

## Chapter 1

# Introduction to R&D statistics and the Frascati Manual

*The Frascati Manual has been an international standard for more than fifty years and it is now a world standard. The use of research and experimental development (R&D) statistics, based on the guidance in the manual, has gained influence and the statistics are being used in a wide range of policy areas, and in many countries outside of the OECD. The manual provides the basis for a common language for talking about R&D and its outcomes. In keeping with the extensive use of the manual, and the presence of its definitions in other international manuals and in country regulations, the definition of R&D and its components have been kept close to those in previous editions. More attention has been spent on identifying boundaries between what is and what is not R&D and on meeting new demands on R&D statistics. An example is the decision to treat expenditure on R&D as a capital investment in the System of National Accounts (SNA) and this has required greater attention to the flows of funds for R&D. Tax incentives for R&D performance are widespread and a chapter has been added to cover this. A new chapter has been added to address globalisation and its implications for R&D statistics. To remain current, extensive use is made of online annexes. This chapter introduces the manual.*

## 1.1. Objectives and background of the Frascati Manual

1.1 For more than 50 years, the OECD *Frascati Manual* has been the acknowledged worldwide standard for collecting and reporting internationally comparable statistics on the financial and human resources devoted to research and experimental development. The co-ordinated efforts among and beyond OECD countries to define and implement the recommendations in this manual have resulted in a valuable source of evidence for science, research and economic policy makers. The definitions provided herein have been adopted and adapted by many governments and serve as a common language for discussions across multiple domains, including those related to science and technology policy, economic development policy, and fiscal, tax and regulatory policy, as well as for the development of guidance on financial accounting, investment and trade statistics, among others.

1.2 Interest in measuring research and experimental development (which in this manual is used interchangeably, but precisely, with the term “R&D”) stems from its potential to make a significant contribution to economic growth and prosperity. The new knowledge resulting from R&D can be used to meet national needs and global challenges and to improve overall societal well-being. Individuals, institutions, economic sectors and countries, both developed and developing, are affected in multiple ways by the outcomes of R&D. Hence, the indicators collected in the framework of the *Frascati Manual* influence and inform discussions on such important debates.

1.3 From its initial origins, the *Frascati Manual* has been written by and for national experts who collect and issue national R&D statistics and submit responses to R&D surveys by the OECD, the EU, UNESCO and other international organisations. Although many examples are given, this manual remains a technical document that is intended as a reference work. In the same vein, the *Frascati Manual* has never been a binding document but instead a set of proposed guidelines discussed at length and agreed upon by consensus. Since the first guidelines were adopted in 1963 by the conference of national experts from OECD member countries in the Italian town of Frascati, this manual had been revised on five previous occasions, to reflect and address known measurement challenges, new user needs and best practices developed worldwide. The process of revision and dialogue with users reflects the capacity for the community of experts that produce this manual to engage in on-going learning.

1.4 Throughout its history, the *Frascati Manual* has provided the definitions of R&D used in other manuals, and it has been complementary to other manuals

that have appeared and now form part of a framework for science, technology and innovation statistics, known as the Frascati “family” of manuals, a body of guidelines in a state of constant and overlapping evolution.

### **Main objectives of the revision**

1.5 This current version represents the outcome of the sixth revision of the *Frascati Manual* and incorporates major changes in terms of presentation, coverage and collection detail. Major changes, revisions and improvements are highlighted—in a chapter-by-chapter summary—in the second part of this introductory chapter. However, it is important to emphasise at the outset that the definition of R&D presented in Chapter 2 of this manual, while clearer and more precise, is still consistent with the definition of R&D used in the previous edition of the *Frascati Manual* (OECD, 2002) and is intended to cover the same range of activities. Indeed, every effort was made to minimise the potential need for revisions in major statistical R&D indicator time series. Nonetheless, revisions may be the necessary outcome in the practice of some individual countries, as the steps for convergence with established international guidance become clearer with the revised manual. It is also intended and expected that the clarifications contained in this manual will facilitate the assessment and interpretation by policy makers of official R&D statistics and of R&D figures obtained from complementary accounting, tax, trade and other sources.

1.6 Unlike the more recent revisions to this manual, the changes introduced in this edition appear, and to some degree are, extensive. A number of factors weighed on the decision to expand coverage and increase guidance on the hows, whats and whys of collecting R&D statistics. Several of the more influential factors included the following:

- From its very beginning, this manual has been closely linked to the System of National Accounts (SNA). One major change in the 2008 revision of the SNA was the explicit adoption of Frascati R&D definitions and data as the basis for recommending the treatment of R&D expenditures as capital formation, that is, as investment. This development placed the *Frascati Manual* firmly within the framework of national statistical accounting standards, but also called for a number of adaptations to facilitate the use of Frascati R&D data by national statisticians. This revision thus considered the feasibility of implementing a number of recommendations laid out in the *OECD Handbook on Deriving Capital Measures of Intellectual Property Products* (OECD, 2009a). Classification relationships with and data needs for the SNA are introduced in detail in Chapter 3 and then highlighted and clarified throughout this manual.
- The widespread use of this manual for both statistical and policy-related purposes has resulted in repeated calls to clarify concepts, definitions and measurement practices. Quite often these requests reflect conflicting agendas and vested interests. This manual does not presume to take sides on such matters, but rather offers clear guidance on the preferred and recommended

definitions and collection methods that should—or can be—universally applied. To that end, it has been necessary on the one hand to expand the manual's coverage to make R&D statistics relevant for a wider range of policy decisions but on the other hand to provide for as few changes as possible so that there remains stability in the core historical series. Expanded coverage on R&D tax relief in Chapter 13 treated outside of the historical measurement issues of business R&D expenditures is one such example.

