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A RESEARCH AND DEVELOPMENT MODULE SUPPLEMENTING THE NATIONAL ACCOUNTS

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This paper presents a national accounting framework that is tailored to a description of the role of Research and Development (R&D) in the national economy. The main differences from the standard national accounts are some changes in basic concepts and the introduction of additional, more detailed, classifications. The framework facilitates drawing macro-economic conclusions from all kinds of data on R&D. Figures presented in this way can serve as a data base for modelling the role of R&D in the national economy.

1. INTRODUCTION

For decades, much of economic research has focused on investigating the role of Research and Development (R&D) and technological progress (see the overviews by Mowery and Rosenberg, 1989; Nelson and Wright, 1992; Scherer, 1992). In particular this pertains to various productivity studies on the role of R&D. In these studies, concrete inferences about R&D, productivity and spillover effects are made on the basis of special surveys conducted among a selected group of enterprises, e.g. those in manufacturing. Other studies concentrated on calculating the returns of individual inventions.

A recent development in economic theory is the so-called new growth theory. The major innovation of this theory is that it suggests increasing returns to scale and spillover effects for i.a. R&D, innovation and human capital formation (see Grossman and Helpman, 1991; Solow, 1992). Governments have also attached an important role to R&D. They 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 European Community (EC) and the Organization for Economic Co-operation and Development (OECD).

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The importance of R&D for the national economy is 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, the first international guidelines on R&D statistics were published: the *Frascati Manual*. It was meant to harmonize the national R&D statistics and to stimulate national statistical offices to set up such statistics. Another recent development is the compilation of national R&D data into international R&D statistics. For example, the OECD started the Structural Analysis (STAN) database project in 1988. The STAN database is meant "to form the most comprehensive, disaggregated, technology/industry database available" (OECD, 1990, p. 1), combining industrial and technological data for all OECD countries and a number of non-OECD countries.

In the mid 1970s, the French statistical office—in cooperation with the French ministry of Research and Technology—started to compile a research satellite account (or module) linked to the national acccounts.[1] 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 was also 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). This satellite account focuses on the R&D activities of academic institutions and pays special attention to the structure of researchers and its changes over time.

Most incomes and expenditures related to R&D are not specified as such in the national accounts. In this paper, a R&D module that supplements the national accounts is presented.[2] This module should bridge the gap between special R&D surveys and various R&D statistics on the one hand and the national accounts on the other.

In common with the French satellite account, a major purpose is to establish a linkage between R&D statistics and the national accounts. In addition, the module aims at providing a more general perspective on the role of R&D in the national economy by also paying attention to e.g. the role of multinationals and patents. In this respect, it has more in common with a report by the Dutch Advisory Council on Science and Technology Policy (Horn and Langendorff,

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

[2]The notion of modules supplementing the National Accounts has been advocated for many years by various authors from Netherlands Statistics (for an overview, see den Bakker, 1992). They have argued that a flexible national accounting system, containing a core and modules is the 'ideal' NA system. The core should consist of a basic set of accounts for general purposes. The modules should meet with more specific data needs. Examples are:

— a socio-economic accounts module (Gorter and van der Laan, 1992);
— an environmental module (figures for 1989 are presented in de Haan *et al.*, 1993);
— a module on the allocation of time (Kazemier and Exel, 1992);
— a human capital module (Bos, 1994).

1991) or the extensive R&D statistics of Canada (Statistics Canada, 1989).[3] Furthermore, some standard national accounting concepts are modified in order to provide a better account of R&D.

The remainder of this paper is organized as follows. The concepts and classifications in the R&D module are described in sections 2 and 3. The overview matrix of the module is the topic of section 4. In section 5, conclusions are drawn and linkages with the standard productivity work on R&D are demonstrated.

2. Concepts in the R&D Module

The general concepts in the R&D module are those of the international guidelines on national accounting: the System of National Accounts (SNA: United Nations, 1993). Only some specific adjustments are introduced to better account for the role of R&D. For a discussion of alternative procedures we refer to Muller (1990), OECD (1989b) and Harrison (1990).

In our 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 Bos, Hollanders and Keuning, 1992). The categories Research and Development in the International Standard Industrial Classification (ISIC: UN, 1968*b* and 1990), the Central Product Classification (CPC: UN, 1991), the Classification of the Purposes of Private Non-Profit Institutions (COPNI: UN, 1993, table 103, p. 418) and the Classification of Outlays of Producers by Purpose (COPP: UN, 1993, table 104, p. 419) are also based on the Frascati concept. So, the R&D concept in the module is the same as that employed in most (international) R&D statistics (e.g. OECD, 1991).

A drawback of this Frascati-type R&D concept 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, 1989*b*, 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 of the module, because that would imply almost insurmountable data problems (all relevant data sources employ a Frascati-type concept).

