNP's serving business	
Government sector	3. General government sector
- government agencies	
- PNP's serving government	4. Household sector (employers, own-account workers, employees, recipients of property or transfer income)
Higher education sector	
- universities	
- other post-secondary education	
- PNP's serving higher education	
Private-non-profit sector	5. Private Non-profit institutions serving households
- other PNP's	
- households and unincorporated enterprises	

The Frascati Manual recommends to subclassify the Business enterprise sector according to a specific rearrangement of the International Standard Industrial Classification (ISIC Rev. 2) (see table A.2 = Table III.1, pp. 41, 42 in OECD, 1981). A problem with this rearrangement is that the rearrangement occurs at a level of detail that is generally not published in the national accounts. As a consequence, linkage with published national accounts tables classified by industry is usually not possible.

The statistical unit (the 'unit of classification') recommended for the sector Business enterprises is the 'enterprise-type unit', because "one of the most fundamental questions concerns the sources of funds for R&D" (OECD, 1981, p. 43). This statistical unit is preferable for establishing a linkage to the Income and Outlay and Capital Finance Accounts in the National Accounts. However, as a consequence, the data on Business Enterprises by industry in the Frascati Manual do not correspond with the figures in the production account of the National Accounts. In the Dutch R&D statistic, the statistical unit employed corresponds to enterprises and sometimes even groups of enterprises (CBS, 1991); in the latter cases, it certainly deviates from the unit employed in the National Accounts.

The Frascati Manual recommends to subclassify the sector Business Enterprises also by size of employment, because this normally affects the "extent and nature of the R&D programmes of entities in the Business Enterprise Sector" (OECD, 1981, p. 45). Separate classifications are recommended for larger and smaller economies.

Table A.2. International Standard Industrial Classification (ISIC) arranged for the purposes of R&D statistics

OECD surveys of the business enterprise sector Industry groups	Component industries	ISIC reference[a]
Agriculture	Agriculture	Major division 1
Mining	Mining	Major division 2
Electrical group	Electrical machinery	383 except 3832
	Electronic equipment and components	3832
Chemical group	Chemicals	351, 352 except 3522
	Drugs	3522
	Petroleum refining	353, 354
Aerospace	Aerospace	3845, part of 3829
Transport equipment (except aerospace)	Motor vehicles	3843
	Ships	3841
	Other transport	3842, 3844, 3849
Basic metals	Ferrous metals	371
	Non-ferrous metals	372
	Fabricated metal products	381
Machinery	Instruments	385
	Office and computing machinery	3825
	Machinery n.e.c.	382 except 3825 and part of 3829
Chemical-linked	Food, drink and tobacco	31
	Textiles, footwear and leather	32
	Rubber and plastic products	355, 356
Other manufacturing	Stone, clay, glass	36
	Paper and printing	34
	Wood, cork and furniture	33
	Other manufacturing	39
Total manufacturing	Total manufacturing	Major division 3
Services	Utilities	Major division 4
	Construction	Major division 5
	Transport, storage	71
	Communication	72
	Scientific and engineering services	8324, 9320
	Other	Major division 6 Major division 8 n.e.c. Major division 9
Total services	Total services	Major divisions 4-9
Total business enterprise sector		

a) International Standard Industrial Classification of all Economic Activities (ISIC), Series M. No.4, Rev.2, United Nations, New York, 1968.

In the Frascati Manual, two types of R&D expenditures are distinguished. Intramural expenditures comprise all expenditures for R&D spent within the statistical unit. All expenditures spent outside the statistical unit are classified as extramural. The intramural expenditures are subdivided into:

- labour costs

- other current expenditure
- capital expenditure.

The labour costs comprise wages, salaries and fringe benefits paid to the personnel directly contributing to R&D; the other current costs comprise non-capital purchases of materials and equipment, and the labour costs of those providing indirect services.

