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4.2.2 Capturing the inputs of science, technology, and innovation

TOMIZAWA Hiroyuki [1]

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Abstract

The measurement and evaluation of scientific and technological innovation is becoming a major topic. As one of the topics of Section 4.2, this paper discusses the measurement and indicators of the "inputs" in science, technology, and innovation. "Inputs" in science, technology, and innovation refer to the resources allocated to activities related to science, technology, and innovation, such as the funding and labor allocated to research and development. This paper outlines the measurement and evaluation indicators for capturing the inputs of science, technology, and innovation.

Keywords

Research and development statistics, Frascati Manual, Oslo Manual

1 The significance of capturing inputs

In measuring and evaluating science, technology, and innovation, it is important to capture the outputs and outcomes of science, technology, and innovation. It seems clear that measurement and evaluation are almost synonymous with capturing the outputs and outcomes of the activities and systems under study. However, in practice, capturing inputs is just as important in the measurement and evaluation of science, technology, and innovation. Why is it necessary and significant to capture such inputs?

1 National Institute for Science and Technology Policy

First, even if outputs and outcomes are measured, it is seldom possible to judge whether they are sufficient by themselves, making it necessary to look at the relative magnitude of outputs/outcomes to inputs as a criterion. In particular, in order to compare multiple subjects of measurement and evaluation, it is often necessary to consider the magnitude of their inputs before making comparisons, as a simple comparison of their outputs and outcomes will not yield useful information. It is also necessary to standardize output indicators with input indicators in order to measure performance and efficiency. In other words, capturing inputs is important insofar as it provides a basis for evaluating outputs and outcomes.

Second, it is also important to capture inputs because if we want to link the measurement and evaluation of a subject to the improvement of that subject, it is necessary to capture which inputs have been provided. In other words, as outputs and outcomes are simply the results of activities and processes, it is impossible to know what to improve by looking at these alone; however, as inputs are one of the factors that affect the results, capturing them is useful for achieving improvement. In terms of the Plan-Do-Check-Act (PDCA) cycle, it is important to understand the outputs and outcomes for Check (confirmation) and understand the inputs for Check (confirmation) and Act (improvement) based on the status of Plan (planning) and Do (execution). In this case, simply measuring the overall amount and size of input resources is not all that meaningful, but it is important to capture the breakdown and content of the inputs. For example, government R&D investment is one of the major inputs in a country's R&D system. By measuring the amount of investment and obtaining data on its breakdown and use, and combining this with data on outputs and outcomes, it becomes possible to identify issues and areas for improvement.

Apart from the importance of capturing inputs as described above, there are cases where it is difficult to capture outputs or outcomes, resulting in greater focus on capturing inputs. It is often difficult to measure outputs and outcomes in science, technology, and innovation in particular. Accordingly, we often attempt to understand and grasp the state of science, technology, and innovation activities and systems by measuring inputs, which are relatively easy to measure.

2 Research and development statistics

There are various indicators and data on inputs to science, technology, and innovation. Below, I first discuss R&D statistics, which are central among these indicators, and then explore other input indicators/data in comparison. I utilize this structure because R&D statistics have a long history and often serve as a model for various indicators and exceptions in the data. Furthermore, many concepts and principles related to R&D statistics are useful when considering various indicators/data for science, technology, and innovation.

2.1 The origins of R&D statistics and the Frascati Manual

Currently produced by governmental and public organizations in countries around the world, research and development statistics originated in the 1950s with the production science and technology statistics by governmental organizations in several countries, chiefly the NSF in the United States.[2] In Japan, the "Survey of Basic Statistics on Research Institutes"—the predecessor of the current "Survey of Science and Technology Research"—was launched in 1953. Therefore, Japan can be regarded a relatively early adopter of R&D statistics.[3]

These pioneering R&D statistics were subsequently created in several countries, and the international standardization of R&D statistics was initiated by OECD and UNESCO around 1960. One of the outcomes of this was the publication of the OECD's first guidelines for R&D statistics in 1963, which were subsequently endorsed by OECD member countries in 1964. These guidelines were commonly known as the Frascati Manual; derived from the name of the Italian location where the conference to establish the guidelines was held, this later became the official name for the guidelines. The Frascati Manual has been revised several times since then, with the current version published in 2015 (OECD, 2015). It also serves as a set of guidelines for R&D statistics, not only for OECD countries but worldwide.