In contrast to the 1993 SNA, production of R&D by establishments also encompasses their own-account production in the module. Furthermore, selling patents is regarded as a trade activity and as a disinvestment, and not as the sale

[3]It should be noted that these statistics also include various science and technology (S&T) indicators, most of which can be integrated into our R&D module. These S&T indicators, defined as "statistics on the creation, dissemination and application of science and technology" (Statistics Canada, 1989) include both input and output statistics. The input statistics encompass both data on R&D personnel (e.g. classified by level of occupation and education), and R&D expenditures. The output statistics encompass data on research output, such as bibliometric indicators (e.g. numbers of published scientific papers and citations); the application of technology (e.g. data on patents and capital investments); and on the international transfer of technology, including statistics on trade R&D-intensive commodities, on the technological balance of payments and on foreign direct investment.

of a nonproduced asset. Like the 1993 SNA, the rental of patents by means of licences is registered as a production activity generating value added and not as a transaction that generates property income (as in the 1968 SNA). These modifications imply an extension of the 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 in the SNA (due to the convention that their output equals the costs of production), but not specifically as R&D-output.[4]

R&D production differs from most other types of production in two important respects. 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 output, it is usually uncertain what the revenues will be; this uncertainty may last 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 (i.e. selling R&D assets) and licenses (i.e. renting out R&D assets). In the module, R&D production is valued at costs, whether it is successful or not, and independent of what the expected revenues from patents and licenses are. The only exception is made for R&D sold on contract, as in that case the output price is known. As stated above, the 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.

All R&D output is recorded as capital formation. As a consequence, expenditure on R&D production is no longer recorded as intermediate or final consumption. For own-account capital formation, the distinction between work-in-progress and fixed capital formation is important. In the national accounts, the concept of fixed capital formation only pertains to assets whose services are readily available for production of goods and services. Work-in-progress contains assets whose services are not (yet) readily available for production or are intended for sale.

This distinction between work-in-progress and fixed capital formation can also be applied to own-account production of R&D. A possibility is to link the accounting procedure to patenting: e.g. expenditure on R&D is recorded as work-in-progress, and when a patent is granted fixed capital formation is recorded (see Bos, Hollanders and Keuning, 1992, pp. 6, 7). Note that when a patent is granted, an identifiable economic asset has been created. This patent does not necessarily relate to the R&D output proper. It may also be granted on a new product or production process in which R&D output has been embodied. However, it must be realized that successful commercial R&D will not always be (indirectly) patented, and that there remain some statistical difficulties to be solved. In any case, one might also use business accounts that have capitalized R&D output that has not been patented.

[4]Note that the output of government R&D can sometimes be seen as an investment in a specific industry. For instance, R&D-output by technical or agricultural universities may be directly applicable in private business operating in these fields. In this way, there exists an analogy with physical infrastructure constructed by government.

When a 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 acquistion 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.

Accounting for R&D assets as fixed capital formation also necessitates calculating their capital consumption. For tangible assets, capital consumption is calculated using the Perpetual Inventory Method, using specific retirement rates and service lives (see Bos, 1990; Ward, 1976). Determining the service life of R&D assets is rather difficult because usually one does not know when they cease to generate additional value added. Therefore, some simplifying assumptions must be made.

There are several possibilities (see OECD, 1989b). First, if it is assumed that R&D assets never cease to be useful, i.e. that they have infinite lives, capital consumption of R&D assets would be zero. Secondly, R&D assets could be fully written-off in the same year in which they are created. This would be very close to the way in which R&D is treated in the SNA. However, as the economic value of R&D usually extends over more than one year but does not last indefinitely, a third solution is adopted: capital consumption of R&D assets is calculated on the basis of straight-line depreciation on the assumption of expected economic lifetimes. The latter can be determined on the basis of expert knowledge, practice in the business accounts that have capitalized R&D expenditure, and data on patent lives.

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 to produce 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 explicitly accounted for in the SNA. According to the *Frascati Manual* they should also not be accounted for (explicitly). However, compiling such information seems crucial for analyzing the role of 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 SNA.

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 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."

The consequences of these changes in concepts for balancing items like Domestic Product, National Income and Net Lending are discussed in Bos *et al.* (1992, Appendix B).

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. This mainly pertains to categories employed in special surveys on R&D and productivity and to categories recommended in the *Oslo Manual* (OECD, 1992).[5] We will subsequently discuss the main taxonomies in the national accounts and those proposed for the R&D module. Attention is restricted to those classifications that deviate from the standard ones:

— the classification by industries;
— the classification by institutional sectors;
— the commodity classification;
— classification of primary input categories;
— classification of current taxes and transfers;
— classification of capital transfers.