'Capital expenditures' consist of those expenditures made for land and buildings explicitly used in the production of R&D; and expenditures on instruments and equipment of a capital nature. The concept of 'capital expenditure' in the Frascati Manual differs from the concept of 'fixed capital formation' employed in the standard national accounts. The latter concept does not include the purchase of land but encompasses all expenditure on behalf of own-account capital formation. Furthermore, the Frascati Manual is not very clear about the treatment of, e.g., delivery and installation costs, because "it is neither necessary nor practical to insist on any rigid standard for this purpose" (OECD, 1981, p. 75).

The Manual recommends to collect data on the intramural expenditures. The national intramural aggregate, Gross Domestic Expenditures on R&D (GERD) includes all expenditures on R&D performed within the country, disregarding whether residents or non-residents finance these expenditures. From a national accounting point of view, international comparisons on the basis of GERD are imperfect as measures of 'national efforts on R&D', because:

- capital consumption instead of capital expenditure should have been included;
- the national accounting concept of fixed capital formation should have been employed.

In the Frascati Manual, a distinction is also made between 'Natural sciences and engineering' (NSE) and 'Social sciences and humanities' (SSH). The NSE cover "the physical sciences, the life sciences, including the medical and agricultural sciences, plus engineering" (OECD, 1981, p. 17). For the business enterprise sector, the Manual

focuses exclusively on R&D in the NSE.

The size of R&D manpower is an important input indicator as a major part of expenditures on R&D consists of labour costs. All persons working directly on R&D or providing direct services should be counted as R&D personnel. These counts should be converted into full-time equivalents (FTE's). Especially in universities, where most researchers have to perform a good deal of educational (and managerial) tasks as well, the distinction between R&D and other activities cannot easily be drawn. The Manual states that estimates of the share of R&D of university researchers have to be based on detailed studies of the proportion of working time devoted to this activity.

In the Frascati Manual, unlike in the National Accounts, no distinction is made between transfers and the purchase of goods and services. For example, the term 'direct transfers' in the Frascati Manual encompasses contracts paid for the performance of R&D as well as donations (OECD, 1981, pp. 76, 77). The absence of this distinction is a pity, as it is important for analyzing the financing of R&D expenditure. For example, a subsidy by the government of a R&D project is generally rather different in nature and motive than the purchase of R&D by the government. A similar argument applies to the difference between sponsoring of medical research for reasons of good-will on the one hand and a contractual payment for medical research against a claim on resulting patents and other commercial off-shoots on the other hand.

In the National Accounts, a distinction is also made between current transfers and capital transfers. This distinction is absent in the Frascati Manual (see OECD, 1981, p. 112). This reflects the notion of the Frascati Manual to explain the financing of R&D expenditure, irrespective of whether this concerns current or capital expenditure.

Appendix B. Linking the module to the core

In the R&D module, the concepts and classifications differ in several respects from those in the standard national accounts. The differences in classification have been summarized in subsection 2.3 in tables 1-7. The conceptual amendations have been discussed in subsection 2.2. However, the consequences of these modifications for aggregates like fixed capital formation and final consumption and various balancing items have not yet been investigated. This will be the topic of this appendix. We start with a general overview of the consequences and then present some concrete examples for further clarification.

In table B.1, the relationship between output in the standard national accounts and in the R&D module is made explicit. The consequences of modifying the concepts depend on whether a market or a

Table B.1. The relationship between Output in the standard national accounts (the core) and in the R&D module.

Market producers that produce R&D:
Output in the core
+ Costs of R&D production not on contract
+ Costs of patent-filing
+ Trade margin on the sale of patents
+ Revenues from the rental of patents

Output in the R&D module

Non-market producers that produce R&D:
Output in the core
+ Capital consumption on patents

Output in the R&D module

Market producers that buy or rent R&D:
Output in the core = Output in the R&D module

Non-market producers that buy or rent R&D:
Output in the core
+ Costs of rental of patents
+ Capital consumption on patents

Output in the R&D module

non-market producer is involved. In case of non-market producers, output is namely calculated by adding up all (non-financial) costs. In table B.1, a distinction is therefore made between the consequences for market producers and those for non-market producers. For clarity's sake, a

distinction is also made between buyers and renters of R&D on the one hand and producers of R&D on the other hand. Of course, sometimes a producer of R&D also buys or rents R&D and then both types of consequences apply simultaneously.