- The *Frascati Manual* is the *de facto* R&D reference document across countries at different stages of economic development, with varying forms of economic structures and national research systems and with a wide spectrum of statistical infrastructures. In line with the expanding membership of the OECD itself and a major shift towards greater engagement with non-member countries, this manual attempts to provide guidance for identifying and collecting R&D data that is relevant for countries with very diverse economic and research characteristics. A conscious effort has been made to understand the idiosyncratic approaches used by some countries in apparent contradiction with Frascati guidance and to find a more appropriate formulation of the intentions behind the existing guidelines. To that end, this manual introduces individual sector-specific chapters (7 to 10), which allow for greater granularity in collection guidance than had previously been possible.
- There is mounting recognition of the importance of a variety of ongoing changes in the organisation of R&D activities and the challenges these pose. These changes include R&D's role in the globalisation of value chains; the adoption of new organisational arrangements that extend beyond the traditional boundaries of individual organisations, sectors or countries; and new approaches to providing financial support for R&D, all of which are giving rise to new user needs as well as calls for data collection practices to be revised and extended. This manual recognises the importance of such developments and to the extent possible offers guidance on how to address these new statistical challenges. For example, there is extensive new material on measuring intramural versus extramural R&D flows in Chapter 4 and internal versus external R&D personnel in Chapter 5. An entirely new chapter (11) on R&D globalisation considerations is introduced in this manual.
- The need to address emerging methodological challenges and opportunities is paramount. On the one hand, general guidance on such matters is of relevance to the collection of all types of economic statistics. On the other hand, the atypical characteristics of R&D both from an activity perspective (a difficult-to-define, often nonexclusive, intangible service) and from a statistical perspective (a rare, highly skewed often non-continuous event) warrant special methodological guidance. There is furthermore the need to take into account new types of uses of R&D data, including causal analysis of the relationship between inputs and outputs, using micro-data, subject to confidentiality constraints, matched with supplementary sources. An expanded Chapter 6 on statistical methodology as well as sector-specific

guidance in the individual sector chapters addresses key issues, including difficulties experienced in maintaining response rates and reducing the burden on respondents; the use of administrative data sources; and demands for ensuring the international comparability and consistency over time of national R&D indicators. Adherence to such guidance will enable countries to demonstrate compliance with best statistical practices and exploit the full potential of the resulting microdata.

- Finally, and of practical importance, there is the need to reflect changes in statistical classification systems and practices, such as the UN classifications of industry (ISIC), education (ISCED) and the 2008 SNA. Most statistical manuals have been revised since the 2002 edition of the *Frascati Manual*, which until this revision continued to refer to some outdated statistical practices and concepts. This manual's latest edition makes more active use of online annexes to keep track of possible future changes in such classifications.

1.7 The remainder of this Chapter 1 provides a summary of the coverage and contents of this manual in order to help in the use and interpretation of the data when its guidelines are followed. It also indicates why certain types of data are, or are not, collected, and the challenges of comparability this poses.

### **The origins of the Frascati Manual**

1.8 For more than half a century, the *Frascati Manual* has provided the definition of research and experimental development (R&D) that has been used to gather data on financial and human resources allocated to R&D. One of the original intentions of the manual was to support the compilation of data, so that changes in resource allocations could be monitored over time and compared with those in other countries.

1.9 As R&D statistics became standardised and were increasingly adopted by countries, international comparisons raised questions about their relative ranking based on R&D performance. In time, this led governments to set targets as well as to policy initiatives to support R&D and to advance strategic sectors or achieve strategic objectives. R&D statistics became influential in science policy, and continue to be. They have also become influential in economic policy more generally, as it has been realised that knowledge, and new knowledge in particular, is a core contributor to economic growth and development. The manual provided the means with which to address a number of questions on the absolute and relative level of national R&D efforts that mattered greatly at the time, and that still continue to be relevant to this date, although in a very different context.

1.10 The basic approach of the *Frascati Manual* in identifying resources for R&D is to study the activities of the R&D performers. Part of understanding R&D activities is determining the sources of funds for the performance of R&D. Taken together, the institutions, the magnitude of their performance and the provision

of funds, and changes in these over time, provide a picture of the R&D system in a country and its relations to the rest of the world. Governments are significant funders of R&D as well as being performers, and therefore this manual also provides guidance on collecting information on government budgets for R&D funding.

1.11 The policy importance of R&D statistics has placed a responsibility on those gathering the data to provide statistics that are both relevant to policy development and evaluation as well as accurate, timely and accessible. This manual has supported these objectives by providing the definitions needed and discussing the domains of applicability, and their boundaries, based on the best practices of the OECD member and partner countries and organisations that have contributed to the content of the manual and that continue to do so through each of the revisions. A more detailed history of the changes in each revision is found in Annex 1 and should be consulted in particular when dealing with long time series of R&D data.