While the Frascati Manual is a set of statistical guidelines for systematically measuring a country's R&D activities, it focuses on the measurement of funds and manpower invested in R&D activities and is thus dedicated to the measurement of inputs. One of the reasons why the Frascati Manual is dedicated to measuring R&D inputs is the "difficulty of identifying and measuring the outputs of R&D." In other words, new knowledge—that is, the output of R&D—cannot be directly measured, and although there are several indirect indicators, they each represent just one aspect of R&D outcomes. Given the high uncertainty of R&D outputs and outcomes, until relatively recently, the prevailing view around the world was that they were produced probabilistically and could not be subject to measurement or evaluation, and that more attention should be paid to the measurement of inputs that could be controlled. This historical background may have had a significant impact on the origins of R&D statistics.

Incidentally, and as mentioned earlier, when the first edition of the Frascati Manual was prepared, several countries had already produced pioneering R&D statistics. As differences had arisen between countries, the manual could not adequately present rigorous international standards. For example, although it presents a definition of R&D expenses and the expense items to be measured, the specific measurement methods identified allow for a certain degree of diversity. Although the manual has been revised over the years, it has continued to allow diversity in measurement methods. This may be one of the reasons why the international comparability of R&D statistics remains a challenge.

2.2 Key R&D statistics concepts as presented in the Frascati Manual

Although the 2015 Frascati Manual covers a wide range of topics, this section focuses on the most important ones from the perspective of measurement and evaluation of science, technology, and innovation,

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2 According to Godin (2004), who compiled a book on the history of science and technology measurement and statistics, systematic science and technology measurement was conducted before the 1950s, but was limited to Eastern Europe.

3 Annex 1 of the 2015 edition of the Frascati Manual presents the history of the manual, including a list of the OECD member countries that first launched R&D statistics; at the top this list is the United States, followed Japan, Canada, the United Kingdom, the Netherlands, and France (OECD, 2015).

and describes the basic concepts of R&D statistics. The manual itself is described in Ijichi (2016a, 2016b).[4] Hereinafter, unless otherwise necessary, the 2015 Frascati Manual is referred to as the Frascati Manual.

2.2.1 Defining R&D

The Frascati Manual provides various guidelines for measuring the financial and human resource inputs expended in R&D, all of which are based on the concept and definition of R&D. First, the Frascati Manual uses the more accurate term "research and experimental development" and the abbreviation R&D for research and development. It subdivides research and experimental development into three types, namely, "basic research," "applied research," and "experimental development," the definitions of which are shown in Table 1. In addition to being useful items of measurement, these three items comprise the concept of "research and experimental development." Except where otherwise necessary, this section refers to "research and experimental development" as "research and development."

Table 1 The definition of R&D in the 2015 Frascati Manual

Research and experimental development (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.
Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations 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.

Source: OECD (2015) Reference: IJICHI Hiroshi (2016b)

4 I reference various explanations and translations from this article in this paper.

Based on the definition above, the Frascati Manual sets guidelines for measuring the financial and human resource inputs invested in R&D from the perspective of distinguishing between R&D and other activities. However, these definitions are conceptual and abstract, and cannot be linked to specific methods of measurement. Consequently, there is marked ambiguity and subjectivity in the distinction between R&D and other activities. This problem is not unique to the Frascati Manual. As R&D is an activity that produces intangible knowledge, it is difficult to make decisions based on external information, and the boundary between R&D and other activities is conceptual and abstract.

2.2.2 Organizational classifications and statistical units

The R&D statistics system presented in the Frascati Manual pays great attention to comprehensively and consistently measuring the R&D activities of the country as a whole, as this is the most essential purpose of the system. The foundation of this system is organizational classification and statistical units.