The consequences of modifying the concepts on final consumption can easily be deducted from table B.1. The changes in final consumption are equal to the changes in output by the Government and by Private non-profit institutions serving households (see table B.2).

Table B.2. The relationship between final consumption and output.

Final consumption expenditure by households
Final consumption of the output by Private non-profit institutions serving households
Final consumption of the output by the Government
Total final consumption

In table B.3, the consequences of the alternative concepts are shown for Net Value Added and Net Domestic Product, both at factor costs. Again, a distinction is made between market and non-market producers and also between producers of R&D and buyers of R&D. The table does not show the consequences for Net Domestic Product of a reclassification of a non-market producer as a market producer. Such a reclassification would amount to changes similar to that for a market producer plus the positive operating surplus of the formerly non-market producer.

The changes in Gross Value Added and Gross Domestic Product can easily be deduced from this table: they are equal to the net changes plus the increase in capital consumption.

Table B.3. The relationship between Net Value Added and Net Domestic Product in the standard national accounts (the core) and the R&D module.

Market producers that produce R&D:
Net value added at factor costs in the core
+ Trade margin on the sale of patents
+ Revenues from the rental of patents (licenses)
+ Gross capital formation of R&D production
- Cap. consumption on R&D assets owned
+ Subsidies on R&D production in the form of a remission of income taxes
- Subsidies for "investing" in R&D (= reclassification as capital transfer)

Net value added at factor costs in the R&D module

Non-market producers that produce R&D:
Net value added at factor costs in the core = Net value added at factor costs in the R&D module

Market producers that buy or rent R&D:
Net value added at factor costs in the core
- Expenditure on the rental of patents (licenses)
+ Acquisition costs for patents
- Cap. consumption on patents
(+ Expenditure on the purchase of R&D production on contract
- Capital consumption on R&D bought on contract)
+ Subsidies on the purchase of R&D in the form of a remission of income taxes
- Subsidies for "investing" in R&D (= reclassification as capital transfer)

Net value added at factor costs in the R&D module

Non-market producers that buy or rent R&D:
Net value added at factor costs in the core = Net value added at factor costs in the R&D module

Domestic Product
Net Domestic Product at factor costs in the core
+ Trade margin on the sale of patents by market producers
+ Balance of revenues from and exp. on rental of patents by market producers
+ Change in net capital formation by market producers
+ Subsidies on the purchase or production of R&D in the form of a remission of income taxes received by market producers
- Subsidies received by market producers that "invest" in R&D

Net Domestic Product at factor costs in the R&D module

In table B.4, the changes in capital formation and capital consumption are summarized.

The modifications in Net Primary Income, Net National Income at market prices, Net Disposable Income and Net Saving are equal to those in Net Value Added and Net Domestic Product with the exception of the modifications on revenues from and expenditure on licenses and those on the subsidies. For Net Lending there is one more difference: it is also not affected by the alternative accounting procedure for patents.

The change in the Current External Balance consists of the net purchases of patents by the Rest of the World: in our module, they are recorded as part of the Rest of the World's Current Account.

Table B.4. The relationship between Capital Formation in the standard national accounts (the core) and in the R&D module.

Producers of R&D:
Changes in stocks in the core
+ Expenditure on R&D production that is intended to be patented
- Costs of R&D production that is patented
- Costs of R&D production that was intended to be patented, but did not result in a patent

Changes in stocks in the R&D module

Gross fixed capital formation in the core
+ Costs of R&D production that is patented
+ Patent filing costs
- Costs of patents that are sold
+ Costs of R&D production that is not intended to be patented
+ Costs of R&D production that was intended to be patented, but did not result in a patent

Gross fixed capital formation in the R&D module
- Capital consumption in the core
- Capital consumption on patents
- Costs of R&D production that is not intended to be patented
- Costs of R&D production that was intended to be patented, but did not result in a patent (= capital consumption)

Net fixed capital formation in the R&D module

Buyers of R&D:
Changes in stocks in the core

Changes in stocks in the R&D module

Gross fixed capital formation in the core
+ Purchases of patents
+ Acquisition costs of patents
+ Purchases of R&D production on contract (without patent)*)

Gross fixed capital formation in the R&D module
- Capital consumption in the core
- Capital consumption on patents
- Purchases of R&D production on contract (without patent)*) (= capital consumption)

Net fixed capital formation in the R&D module

*) In case of R&D production that result in the construction of prototypes, these may already (partly) have been included in Gross fixed capital formation in the core (cf. UN (1992, ..)).

