9 The OECD measurement agenda for innovation

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1. INTRODUCTION

This chapter seeks to explain how the Organisation for Economic Co-operation and Development (OECD) develops indicators to help member countries and other economies build an environment conducive to translating science, technology and knowledge into innovation to enhance economic performance and improve social welfare. It highlights some illustrative examples from recent OECD experience in implementing its innovation measurement agenda and reviewing the innovation measurement framework, from which it draws some implications for the development and revision of measurement guidelines and the future of indicator development at the OECD.

The mission of the OECD[2] is to promote policies that will improve the economic and social well-being of people around the world. In support of this mission, indicators play a key role in presenting an accurate and comparable picture of the state of play of innovation and innovation policies across countries.[3] Measurement matters as the 'first essential step in the direction of learning any subject', as famously noted by Lord Kelvin (1883), who went on to add that 'when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind.' This argument in support of the relevance of measurement has a clear resonance for those who work on a regular basis with policy makers in the domain of science, technology and innovation (STI). STI indicators are, to a large extent, the most tangible and user-friendly statistical output for policy makers in this area. Indicators provide a 'ready-to-use' source of performance benchmarking information which can be used to confirm or refute widely held views about the reality of specific aspects of the innovation system, assess changes over time and drive the policy debate. Indicators are at their most useful when they help set out a core set of relevant facts that policy makers and the public can agree and build upon towards a more sophisticated debate.

In order to present the OECD work on STI indicators in context, Section 2 discusses the entire chain of indicator production and use that spans the process of standards development through to the use of indicators in policy publications and analytical outputs, paying particular attention to recent publications focused on communicating an enhanced portfolio of key innovation indicators. Section 3 follows by providing a summary description of the emerging findings of OECD work to review the measurement framework for innovation. Section 4 concludes.

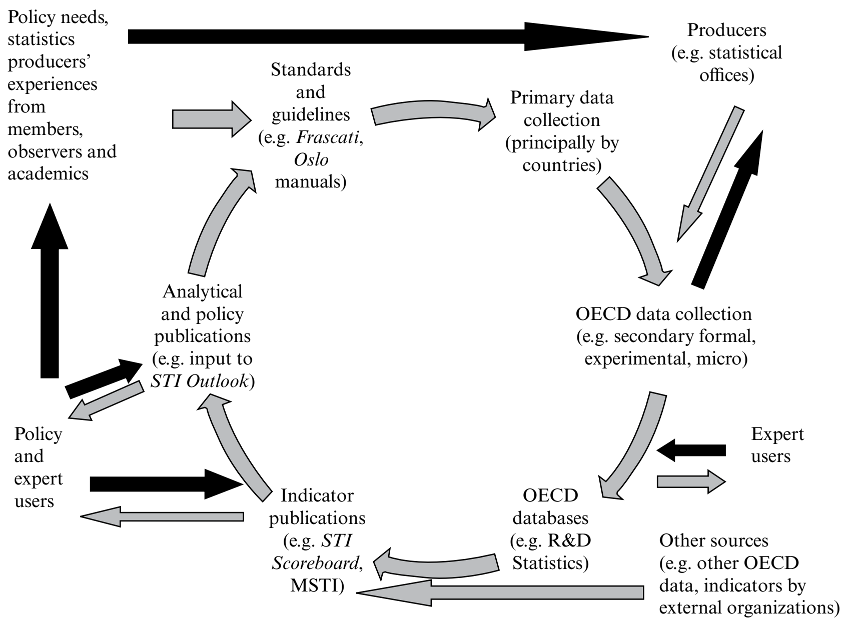
2. THE PRODUCTION AND USE OF STI STATISTICS AT THE OECD

The design, production, publication and use of STI indicators at the OECD are part of a broader effort to produce policy-relevant evidence which is clearly defined by the objective of achieving international comparability. This is an effort that spans different OECD committees,[4] their subsidiary bodies with their membership of designated national experts,[5] and the OECD secretariat, which supports the day-to-day implementation of the committees' work agenda. While responsibility within the OECD for leading the statistical and quantitative analysis work on STI work sits primarily within the Economic Analysis and Statistics (EAS) division[6] at the Directorate for Science, Technology and Industry, the 'whole-of-government' nature of innovation policy predicated by the OECD Innovation Strategy (see OECD 2010a; Chapter 12 in this volume) clearly signals the importance of indicators developed within other OECD divisions and directorates.

Figure 9.1 provides a summary flow representation of the broad range of STI measurement and analytical activities carried out by the OECD and their interdependence, illustrating links with data providers and users.

Standards and Guidelines

The challenging objective of achieving a sufficient degree of international comparability underpins the STI measurement standard-setting activity in the OECD. This entails the review and update of existing guidelines as well as the examination of new areas sufficiently mature for harmonization and codification. OECD standards guide primary data collection activities in OECD members and observer economies across a number of STI domains, most notably statistics on the resources devoted to R&D as set out in the *Frascati Manual* (OECD 2002) and business innovation – the *Oslo Manual* (OECD/Eurostat 2005). The *Frascati* 'family' of manuals also comprises guidelines on patent statistics (OECD 2009a), technol-



Note: Grey arrows signal flows of data, reports and information; black arrows depict feedback flows.

Source: OECD.

Figure 9.1 OECD activities relating to STI measurement

ogy balance of payments (OECD 1990), human resources for science and technology (HRST) – the *Canberra Manual* (OECD/Eurostat 1995) – and biotechnology statistics (OECD 2009b, 2012a). Other relevant methodological frameworks for STI measurement, indicators and interpretation outside the *Frascati* 'family' include the *OECD Guide to Measuring the Information Society* (OECD 2011a) and the *OECD Handbook for Internationally Comparative Education Statistics* (OECD 2004a).[7]

The existence, scope and content of OECD manuals and guidelines on STI measurement relate to the nature of user needs, the feasibility of implementing recommendations and the specific added value of OECD engagement. The last largely rests in its institutional ability to effectively interact with experts and official organizations with responsibility for data collection and reporting at the national level, promoting the adoption of best practices that render indicators and analyses both relevant and internationally comparable. For example, the OECD promotes the harmonization of methodologies on patent statistics (OECD and

European Patent Office 2008), addressing the complexity of patent data and providing statisticians and analysts with guidelines for constructing and analysing patent-related indicators, building on its partnership with the European Patent Office (EPO), which gathers standardized data from patent offices worldwide through the Worldwide Patent Statistics Database (PATSTAT). The *Frascati* and *Oslo* manuals build on the experience of pioneering research and statistical institutes in developing principally survey-based statistical tools to gather information about R&D and innovation activities on a consistent and comparable basis. The direct involvement, and in many cases, leadership of national STI statisticians – that is, those in charge of producing, collecting and interpreting statistics at the national level – in the design and construction of statistics and methodological manuals sets the OECD apart from related organizations, research institutes and think tanks. This approach enables the organization to rapidly gauge which approaches are most likely to be feasible and help secure buy-in for their implementation once approved in its consensus-based environment.

Data Collection

As in many other statistical domains, the collection of primary data on STI is not directly carried out by the OECD itself but by national agencies with direct access to major statistical infrastructure and resources, which decide for themselves on the best approach for implementing OECD guidelines.[8] The OECD collects secondary data from statistics producers within participating countries, encompassing regular data collections such as the one carried out jointly with Eurostat on R&D resources, and experimental data collections the objective of which is to provide a more tentative picture on an issue of interest in order to identify the feasibility of carrying out meaningful international comparisons, support analytical and policy projects, and potentially incorporate the findings into the existing body of measurement guidelines.