In terms of organization, the domestic sector is divided into four sectors—namely, business enterprise (BE), government (GOV), higher education (HE), and private non-profit (PNP)—as well as the "rest of the world." These organizational classifications are modeled on the sectoral accounts of the System of National Accounts (SNA). As Table 2 shows, there are many similarities between the two organizational classification systems. There are two main differences. First, the Frascati Manual has a separate HE category, which is not included in the SNA. Second, the "household" category included in the SNA's classification system is not present in the Frascati Manual. In the Frascati Manual, the SNA "household" classification is included under BE for self-employment similar to businesses and as PNP in all other cases. Moreover, under the BE category, the "statistical units" for which statistical information is considered and finalized are companies. Meanwhile, the GOV category comprises ministries and agencies for unincorporated administrative organizations, and corporations for incorporated institutions. However, the higher education sector (HE) is not clearly defined, as different countries have different education systems. In addition to these "statistical units," the Frascati Manual employs the concept of "reporting units." The term "reporting unit" refers to the entity (e.g., agency, organization) from which statistics are collected, or in the case of a questionnaire-based statistical survey, the entity that responds to the questionnaire. The SNA concept of "institutional units" can also be used.

Table 2 Correspondence between the Frascati Manual and SNA organizational categories

SNA institutional sectors	Frascati sectors: Higher education (HE)	Business enterprise (BE)	Government (GOV)	Private non-profit (PNP)
Corporations (financial and non-financial)	HE institutions in the Corporations sector	Same as SNA Corporations sector, including public corporations, but not HE institutions in the Corporations sector		
General government	HE institutions in the General government sector		Same as SNA General government sector, except for the HE institutions	
NPISH	HE institutions in the NPISH sector			Same as SNA NPISH sector, except for the HE institutions in the NPISH sector
Households		Enterprise-like self-employed (most likely captured as quasi corporations)		For completeness: Same as SNA Households sector, except for the households "enterprise-like self-employed"

Source: Ijichi Hiroshi (2016a) [Japanese translation of Table 3.1 in OECD (2015)].
Note: Non-profit institutions serving households (NPISH) are private, non-government-controlled institutions that are non-market producers within the non-profit sector.

2.2.3 The significance of R&D expenditures

The Frascati Manual defines R&D expenditure, the core measurement of R&D statistics, as "expenditure on research and experimental development"—that is, the value of "expenditure" on research and development during the reference period (e.g., a one-year period for a given fiscal year). In this respect, it is important to note that "expenditure" is the subject of measurement, not :expense."[5] For example, if land, facilities, equipment, and so on are purchased for research and development, the amount spent in the reference period is recorded, not the value of their depreciation.[6]

In the case of the internal R&D expenditures of an institution (referred to as "internal R&D expenditures," defined in greater detail later), the breakdown of the expenditures recorded as R&D expenditures is the sum of "current expenditures" and "gross fixed capital expenditures." Current expenditures include labor costs for internally hired R&D personnel, purchases of services and expenditures for external R&D personnel, purchases of materials, and general administrative expenses. Meanwhile, fixed capital expenditures include

5 The concept of "expenditure" differs from that of "expense" in accounting. For accounting purposes, "expenses" are the amounts recorded when the decision to pay them is made (so-called "accrual basis"), and include depreciation, the value of services or goods provided even if not paid for, allowance for uncollectable accounts, and allowance for retirement benefits. In contrast, expenditure refers to the actual amount paid.

6 Note, because companies may mistakenly record "R&D expenses" when responding to R&D statistical surveys, the Frascati Manual recommends that respondents also be asked to record R&D-related depreciation expenses based on the concept of "expense," separate to the value of R&D expenditure.

land and buildings, machinery and equipment, computer software subject to capitalization, and intellectual property deliverables.[7]

As noted, the inclusion of labor costs in R&D expenditures is crucial in interpreting the data. In many cases, the analysis and discussion of research expenditures are based on an image of research expenditures that does not include the personnel costs of researchers. Nonetheless, it should be noted that R&D expenditure data measured by R&D statistics differ from this.