Two examples may illustrate and clarify the consequences as described above. We will discuss them in terms of our overview matrix (table 8).

By recording own-account R&D production by market producers as gross fixed capital formation, gross capital formation in cell (1,11), output in cell (3,1) and gross value added increase by the same amount. In order to calculate the change in net value added in cell (5,3), capital consumption on this R&D asset should be deducted (see cell (10,3)). The change in net value added trickles down in all other balancing items: net generated income in cell (6,5), net national income in cell (7,6), net disposable income in cell (8,7), net saving in cell (10,8) and the

sectoral investment allocation (11,10) all change by exactly the same amount as net value added in cell (5,3).

In the standard accounts, the sale and purchase of patents is registered in the capital account. By recording it as the sale and purchase of a commodity, several changes occur in the accounts 'above' the capital account; the balancing item of the capital account (Net lending) remains unaffected. Our alternative accounting procedure, implies that in case of the purchase of a patent, fixed capital formation is registered in cells (1,11) or (1,12) with the purchaser, negative capital formation is recorded in the same cells with the seller, and a trade and transport margin on the sale is recorded in cell (2,1), counterbalanced by a negative item in cell (2,2). In turn this is countervailed by a positive change in the output of trade (cell (4,2)).

In case of a purchase from abroad, imports in cell (14,1) also increase. In case of a sale of a patent to abroad, exports in cell (1,14) are augmented. The increase in trade and transport margins trickles down in output in cell (4,2), net value added in cell (5,4) and in the balancing items in cells (6,5), (7,6), (8,7) and (10,8). Finally, the investment allocation in (11,10) or (12,10) is affected. On the other hand, capital transfers in cell (10,10) no longer include this transaction. The changes in imports and exports also affect the current external balance in cell (15,14) and this is compensated by a concomitant change in capital tranfers to and from abroad (cells (15,10) and (10,15)).

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National Accounts Occasional Papers

NA/01 **Flexibility in the system of National Accounts**, Van Eck, R., C.N. Gorter and H.K. van Tuinen (1983).
This paper sets out some of the main ideas of what gradually developed into the Dutch view on the fourth revision of the SNA. In particular it focuses on the validity and even desirability of the inclusion of a number of carefully chosen alternative definitions in the "Blue Book", and the organization of a flexible system starting from a core that is easier to understand than the 1968 SNA.

NA/02 **The unobserved economy and the National Accounts in the Netherlands, a sensitivity analysis**, Broesterhuizen, G.A.A.M. (1983).
This paper studies the influence of fraud on macro-economic statistics, especially GDP. The term "fraud" is used as meaning unreporting or underreporting income (e.g. to the tax authorities). The conclusion of the analysis of growth figures is that a bias in the growth of GDP of more than 0.5% is very unlikely.

NA/03 **Secondary activities and the National Accounts: Aspects of the Dutch measurement practice and its effects on the unofficial economy**, Van Eck, R. (1985).
In the process of estimating national product and other variables in the National Accounts a number of methods is used to obtain initial estimates for each economic activity. These methods are described and for each method various possibilities for distortion are considered.

NA/04 **Comparability of input-output tables in time**, Al, P.G. and G.A.A.M. Broesterhuizen (1985).
It is argued that the comparability in time of statistics, and input-output tables in particular, can be filled in in various ways. The way in which it is filled depends on the structure and object of the statistics concerned. In this respect it is important to differentiate between coordinated input-output tables, in which groups of units (industries) are divided into rows and columns, and analytical input-output tables, in which the rows and columns refer to homogeneous activities.