Databases

When the STI data collected by the OECD meet quality and relevance requirements, these are processed and released in the form of databases mainly for use by experts outside the OECD. This is the case of the R&D Statistics database,[9] which can be downloaded from the main OECD statistics portal, and the accompanying 'Sources and Methods' metadata tool, which provides detailed information on how R&D statistics are collected on a country and topic basis.[10] Due to their size, detailed OECD patent databases are intended for research and analytical work only and can be downloaded from a secure – password-protected – server.[11] At present, there is no standard OECD database that covers *Oslo Manual*-based innovation statistics. This decision reflects difficulties experienced to date in comparing results based on different survey methodologies, particularly between countries that follow the Eurostat CIS model questionnaire[12] and other non-EU countries that implement the same concepts and definitions in different ways, as will be discussed in the next section.

Indicator Publications

Indicators are probably the most easily recognizable STI measurement outputs of the OECD. In designing, selecting and publishing a given set of indicators, the OECD goes beyond the mere role of data aggregator and provider, serving users with a portfolio of key issue-oriented evidence on the state of innovation across countries. Indicators are identified on the basis of their policy relevance, analytical soundness, statistical quality and reliability for international and time-series comparisons. By publishing any given STI indicator, the OECD endorses its quality, robustness and international comparability. STI indicators feature within a diverse range of publications.

The *OECD Main Science and Technology Indicators* (MSTI) is published biannually, providing the core set of STI indicators based on the latest available OECD data on R&D expenditures and personnel, patents, technology balance of payments and international trade in R&D-intensive industries.

The OECD also releases compendia on specific topics on an *ad hoc* basis, as for example in the case of the *Patent Statistics Manual* (OECD 2009a), the *OECD Biotechnology Indicators* (OECD 2009b) and the *Science and Technology Statistical Compendium 2004* (OECD 2004b), which was prepared for the January 2004 meeting of the Committee for Scientific and Technological Policy (CSTP) at ministerial level.

Measuring innovation: a new perspective

The 2010 OECD monograph dedicated to *Measuring Innovation* (OECD 2010b) was produced as part of the OECD Innovation Strategy (OECD 2010a), closely mirroring its broad, horizontal focus. *Measuring Innovation* (OECD 2010b) presented new measures and new ways of looking at traditional indicators. Building on the OECD's half-century of indicator development, it sought to reflect adequately and as comprehensively as possible the diversity of innovation actors and processes and the linkages among them. *Measuring Innovation* (OECD 2010b) moved forward the OECD Blue Sky measurement agenda (OECD 2007) – described in a section below – on STI indicators and drew on measures of education, entrepreneurship, economic, environmental and social outcomes, and the framework conditions that support or inhibit innovation.

Measuring Innovation set out a number of 'positioning indicators' for which there is broad international coverage over time and which helps countries to compare themselves to other countries and monitor their progress towards a desired national or supranational policy goal. It also attempted to illustrate the link between the positioning indicator and a policy measure, proxying a policy mix or instrument that can be used to progress towards an outcome or target; for example, if a country sets a target in terms of business R&D intensity (R&D/GDP), a policy mix indicator can provide a picture of the extent of direct or indirect public support to business R&D. Some of these indicators were more experimental in nature, had less country coverage or were even first-time indicators. Some have already or might eventually become part of the regularly produced OECD indicators repertoire.

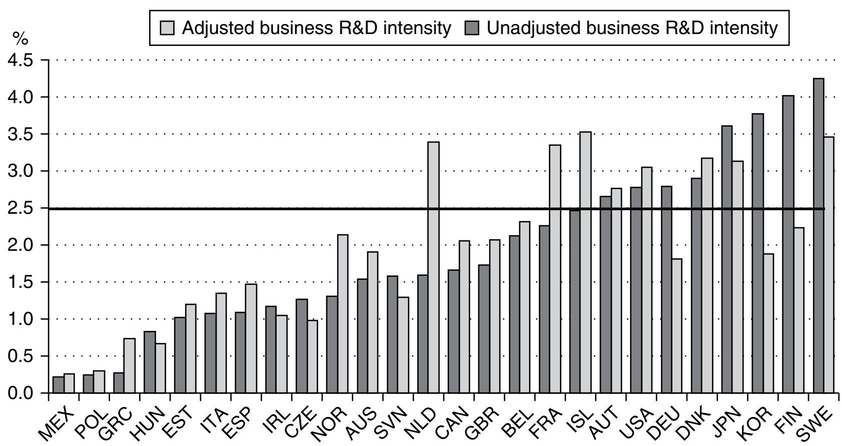
The Science, Technology and Industry Scoreboard

A varying selection of more established indicators are typically reported in the *Science, Technology and Industry Scoreboard*,[13] an OECD flagship publication that is produced every two years by the EAS division and formally produced under the aegis of the OECD Committee for Industry, Innovation and Entrepreneurship, setting out the latest international evidence on the state of science, technology and industry.[14] The 2011 *Scoreboard* (OECD 2011b) drew in particular on the latest internationally comparable data to explore the challenges faced by member countries of the OECD and other leading economies as the repercussions from the recent financial and economic crises that started in 2007/8 continued to be felt, and data, often available with a lag, began to become available. Over 180 indicators illustrated and analysed trends in science, technology, innovation and industrial performance in OECD and major non-OECD countries (notably Brazil, the Russian Federation, India, Indonesia, the People's Republic of China and South Africa), presenting indicators traditionally used to monitor developments in science, technology, innovation and industry, and complementing them with experimental indicators that provide new insights into areas of policy interest.

As in most OECD publications, the *Scoreboard* contents are driven by the need to allow policy makers and analysts to compare their economies with others of a similar size or with similar structure, and monitor their progress towards desired national or supranational policy goals. It therefore avoids the explicit 'ranking' of countries on a single dimension and the synthesis of its indicators into a single composite indicator. The main audience of the OECD *Scoreboard* is the policy analyst with a good level of understanding of the use of indicators and all those engaged in producing indicators for policy making. A few paragraphs introduce each of the indicators and offer interpretations, accompanied by a 'Definitions' box for those less familiar with the methods used. A 'Measurability' box summarizes measurement challenges, gaps and recent initiatives, hinting at the direction of the OECD measurement agenda. To facilitate access and practical usage, all charts and underlying data can be downloaded using *Statlinks*, that is, hyperlinks to a web page.

A number of examples in the 2011 *Scoreboard* illustrate the direction of the OECD measurement agenda on indicators. For example, experimental patent quality indicators developed under the aegis of the Working Party of Industry Analysis were first presented in 2011 aiming to capture the technological and the economic value of inventions. The indicators, based on patent citations, claims, patent renewals and patent family size, draw on the findings in the academic literature and present plausible and meaningful measures of research productivity correlated with the social and private value of the patented inventions.

The *Scoreboard* also shows that when comparing countries it is important to take into account differences in their industrial structure (see Figure 9.2). For example, when comparing total business research and



Source: OECD (2011b). Based on the Structural Analysis (STAN) and ANBERD databases, July 2011; OECD, Main Science and Technology Indicators databases, June 2011.

Figure 9.2 Business R&D intensity (% industry value added) adjusted for industrial structure, 2008 development (R&D) intensity (R&D expenditure relative to value added or GDP), while there is significant variation in R&D intensity within sectors, some sector-specific patterns make it very difficult for a country to raise its R&D intensity significantly without fundamentally changing its industrial structure. An understanding of the extent to which structural differences can account for observed differences in overall business R&D intensity can be achieved by constructing an indicator that shows what a country's total R&D intensity would be if it had the same industrial structure as the average for OECD countries. Work is being currently carried out to produce similar indicators focused on broader measures of business innovation.