The *classification by industries* in the module should show the major producers and users of R&D and be based on ISIC (UN, 1968b and 1990). In the module, a maximum level of detail seems most appropriate. As most R&D statistics are based on ISIC rev. 2 (UN, 1968b), the industrial classification in the module follows this classification. With the adoption of ISIC rev. 3 (UN, 1990), the level of detail of some of the non-manufacturing industries could be increased. For instance, the division "Research and Development" and the subdivision "Defence activities" can be separately identified (see Bos *et al.*, 1992, Table 1). However, the level of detail recommended by the *Frascati Manual*, e.g. including a separate category Aerospace, is not always appropriate, if only for reasons of confidentiality.

The *classification by institutional sectors* in the module differs in several respects from that in the SNA (UN, 1993, Chapter IV). The "Non-financial corporate sector" and "Financial corporate sector" are grouped together in a new sector "Business." This sector is subdivided into "Foreign-controlled corporations," "Domestic multinationals" and "Other business." Foreign-controlled corporations are also distinguished as a subsector in the SNA. However, our subsector Domestic multinationals is new. It is defined as the mirror-image of Foreign-controlled corporations, that is as 'those domestic corporations that control foreign corporations.' This sector classification helps to account for the

[5]This manual "provides guidelines by which comparable innovation indicators can be developed in OECD countries, and . . . has two objectives, to provide a framework within which existing [innovation] surveys can evolve towards comparability, and to assist newcomers to this . . . field" (OECD, 1992, p. 10). It not only considers R&D and patent data, but also other data related to the innovation process, e.g. data on sales and exports due to new products, data on the duration of innovation projects, and data on cooperative research with universities and other organizations.

important role played by multinationals. Multinations frequently act as *international networks* for disseminating know-how. They are crucial in understanding the increased *globalization* in the production and use of R&D in the last decades.

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 Bos *et al.*, 1992, Appendix A). This classification is akin to that in the SNA, but unlike the one in the *Frascati Manual.* The Household sector and the Private non-profit institutions serving households sector are similar to those in the SNA.

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, servies 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. 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 and 1989a). 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. In this way it is very well possible that market enterprises produce non-market R&D, e.g. if it is for use in their own organization.

In our modified concepts (see section 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.

In the *classification by primary input categories*, compensation of employees is subdivided into high and low skilled labour income. This distinction is introduced because R&D production 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 vs. 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 primary input categories 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.

In the *classification of current taxes and transfers*, 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 of purchases does not seen 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.

In the *classification of capital transfers*, 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. Capital 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.[6]

4. The Design of The R&D Module

The R&D module consists of five types of tables:

- — An overview matrix which serves as the framework of the module;
- — Tables which are magnified cells of the overview matrix;
- — A table comparing major aggregates in the module with those in the SNA;
- — Supplementary tables in non-monetary terms (e.g. numbers of employees or number of patents classified by subject). In general, these tables are also magnified cells of the overview matrix. However, the figures are in non-monetary terms and supplementary classifications may be used;
- — Tables with figures for intertemporal and international comparisons.

In this paper, we will restrict ourselves to a discussion of the overview matrix (see Table 1);the other tables are presented in Bos, Hollanders and Keuning (1992).

The overview matrix shows the accounts, the 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 social accounting matrices (SAM) presented by Keuning (1991). For explanatory purposes, a stylized

[6]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 a separate table (see Bos *et al.*, 1992, Table 7) we have introduced a category Loans at non-market conditions for financing R&D expenditure. In principle, the interest differential should be recorded as a gift or a subsidy.

numerical example is included in Table 1. We will restrict our discussion to the accounts that deviate from those in the international guidelines.

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 (output and imports). The intermediate and final consumption of R&D commodities consist of the rental of patents (see Section 2 above). In cells (2, 1) and (2, 2) trade and transport margins 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 accomplished by inserting the total 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 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 (accounts 3 and 4). This split is 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 should 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 (account 9). The indirect taxes are recorded in the rows and the subsidies in the columns. Another advantage of this accounting procedure is that the indirect tax revenues related to R&D production and consumption are also shown explicitly. 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.

Our overview matrix reveals that the R&D module aims at a simultaneous description 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.

It should be noted that the module incorporates supply and use tables (rows and columns 1–4 in the overview matrix). Linking these tables to the sectoral accounts as is done in our SAM-type framework is quite relevant to the modelling of the interlinkages and spillover effects of R&D.

5. Conclusions

The Research and Development (R&D) module is a national accounting framework which organizes multivarious data on R&D, ranging from money flows (e.g. expenditure on R&D and subsidies and taxes on R&D) to data on the quality of labour inputs and type of patents. The framework enforces the consistent use of all these data and broadens the scope for analysis.