NA/05 **The use of chain indices for deflating the National Accounts**, Al, P.G., B.M. Balk, S. de Boer and G.P. den Bakker (1985).
This paper is devoted to the problem of deflating National Accounts and input-output tables. This problem is approached from the theoretical as well as from the practical side. Although the theoretical argument favors the use of chained Vartia-I indices, the current practice of compilating National Accounts restricts to using chained Paasche and Laspeyres indices. Various possible objections to the use of chained indices are discussed and rejected.

NA/06 **Revision of the system of National Accounts: the case for flexibility**, Van Bochove, C.A. and H.K. van Tuinen (1985).
It is argued that the structure of the SNA should be made more flexible. This can be achieved by means of a system of a general purpose core supplemented with special modules. This core is a fully fledged, detailed system of National Accounts with a greater institutional content than the present SNA and a more elaborate description of the economy at the meso-level. The modules are more analytic and reflect special purposes and specific theoretical views.

NA/07 **Integration of input-output tables and sector accounts; a possible solution**, Van den Bos, C. (1985).
The establishment-enterprise problem is tackled by taking the institutional sectors to which the establishments belong into account during the construction of input-output tables. The extra burden on the construction of input-output tables resulting from this approach is examined for the Dutch situation. An adapted sectoring of institutional units is proposed for the construction of input-output tables.

NA/08 **A note on Dutch National Accounting data 1900-1984**, Van Bochove, C.A. (1985).
This note provides a brief survey of Dutch national accounting data for 1900-1984, concentrating on national income. It indicates where these data can be found and what the major discontinuities are. The note concludes that estimates of the level of national income may contain inaccuracies; that its growth rate is measured accurately for the period since 1948; and that the real income growth rate series for 1900-1984 may contain a systematic bias.

NA/09 **The structure of the next SNA: review of the basic options**, Van Bochove, C.A. and A.M. Bloem (1985).
There are two basic issues with respect to the structure of the next version of the UN System of National Accounts. The first is its 'size': reviewing this issue, it can be concluded that the next SNA should contain an integrated meso-economic statistical system. It is essential that the next SNA contains an institutional system without the imputations and attributions that pollute the present SNA. This can be achieved by distinguishing, in the central system of the next SNA, a core (the institutional system), a standard module for non-market production and a standard module describing attributed income and consumption of the household sector.

NA/10 **Dual sectoring in National Accounts**, Al, P.G. (1985).
Following a conceptual explanation of dual sectoring, an outline is given of a statistical system with complete dual sectoring in which the linkages are also defined and worked out. It is shown that the SNA 1968 is incomplete and obscure with respect to the links between the two sub-processes.

NA/11 **Backward and forward linkages with an application to the Dutch agro-industrial complex**, Harthoorn, R. (1985).
Some industries induce production in other industries. An elegant method is developed for calculating forward and backward linkages avoiding double counting. For 1981 these methods have been applied to determine the influence of Dutch agriculture in the Dutch economy in terms of value added and labour force.

NA/12 **Production chains**, Harthoorn, R. (1986).
This paper introduces the notion of production chains as a measure of the hierarchy of industries in the production process. Production chains are sequences of transformation of products by successive industries. It is possible to calculate forward transformations as well as backward ones.

NA/13 **The simultaneous compilation of current price and deflated input-output tables**, De Boer, S. and G.A.A.M. Broesterhuizen (1986).
A few years ago the method of compiling input-output tables underwent in the Netherlands an essential revision. The most significant improvement is that during the entire statistical process, from the processing and analysis of the basic data up to and including the phase of balancing the tables, data in current prices and deflated data are obtained simultaneously and in consistency with each other.

NA/14 **A proposal for the synoptic structure of the next SNA**, Al, P.G. and C.A. van Bochove (1986).

NA/15 **Features of the hidden economy in the Netherlands**, Van Eck, R. and B. Kazemier (1986).
This paper presents survey results on the size and structure of the hidden labour market in the Netherlands.

NA/16 **Uncovering hidden income distributions: the Dutch approach**, Van Bochove, C.A. (1987).

NA/17 **Main national accounting series 1900-1986**, Van Bochove, C.A. and T.A. Huitker (1987).
The main national accounting series for the Netherlands, 1900-1986, are provided, along with a brief explanation.