### **Stable definitions to serve user needs**

1.12 Throughout extensive consultation for this revision, users have stressed the importance of a consistent approach to defining R&D and preserving the historical R&D data series. This manual's revision has taken into account the fact that, in many countries, legislation refers explicitly to this manual and definitions herein. While such uses are beyond the initial intention and core objectives of this manual, such uses have been taken into account as much as possible. As a result, the core definitions of R&D are unchanged to the extent possible. Apart from minor changes in language in order to become gender neutral and a clearer formulation on how to describe the intention to devise new applications, this stability has been achieved for the basic definition of R&D. As a result, external references to the definition in national legislation and other classifications and statistical systems should not present a problem.

1.13 Although the basic definition of R&D is retained, there are slight modifications to the text of the definitions of its subcomponents – basic research, applied research and experimental development – with the last most affected. It was necessary in particular to clarify the distinction between R&D and other types of innovation activities.

1.14 This manual introduces a set of five core criteria that explain what key features must be met for an activity to qualify as R&D, and these are highlighted in this manual. The same criteria were effectively present in the previous edition, but did not appear in the same place to help interpret the R&D definition. A number of countries have satisfactorily tested these criteria throughout the revision process in interviews with potential R&D performers.

1.15 An effort has also been made in this edition to better align the information on the human and financial resources devoted to R&D, namely R&D personnel and R&D expenditures. The definition of R&D personnel is slightly modified to clarify two issues: the treatment of doctoral and master's students,

and the distinction between external personnel and persons employed by the statistical unit.

### **Inputs and outputs of R&D**

1.16 The defining feature of R&D in this manual is that it is carried out in order to generate new knowledge as an output, irrespective of its purpose, which could be the generation of economic benefit, addressing societal challenges or simply having the knowledge in itself. This intentionality is used in this manual to distinguish between experimental development and basic and applied research. In the same manner, it is of interest to identify and, if possible, to measure the different types of outputs from R&D.

1.17 However, it is difficult to identify and measure R&D outputs. This is due to a series of factors that affect both how knowledge is distributed and used in the economy and the complementary inputs necessary for results to occur. Any outputs and effects may take a long time to be realised and may occur at different places and for different actors than those carrying out the R&D. Only very partial outputs can currently be directly identified and measured as part of collecting information on R&D activities and funding. This manual provides a number of recommendations that can assist in that endeavour, in particular concerning R&D micro data, the use of linked registers, and classifications that facilitate the analysis of knowledge flows.

### **The Frascati family of manuals**

1.18 R&D takes place throughout the economy, but it has certain characteristics that distinguish it from the larger family of scientific activities and from the economic activities of which it is a part. From the outset, it was intended that the OECD should establish a set of guidelines as a framework for the measurement of science, technology and innovation. Over time, additional manuals have been added to the framework, such as the OECD Patent Statistics Manual (OECD, 2009b), and the Oslo Manual (OECD/Eurostat, 2005), which provides guidelines for collecting and interpreting innovation data. There are others too.

1.19 Since the *Frascati Manual* is one of a family of manuals, the boundaries between the subject matter of the other manuals and that of the *Frascati Manual* need to be clear. Clarifying this is an objective of the current revision.

1.20 There is a division of labour between the different manuals and the production of the statistics that result from their implementation. To achieve and benefit from this, it is necessary to consider at which levels of aggregation, and for what samples or populations of observations, statistics from different sources can be combined and jointly analysed.

1.21 There is active work in the OECD to compare and test successful experiences at the country level before recommending their broad international adoption. This manual's revision has collected a wealth of evidence that is relevant to that objective.

## **New uses and users of R&D statistics**

1.22 In the first edition, the main objective was that the *Frascati Manual* would lead to the adoption of standard practices by countries and to an improvement of R&D statistics and their comparability. This is still an objective of this manual. However, half a century later the definition of R&D is found in national legislation, and it also appears, sometimes with the text modified, in legislation and regulations pursuant to legislation related to tax or other types of financial support in some countries. The measurement of R&D activities is now an integral part of official statistics and a key input to the policy process. The *Frascati Manual* is used for training statisticians and users of the data, in academic courses and in research into the science of science policy. The manual has acquired a relevance that goes beyond its initial role of providing guidance on proposed standard practices for surveys of R&D.

## **Frascati and the System of National Accounts**

1.23 As a statistical standard, the *Frascati Manual* has to align with other standards, the most relevant of which is the SNA. This manual provides the definitions of R&D, but it uses, whenever possible, the SNA sectors. The exception is that this manual defines a separate higher education sector, whereas higher education institutions can appear in any of the SNA sectors. What makes the alignment of this manual and the SNA 2008 more important is the latter's recommendation for the first time to treat expenditures on R&D as leading to the creation of a capital asset, rather than as an expense. The SNA 2008 thus considers R&D as a production and investment activity, a decision that changes how GDP is measured and how exercises in growth accounting interpret the contribution of R&D to economic growth. In taking this decision, the SNA drew on the experience of the R&D satellite accounts referred to in an annex to the previous edition of this manual and adopted the Frascati R&D definition and its derived data as the basis upon which revised measures of capital investment and GDP can be constructed. This manual thus incorporates a number of recommendations made in the *OECD Handbook on Deriving Capital Measures of Intellectual Property Products* (OECD, 2009a), whose section on R&D was developed jointly between the national accounting and R&D statistics communities to guide national accountants in implementing the SNA decision.