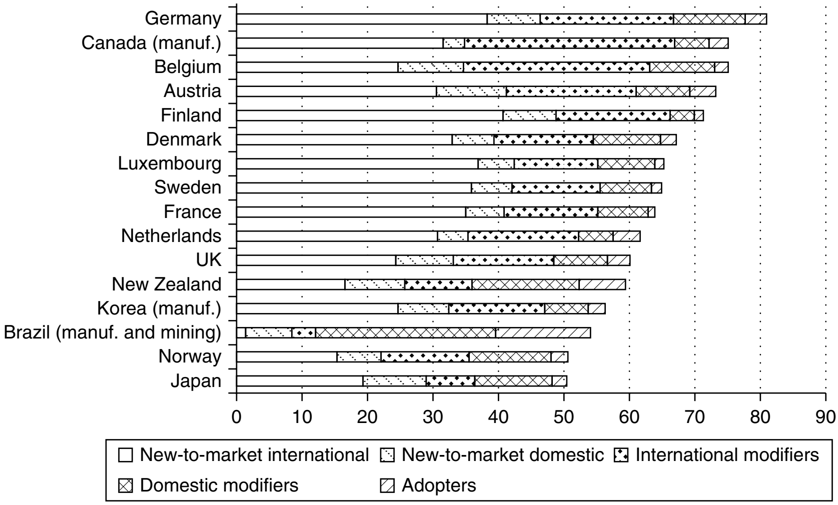
Indicators produced and used at the OECD are underpinned by data that are principally but not necessarily collected in line with OECD standards and obtained directly through members. The OECD role as a clearing house for the exchange of information and experience on methods of collection, compilation, analysis and presentation of science and technology indicators implies a duty to stay closely engaged in external developments, bringing those to the attention of experts and policy makers from member and observer countries who aim to access an evidence base on STI as comprehensive as possible. The OECD approach towards indicators, based on 'external sources' is that of leading user, with an interest in sharing of best usage practice for informing policy, as is the case with bibliometric indicators.[15]

Beyond Indicators – Analysis and Policy Publications

STI indicators publications by the OECD typically remind users that the appropriateness of a given set of indicators ultimately depends on its use. One pitfall of indicators is the ease with which particular combinations of aggregate indicators may end up misinterpreted as evidence of causal relations. For this reason, the OECD places considerable emphasis on informing users about the limitations of indicators as well as promoting the use of STI data for more advanced analytical purposes and inclusion in policy-focused publications.

Analytical publications

This approach is exemplified in analytical publications such as the *Innovation in Firms* monograph (OECD 2009c), which is the main output of the first phase of the Innovation Microdata Project launched in 2006. The project was designed to examine a range of issues relating to innovation and business performance using a common methodology, making the most of innovation survey data collected by OECD countries and



Notes: For New Zealand: 2004–2005; for Japan: 1999–2001; for Brazil: 2003–2005.

Source: OECD (2009c), based on OECD innovation Microdata Project, 2008.

Figure 9.3 Output-based modes of innovation, all firms, 2002–2004

observer economies. The project demonstrated the potential for better understanding the diversity of innovation performance at the micro level, making use of information typically neglected when compiling traditional aggregate indicators.[16] Relatively simple cross-tabulations of indicators, as in the example reproduced in Figure 9.3, which effectively combines information on whether the innovation was new to the international or domestic market and whether the company developed the innovation itself (as opposed to adopting it), give rise to five different modes of innovation.

Furthermore, it enabled the detailed exploration of the link between innovation and productivity and the role of intellectual property rights in a consistent way, for example using a common set of control variables and an econometric behavioural model with which to test hypotheses. This in turn further highlighted the importance of promoting the development of a microdata infrastructure that reduces the burden on statistical offices and respondents, supports data linking and empirical analysis, including policy evaluation.

Indicators within policy publications

Another key outlet for OECD STI indicators is the *OECD Science, Technology and Industry Outlook*, which is produced under the aegis of the

Committee for Science and Technological Policy by the Country Studies and Outlook Division at DSTI in alternate years to the *Scoreboard*. The main focus of the *Outlook* is to inform policy makers responsible for STI policies about recent and possible future changes in the global patterns of science, technology and innovation, and their possible implications for national science and innovation policies. It allows countries to benchmark themselves against each other in the field of innovation and provides comparative analysis of new policies and instruments being used in OECD countries and beyond. A dedicated chapter within the *Outlook* presents, in a series of country profiles, the main features, strengths and weaknesses of national STI systems and major recent changes in national STI policy. In the *OECD Science, Technology and Industry Outlook* (OECD 2012b) 2012 edition, the country profiles have been expanded to cover from 20 to over 300 key indicators in selected STI areas, with particular focus on innovation performance, structural features of the innovation systems and the policy mix. An important novelty in this latest edition is the combined presentation of quantitative indicator data with qualitative information collected through a dedicated policy questionnaire from which government officials from 43 countries have provided information on national STI priorities and recent policy developments in their own countries.

The integration of indicators and policy-related information is also a key feature of a new product currently in development by the OECD. The OECD Innovation Policy Platform[17] is an experimental web-based tool aimed at providing policy makers and 'shapers' (stakeholders, analysts etc.) with a navigable knowledge management system that guides them in identifying the problems that characterize their system of innovation and in designing appropriate policy solutions. Indicators will be part of its base layer information repository also comprising briefs, country profiles and case studies that are intended to inform analyses and associated interpretation processes. A consultation process is under way regarding, among other things, the appropriate contents (e.g. country coverage, types of indicators) and functionalities for indicators to be ultimately provided by the Platform.

Finally, policy briefs and thematically focused policy publications make intensive usage of STI indicators developed at the OECD, as is customary in OECD reports across most subjects. The use of indicators plays not only a vital role in contextualizing the policy discussion,[18] but is also a key driver of development work towards producing actual policy indicators, as exemplified in the brief that contained the OECD testimony to the US Senate Committee on Finance on the international experience with R&D tax incentives.[19]

3. THE MEASUREMENT AGENDA: REVIEWING AND DEVELOPING CONCEPTS, DEFINITIONS AND MEASUREMENT PRACTICES

The 'Blue Sky Indicators Project' and its Follow-up

In the mid-1990s, OECD science ministers requested that the organization launch a 'New S&T Indicators' project. This 'Blue Sky indicators' project set out to think creatively about developing new indicators to meet policy needs, proposing new indicators that would shed light on the broad system of innovation. The first Blue Sky Forum took place in Paris in 1996, followed ten years later by the Blue Sky Forum II held in Ottawa (Canada). In the interim period, the scope of OECD work on STI indicators had significantly broadened in terms of the number of areas covered, resulting for example in new measures of human resources devoted to science and technology (HRST), patent, ICT[20] and biotechnology indicators. Another substantial development over this period was, as described in Chapter 2, the third revision of the *Oslo Manual* (OECD/Eurostat 2005). This revision consolidated the move – already initiated in its second revision – towards enhancing the existing conceptual framework to better capture non-technological forms of innovation and innovation practices in the service sector, codifying new concepts and approaches that had already been tested in several OECD countries with promising results.

Notwithstanding these important developments, changes in the nature of science, technology and innovation have continued to add on new questions and proposals to an already long list of policy questions for which existing indicators could provide only a partial picture. The Blue Sky II appraisal of the supply of innovation indicators was a critical one, highlighting the challenge posed by the fact that the available range of STI indicators was almost entirely limited to inputs, in particular R&D resources, innovative activities and intermediate indicators that measure invention, or the disclosure component of the innovation process, such as patents and bibliometrics (OECD 2007). Blue Sky II thus triggered a significant broadening of the types of measurement approaches used, with a marked increase in microdata, analytical work more directly linked to research on the economic impacts of innovation and their policy implications, with the launch of Innovation Microdata Project in that same year.

