

OECD Main Science and Technology Indicators

Highlights - March 2023

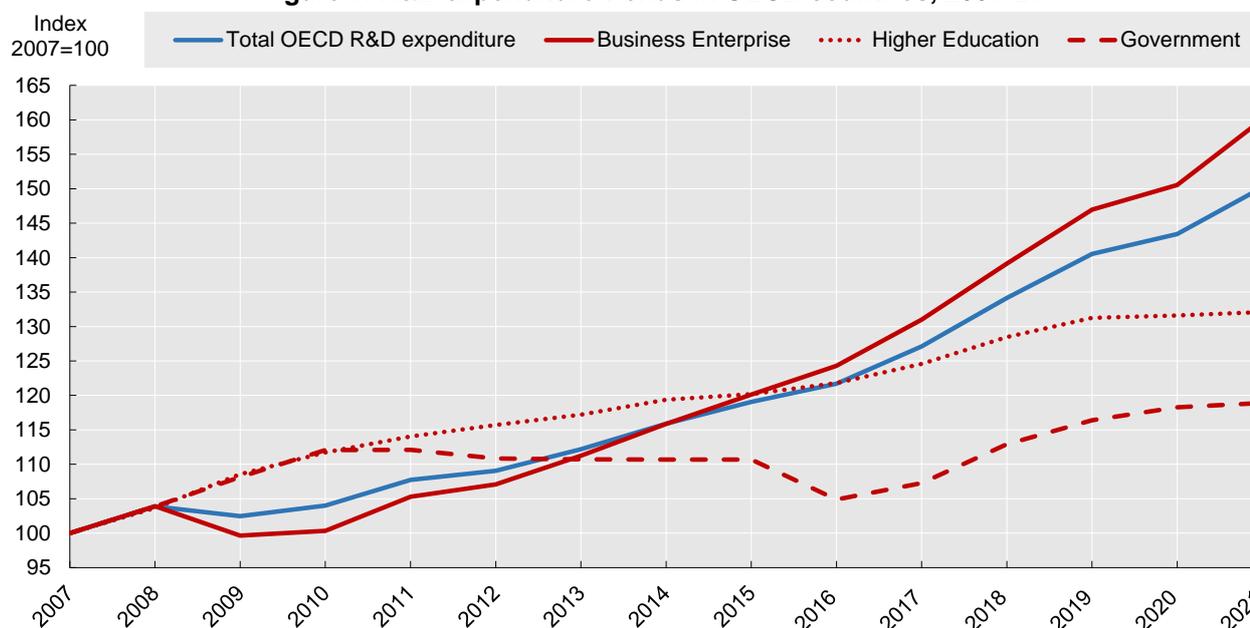
- **R&D investment in the OECD area continued to grow in 2021 at pre-COVID-19 rates after demonstrating unprecedented resilience in 2020.**
- **Leading indicators show inflation eroding growth in private and public R&D in 2022.**
- **COVID-19 kept transforming the scientific publication output landscape in 2021.**

In 2021, Research and Experimental Development (R&D) expenditures in the OECD area resumed their growth trajectory prior to the COVID-19 crisis. According to the latest data published in the [OECD Main Science and Technology Indicators \(MSTI\)](#) on 31 March 2023, drawing on the OECD R&D statistics database compiled with contributions from OECD members and other selected economies, **R&D expenditure in the OECD area grew in 2021 by 4.7%** in inflation adjusted terms, marking a return to pre-COVID crisis trends after it had slowed down to 2% growth in 2020.

R&D in the business sector resumed in 2021 its role as main driver of R&D growth, while R&D in government and higher education institutions came to a virtual standstill

Since the 2009 global financial crisis and up until the COVID-19 crisis, businesses have seen their share of total expenditure on R&D performance in the OECD area increase to well over three quarters and have been leading OECD R&D growth. After trailing other sectors in terms of R&D expenditure growth in 2020, R&D expenditures in the business sector grew by 6.3% while R&D in the Higher Education and Government sector barely increased at 0.4% and 0.5% respectively.

Figure 1. R&D expenditure trends in OECD countries, 2007-21



Note: Estimates adjusted for inflation. Base year 2007=100.

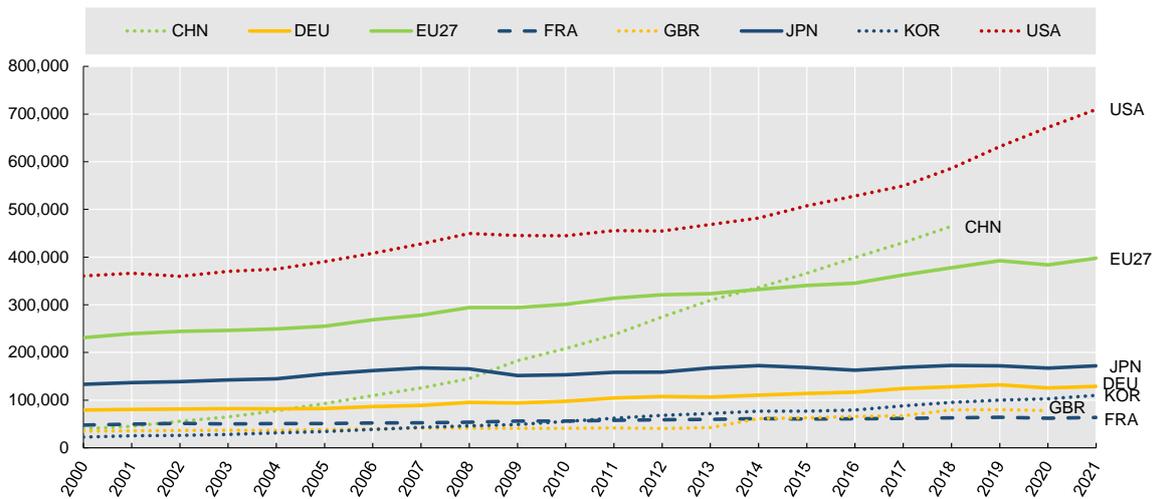
Source: OECD Main Science and Technology Indicators (MSTI) Database, March 2023. <http://oe.cd/msti>