1.24 As a result of a broader and more differentiated interest in R&D and the use of definitions and data, the reported figures for R&D activity from different producers and for different purposes in some cases also differ in magnitude. It is extremely important to be aware of and understand such differences in order to avoid any misuse or misinterpretation of the data. There are two different approaches in the manual to collecting information, which yield different results: information collected from those performing R&D (recommended), and information collected from those funding it (complementary). Similarly, there are differences between Frascati-based R&D data and information reported in the SNA. National accountants draw on Frascati and other data sources and

assumptions to derive SNA-consistent measures of output, capital investment and capital stocks. Specific differences arise in relation to the way software R&D is reported as part of R&D totals from a Frascati perspective, but is included in software totals in the SNA. These points are covered in Chapter 4 of this manual. A detailed and up-to-date overview of the relationship between the SNA and Frascati approaches is to be found as part of the online guidance in the annex to this manual, at <http://oe.cd/frascati>.

### **Other international standards**

1.25 Another type of R&D data that is sometimes confused with Frascati-based R&D is accounting data, where R&D is one of the components that businesses include in their financial reports and sometimes itemise separately, based on a number of rules and strategies. The coverage is generally different, as is the definition in many cases. The two series are generally not comparable. This is detailed in Chapter 7.

1.26 Because of the need to situate R&D in a wider context, both conceptually, in terms of databases, and in order to match R&D data with supplementary information, United Nations (UN) classifications are used as far as possible. These include the System of National Accounts, 2008 (EC et al., 2009), the International Standard Industrial Classification of All Economic Activities – ISIC (United Nations, 2008) and the International Standard Classification of Education – ISCED (UNESCO-UIS, 2012).

1.27 These external classifications are regularly updated. To deal with this, the current citations are given in the printed manual, but an updated set of references to classifications is maintained online as annex guidance to this manual.

### **A truly global manual**

1.28 The performance of R&D and the use of R&D statistics in policy are not the exclusive province of the OECD countries or the developed countries. There are initiatives throughout the world to conduct R&D surveys and to use the results in the policymaking process. As a result, this revision of the manual aims to be accessible to developed and developing countries as part of its role as a world standard. It also means that input to this revision has been sought and obtained from emerging and developing countries, as well as the institutions that support their efforts to develop R&D measurement capabilities. The recommendations contained in a previous online annex on measuring R&D in developing countries have now been mainstreamed and integrated into the core manual.

1.29 As a consequence of treating the manual as a global standard, the operational aspects of reporting data and indicators to the OECD are not covered in any detail. That is now left to the OECD and reporting countries to address. A description of the level of detail necessary to produce internationally comparable statistics is included in the manual.

## 1.2. General overview of the manual

1.30 This section provides information on the coverage and contents of the different chapters of the manual as a guide to the reader. The full text should be consulted as the authoritative source.

### **Outline**

1.31 Chapter 1 introduces the manual and the twelve subsequent chapters provide guidance on specific topics. A historical review of the *Frascati Manual* is provided in Annex 1. The five chapters (2-6) that follow contain general guidance on defining and measuring R&D in all sectors of R&D performance: concepts and definitions, institutional sectors, R&D expenditures, R&D personnel, and statistical methodologies and procedures. Then come five chapters (7-11) that address particular methodological and classification issues specific to each performing sector. The sectors are: Business enterprise, Government, Higher education and Private non-profit. The fifth sector, the Rest of the world (formerly referred to as Abroad) is discussed in Chapter 11 on R&D globalisation, which addresses the performance and funding of R&D in the Rest of the world. In addition, and for the first time, there is guidance on data collection on multinational enterprises (MNEs) and R&D services trade. The sector chapters are followed by two chapters that approach the measurement of government support for R&D from a funder perspective: government budget allocations for R&D and measurements of tax relief for R&D. Some very detailed information and references to external classification systems that are being regularly updated are available online in annex guidance to this manual at <http://oe.cd/frascati>. A glossary of terms is also included in this manual and maintained online.

### **Concepts and definitions for identifying R&D (Chapter 2)**

1.32 R&D comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge.

1.33 A set of common features identifies R&D activities that aim to achieve either specific or general objectives, even if these are carried out by different performers. For an activity to be an R&D activity, it must satisfy five core criteria. The activity must be:

- novel
- creative
- uncertain
- systematic
- transferable and/or reproducible.

1.34 The definition of R&D just given is consistent with the definition of R&D used in the previous edition of the *Frascati Manual* (OECD, 2002) and covers the same range of activities.

1.35 The term R&D covers three types of activity: 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 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 knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes. This manual follows the SNA convention in which “product” refers to a good or a service. Further, throughout the manual, “process” refers to the transformation of inputs to outputs and to their delivery or to organisational structures or practices.