The *Measuring Innovation* monograph (OECD 2010b) reflected OECD progress towards meeting some of the objectives highlighted in Blue Sky II – for example on micro-based estimates of innovation, within and outside R&D-performing firms, indicators of science–technology linkages, career and mobility of doctorate holders and policy-related indicators of support for R&D through the tax system.[21] Furthermore, it also highlighted outstanding measurement gaps and proposed international action for advancing the measurement agenda in five broad areas:

- develop innovation indicators that can be linked to aggregate measures of economic performance;
- invest in a high-quality and comprehensive statistical infrastructure to analyse innovation at the firm level;
- promote measures of innovation in the public sector and for public policy evaluation;
- find new and interdisciplinary approaches to capture knowledge creation and flows; and
- promote the measurement of innovation for social goals and of social impacts of innovation.

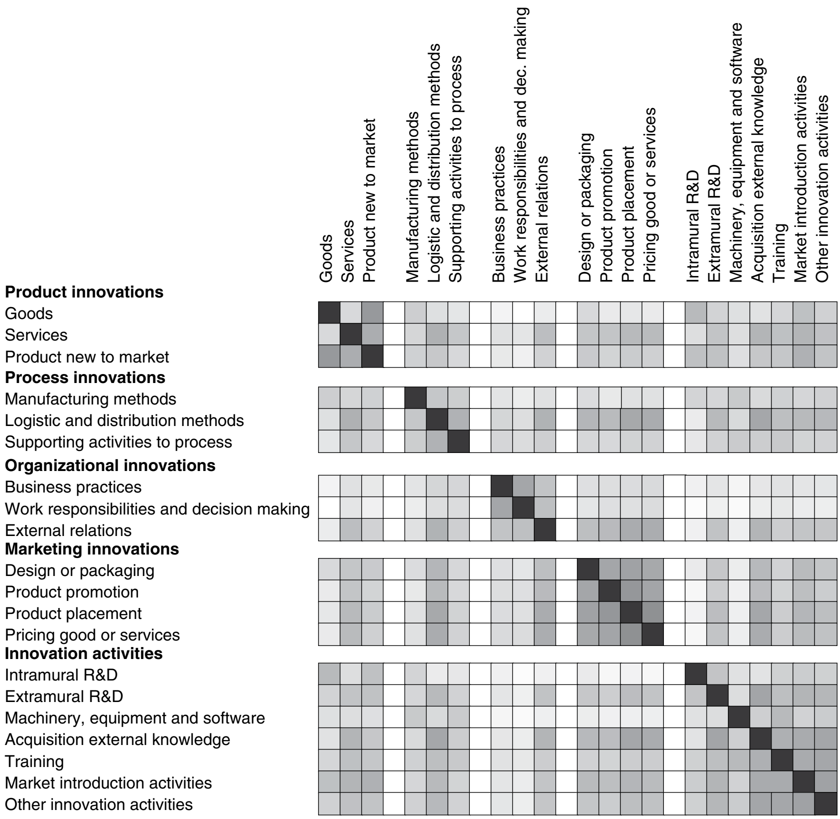
These key action areas have provided the basis for the OECD proposed forward-looking, longer-term, international measurement agenda for innovation. The roadmap 'tool' used within OECD expert groups such as NESTI has proved to be useful to build a consensus and a 'momentum' around setting and implementing priorities, requiring a continued communication effort with regard to external stakeholders. The strategic priorities expressed by policy committees and the engagement of countries in the development of the roadmap have enabled OECD to prioritize its work among a wide range of possible activities in the framework of the Innovation Strategy Measurement Agenda.

Understanding Why and How Innovation Happens in Firms

'Innovation surveys' were primarily developed to increase knowledge about innovation in firms, with the dual purpose of improving the understanding of the processes and outcomes of innovation and developing effective innovation policies. As part of its review of the measurement framework for innovation, the OECD set up in 2010 a task force to review current business R&D and innovation surveys, and to provide suggestions for future improvements with a view to identifying issues to be addressed in forthcoming revisions of the *Frascati* and *Oslo* manuals. A key component of this work is the review and assessment of the quality and comparability of innovation surveys in order to monitor how the revisions adopted in the 2005 *Oslo Manual* are being implemented. Surveys comprising questions on innovation based on the *Oslo Manual* framework have been carried out in nearly 80 countries over more than 20 years, with the USA and China being among the most recent adopters. There is an important virtuous circle at work in this agenda. Better understanding of why and how innovation happens in firms leads to improved measurements, which in turn leads to a better understanding of innovation and its policy implications.

This justifies the strong methodological focus of the work, in which the use of qualitative research methods becomes critical given the complex nature of innovation concepts. Although it is a resource-intensive initiative, the inclusion of open-ended questions in surveys prompting for examples of innovation has proved a useful source of information for STI researchers and statisticians.[22] In this vein, Francoz and Corbel (2005) contributed to the latest review of the *Oslo Manual* review process by making an innovative use of techniques aimed at evaluating the robustness of responses to qualitative questions open to subjective interpretation, as is the case of many *Oslo* concepts. The 'vignette' technique presented summary descriptions of a number of hypothetical business change scenarios so that respondents could indicate whether these conform to a given definition of innovation. The technique, which was applied to the group of NESTI experts as well as companies in a number of participating countries, provided a useful mechanism for identifying differences in perceptions and difficulties in implementing the existing concepts. This evidence supported a move away from a purely technological interpretation of product and process innovation towards a framework more focused on identifying the degree of novelty of the innovation. Other elements tested included the respondents' view of organizational and marketing innovations – and their relationship to product and process innovation in the services sector – and the role of R&D, including in the social sciences and humanities. The vignette approach has been recently applied by experts at the National Institute of Science and Technology (NISTEP) in Japan (Yonetani 2012), comparing responses from the USA, Germany and Japan. Based on nearly 3000 replies from individuals, the preliminary results indicate a considerable degree of national difference in the appreciation of what is meant by innovation, with highest reluctance to define a given vignette as an innovation found for Japan, followed by Germany, relative to the USA. The potential for further use of vignette methods in the measurement of business innovation is high; they will probably play a helpful role in a future revision of the *Oslo Manual* and in promoting international comparability, both as a testing tool and as an instrument within innovation surveys.

A form of cognitive interviewing widely applied in other disciplines and also by the US National Center for Science and Engineering Statistics (NCSES) is now being used by the OECD with a similar objective. Early scoping cognitive interviews have been taking place across a number of participating countries for the first time to shed light on how companies



Note: Shaded cells represent higher similarities across types of innovation and innovation activities.

Source: OECD, based on pooled CIS 2008 microdata for 16 EU countries deposited at Eurostat's Safe Data Centre.

Figure 9.4 Similarities in types of innovation and innovation activities across European firms, 2006–2008

with different profiles manage and think about innovation as part of the broad strategy and approach to change, and their ability to relate their own experiences to the framework of the *Oslo Manual*. In addition to helping assess the continued relevance of concepts and definitions, scoping interviews are a key step towards developing model questions for detailed testing in a coordinated fashion in an international context.

Analysis of innovation microdata can help improve our understanding of how firms innovate. Figure 9.4 displays a 'heatmap' of the similarities across the different types of innovation recognized in the *Oslo Manual* third edition and the innovation activities in firms that made their CIS 2008 anonymized microdata available for analysis by the OECD at the Eurostat Safe Data Centre.[23] The heatmap provides a visualization of how similar the different 'modes' are by portraying frequently co-occurring innovations and activities in shaded cells of the interaction matrix. This provides, for example, a fairly simple way to inspect the relevance of including organizational and marketing innovation. Comparing goods and service innovation, for example, it is possible to see that the former is only visibly close to manufacturing methods innovation, R&D and market introduction methods. In contrast, service innovation displays substantial proximity to nearly all variables, with the exceptions of R&D and investment in plant and machinery. In addition to service innovation, both organizational and marketing innovations are very weakly related to R&D. This central positioning of service innovation in the broad innovation mode landscape appears to confirm the importance of the decision to extend the broad definition of innovation in order to better capture the nature of innovation in services. This display also suggests that some generic types of innovation are quite cohesive, as is the case of marketing innovations, while within organizational innovations those oriented towards external relations appear to be more similar to marketing innovations.