TABLE 1

A Matrix Showing the Major Accounts and Aggregates in the R&D Module (Numerical Example)

Account (Classification)	codes	0. R&D Services (Product Groups)	0. Other Goods & Services (Product Groups)	I. R&D Production (Industries)	I. Other Production (Industries)	II.1.1. Generation of Income (Primary Input categories)	II.1.2. Allocation of Primary Income (Institutional Sectors)	II.2. Secondary Distribution of Income (Institutional Sectors)
		1	2	3	4	5	6	7
0. R&D Services (Product Groups)	1			Intermediate consumption 1	Intermediate consumption 1			
0. Other Goods & Services (Product Groups)	2	Trade & transport margins 2	Trade & transport margins −2	Intermediate consumption 4	Intermediate consumption 394			
I. R&D Production (Industries)	3	Output (basic prices) 9						
I. Other Production (Industries)	4		Output (basic prices) 834					
II.1.1. Generation of Income (Primary Input Categories)	5			Net value added (factor costs) 3	Net value added (factor costs 385			
II.1.2. Allocation of Primary Income (Inst. Sectors)	6					Net Generated Income (factor costs) 386	Property income flows 151	
II.2. Secondary Distribution of Income (Inst. Sectors)	7						Net National Income (market prices) 405	Current taxes and transfers 295
II.4.1. Use of Income (Institutional Sectors)	8							Net Disposable income 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			
III.1 Capital (Institutional Sectors)	10			Consumption of fixed capital 4	Consumption of fixed capital 48			
Capital Formation in R&D Production (Industries)	11							
Capital Formation in Other Production (Industries)	12							
III.2. Financial (Financial Assets)	13							
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
V. Rest of the World, Capital	15							
Total		15	1,082	13	843	389	590	711

TABLE 1—continued

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
8	9	10	11	12	13	14	15	
Final consumption 1			Gross capital formation 1	Gross capital formation 9		Exports 2		15
Final consumption 340	Subsidies *on products* 8		Gross capital *formation* 2	Gross capital formation 89		Exports 245		1082
	Other subsidies on Production 4							13
	Other subsidies on Production 9							843
						Compensation of employees from ROW 1		389
	Net indirect Taxes 22					Property income from ROW 31		590
						Current transfers from ROW 11		711
								402
								43
Net saving 61		Capital taxes and transfers 91			Borrowing 49		Capital transfers from ROW 1	254
		Investment allocation 3						3
		Investment allocation 98						98
		Lending 58					Net lending of ROW −9	49
								278
		Capital transfers to ROW 4				Current external balance −12		−8
402	43	254	3	98	49	278	−8	

The concepts and classifications of the international guidelines on national accounting are modified in order to better account for the role of R&D. Cases in point are:

— R&D is measured for establishments, so that a linkage to the national accounts is possible, and not for enterprises (as in the *Frascati Manual*);
— The purchase of patents is recorded as fixed capital formation;
— Implicit subsidies, like remission of income taxes, are also recorded as subsidies;
— Domestic multinationals are introduced as a subsector (in addition to the SNAs Foreign-controlled corporations).

Compiling figures for the Research and Development module may well have some positive external effects for both the national accounts and the R&D statistics:

— The economic activity classification in the national accounts will be checked on its validity with respect to R&D. It may be the case that not all activities of establishments mainly producing R&D are recorded at the economic activity Research and Development;
— The link between national accounts data and data of the R&D statistics will be scrutinized (see also Bos, Hollanders and Keuning, 1992, Appendix A);
— Investigating the relation between productivity changes and R&D is vulnerable to the deflation procedures employed. Compiling the R&D module may therefore induce further investigation of present deflation procedures.

In making estimates of the productivity contributions of R&D, it is necessary to have an output measure of the investments in R&D. However, in measuring the output of these investments, several problems occur (Griliches, 1973 and 1988). In several respects, the data framework proposed in this paper is better tailored to a solution of these problems than the SNA. First of all, the R&D concept used in the module includes own-account production by market establishments. Secondly, all successful R&D is accounted for as capital formation. Thirdly, a consistent valuation procedure is applied: R&D is measured at costs, just like any other capital input. If R&D is sold, a possible profit is booked as a trading gain. Fourthly, the role of R&D is made explicit within an overall matrix-framework that contains both inter-industry and inter-sectoral linkages. This enables a better analysis of spillover effects than is possible with traditional t-accounts. The latter do not containin a simultaneous breakdown of interrelated transactions by both paying and receiving units. Fifthly, the role of multinationals as international networks for disseminating R&D is explicitly accounted for. Finally, the module broadens the scope of productivity studies as it shows the linkages to the role of the government (subsidies) and the labour market.

The merits of the R&D module can be summarized as follows. It provides scientists and politicians with an integrated overview of all kinds of data on R&D (also micro data and qualitative information). Simultaneously, as the R&D module records all kinds of interlinkages within an overall matrix framework, it is suitable to serve as a data base for modelling the role of R&D in the national economy.

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