


NATIONAL SCIENCE BOARD
SCIENCE & ENGINEERING INDICATORS 2020

R&D

Research and Development: U.S. Trends and International Comparisons

Technical Appendix

NSB-2020-3

January 15, 2020

This publication is part of the *Science and Engineering Indicators* suite of reports. *Indicators* is a congressionally mandated report on the state of the U.S. science and engineering enterprise. It is policy relevant and policy neutral. *Indicators* is prepared under the guidance of the National Science Board by the National Center for Science and Engineering Statistics, a federal statistical agency within the National Science Foundation. With the 2020 edition, *Indicators* is changing from a single report to a set of disaggregated and streamlined reports published on a rolling basis. Detailed data tables will continue to be available online.

Table of Contents

Measuring U.S. R&D 5

Comparing International R&D Expenditures 6

References 6

Measuring U.S. R&D

The statistics on U.S. research and development (R&D) discussed in this section reflect the latest edition of the *National Patterns of R&D Resources* reports from the National Science Foundation's (NSF's) National Center for Science and Engineering Statistics (NCSES). These reports provide a comprehensive account of U.S. R&D performance (**https://www.nsf.gov/statistics/natlpatterns/**).

The *National Patterns* data, in turn, derive principally from six regular NCSES surveys of the organizations that perform or fund the bulk of U.S. R&D. Details on the scope and methodologies of each of these surveys are available on the NCSES website:

- Business R&D Survey (**https://www.nsf.gov/statistics/srvyindustry/**)
- Higher Education Research and Development Survey (**https://www.nsf.gov/statistics/srvyherd/**)
- Survey of Federal Funds for Research and Development (**https://www.nsf.gov/statistics/srvyfedfunds/**)
- Federally Funded Research and Development Center R&D Survey (**https://www.nsf.gov/statistics/srvyffrdc/**)
- Survey of State Government Research and Development (**https://www.nsf.gov/statistics/srvystaterd/**)
- Survey of Research and Development Funding and Performance by Nonprofit Organizations (**http://www.nsf.gov/statistics/nsf02303/**)

The *National Patterns* analysis integrates R&D spending and funding data from these separate surveys into U.S. R&D performance totals, which are then reported on a calendar year basis and for the main performing sectors and funding sources.

NCSES's R&D surveys have long been consistent with international definitions and standards, as reflected in the Organisation for Economic Development (OECD) *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development* (**https://www.oecd.org/sti/frascati-manual-2015-9789264239012-en.htm**).

The U.S. business R&D estimates are derived from an NCSES and U.S. Census Bureau survey, conducted annually, of R&D-performing companies. Through 2016, the reported data included companies with 5 or more employees. In 2017 (and beyond) the coverage was revised to include companies with 10 or more employees. NCSES survey development efforts have been underway over the last several years to collect annual R&D data on the population of companies in the size range of 1–9 employees (**https://www.nsf.gov/statistics/srvymicrobus/**).

The statistics for academic R&D reflect the expenditures of sponsored research and institutionally funded research that are separately accounted for by the university. U.S. universities do not report funds for research that are not separately accounted, such as estimates of faculty time spent on research beyond formally tracked research projects. This can be a limitation in international R&D comparisons because such estimates are often included in the national statistics of other countries. Likewise, the activity of individuals performing R&D on their own time and not under the auspices of a corporation, university, or other organization is omitted from official U.S. R&D statistics (as is the case for all other countries).

Statistics on R&D performed by state governments are collected in an annual NCSES and U.S. Census Bureau survey. Although these data represent small amounts (typically totaling only several hundred million dollars annually), they are now included in the *National Patterns* totals.

Estimates for the R&D performed in the United States by nonprofit organizations remain based on parameters in NSF's 1996–97 survey of this sector. They also include current data on federal R&D support to nonprofit organizations reported in the annual Survey of Federal Funds for R&D. Since 2016, NCSES has been developing a comprehensive new survey on R&D performance and funding by nonprofit organizations in the United States (**https://www.nsf.gov/statistics/srvynpra/**). A pilot was completed in 2016, and a full-scale edition of this survey has been in the field since early 2018.

Comparing International R&D Expenditures

Comparisons of international R&D statistics are hampered by the lack of R&D-specific exchange rates. Two approaches are commonly used: (1) express national R&D expenditures as a percentage of gross domestic product (GDP), or (2) convert all expenditures to a single currency. The first method is straightforward but permits only gross comparisons of R&D intensity. The second method permits absolute level-of-effort comparisons and finer-grain analyses but entails selecting an appropriate method of currency conversion. For all practical purposes, the choice is between market exchange rates (MERs) and purchasing power parities (PPPs), both of which are available for many countries over an extended period.

MERs represent the relative value of currencies for cross-border trade of goods and services but may not accurately reflect the cost of nontraded goods and services. They are also subject to currency speculation, political events, wars or boycotts, and official currency intervention. PPPs were developed to overcome these shortcomings (Ward 1985); they take into account the cost differences of buying a similar market basket of goods and services covering tradables and nontradables. The PPP basket is assumed to be representative of total GDP across countries. PPPs are the preferred international standard for calculating cross-country R&D comparisons and are used in all official R&D tabulations of the OECD.

Because MERs tend to understate the domestic purchasing power of developing countries' currencies, PPPs can produce substantially larger R&D estimates than MERs for these countries. For example, China's R&D expenditures in 2017 (as reported to OECD) were $496 billion in PPP terms but only $260 billion using MERs. However, PPPs for large developing countries such as China and India are often rough approximations and have shortcomings. For example, structural differences and income disparities between developing and developed countries may result in PPPs based on markedly different sets of goods and services. In addition, the resulting PPPs may have very different relationships to the cost of R&D in different countries.

R&D performance in developing countries is often concentrated geographically in the most advanced cities and regions in terms of infrastructure and level of educated workforce. The costs of goods and services in these areas can be substantially greater than for the country as a whole.

Nonetheless, there are some unresolved questions about the use of GDP PPPs for deflating R&D expenditures. One such issue is the differences in dollar comparisons resulting from PPPs specific for R&D expenditures versus those from the standard GDP-based PPPs. In analyzing the manufacturing R&D inputs and outputs of six industrialized OECD countries, Dougherty and colleagues (2007:312) concluded that "the use of an R&D PPP will yield comparative costs and R&D intensities that vary substantially from the current practice of using GDP PPPs, likely increasing the real R&D performance of the comparison countries relative to the United States."

References

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Ward M. 1985. *Purchasing Power Parities and Real Expenditures in the OECD.* Paris: Organisation for Economic Co-Operation and Development.