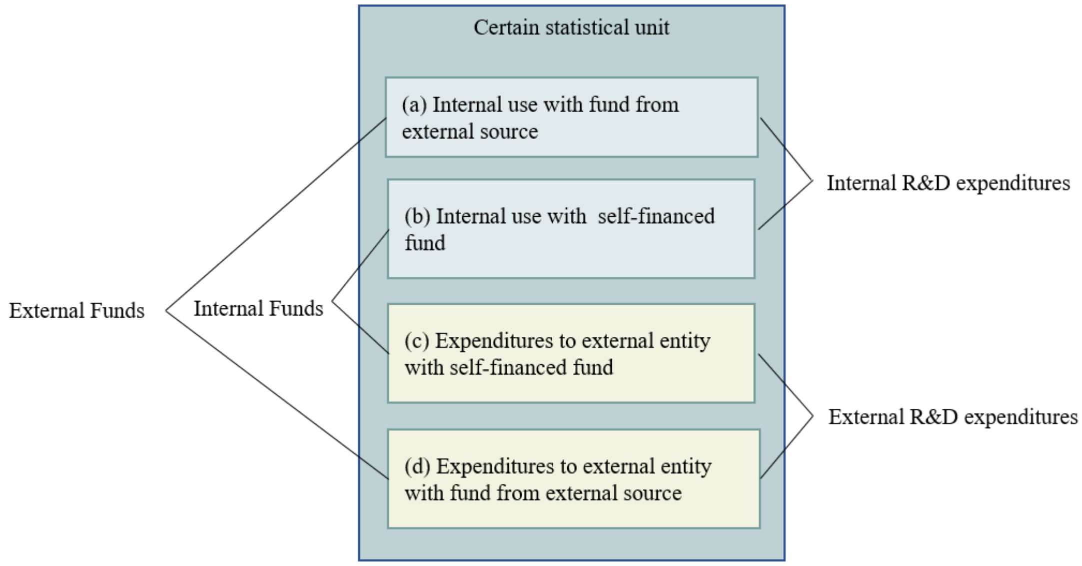
2.2.4 R&D expenditure statistics

Of the various statistics available for R&D expenditures depending on the scope of aggregation, "intramural R&D expenditures"—sometimes translated as "internal R&D expenditures"—are the most basic. Intramural R&D expenditure is the total amount of money spent on research and development within an institution (statistical unit) during the reference period. In contrast, externally disbursed R&D expenditures are called "extramural R&D expenditures." Although excluded from sectoral and countrywide aggregates in order to eliminate duplication and ensure consistent aggregation of R&D expenditures, extramural R&D expenditures are an important statistic for understanding R&D activities.

The aforementioned statistics can be distinguished according to whether the R&D expenditures were used within or outside the statistical unit. Another distinction is based on whether the source of R&D funding is internal or external to the statistical unit. In this regard, there is a difference between "internal funds," which are provided by the statistical unit's institution itself, and "external funds," which are funds provided from outside the statistical unit.

The relationship between the four statistics above can be summarized as follows: first, there is a distinction between whether R&D expenditures are used internally or externally; second, there is a distinction based on whether the source of funds is external (i.e., funding received from an external source) or internal (i.e., self-finance). Figure 1 illustrates this relationship.

7 The distinction between the two is that "current expenditure" is the value of expenditure that takes effect at the same time as the expenditure (i.e., within one year), while "fixed capital expenditure" is the value of expenditure that takes effect more than one year after the expenditure.



The "Internal R&D Expenditures" for a given statistical unit include (a) + (b), which are internal expenditures, regardless of whether the source of the funds is self-financed or received from outside sources. "External R&D expenditures" include (c) + (d), which are external expenditures, regardless of the source of the funds. Internal Funds" include (b) + (c), which are self-financed, and "External Funds" include (a) + (d), which are received from external sources.

Figure 1. Classification of R&D expenditures by recipient and source of funds.
Source: Created by the author

2.2.5 Gross domestic expenditure on R&D (GERD) and R&D expenditure by sector

The total value of domestic R&D expenditure of a country is called "gross domestic expenditure on research and experimental development" (GERD). Like GDP (gross domestic product) in the SNA, GERD is a statistic that occupies a core position in R&D statistics. In principle, a country's GERD is obtained by summing the amounts of institutional R&D expenditures by all institutions/organizations conducting R&D in the country. This means that we are trying to grasp the R&D expenditures of the entire country without duplication by distinguishing between the users and payers of R&D expenditures and then comprehensively aggregating only the users of R&D expenditures. Figure 1 depicts this as the sum of (a) + (b) for each statistical unit and (a) + (b) for all statistical units.

In the Frascati Manual system, the amount of R&D expenses incurred by each sector can also be tabulated. More specifically, the R&D expenditure of the entire country is divided into user and payer sectors, and each of these two sectors can be divided into the four sectors described above. The flow of R&D expenditures between the four payer-side sectors (or five sectors if foreign countries are included) and the four user-side sectors can also be considered in a way that allows them to be measured. As an example of real-world data, Figure 2 illustrates the flow of R&D expenditures between sectors in Japan.