As demonstrated by the OECD Innovation Microdata Project (OECD 2009c), microdata analysis allows for a detailed examination of the interdependence of various facets of innovations and business characteristics, providing a means for assessing potential anomalies in the data themselves from which indicators are constructed; understanding whether it is structural conditions that underpin – to any significant extent – observed innovation rates; assessing the external validity of innovation indicators by exploring their association with economic outcomes of interest; and facilitating the construction of indicators based on the association between variables to reflect different 'modes' of innovation. Since the publication of the results of phase one, the OECD work on innovation microdata analysis has continued through the development of typologies of innovation modes or strategies for groups of firms (Frenz and Lambert 2012), measures of sectoral innovation intensity, the innovation and productivity link and the role of product market competition and more recent analytical assessments of the impact of service innovation and innovation in the service sector, in the framework of the EU FP7-funded KNOWINNO-INNOSERV project.[24]

Innovation Indicators and Aggregate Measures of Economic Performance

There is a pressing user need to reflect new patterns of R&D and innovation in existing and new innovation indicators, which can in turn be linked to aggregate measures of economic performance. The challenges identified in the Blue Sky II Forum, such as a globalization and the adoption of open and collaborative innovation strategies and the use of social science research methods in business, particularly within services, are increasingly important phenomena that call for new indicators and revised measurement frameworks.

Such trends also affect the ability of reporting units to provide reliable information from which to construct and interpret existing indicators. For instance, the ongoing adoption of new corporate reporting rules and practices in firms, which also take into account the tax advantages conferred upon certain innovation activities, will shape the type of information companies will be able to report via statistical surveys in future years. Some evidence suggests that a non-trivial number of firms responding to business enterprise expenditure on R&D (BERD) surveys may be facing serious challenges when attempting to identify intra/extramural expenditure, as well as when trying to distinguish R&D expenditure (own funds) from R&D income (e.g. from grants, contracts). Firms may also be facing problems when reporting subcontracted R&D carried out for others, or when accounting for payments as part of collaborative R&D projects.[25] This implies both a challenge and an opportunity for STI statistics, in that the widespread use by firms of internal measures such as R&D expense or R&D eligible for tax incentives might be used as a starting point for surveys upon which to retrieve *Frascati*-like data and indicators. Furthermore, for some types of firms, such data may be used to reduce survey burdens if they can provide a reasonably good statistical approximation to the magnitude of interest.[26]

The recognition of R&D as an asset-creating activity in the 2008 *System of National Accounts* (EC et al. 2009) and its adoption of the OECD *Frascati* definition provide a unique opportunity to make a more explicit link between an important indicator of innovative activity and macroeconomic performance. This is relevant not only for STI policy makers in the traditional sense, but also for those in central economic policy roles for whom it is vital to understand the role of intellectual capital in measures of spare capacity or trade imbalances. Subject to 'bridging' adjustments laid out in the OECD *Handbook on Deriving Capital Measures of Intellectual Property Products* (OECD 2010c), *Frascati* R&D data will be the main input into the construction of new investment and capital stock series which can feed into traditional measures of productive potential as well as growth-accounting exercises.

While satellite R&D accounts can be reasonably approximated with existing *Frascati* sources, building measures that fit into the mainstream national accounts will require in the medium term more detailed information than is currently available. National accountants and STI statisticians worldwide are currently debating how *Frascati* sources can be best adapted to meet SNA needs, as the latter focus on the nature of the economic – not necessarily financial – transactions between different parties. National accountants have benefited from the expertise of STI statisticians to implement new questions aimed at drawing a distinction between R&D expenditures on a performance, funding and ownership basis, or aiming to identify the expected useful life of R&D investments.[27] The experience so far has shown that such questions can be asked but some of these concepts should be substantially adapted in order to work in practice, rather than asking directly about them. Traditional R&D-based indicators have also much to gain from this process in which the OECD is playing a leading role. When R&D becomes capitalized it will increase the value of the headline measure of GDP. Since GDP is used to normalize gross domestic expenditures on R&D (GERD), this will lead to apparently lower R&D intensity rates than would otherwise be reported. With some exceptions, the accounting impact on the level of GDP is expected to be for most countries of a similar order of magnitude to the current measure of R&D intensity.[28]

Over the last decade, there has been an explosion of interest in the role of a broader range of intangible assets other than R&D, encompassing investments such as software, training, brands and organizational capital as sources of innovation and growth at the micro and macro levels.[29] Measures of intangible asset investment, also known as knowledge-based capital, have joined the set of instruments used to measure and assess the performance of knowledge-based economies. The neoclassical macroeconomic framework developed by Corrado et al. (2005) has been particularly influential through its focus on capturing the cost of activities that give rise in principle to intangible assets, all within an expanded national-accounts-like capitalization framework.

However, it is important to recall that the capitalization of R&D or other intangibles will not by itself provide estimates of the broad impact of R&D in the way that most policy users tend to think, including spillovers, because in the SNA the attribution of benefits to R&D or any other asset is based on the principle of economic ownership. Spillovers are by construction excluded although they can implicitly show up as unexplained changes in multifactor productivity. Nonetheless, the enhanced availability of indicators on intangibles should facilitate the study of externalities and other market failures in the production and use of knowledge-based capital, complementing existing and new measures of intellectual property rights. The intangibles framework has been welcomed and adopted by many innovation researchers and experimental exercises in constructing internationally comparable indicators.[30]

The analogies between the notion of intangibles and expenditures on innovation activities are considerable.[31]Investment in knowledge refers to the accumulation of knowledge-based assets that are expected to deliver benefits to their owner beyond the current period, while innovation activities are, broadly speaking, knowledge-intensive activities or 'steps which intend to lead to the implementation of innovations', as defined in the *Oslo Manual*, which highlights the potential use of innovation expenditures to calculate returns to innovation activities. In a recent survey of NESTI members, this was identified as the most problematic question for companies responding to innovation surveys. The OECD has provided a forum for discussing experiences from pilot surveys dedicated to measuring expenditures on intangibles by firms. Such an exercise has already been carried out twice in the UK and once in Italy for large R&D performers, while similar questions are intended for inclusion in the 2013 Japanese National Innovation Survey alongside standard innovation questions. The relationship between micro-based measures of intangibles and measures of expenditures on innovation activities is of particular interest given the (untested) potential for the intangible 'accounting'-type measures to provide a basis upon which to elicit a meaningful answer to the *Oslo* concepts. This could in principle help overcome the current lack of systematic alignment between OECD innovation definitions and business accounting practices.

The review of the innovation measurement framework is equally concerned with the use of innovation survey indicators for international benchmarking purposes. The adoption of different types of survey instruments for collecting information on the innovation activities of firms has long been suspected of reducing the scope for international comparisons. The OECD has recently carried out a comprehensive collection of metadata on innovation surveys across members and observer countries, adopting a model based on Eurostat quality reviews for European countries, with the objective of investigating for the first time the impact of survey design methodologies for implementing *Oslo*-based questions.[32] This has helped document differences in the design of innovation surveys, covering elements such as (a) the use of stand-alone innovation surveys versus combination with R&D or more generic business surveys, (b) differences in sector coverage, (c) the extent to which response by business is compulsory and enforceable, and (d) the nature of the unit in charge of implementing the survey and the extent to which it can draw upon the authority of a national statistical office. Preliminary results exploring the correlation between these design and implementation features and survey results appear to indicate that there may be systematic impacts. While this could have an impact on cross-country and time-series benchmarking, work is ongoing to fully assess the implications and draw better recommendations that serve the intended uses of innovation data.