NA/18 **The Dutch economy, 1921-1939 and 1969-1985. A comparison based on revised macro-economic data for the interwar period**, Den Bakker, G.P., T.A. Huitker and C.A. van Bochove (1987).
A set of macro-economic time series for the Netherlands 1921-1939 is presented. The new series differ considerably from the data that had been published before. They are also more comprehensive, more detailed, and conceptually consistent with the modern National Accounts. The macro-economic developments that are shown by the new series are discussed. It turns out that the traditional economic-historical view of the Dutch economy has to be reversed.

NA/19 **Constant wealth national income: accounting for war damage with an application to the Netherlands, 1940-1945**, Van Bochove, C.A. and W. van Sorge (1987).

NA/20 **The micro-meso-macro linkage for business in an SNA-compatible system of economic statistics**, Van Bochove, C.A. (1987).

NA/21 **Micro-macro link for government**, Bloem, A.M. (1987).
This paper describes the way the link between the statistics on government finance and national accounts is provided for in the Dutch government finance statistics.

NA/22 **Some extensions of the static open Leontief model**, Harthoorn, R.(1987).
The results of input-output analysis are invariant for a transformation of the system of units. Such transformation can be used to derive the Leontief price model, for forecasting input-output tables and for the calculation of cumulative factor costs. Finally the series expansion of the Leontief inverse is used to describe how certain economic processes are spread out over time.

NA/23 **Compilation of household sector accounts in the Netherlands National Accounts**, Van der Laan, P. (1987).
This paper provides a concise description of the way in which household sector accounts are compiled within the Netherlands National Accounts. Special attention is paid to differences with the recommendations in the United Nations System of National Accounts (SNA).

NA/24 **On the adjustment of tables with Lagrange multipliers**, Harthoorn, R. and J. van Dalen (1987).
An efficient variant of the Lagrange method is given, which uses no more computer time and central memory then the widely used RAS method. Also some special cases are discussed: the adjustment of row sums and column sums, additional restraints, mutual connections between tables and three dimensional tables.

NA/25 **The methodology of the Dutch system of quarterly accounts**, Janssen, R.J.A. and S.B. Algera (1988).
In this paper a description is given of the Dutch system of quarterly national accounts. The backbone of the method is the compilation of a quarterly input-output table by integrating short-term economic statistics.

NA/26 **Imputations and re-routeings in the National Accounts**, Gorter, Cor N. (1988).
Starting out from a definition of 'actual' transactions an inventory of all imputations and re-routeings in the SNA is made. It is discussed which of those should be retained in the core of a flexible system of National Accounts. Conceptual and practical questions of presentation are brought up. Numerical examples are given.

NA/27 **Registration of trade in services and market valuation of imports and exports in the National Accounts**, Bos, Frits (1988).
The registration of external trade transactions in the main tables of the National Accounts should be based on invoice value; this is not only conceptually very attractive, but also suitable for data collection purposes.

NA/28 **The institutional sector classification**, Van den Bos, C. (1988).
A background paper on the conceptual side of the grouping of financing units. A limited number of criteria are formulated.

NA/29 **The concept of (transactor-)units in the National Accounts and in the basic system of economic statistics**, Bloem, Adriaan M. (1989).
Units in legal-administrative reality are often not suitable as statistical units in describing economic processes. Some transformation of legal-administrative units into economic statistical units is needed. This paper examines this transformation and furnishes definitions of economic statistical units. Proper definitions are especially important because of the forthcoming revision of the SNA.

NA/30 **Regional income concepts**, Bloem, Adriaan M. and Bas De Vet (1989).
In this paper, the conceptual and statistical problems involved in the regionalization of national accounting variables are discussed. Examples are the regionalization of Gross Domestic Product, Gross National Income, Disposable National Income and Total Income of the Population.

NA/31 **The use of tendency surveys in extrapolating National Accounts**, Oudde-ken, Frank and Gerrit Zijlmans (1989).
This paper discusses the feasibility of the use of tendency survey data in the compilation of very timely Quarterly Accounts. Some preliminary estimates of relations between tendency survey data and regular Quarterly Accounts-indicators are also presented.