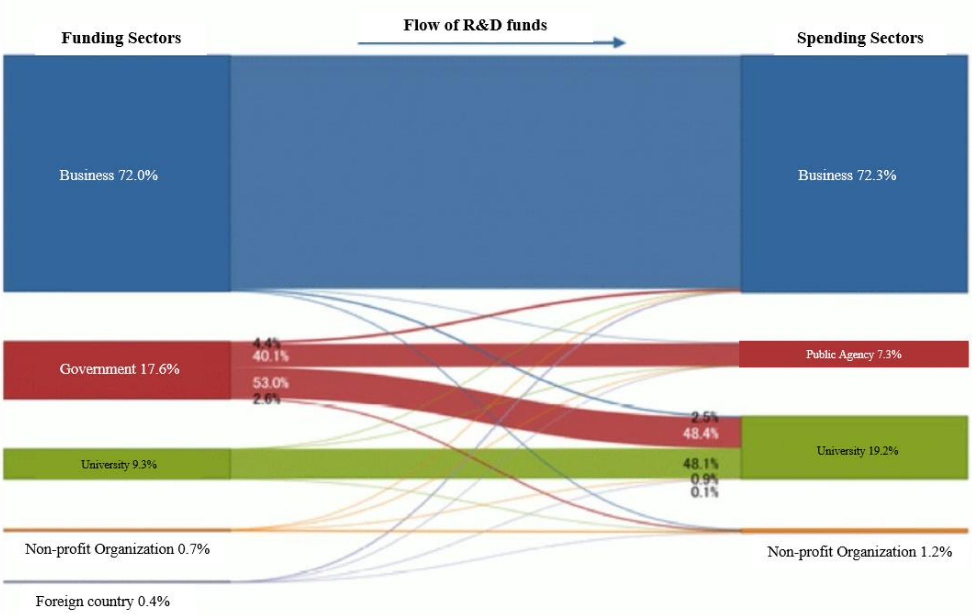


Figure 2. Flows of R&D spending across sectors in Japan (2015).

Source: National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology, "Science and Technology Indicators 2017," Survey Document-261, August 2017.

Data: Ministry of Internal Affairs and Communications, "Science and Technology Research Survey Report."

2.2.6 The definition and classification of R&D personnel

Alongside R&D expenditures, R&D personnel is a key measurement in R&D statistics. The Frascati Manual defines R&D human resources as, "persons who are directly engaged in research and development in a given statistical unit, whether employed therein or as external contributors, and those who provide direct services to the unit's intramural research and development activities." R&D personnel are categorized as "researchers," "technicians," and "other support staff" according to their roles within R&D. As all of these categories refer to individuals directly involved in "research and development" as defined above, it should be noted that "researcher" is a broad term that encompasses researchers in both the general sense and more narrowly, such as the personnel involved in research and development within companies.

In defining and classifying R&D human resources, special consideration should be paid to higher education institutions. While doctoral students engaged in R&D activities are included as researchers, master's students are only included as R&D workers if they are paid for the R&D activities in which they are engaged. Post-doctoral fellows engaged in R&D activities as young researchers in higher education institutions and public research institutions are not treated in a uniform manner due to the diversity of the nature of their activities and the manner in which they are employed or paid. Accordingly, their treatment is determined based on the definition of R&D human resources and the aggregation criteria described above.

2.2.7 Measuring R&D human resources

As with the aggregation of R&D expenditures, the number of R&D personnel is aggregated based on the statistical unit of R&D. Individuals engaged in intramural research and development activities may be employed or salaried employees of the institution, or employed or unpaid employees of other institutions; the latter are referred to as external contributors rather than employees. In order to correspond to the value of institutional R&D expenditures, the former is classified as "internal R&D personnel" and the latter as "external R&D personnel."