Capturing Knowledge Interactions

In order to implement a measurement agenda linking inputs, outputs and outcomes, it is critical for indicators to be integrated within an analytical system that captures the essential structure of the actual innovation system it seeks to portray. The term 'national innovation system' was coined to represent the interplay of institutions and the interactive processes at work in the creation of knowledge and in its diffusion and application. Introduced by Freeman (1987) and subsequently adopted in OECD work – for example OECD (1997) – the concept stresses that the flow of technology and information among people, enterprises and institutions plays a key role in the innovative process. The study of innovation systems directs attention to the linkages or web of interaction within the overall innovation system (OECD 1997). The production of new knowledge is often a collective process involving a significant number of individuals and organizations and requiring communication and coordination. Knowledge produced in such a complex but structured way may have public-good aspects. Such interactions or 'networks' may be usefully tracked and embedded into the innovation measurement framework.

However, linkages are not obvious objects of statistical measurement. Their potential diversity in numbers, partners and intensity levels does not easily fit within surveys, while administrative sources cover only specific aspects such as citations, co-inventorship or co-authorship, and very rarely financial transactions. As science and innovation activities increasingly rely on dispersed networks of actors, they sometimes tend to cluster in certain places or around certain institutions (e.g. a leading university or a research laboratory of a multinational corporation). To analyse the changing landscape of science, technology and innovation, it is likely that new units of analysis will be required with different geographical scope, as well as novel sources that have yet to demonstrate the necessary statistical robustness.

One area of particular policy interest is the measurement of technology transfer between universities and industries. While some countries and associations carry out specific surveys that apply, for example, to the activities of their technology transfer offices, so far only a few countries, such as Canada, Australia and Israel, have carried out dedicated official surveys and no specific international measurement framework is in place. A key challenge in this area is to go beyond pure measures of commercialization (such as licensing revenue or spin-offs) to measures that provide indicators of the return to public funding provided to those organizations, given the fact that universities carry out a wider range of third-mission activities, from collaborative R&D through to consultancy, infrastructure services and other types of community support.[33]

The OECD has been constructing a broad research agenda for developing a new generation of indicators on knowledge flows. The relationship between the science base and the research system is being addressed by the OECD by taking forward an ambitious data linking agenda matching scientific and patent literature through bibliographic references included in the latter. Initial results point, for example, to the importance of fundamental disciplines in providing the knowledge base for supporting inventions in the green technology domain (OECD 2010b, 2011b). Rapidly developing enabling technologies such as information and communication technologies (ICT), biotechnologies and nanotechnologies draw on interdisciplinary research and tend to be 'general purpose technologies' that can be used across a broad range of industries (see Chapter 15 in this volume). An OECD project has been looking at the feasibility of producing a consistent measurement framework across technologies that might not only facilitate a better integration with existing statistical sources but also help make it possible to compare their impacts. The work has so far highlighted the diversity of efforts to measure technology development and usage, which could be better integrated into the existing measurement framework, and the importance of adopting new statistical methods and interdisciplinary approaches to data collection.

The training of an educated workforce is probably the largest contribution of universities to the innovation system and, in all likelihood, the largest knowledge market is that for skilled labour. Indicators of how graduates and individuals with postgraduate qualifications in different subjects are deployed across the economy, in different sectors and occupations, are in significant demand but the supply is still very limited. The mobility of the highly skilled implies knowledge flows across disciplines, sectors and borders. Survey data, including from recent data collections as part of the project on the Career of Doctorate Holders,[34] have provided some key new insights and the OECD is carrying out further work to ensure a wider country coverage and better analysis of existing data at the micro and macro levels. A more sophisticated and linked use of bibliometric, patent and other administrative data may also help reveal how these multidisciplinary, transnational networks are evolving.

The *Oslo Manual* highlights how the study of linkages can make a valuable contribution to understanding the innovation system and the role of policies. One question that has been successfully tested in the past concerns whether third parties have been involved in developing product or process innovations implemented by the firm, although results appear to indicate that a very low proportion of implementers are only adopters. This may signal some bias in the understanding of the generic innovation question, which may lead to the exclusion of some adopters (see Chapter 5 in this volume). This question is rarely asked of organizational or marketing innovations. A second type of questions concerns the nature of innovation activities. Some, like extramural R&D and the acquisition of existing IPRs, directly identify knowledge inflows. Others are ambiguous, as software can be developed in house or acquired, as is the case of training for innovation, marketing, organizational or general design costs. In practice, most innovation survey users relate the concept of linkages to questions on sources of information for innovation (some of which may be paid for as services and included in the previous category), and types of innovation collaboration, which requires active cooperation with other firms or public research institutions on innovation activities (and may also include purchases of knowledge and technology).

The survey implementation of the *Oslo* concepts on linkages is still to be fully subject to cognitive testing in most countries. There is a clear trade-off between designing a comprehensive taxonomy of knowledge flows and having a set of questions that companies can easily respond to. One particular dimension that is currently missing in most official innovation surveys is the outward dimension of open innovation, that is, the innovation activity of companies whose knowledge 'products' are implemented or adopted by other companies. The OECD has been following recent developments principally led by academics to measure such outward flows.[35]

Understanding the Role of Government and the Economic and Social Impact of Innovation Policies

While universities and firms are covered by conventional indicators, current measures do not fully take account of the roles of individuals (in multiple roles, e.g. as consumers, employees etc.) and government in the innovation process. There are several compelling reasons for developing indicators and definitions for innovation in the public sector and measures of policy efforts to foster innovation. There is a need to account for the use of public funds for innovation, improve learning outcomes and the quality of the provision of education, health or other public services, particularly at a time when most governments worldwide are looking for efficiency savings while maintaining or enhancing current service provision levels.

Public sector innovation

Internationally agreed concepts and comparable indicators for studying innovation in the public sector do not yet exist. In addition to this, through a review of the business innovation measurement framework, the OECD has begun to explore how to extend the scope of the innovation measurement framework to reflect the role played by a broader range of actors, including assessing the feasibility of producing guidelines for the measurement of public sector innovation. Work on this topic, covered in detail in Chapter 17 of this handbook, has highlighted some of the limitations of the framework as currently implemented in the business sector, primarily across industry and a subset of service sectors. For example, the subject-based approach adopted in the *Oslo Manual* might be better suited to units with well-defined performance measures such as firms, for which output and productivity measures can be estimated based on market prices. The challenge of measuring productivity in many services and in the public sector in particular requires a fundamental rethink not just of what is an innovation in this context, but also of what is the purpose of measurement and its potential uses. One further contribution the OECD is expected to make in the near future in this domain is to consolidate the very diverse set of definitions often used interchangeably to describe innovation by economic activities typically associated with public services (i.e. public administration, but also health and education in many countries), innovation carried out by units in the government or the non-profit sector, as opposed to those operating in the market sector (which comprises both private and public enterprises); and innovation understood in a broad sense with public or social goals. This may require a concept of 'policy-driven' innovation that can also respond to social challenges or address social needs. Some innovations that generate income for firms may, of course, reduce environmental impacts and improve social well-being.