1.36 It is often helpful and relevant to classify R&D according to the knowledge domain in which it is conducted, including the natural sciences, engineering and technology, the medical and health sciences, the agricultural and veterinary sciences, the social sciences, the humanities and the arts.

### ***Institutional sectors and classifications for R&D statistics (Chapter 3)***

1.37 This chapter explains the institutional approach to R&D statistics, in particular the collection and presentation of statistics based on the generic attributes of the institutional units. In this approach, the resources of an institutional unit that are dedicated to R&D are attributed to the sector in which the unit is classified. The classification of institutional units for R&D purposes aims to ensure full consistency with the definition of R&D and with the explicit needs of established R&D statistics users, as well as with the classification criteria used by the System of National Accounts. The latter include residence criteria, the reference to the type of economic activity, and ownership and economic control.

1.38 Four main sectors (and the Rest of the world) are identified in this manual for the measurement of R&D. The sectors are: Business enterprise, Government, Higher education and Private non-profit. The Higher education sector, institutions of which may be classified in the SNA as corporation, government unit or NPISH, according to the market and government control criteria that are applicable in each country, is kept as a separate sector for R&D statistics.

1.39 A decision tree to assign institutional units to the different sectors is found in Figure 3.1 of Chapter 3.

### **Measurement of R&D expenditures: Performance and sources of funds (Chapter 4)**

1.40 The amount of money spent on research and experimental development (R&D expenditure) is of considerable interest to national and international policymakers. In particular, such statistics are used to measure who conducts and who funds R&D and where it takes place, the level and purpose of such activities, and the interactions and collaborations between institutions and sectors. Intramural R&D expenditures are all current expenditures (including labour and other costs) plus gross fixed capital expenditures (such as for land, buildings, machinery and equipment) for R&D performed within a statistical unit during a specific reference period, whatever the source of funds.

1.41 A major change in the 2008 revision of the SNA was the explicit treatment of R&D as capital formation, that is, “investment”. This change resulted in attendant demands for more detailed breakdowns of R&D expenditures that are noted throughout this chapter, including guidance for collecting detailed data on the sources and flows of R&D funds and on the types of R&D transactions. In particular, additional and more extensive information is needed to help measure R&D sales and purchases than previously existed.

1.42 The basic concepts used to structure the collection of R&D statistics for the purposes of this manual include the following (see Figure 4.1 in Chapter 4):

- expenditures on intramural R&D are the amount of money spent on R&D that is performed within a reporting unit; expenditures on (the funding of) extramural R&D are the amount of money spent on R&D that is performed outside a reporting unit
- internal R&D funds are the amount of money spent on R&D that originate within the control of a reporting unit; external R&D funds are the amount of money spent on R&D that originates outside the control of a reporting unit
- exchange R&D funds are funds that flow between statistical units with a compensatory return flow of R&D; transfer R&D funds are funds that flow between statistical units without a compensatory return flow of R&D.

1.43 The main aggregate statistic used to describe a country’s R&D activities is gross domestic expenditure on R&D (GERD), which covers all expenditures for R&D performed in the national territory during a specific reference period. GERD is a primary indicator for international comparisons of R&D activity.

### **R&D personnel: Persons employed and external contributors (Chapter 5)**

1.44 In broad terms, R&D personnel include highly trained researchers, specialists with high levels of technical experience and training, and other supporting staff who contribute directly to carrying out R&D projects and activities. Consistently with this manual’s definition of R&D, the scope of this concept encompasses all knowledge domains.

1.45 R&D personnel in a statistical unit include all persons engaged directly in R&D, whether they are employed by the statistical unit or are external contributors fully integrated into the statistical unit's R&D activities, as well as those providing direct services for the R&D activities (such as R&D managers, administrators, technicians and clerical staff).

1.46 Two main groups of individuals who potentially contribute to the R&D activities can be identified in a statistical unit, with some differences according to the institutional sector it belongs to:

- Persons employed by the statistical unit who contribute to the unit's intramural R&D activities (used interchangeably with the term "**internal R&D personnel**" in this manual).
- External contributors to the unit's intramural R&D activities (used interchangeably with the term "**external R&D personnel**" in this manual). This group includes two subgroups: (i) persons who receive wages/salaries but not from the statistical unit performing the R&D, and (ii) a number of special cases of persons external to a statistical unit who contribute to intramural R&D.

1.47 Doctoral and master's students may be included in either group of R&D personnel if they meet the specific criteria identified in this chapter aimed at ensuring that only individuals with an appreciable contribution to the institution's R&D are included.

1.48 R&D personnel are identified according to their R&D function: Researchers, Technicians, and Other supporting staff.

1.49 The measurement of R&D personnel (both persons employed and external R&D personnel) involves three types of indicators:

- their number in headcounts (HC)
- their R&D activities in full-time equivalent (FTE) or person-years
- their characteristics, including sex, R&D function, age and formal qualification.

### **Measuring R&D: Methodologies and procedures (Chapter 6)**

1.50 A fundamental concern for R&D statistics is to produce internationally comparable statistics. This is dependent not only on sound and consistent definitions, but also on the application of the definitions in practical data collection. Differences in methodological practices and in the application of definitions and recommendations are considered a major cause of the reduced comparability of R&D data between countries. For this reason, a separate chapter on common methodological challenges across sectors is included in addition to sector-specific chapters.