NA/32 **An economic core system and the socio-economic accounts module for the Netherlands**, Gorter, Cor N. and Paul van der Laan (1989).
A discussion of the core and various types of modules in an overall system of economy related statistics. Special attention is paid to the Dutch Socio-economic Accounts. Tables and figures for the Netherlands are added.

NA/33 **A systems view on concepts of income in the National Accounts**, Bos, Frits (1989).
In this paper, concepts of income are explicitly linked to the purposes of use and to actual circumstances. Main choices in defining income are presented in a general system. The National Accounts is a multi-purpose framework. It should therefore contain several concepts of income, e.g. differing with respect to the production boundary. Furthermore, concepts of national income do not necessarily constitute an aggregation of income at a micro-level.

NA/34 **How to treat borrowing and leasing in the next SNA**, Keuning, Steven J. (1990).
The use of services related to borrowing money, leasing capital goods, and renting land should not be considered as intermediate inputs into specific production processes. It is argued that the way of recording the use of financial services in the present SNA should remain largely intact.

NA/35 **A summary description of sources and methods used in compiling the final estimates of Dutch National Income 1986**, Gorter, Cor N. and others (1990).
Translation of the inventory report submitted to the GNP Management Committee of the European Communities.

NA/36 **The registration of processing in make and use tables and input-output tables**, Bloem, Adriaan M., Sake De Boer and Pieter Wind (1990, forthcoming).
The registration of processing is discussed primarily with regard to its effects on input-output-type tables and input-output quotes. Links between National Accounts and basic statistics, user demands and international guidelines are examined.

NA/37 **A proposal for a SAM which fits into the next System of National Accounts**, Keuning, Steven J. (1990).
This paper shows that all flow accounts which may become part of the next System of National Accounts can be embedded easily in a Social Accounting Matrix (SAM). In fact, for many purposes a SAM format may be preferred to the traditional T-accounts for the institutional sectors, since it allows for more flexibility in selecting relevant classifications and valuation principles.

NA/38 **Net versus gross National Income**, Bos, Frits (1990).
In practice, gross figures of Domestic Product, National Product and National Income are most often preferred to net figures. In this paper, this practice is challenged. Conceptual issues and the reliability of capital consumption estimates are discussed.

NA/39 **Concealed interest income of households in the Netherlands; 1977, 1979 and 1981**, Kazemier, Brugt (1990).
The major problem in estimating the size of hidden income is that total income, reported plus unreported, is unknown. However, this is not the case with total interest income of households in the Netherlands. This makes it possible to estimate at least the order of magnitude of this part of hidden income. In this paper it will be shown that in 1977, 1979 and 1981 almost 50% of total interest received by households was concealed.

NA/40 **Who came off worst: Structural change of Dutch value added and employ-- ment during the interwar period**, Den Bakker, Gert P. and Jan de Gijt (1990).
In this paper new data for the interwar period are presented. The distribution of value added over industries and a break-down of value added into components is given. Employment by industry is estimated as well. Moreover, structural changes during the interwar years and in the more recent past are juxtaposed.

NA/41 **The supply of hidden labour in the Netherlands: a model**, Kazemier, Brugt and Rob van Eck (1990).
This paper presents a model of the supply of hidden labour in the Netherlands. Model simulations show that the supply of hidden labour is not very sensitive to cyclical fluctuations. A tax exempt of 1500 guilders for second jobs and a higher probability of detection, however, may substantially decrease the magnitude of the hidden labour market.

NA/42 **Benefits from productivity growth and the distribution of income**, Keuning, Steven J. (1990).
This paper contains a discussion on the measurement of multifactor productivity and sketches a framework for analyzing the relation between productivity changes and changes in the average factor remuneration rate by industry. Subsequently, the effects on the average wage rate by labour category and the household primary income distribution are studied.

NA/43 **Valuation principles in supply and use tables and in the sectoral accounts**, Keuning, Steven J. (1991).
In many instances, the valuation of transactions in goods and services in the national accounts poses a problem. The main reason is that the price paid by the purchaser deviates from the price received by the producers. The paper discusses these problems and demonstrates that different valuations should be used in the supply and use tables and in the sectoral accounts.