Existing classification systems, concepts and definitions from various frameworks can be fruitfully deployed to facilitate discussions on which are the most promising measurement approaches. The increasing number of pilot experiences is expected to provide a wealth of information that could be complemented by the use of methodological approaches such as those described in the context of business sector innovation. The OECD is ready to play a coordination role as initiatives are developed and users begin to demand indicators for a number of possible uses, leveraging on the input of its various policy committees with an interest in this topic.[36]

Measuring the economic and social impacts of science and innovation policy
The effort towards developing indicators of innovation in the public and private sectors raises the question of how to produce better output and outcome indicators for innovation to measure its impacts, while, as the public debate begins to recognize that innovation is more than just R&D, it becomes apparent that much needs to be done to achieve high-quality and internationally comparable measures of innovation inputs. While this may suggest that there is a hard choice to be made between focusing on inputs or outputs and outcomes as priorities for indicator development, the OECD experience is that these two objectives are in reality highly complementary, particularly when a robust infrastructure is in place that supports linking those measures at the micro, meso and macro levels. The analysis of impacts, the evaluation literature shows, is not particularly well served by attempts to design 'impact' indicators as directly drawn from answers to questions. In a survey context, direct questions on impacts can be interpreted in very different ways if there is no clear counterfactual. The process of indicator design applied in *Measuring Innovation* and the *STI Scoreboard* highlights the scope for using already-available indicators of economic and social outcomes of interest and, from there, working to identify which are the relevant innovation input and throughput data and indicators worth collecting. The analysis of impacts requires being able to link hard-to-find measures of inputs and outputs in a meaningful research design context. In the case of policy evaluation, a number of approaches can be adopted to ensure that impacts can be identified using econometric and other statistical methods.[37]

As innovation policies become more widely applied and nuanced, a new generation of indicators and guidelines for measuring public support for R&D and innovation is in high demand by policy users. *Measuring Innovation* included as one of its priority actions the development of indicators to capture the nature, direction and intensity of public support for innovation, at national and sub-national levels. This is one of the areas of the highest policy interest and one in which OECD has provided quantitative evidence on the balance across different mechanisms used to support R&D and innovation (OECD 2010b, 2011b). In recent years, the OECD has successfully introduced regular data collections on the design and financial cost to governments of providing tax incentives for R&D. Based on this experience, it may soon be possible to codify these concepts and definitions so that they can be integrated into the R&D measurement framework, potentially alongside existing guidelines on measuring government budget appropriations or outlays on R&D (GBAORD) given the similar administrative/budgetary nature of these data.

In parallel to this work on improving the comparability of data on the cost of R&D tax incentives, an OECD project has been assessing the feasibility of producing policy-relevant breakdowns of available GBAORD estimates beyond the traditional socioeconomic objectives, identifying among other things what prioritization mechanisms governments use when allocating funds in support for R&D, for example by entrusting arm's-length institutions and third parties with decisions on which projects to fund, or allocating funds directly through programmes (van Steen 2012). The review and future implementation of *Frascati* guidelines on measuring public funds for R&D to fully encompass R&D tax incentives and identify the contributions of specific policy instruments (such as procurement and subsidies) provide a key opportunity to strengthen the policy user input into the design of STI indicators and guidelines.

A more experimental line of work currently being pursued at the OECD concerns the measurement of public support for innovation in its broader sense. National experts participating in OECD discussions are being increasingly compelled to report how much governments spend on promoting innovation and how these funds are allocated. The difficulties experienced in measuring business expenditure on innovation activities and the fact that most subsidy-based support for innovation occurs through R&D grants appear to have prevented experimentation with approaches to estimating funding breakdowns by sector, as done for R&D. On the funder side, currently available budget-based measures are difficult to compare internationally, although some experimental innovation budget indicators might be feasible for a reduced set of countries with comparable sources. Such difficulties call for a detailed examination of which approaches are most likely to meet key user priorities. For example, the Europe 2020 flagship initiative 'Innovation Union' stipulates that 'from 2011, Member States and regions should set aside dedicated budgets for pre-commercial procurements and public procurements of innovative products and services'. Some countries are in the process of adopting policy targets (e.g. as a proportion of total procurement budgets) that will require an underlying measurement framework in order to be monitored effectively. Given the sheer size of general procurement budgets and their potential impact in driving demand for new goods and services and the link to the issue of public sector innovation, the measurement of public procurement is being subject to research by OECD as part of its innovation measurement agenda.

4. CONCLUSION

The OECD Blue Sky Forum meeting held in 2006 pointed to the need to address the state of fragmentation of research in innovation, particularly in the domain of data infrastructure and collection activities, highlighting the need for a general framework of analysis and greater coordination of research efforts. The goal to this day continues to be the improved understanding of the entire story of innovation, from inputs to economic and social impacts, embedded into a coherent system framework.

This chapter has shown how the OECD constructs, publishes and uses indicators as part of its complete range of STI statistical and analytical activities. The OECD central role in setting standards for the collection and interpretation of STI statistics enables the use of such indicators for meaningful international comparisons and dissemination of best measurement practices. This, as highlighted in the second part of this chapter, requires a continued and dynamic review of what works and what does not within the existing measurement framework, creating new concepts and definitions, refining existing ones and, in some cases, abandoning approaches that proved impossible to implement, were less effective or became unnecessary. The ongoing review of the innovation measurement framework will shape and inform the next revisions of OECD manuals in the *Frascati* family of measurement guidelines.

As part of this review process, the NESTI Advisory Board held a special workshop in June 2012 in partnership with the US National Academies Panel on the subject of 'Developing Science, Technology and Innovation Indicators for the Future'. The workshop contributed to link the work of the Panel to that of the OECD, the first STI Blue Sky Forum held in 1996 in Paris and its follow-up in 2006 in Ottawa, which looked at new STI indicators, the use of existing indicators for STI purposes, and the better use of existing STI indicators, providing a first step towards building the agenda of the next Blue Sky Forum anticipated for 2016. The main recurring themes in the workshop echoed the priorities set out in the OECD measurement agenda – to improve the comprehensiveness and timeliness of the currently available set of indicators while driving indicator and related econometric research to move forward from innovation inputs and activities to include the outputs and impacts of innovation. Mapping the innovation system, understanding it, and explaining it to policy makers – all themes in the workshop – require a strategic approach that goes beyond the specific notion of indicator design but greatly benefit from it.

A clear lesson from past and recent work is that meeting user needs for STI statistics requires adopting a sufficiently long-term perspective, particularly if the objective is to achieve indicators and analytical results that can be meaningfully compared across countries. Setting realistic expectations for new developments is of paramount importance in the current financial environment, in which the development of new indicators and their underlying sources has to take place within increasingly narrow resource constraints. Several data collection initiatives have been discontinued or reorganized in recent years. In this context, the OECD also attempts to be a vehicle for communicating experiences on how this process of consolidation can be supported by a high-quality and flexible data infrastructure, backed by reliable registers that enable the linking of different sources and administrative records to help reduce both collection and respondent burdens. Access to data by the research community in a privacy and confidentiality-preserving environment is critical so that research questions can be formulated and addressed through data analysis and assist the indicator prioritization process. The OECD is doing its part through the development of its own microdata lab. This resource is intended to support the analytical work required by OECD committees, including supporting the regular flow of indicators based on data linking across scientific publications, patents and other IPRs, and business data, to cite some examples. A key feature of the STI lab at the OECD is its openness to the expertise of external researchers wishing to visit the OECD to collaborate in projects of common interest.

To conclude, the next revision of the *Frascati* family of guidelines is likely to prove a substantial undertaking not only for the OECD but for the broader STI analytical community. There is considerable wealth of experiences accumulated across OECD members, and other economies, particularly in developing countries, from which new recommendations and guidelines will be drawn over the next few years. Following the Blue Sky II objective of achieving a marked improvement in the policy relevance of innovation research, users will be asked to play an active role in this review process. Through this effort and the new and ongoing projects discussed above, the OECD will continue to serve the needs of its national experts as well as its rapidly expanding user community.