1.51 Many considerations drive the methodology and procedures used to measure R&D performance. R&D activity tends to be concentrated in relatively few entities, particularly in the Business enterprise sector. While R&D activity is highly concentrated, it occurs throughout the economy. Both the concentration and the breadth of occurrence have implications for guidelines on sampling

strategy. In addition to these characteristics, the objectives of R&D statistical programmes are multidimensional, including: aggregate indicators to support science policy; expenditures that provide input to a capital stock of R&D in the SNA; and micro-level data to support – under restrictions with regard to data protection – unit-level analysis. These sometimes conflicting objectives influence sampling and processing strategies.

1.52 The data on R&D may come from a variety of sources, including, but not necessarily limited to, direct measurement through surveys and administrative data sources. In some cases, estimates are required to supplement surveys and administrative data sources. Statistical offices decide on the sources of the data used based on their availability, quality, appropriateness and cost. This varies across countries.

### **Business enterprise R&D (Chapter 7)**

1.53 For most industrialised countries, the Business enterprise sector accounts for the largest share of R&D expenditures and personnel. In analysing this sector and the units within it, it is important to take into account the multiple approaches used by companies to manage their R&D activities. In particular, related businesses may jointly fund, generate, exchange and use R&D knowledge in diverse and assorted ways. Complex business structures, particularly used by multinational enterprises (MNEs), are challenging for R&D measurement. Also, for some businesses, R&D is an occasional, rather than an on-going activity and therefore more difficult to identify and measure. From a methodological perspective, the collection of data from business enterprises also entails a number of practical challenges, ranging from the identification of firms that perform R&D to obtaining information on R&D as required in this manual, and including dealing with confidentiality and minimising the response burden.

1.54 The Business enterprise sector comprises:

- All resident corporations, including not only legally incorporated enterprises, regardless of the residence of their shareholders. It includes both private business enterprises (both publicly listed and traded, or not) and public business enterprises (i.e. government-controlled enterprises).
- The unincorporated branches of non-resident enterprises deemed to be resident and part of this sector because they are engaged in production on the economic territory on a long-term basis.
- All resident non-profit institutions (NPIs) that are market producers of goods or services or serve business.

1.55 This is a new stand-alone chapter in this current manual. The chapter highlights and gives recommendations on methodological challenges related to identifying the statistical and reporting units, sampling, and the classification of the activity according to several international standards. Measurement challenges in differentiating expenditures for intramural and extramural R&D are identified.

1.56 The main aggregate statistic used to describe R&D performance within the Business enterprise sector is BERD, Business enterprise Expenditure on R&D. BERD represents the component of GERD (see Chapter 4) incurred by units belonging to this sector. It is the measure of intramural R&D expenditures within the Business enterprise sector. There are a number of variables for which BERD might be usefully compiled, distributed and reported.

### **Government R&D (Chapter 8)**

1.57 This chapter focuses primarily on the measurement of R&D performance and personnel within the Government sector. It also attempts to provide a nexus between the performer and the complementary funder-based approaches to measuring the role of government as a funder of R&D throughout the entire economy. In addition, this chapter draws links with Chapter 12, on the measurement of government budget allocations for R&D, and Chapter 13, on tax relief for R&D. The Government sector comprises:

- all units of central/federal, regional/state and local/municipal government, including social security funds, except those units that fit the description of higher education institutions provided in Chapter 3 and further described in Chapter 9
- other government bodies: performing and/or funding agencies and all non-market NPIs that are controlled by government units, and that are not themselves part of the Higher education sector.

1.58 This is a new stand-alone chapter in this current manual. Extensive guidance is presented to address difficulties in separating R&D from other related activities that arise when these activities are undertaken simultaneously within a Government unit.

1.59 The main aggregate statistic used to describe R&D performance within the Government sector is GOVERD, Government Expenditure on R&D. GOVERD represents the component of GERD (see Chapter 4) incurred by units belonging to this sector. It is the measure of intramural R&D expenditures within the Government sector. Special guidance is provided on how to treat R&D funding flows between and among units in this sector, including with intermediary funding agencies, to avoid the double counting of R&D.

### **Higher education R&D (Chapter 9)**

1.60 This is a new stand-alone chapter in this current manual, replacing and extending what was previously an annex. The Higher education sector is unique to this edition of the manual and has no direct counterpart in the SNA. Institutions in the Higher education sector can be classified in any of the SNA sectors. The reason for the separate treatment of this sector is the policy relevance of information on its R&D performing institutions.

1.61 The Higher education sector comprises:

- all universities, colleges of technology and other institutions providing formal tertiary education programmes, whatever their source of finance or legal status
- all research institutes, centres, experimental stations and clinics that have their R&D activities under the direct control of, or administered by, tertiary education institutions.

1.62 The Higher education sector is very heterogeneous, and countries' higher education systems and institutions are organised in many different ways. This is challenging for the compilation of R&D statistics, and there are large variations between countries with regard to statistical methodology. This chapter gives general information on the methods used for calculating and estimating higher education R&D expenditures and personnel. The different approaches are illustrated in Figure 9.1; the methodologies used include institutional surveys (full or partial), administrative data, and varying combinations of these data sources, often combined with R&D coefficients from time-use surveys. There is a special focus on methods to estimate R&D funded by a public block grant known as public general university funds (GUF), which many public higher education institutions receive to support all their activities.