The Frascati Manual recommends that R&D personnel be counted using full-time equivalent (FTE) of R&D in addition to a physical headcount. FTE for R&D is a method of measuring human resources in R&D that takes into account the percentage of time that they are engaged in R&D activities. The proportion of time spent on R&D is basically determined by the ratio of time spent on R&D to time spent on other work. It is worth noting that FTE for R&D differs from the general concept of FTE. For example, in the SNA, full-time conversion simply calculates the total number of hours worked; however, in this case, the concept of full-time conversion involves converting the labor input of part-time workers into the corresponding labor input of full-time workers according to the number of hours worked. In contrast, FTE for R&D is measured not by simple hours worked, but by determining whether the work falls under R&D.

2.3 R&D-related statistics in Japan

In this section, I discuss the major statistical surveys conducted in Japan for which the resulting statistical data are publicly available. This section covers not only R&D statistics in the narrow sense, but various other statistics that include survey items pertaining to R&D.

2.3.1 Science and Technology Research Surveys

The Science and Technology Research Survey is an annual statistical survey conducted by the Statistics Bureau of the Ministry of Internal Affairs and Communications, and is one of the core statistical surveys based on the Statistics Law. The majority of the report is based on the Frascati Manual, and covers private companies, universities, government agencies, and private non-profit organizations. It examines research expenditures ("R&D expenditures" per Frascati Manual standards) and the number of research workers ("R&D personnel" per Frascati Manual standards) in each of the aforementioned sectors and in Japan as a whole.

In this survey, the concepts corresponding to the Frascati Manual's "research and experimental development" and its three categories of "basic research," "applied research," and "experimental development" are referred to as "research," "basic research," "applied research," and "development research," respectively; the survey presents the definition of each accordingly. Although not completely exact, they are generally similar.

As an example of how the Frascati Manual's concepts of R&D statistics are embodied in the Survey of Scientific and Technological Research, Table 3 shows the survey methodology for the classification of R&D expenditures by recipient and funding source, as shown in Table 1 above.

Table 3. Questions concerning the sources and recipients of R&D expenditures in the Science and Technology Research Survey questionnaire

【12】 Fill in research funds received from outside sources.

			Revenue	Internally used Revenue
Sum				
Public institute	National and local public body	Central Government		
		Local Government		
		National and public University		
		National and public Institute		
		Others		
	Semi-governmental Agency	Laboratories, etc.		
		Public corporations, etc.		
		Others		
Company				
Private university				
Non-profit organization				
Foreign country				

【13】 Fill in research expenses paid for external entities.

			Expenditure	Self-financed Expenditures
Sum				
Public institute	National and local public body	Central Government		
		Local Government		
		National and public University		
		National and public Institute		
		Others		
	Semi-governmental Agency	Laboratories, etc.		
		Public corporations, etc.		
		Others		
Company				
Private university				
Non-profit organization				
Foreign country				

The left side of the above question asks for a response for "research fund received from outside sources," but it also asks for a response for "research funds used internally" as a fraction of that amount, with the former corresponding to "(a) ＋ (b)" in Figure 1 and the latter to "(a)" in Figure 1. Apart from this question, a more basic statistic, "total research expenses spent internally," i.e., the amount that corresponds to "(a) ＋ (b)" in Figure 1, is required, so that the amount of "(b)" in combination with the amount of "(a)" obtained from the above figure can also be found. (b)" in combination with the amount of "(a)" obtained from the above figure. Since the left side of the above figure asks for the answer of the amount for each organizational category of the funding source of "research expenses received from outside" in "(a)," it is a data source for the flow of research expenses among sectors, as shown in Figure 2, which breaks down research expenses by funding sectors.

Source: Ministry of Internal Affairs and Communications, Science and Technology Research Survey Report

In respect to research personnel, although the Science and Technology Research Survey covers both head-count figures and FTEs for sectors other than higher education, it only surveys head-count figures for the higher education sector. This is because measuring the number of researchers in the higher education sector in terms of FTE is complex. Moreover, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) conducts a survey on full-time equivalent data at universities every five years.

2.3.2 Survey on private sector R&D

The Survey on Research and Development Activities of Firms in the Private Sector is an annual statistical survey conducted by MEXT's National Institute of Science and Technology Policy and constitutes one of the general statistics in the Statistics Law. An R&D statistic in a broad sense, the survey focuses on obtaining qualitative data on corporate R&D trends, strategies, and organizations. It also supplements the Science and Technology Research Survey for quantitative data such as R&D expenditures. Accordingly, its various definitions, classifications, and so on are based on those of the Frascati Manual. Moreover, as a survey item that goes beyond R&D statistics in the narrow sense, it also surveys the state of and trends in innovation activities.