NOTES

1. The views expressed here are solely those of the author and do not reflect those of the OECD, its Council or its member countries. The author would like to acknowledge the useful comments provided by OECD colleagues.
2. The OECD is a Paris-based international organization that provides a forum for policy makers from 34 member countries and observer economies to meet in specialized committees to advance ideas and review progress in specific areas pertaining to economic cooperation and development. The Council, which comprises permanent representatives from countries and in which decisions are taken by consensus, sets the mandate and programme of work of the OECD committees, which are supported in their day-to-day work by the OECD Secretariat, led by the Secretary General and structured and organized into thematically focused directorates. See www.oecd.org/about.
3. A recent example of the increasing user interest in the role of indicators for the purpose of policy monitoring is the declaration by the G8 group of countries at the Deauville Summit in May 2011, where G8 members noted: 'we also invite the OECD to develop

in a fully inclusive, open and accountable way in co-operation with relevant international organizations, measurements of innovation performance, focussing on concrete impacts on growth and jobs rather than inputs and investigating the systemic relationship between indicators' (accessed from http://www.g20-g8.com/g8-g20/g8/english/live/news/renewed-commitment-for-freedom-and-democracy.1314.html).

4. The key committees at the OECD with responsibility for science, technology and innovation issues are the Committee on Industry, Innovation and Entrepreneurship, the Committee for Information, Computer and Communications Policy, and the Committee for Science and Technological Policy.
5. The measurement of STI within the OECD has its roots in the formal creation of the Working Party of National Experts on Science and Technology Indicators (NESTI) in 1962, pre-dated by an informal group in 1957 within the OECD's predecessor – the Organisation for European Economic Co-operation – leading to an international agreement on a standard for carrying out surveys on research and experimental development (R&D), the *Frascati Manual* (OECD 1963).
6. EAS supports three statistically and analytically focused OECD working parties, namely the Working Party of Industry Analysis (WPIA), the Working Party on Indicators for the Information Society (WPIIS) and the Working Party of National Experts on Science and Technology Indicators (NESTI). The remit of these working parties concerns, respectively, the analysis of industrial competitiveness as it relates to innovation, indicators for the information society, and generic science, technology and innovation statistics and analysis, reporting to different committees supported by DSTI although often engaging in joint activities.
7. Further relevant frameworks concern the classification of high technology sectors (Hatzichronoglou 1997) and bibliometric indicators (Okubo 1997).
8. Countries thus have a considerable degree of flexibility on what specific data to collect and how to do so. Such an approach stands in contrast, for example, with projects such as the OECD Programme for International Student Assessment (PISA), where a central team directly coordinates primary data collection from schools, their students and staff. Common guidelines, requests for clearly defined data and metadata (as in the case of the joint OECD/Eurostat R&D data collection) are sometimes complemented by the use of model questionnaires to promote a basic degree of uniformity. International comparability may sometimes be reduced in order to allow countries to implement potentially more cost-effective solutions within their own specific context.
9. See www.oecd.org/sti/rds. A related database, linked to the STAN family of industry structural databases, provides information on R&D resources devoted by business at the industry sector level: www.oecd.org/sti/anberd.
10. See http://webnet.oecd.org/rd_gbaord_metadata/default.aspx.
11. See http://www.oecd.org/sti/innovationinsciencetechnologyandindustry/oecdpatentdatabases.htm.
12. Eurostat publishes results from the Community Innovation Survey for the EU and associated member states in its statistics portal. See http://epp.eurostat.ec.europa.eu/portal/page/portal/science_technology_innovation/data/database.
13. There are other sets of indicators regularly published by OECD, such as the OECD key biotechnology indicators, bringing together the latest available economic and activity data on biotechnology and innovation. See http://www.oecd.org/sti/keybiotechnologyindicators.htm.
14. Led by the CIIE, it benefits from contributions by the CSTP and ICCP committees.
15. Bibliometric data are gathered by commercial organizations that compete in their offer to provide access to a more comprehensively indexed scientific literature. The OECD carries out its work on bibliometric indicators by means of partnerships with leading research institutes with demonstrated expertise and access to 'cleaner' sources and, in some instances, carrying out analysis on data directly licensed from data compilers. See Okubo (1997).
16. In other words, traditional indicators based simply on the frequency of responses to a given question.

17. For further information, see http://www.oecd.org/innovation/policyplatform/.
18. For example, see the policy brief on open innovation in global networks: http://www.oecd.org/science/innovationinsciencetechnologyandindustry/41721342.pdf.
19. See http://www.finance.senate.gov/imo/media/doc/OECD%20SFC%20Hearing%20testimony%209%2020%2011.pdf.
20. See, for example, http://www.oecd.org/sti/interneteconomy/oecdkeyictindicators.htm. The first edition of the *OECD Guide to Measuring the Information Society* was first issued in 2005.
21. Some examples are illustrated in Chapter 12 of this handbook.
22. See for example Arundel et al. (2010).
23. See http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis.
24. www.oecd.org/sti/innoserv.
25. Finne (2011) has documented different drivers of potential over- and under-reporting in Norwegian firms. See also Hough et al. (2012) on the experience of redesigning the US business R&D and innovation survey and Howells (2009) on specific challenges for services.
26. For example, Statistics Canada stopped surveying the small performers and funders of R&D in Canada to reduce the reporting burden on companies; it replaced the data previously gathered by the survey by administrative data from the Canada Revenue Agency.
27. Survey-based approaches to estimate R&D asset lives have been already tested in a number of countries, including the USA, Germany, Israel and the UK. The R&D capitalization process also requires producing estimates of R&D deflators, nowcasting estimates of R&D to feed into quarterly national accounts, and, in many countries, constructing regional measures to feed into regional accounts.
28. The likely impact of R&D capitalization on GDP growth rates has been estimated only in a minority of countries. This figure tends to be quite small because R&D is relatively stable compared to overall GDP. Unlike the capitalization of software, the capitalization of R&D will not signal a dramatic change in estimates of past changes in GDP.
29. See OECD (2006, 2008).
30. See Corrado et al. (2012) for a set of estimates of intangible investment and net stocks for European countries and the USA. These estimates are the authors' own elaboration of work they previously conducted under three projects: two funded by the European Commission 7th Framework Programme (COINVEST http://www.coinvest.org.uk/bin/view/CoInvest and INNODRIVE http://innodrive.org/) and an ongoing effort of The Conference Board (http://www.conference-board.org/data/intangibles).
31. Organizations such as Nesta portray the measured contribution of TFP and intangibles accumulation to economic growth as that of innovation. See, for example, http://www.nesta.org.uk/home1/assets/features/innovation_index_2012.
32. The UNESCO Institute of Statistics has been carrying out a project to collect relevant information on innovation surveys carried out in developing countries. See http://www.uis.unesco.org/ScienceTechnology/Pages/innovation-statistics.aspx.
33. The European Commission recently published a report by an expert group on knowledge transfer metrics that provides an overview of activities carried out to date (EC 2011). Abreu et al. (2011) provide comprehensive evidence of the wide range of university interactions with the rest of the economy.
34. See www.oecd.org/sti/cdh for key indicators and further publications and information on this joint OECD–Eurostat–UNESCO project.
35. See, for example, Cosh and Zhang (2011).
36. For example, an Observatory of Public Sector Innovation is being developed under the aegis of the Public Governance Committee to systematically collect, categorize, analyse and share innovative practices from across the public sector. See http://www.oecd.org/governance/oecdobservatoryofpublicsectorinnovation.htm.
37. See Jaffe (2002).

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