1.63 For survey purposes, R&D must be distinguished from a wide range of related activities with a scientific and technological basis. These other activities are very closely linked to R&D both through the flows of information and in terms of the operations, institutions and personnel involved, but they should be excluded as much as possible when measuring R&D. The Higher education sector has some sector-specific activities that are challenging with regard to the concept of R&D. These are in particular related to education and training and specialised health care (e.g. university hospitals).

1.64 The main aggregate statistic used to describe R&D performance within the Higher education sector is HERD, Higher education Expenditure on R&D. HERD represents the component of GERD (see Chapter 4) incurred by units belonging to this sector. It is the measure of intramural R&D expenditures within higher education.

### **Private non-profit R&D (Chapter 10)**

1.65 Private non-profit institutions (NPIs) have traditionally played a significant role in research and development both as performers and as funders, although generally at levels below those of other economic sectors. While this has been recognised in previous versions of this manual, which defined the Private non-profit sector (PNP), this is now the focus of a new stand-alone chapter. It outlines which NPIs should be considered for measurement in the PNP sector and gives guidelines on the measurement of their R&D activities, taking into account both their specificities as well as emerging trends with respect to new forms of R&D funding.

1.66 The Private non-profit sector comprises:

- all non-profit institutions serving households (NPISH), as defined in the SNA 2008, except those classified as part of the Higher education sector
- for completeness of presentation, households and private individuals engaged or not engaged in market activities.

1.67 The main aggregate statistic used to describe R&D performance within the this sector is PNPERD, Private Non-profit Expenditure on R&D. PNPERD represents the component of GERD (see Chapter 4) incurred by units belonging to this sector. It is the measure of intramural R&D expenditures within the Private non-profit sector.

### **Measurement of R&D globalisation (Chapter 11)**

1.68 This manual explicitly recognises the concept of R&D globalisation. Previous editions acknowledged the global aspects of R&D *primarily* as a source of funds for domestic R&D performance (as in the compilation of GERD) or as a destination for national sources of funds (as in the compilation of GNERD). Such sources previously were characterised as funds from/to “Abroad”. Consistent with the SNA, the preferred terminology of the current *Frascati Manual* is “Rest of the world”. The identification and measurement of non-domestic sources of and destinations for R&D funds continues to be an important dimension of R&D and is covered comprehensively. However, this current manual moves beyond flows of R&D funds and covers a more extensive list of measurement issues related to global R&D (OECD, 2005; OECD, 2010). Guidance on this subject and links to other related statistical manuals are presented as a new stand-alone chapter.

1.69 In broad terms, globalisation refers to the international integration of financing, factor supply, R&D, production, and the trade of goods and services. Globalisation in the for-profit sector is associated with international trade and foreign direct investment (FDI) primarily by business enterprises, although public and private non-profit institutions (including government and higher education institutions) also engage in international activities such as R&D funding and collaboration.

1.70 R&D globalisation is a subset of global activities that involve the funding, performance, transfer and use of R&D. This chapter focuses on three measures of business R&D globalisation, and a summary of measurement issues related to non-business sectors.

1.71 The three statistical measures of business R&D globalisation covered are:

- cross-border R&D funding flows
- current costs and personnel for R&D performed by members of multinational enterprises (MNEs) within compiling countries and abroad
- international trade in R&D services.

1.72 Further guidance is provided on the measurement of R&D globalisation phenomena of relevance to the non-business sectors, including the role of international organisations, government funding of R&D performed abroad, foreign campuses, and the international R&D activities of non-governmental organisations.

### **Government budget allocations for R&D (Chapter 12)**

1.73 There are different ways of measuring how much governments dedicate to funding R&D activities. The performer-based approach recommended by this manual is to survey the resident units that perform R&D (businesses, institutes, universities, etc.) in order to identify the amount spent on intramural R&D performance in the reference year. It is then possible to identify the portion of the intramural R&D expenditure funded by government.

1.74 A complementary approach to measuring government funding of R&D has been developed using data from budgets. This type of funder-based approach to reporting R&D involves identifying all the budget items that may support R&D activities and measuring or estimating their R&D content. Some advantages of this approach include presumably the ability to report significantly timelier government R&D totals, since they are based on budgets, and to link the R&D totals to policy considerations through classification by socioeconomic objectives.

1.75 The specifications of such budget-based data are described in this chapter and were first introduced in this manual's third edition. In more recent editions, budget-based data have been formally referred to as "government budget appropriations or outlays for R&D" (GBAORD), a term that is replaced in this edition with government allocations for R&D (GBARD).

1.76 The recommended distribution list is given in Table 12.1 and is based on the European Union classification adopted by Eurostat for the Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS).