The survey targets private companies (with capital of JPY 100 million or more) that claimed to conduct R&D in the Science and Technology Research Survey. A total of 3,573 such companies were included in the 2017 survey.

3 Input indicators besides R&D statistics and their sources

3.1 Innovation Surveys

The Oslo Manual was developed by the OECD and Eurostat as a set of international standards and guidelines for collecting and interpreting statistical data on the state of innovation in addition to R&D. It is currently in its fourth edition, published in 2018 (OECD/Eurostat, 2018). The manual presents the basic concepts and methods for understanding and measuring innovation activities and achievement.

The Oslo Manual is well-known for providing the basic reference for the definition of "innovation." According to the fourth edition of the Oslo Manual (OECD/Eurostat, 2018), "Innovation is a new or improved product or process (or combination of products or processes)"; additionally, it must be "substantially different" from existing products or processes and "usable."[8] As such, the basic definition of "innovation" in the manual is fairly conceptual. The Oslo Manual distinguishes between "innovation" and "outcome" by referring to the activities to produce innovation as "innovation activities" and the outcomes produced through these activities as "innovation." In this respect, it is important to note that innovation as defined above is an "output/outcome side" concept.

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8 Full definition: "An innovation is a new or improved product or process (or combination of products or processes) that is substantially different from the unit's previous products or processes and is made available to potential users (product) or is put to use by the unit (process)." This Japanese translation is based on Hiroshi Ijichi's (2019) discussion of the Oslo Manual, 4th edition (OECD/Eurostat, 2018).

In terms of innovation activity inputs, Section 4.3 of the Oslo Manual defines “innovation activities” in detail, while Section 4.4 discusses “measurement of expenditure data on innovation activities.” In this context, “expenditure” includes “research and development expenditure,” as well as expenditures for “engineering, design and related creative business activities”; “marketing and brand equity activities”; “IP-related activities”; “employee training”; “software development and database activities”; and the “acquisition or lease of tangible assets.”

The Oslo Manual also notes that accounting data may be a good source of data for measuring the value of such expenditures, and that the System of National Accounts (SNA) contains relevant statistics. According to Section 4.5, “other data on innovation activities,” where it is difficult to measure the amount of expenditure on innovation activities, it may be useful to measure the manpower allocated to innovation activities on an FTE basis (Section 4.5.1) or the number of innovation projects (Section 4.5.2).

In Japan, the National Innovation Survey is a statistical survey based on the Oslo Manual conducted every few years by the National Institute of Science and Technology Policy (NISTEP), which is under the jurisdiction of MEXT. This survey collects data on the achievement of innovation in Japanese companies and on innovation activities. While this survey includes internationally comparable statistical data, which are also used by the OECD, it does not measure the value of “expenditure on innovation”.

3.2 The Basic Corporate Activity Survey

The Basic Corporate Activity Survey is a statistical survey conducted annually by the Ministry of Economy, Trade and Industry, and constitutes one of the core statistical surveys under the Statistics Law. As its name suggests, the survey covers basic items related to corporate activities (e.g., number of locations and employees by business organization, parent/subsidiary/affiliate company relationships, and finances); however, it also includes survey items gauging the state of R&D and technology ownership and trade.

More specifically, it surveys the following four R&D items: “in-house R&D expenditure,” “outsourced R&D expenditure,” “outsourced research expenditure,” and “R&D-related tangible fixed asset acquisitions in the current period.” In this survey, the value of consignments with domestic and overseas affiliates are also surveyed as components of “outsourced R&D expenses” and “outsourced research expenses.” It also surveys the value of “capability-building expenditures,” a survey item similar to expenditures for training personnel involved in innovation mentioned in the Oslo Manual.

Meanwhile, in regard to the state of technology ownership and trade, the survey examines the ownership and use of patent, trademark, and design rights. It also examines the sums received and paid for transactions involving intellectual property, which includes copyrights in addition to these patents and other rights.