NA/44 **The choice of index number formulae and weights in the National Accounts. A sensitivity analysis based on macro-economic data for the interwar period**, Bakker, Gert P. den (1991).
The sensitivity of growth estimates to variations in index number formulae and weighting procedures is discussed. The calculations concern the macro-economic variables for the interwar period in the Netherlands. It appears, that the use of different formulae and weights yields large differences in growth rates. Comparisons of Gross Domestic Product growth rates among countries are presently obscured by the use of different deflation methods. There exists an urgent need for standardization of deflation methods at the international level.

NA/45 **Volume measurement of government output in the Netherlands; some alternatives**, Kazemier, Brugt (1991).
This paper discusses three alternative methods for the measurement of the production volume of government. All methods yield almost similar results: the average annual increase in the last two decades of government labour productivity is about 0.7 percent per full-time worker equivalent. The implementation of either one of these methods would have led to circa 0.1 percentage points higher estimates of economic growth in the Netherlands.

NA/46 **An environmental module and the complete system of national accounts**, Boo, Abram J. De, Peter R. Bosch, Cor N. Gorter and Steven J. Keuning (1991).
A linkage between environmental data and the National Accounts is often limited to the production accounts. This paper argues that the consequences of economic actions on ecosystems and vice versa should be considered in terms of the complete System of National Accounts (SNA). One should begin with relating volume flows of environmental matter to the standard economic accounts. For this purpose, a so-called National Accounting Matrix including Environmental Accounts (NAMEA) is proposed. This is illustrated with an example.

NA/47 **Deregulation and economic statistics: Europe 1992**, Bos, Frits (1992).
The consequences of deregulation for economic statistics are discussed with a view to Europe 1992. In particular, the effects of the introduction of the Intrastat-system for statistics on international trade are investigated. It is argued that if the Statistical Offices of the EC-countries do not respond adequately, Europe 1992 will lead to a deterioration of economic statistics: they will become less reliable, less cost effective and less balanced.

NA/48 **The history of national accounting**, Bos, Frits (1992).
At present, the national accounts in most countries are compiled on the basis of concepts and classifications recommended in the 1968-UN-guidelines. In this paper, we trace the roots of these guidelines, compare the subsequent guidelines and discuss also alternative accounting systems like extended accounts and SAMs.

NA/49 **Quality assessment of macroeconomic figures: The Dutch Quarterly Flash**, Reininga, Ted, Gerrit Zijlmans and Ron Janssen (1992).
Since 1989-IV, the Dutch Central Bureau of Statistics has made preliminary estimates of quarterly macroeconomic figures at about 8 weeks after the end of the reference quarter. Since 1991-II, a preliminary or "Flash" estimate of GDP has been published. The decision to do so was based on a study comparing the Flash estimates and the regular Quarterly Accounts figures, which have a 17-week delay. This paper reports on a similar study with figures through 1991-III.

NA/50 **Quality improvement of the Dutch Quarterly Flash: A Time Series Analysis of some Service Industries**, Reininga, Ted and Gerrit Zijlmans (1992).
The Dutch Quarterly Flash (QF) is, just like the regular Quarterly Accounts (QA), a fully integrated statistic based on a quarterly updated input-output table. Not all short term statistics used to update the QA's IO-table are timely enough to be of use for the QF, so other sources have to be found or forecasts have to be made. In large parts of the service industry the latter is the only possibility. This paper reports on the use of econometric techniques (viz. series decomposition and ARIMA modelling) to improve the quality of the forecasts in five parts of the service industry.

NA/51 **A Research and Development Module supplementing the National Accounts**, Bos, Frits, Hugo Hollanders and Steven Keuning (1992).
This paper presents a modified national accounting system tailored to a description of the role of Research and Development (R&D) in the national economy. The main differences with the standard National Accounts are some changes in basic concepts (e.g. own-account production of R&D is considered as capital formation) and the introducton of additional, more detailed, classifications (e.g. new subsectors).

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