### **Measuring tax relief for R&D (Chapter 13)**

1.77 Governments in several countries provide tax support for R&D with the aim of promoting R&D investment in the economy by granting preferential tax treatment of eligible R&D expenditures, especially to business enterprises. Tax expenditures are complex objects of measurement; not all statistical systems separately capture all types of tax relief measures. However, because government policy objectives for R&D tax relief are presumably achievable through either subsidies or other direct outlays, there is widespread acknowledgement that reporting such tax support in supplementary reports would facilitate transparency and more balanced international comparisons.

1.78 In response to user and practitioner interest in addressing this gap in previous editions of this manual, this new chapter to the *Frascati Manual* provides some guidelines on the reporting of government support for R&D through tax incentives, with a view to assisting in the production of internationally comparable indicators of Government Tax Relief for R&D (GTARD).

1.79 Although tax expenditures for R&D have several elements in common with the government budget allocations for R&D (GBARD) described in Chapter 12, as in some instances they can be reported within the budget, this manual proposes that this category should be measured separately and in an integrated fashion, and only then subsequently integrated into the overall presentation of R&D statistics, particularly for international comparisons.

### **Annexes and complementary guidance**

1.80 The printed edition of this manual contains one annex that provides an overview of the history of the *Frascati Manual* and acknowledgements to the main contributors to the previous editions, who ensured the current standing of the manual. In addition, a glossary of terms is included in the printed edition listing the main terms used in this manual as well as their definitions. This glossary of terms is to be maintained and updated online.

1.81 Additional guidance is available through online only annex material at this manual's webpage <http://oe.cd/frascati>. Much of the guidance contained in the annexes available in previous editions has been superseded and/or incorporated in the printed edition of this manual, for example, guidelines on higher education, which now has its own chapter, and guidance on R&D in developing countries, which has been mainstreamed into the manual. The guidance on the regionalisation of R&D statistics, R&D deflators and currency converters, methods for providing up-to-date estimates and projections on R&D, R&D related to Health, Information and Communication Technology (ICT) and Biotechnology is still relevant, and users may wish to refer to the previous edition's annexes while these are pending, until revision by the OECD to incorporate more recent developments and methodologies.

1.82 The classifications referred to within this manual will be also be maintained online, with links to the relevant international standards. Information on the OECD classification by Fields of Research and Development and subsequent updates will also be managed on an online basis, notwithstanding the fact that the current classification is also available in the printed edition. The *Frascati Manual* webpage will be the space for the dissemination of briefing material and recommendations for specific R&D-related measurement practices that are agreed in the future by the OECD community of national experts. As noted throughout, in preparing this manual's edition, the Working Party of National Experts on Science and Technology Indicators (NESTI) has accumulated a wealth of evidence on a number of topics that could provide the basis for future online annexes.

### 1.3. Implementing the recommendations in this manual

1.83 This manual is intended to guide practical data collection and reporting efforts through a common vocabulary, agreed principles and practical conventions. These are aimed at ensuring the comparability of statistical outputs in order to support the build-up of a global statistical information infrastructure on R&D that has relevance for policy makers, academics, industry managers, journalists and the public at large.

1.84 It is however beyond the scope of this manual to cover every possible scenario or regulate which data are to be submitted to the OECD for the purpose of tabulation and dissemination. Additional tools used by NESTI, linked to but separate from this manual, support the implementation of its recommendations to meet user needs and serve the public. These include:

- the questionnaires for collecting aggregate data on R&D from national authorities, as agreed between the OECD, other international organisations, and the countries asked to provide the data
- the quality assurance process, involving the OECD and the national experts providing the data
- the publication of R&D databases and indicators, with the involvement of the relevant OECD committees
- the collection and publication of metadata specifying the main features of the sources and methods used by different countries
- the pursuit of co-ordinated analysis of R&D micro-data in different countries, in order to address questions that cannot be readily assessed through standard indicators
- and, as a novelty arising from this edition, the development of an online community space in which practitioners can share questions and experiences, developing a cumulative and shared pool of precedents on how to treat specific situations.

1.85 The OECD works with other international organisations that play a key role in supporting capability development and R&D data dissemination, aiming to reduce reporting burdens on national organisations.

1.86 The adoption of a revised manual provides an opportunity for a number of countries to revisit some of their practices and bring them in line with globally accepted standards. This may require transitional arrangements as well as the appropriate communication of any potential changes in data series. The revision process has also been an opportunity to develop competencies within organisations and train new staff in charge of collecting and reporting R&D data.

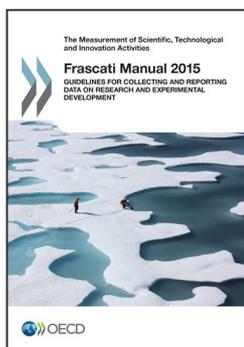
### 1.4. Final remarks

1.87 The intended purpose for the information collected under these *Frascati Manual* guidelines is to help decision makers, especially policy makers. As R&D data have become more widely accessible and feature more prominently

in public discussions, this information has also become an important component of the social and political dialogue about the use and impact of these resources. There is broad awareness that R&D data, alone or in combination with other data, can provide only part of the basis for decision making. However, as long as governments, business leaders and the public recognise the special features of R&D and confer upon it a special status, the measurement of the human and financial efforts dedicated to such endeavours will continue to play a major part in the statistical evidence required by societies worldwide. This manual's seventh edition seeks to support that goal.

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