3.3 Annual securities reports

As stipulated in the Financial Instruments and Exchange Act, an annual securities report is a document prepared by listed companies each fiscal year disclosing information about the company to the outside world. They are a source of data on corporate finances and business conditions, and include data on innovation activities and R&D expenditures. This R&D expense data are called R&D expenses for accounting purposes. In respect to the definition of research and development underpinning this, the Accounting Standards for Research and Development Expenses, published by the Japan Financial Services Agency, defines research as the "systematic investigation and exploration aimed at discovering new knowledge," and development as "the embodiment of the results of research and other knowledge in the form of plans or designs for new products, services or production methods, or plans or designs for significantly improving existing products." This is similar to the definition of research used in the Scientce and Technology Research Survey. However, as the accounting rule for R&D expenses is that "all expenses are to be expensed as incurred," there are differences from R&D expenditures in R&D statistics, such as the inclusion of depreciation.

3.4 Basic Schools Survey (MEXT)

The Basic Schools Survey is a set of statistics on education conducted by MEXT. Survey items related to science and technology include the breakdown of the number of faculty members and students in higher education institutions, and the career paths of graduates. The number of faculty members is virtually the same as that of "researchers" in the Science and Technology Research Survey," although the numbers differ slightly due to the difference in the timing of the survey (as of May 1 in the Basic Schools Survey, and March 31 in the Science and Technology Research Survey). Moreover, the number of researchers at universities and other institutions "enrolled in graduate school doctoral programs" is virtually the same in both surveys.

3.5 School Teachers Statistical Survey

As a core statistical survey based on the Statistics Law, the purpose of the School Teachers Statistical Survey—a survey compiling basic statistics on schoolteachers—is to clarify the composition of schoolteachers, including their personal attributes, duties, transfers, and so on. MEXT conducts this survey in three-year cycles, with the 2016 survey the most recent. Survey items pertaining to science and technology include the number of faculty members at universities, and are broken down by attributes. It is important to note that the survey includes items that are not surveyed in the Science and Technology Research Survey, such as the number of university faculty members by age (rank).

3.6 University and school corporation financial statements

In accordance with the National University Corporation Act (Article 38 of the Act on General Rules Applied Mutatis Mutandis), national universities must not only report their financial statements and so on to the Minister of Education, Culture, Sports, Science and Technology, but make them available for public inspection. Accordingly, national universities make their financial statements public each year by posting them on their websites. Financial statements include balance sheets and profit and loss statements. Data relating to science, technology, and innovation include data on expenses related to the university's main activities, such as "research expenses," "education expenses," and "medical treatment expenses," as well as data on "contracted research expenses," "revenue from contracted research and projects," "revenue from operating subsidies," and "revenue from donations." It is worth noting that "research expenses" and "education expenses" do not include personnel expenses for faculty members, which are recorded separately.

Private universities receive subsidies from the national and local governments under the Private University Promotion and Subsidy Law, and are thus obliged to follow the Accounting Standards for School Corporations (Ordinance of the Ministry of Education, Culture, Sports, Science and Technology) for accounting procedures and the preparation of financial statements. Three financial statements need to be prepared: Cash Flow Statement of Expenses, Statement of Cash Flows from Business Activities, and the Balance Sheet.

3.7 Census

The national census is the most basic national statistical survey, covering all people and households in Japan. The census is conducted every five years, with large-scale surveys conducted in years ending in 0, and simpler surveys conducted in years ending in 5 (Statistics Law, Article 5, Paragraph 2). The two surveys differ in terms of the number of survey items: with the large-scale survey comprising twenty-two items, and the simpler survey comprising seventeen items. The surveys share several common items, including the number of household members, name, gender, date of birth, marital status, nationality, place of residence, employment status, place of employment or schooling, nature of the business in which the individual works, and the nature of the individual's work. Basic statistical data on the domestic population, household and industrial structure, and so on can be obtained from these survey items.

This survey offers the total number of "scientific researchers" and "engineers" as well as their breakdown by attribute, which can be used as basic data on science, technology, and innovation inputs. However, the definitions of "scientific researcher" and "engineer" used in this survey are not based on international definitions, while the definition of "scientific researcher" differs from the definition of "researcher" used in the Science and Technology Research Survey. Consequently, the resulting statistics are quite different in practice. However, as the most comprehensive statistical survey of residents in Japan, this survey identifies the number of people in various occupations and provides a comprehensive overview of the number of "scientific researchers" and "engineers," thus providing important statistical data for understanding and attaining an overview of science and technology activities in Japan.

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