As more comprehensive data have been reported by OECD countries over the past year, figures previously published in MSTI in March and September 2022 have been revised in the March 2023 editions. R&D growth in the OECD area for 2020 has been revised up from 1.5% in March 2022 to 2% one year later, principally driven by upward revisions for the United States and the United Kingdom (see explanatory **Box 1** below).

R&D growth in the OECD area was pervasive but unevenly distributed across countries in 2021. Differences in the level of R&D expenditures amplified

Pervasive growth in inflation-adjusted R&D expenditure in the OECD area in 2021 was led by intensified R&D growth in the United States at 5.6% and Korea at 7.1%, supported by a noteworthy recovery in countries like France, Germany and Japan, where R&D expenditure grew at close to 3% after negative growth in 2020. Several OECD economies reported growth rates over 10% in 2021. R&D expenditure in the EU27 area rose by 3.6% after a decline of 2.3% in 2020. Data published by China’s authorities implies that in purchasing power adjusted terms, China’s R&D would be close to 80% of total R&D performed in the United States. These statistics have been temporarily suppressed as they are currently under review by OECD (see **Box 1**).

Figure 2. Gross domestic expenditure on R&D, selected economics, 2000-21
USD million in constant PPP prices



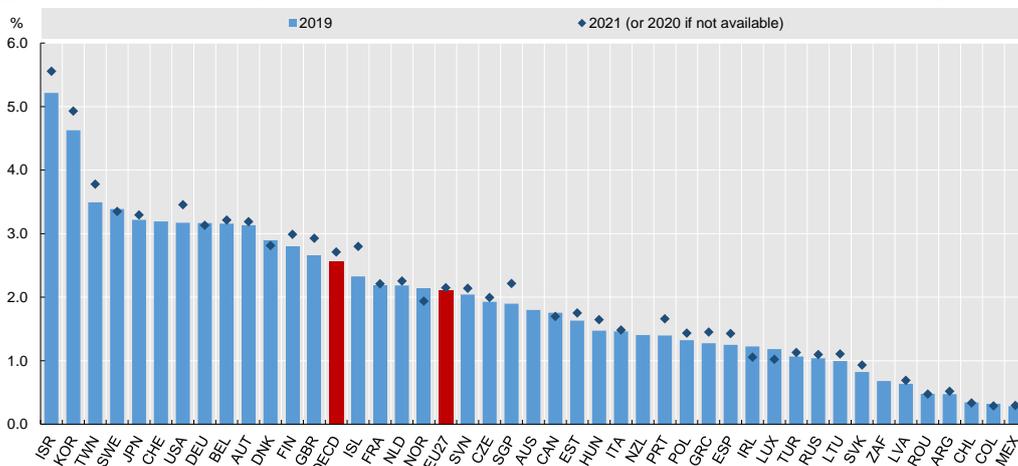
Note: More recent data for China temporarily suppressed as currently under review by OECD (see Box 1).

Source: OECD Main Science and Technology Indicators Database, March 2023. <http://oe.cd/msti>

Compared with 2020, R&D intensity in the OECD area declined in 2021 because GDP outpaced growth in R&D expenditure, but it still stands above pre-crisis levels

R&D growth in the OECD area in 2021 (4.7%) fell short of GDP growth (5.6%) after the opposite held in 2020. As economic growth resumed in 2021, R&D intensity – a headline measure of domestic expenditure on R&D expressed as a percentage of GDP – can be meaningfully compared with pre-crisis levels. In the OECD area, R&D intensity stood in 2021 at 2.7%, higher than 2.56% in 2019, while for the EU27 it stood at 2.15% compared with 2.1%. Across the OECD, Israel and Korea continued to report the highest levels of R&D intensity, at 5.6% and 4.9% of GDP, respectively.

Figure 3. R&D intensity: Gross domestic expenditure on R&D as a percentage of GDP



Source: OECD Main Science and Technology Indicators Database, March 2023. <http://oe.cd/msti>

Box 1. Main coverage changes and major revisions to R&D data in the MSTI March 2023 edition

MSTI coverage is defined by the reporting by countries to OECD of R&D data that are consistent with the guidance in the OECD Frascati Manual. The statistics compiled by OECD are based on data provided by responsible national bodies to the OECD annual call for R&D data from OECD member countries and selected non-member economies. In its latest available edition, MSTI reports indicators on 37 out of 38 OECD Member countries with most recent data typically reaching up to 2021 (2022 in the case of R&D budgets). **Costa Rica**, which became the 38th member of the OECD in May 2021 is not yet included in MSTI pending final verification that its R&D statistics are suitable for inclusion in the OECD R&D statistics database on which MSTI R&D indicators are based.

In response to **Russia's** large-scale aggression against Ukraine, the OECD Council decided on 8 March 2022 to immediately suspend the participation of Russia and Belarus in OECD bodies. In view of this decision, the OECD suspended its solicitation of official statistics on R&D from Russian authorities, leading to the absence of more recent R&D statistics for this country in the OECD database, while previously compiled data are still available.

In this latest edition, the OECD has decided to put under review data for a number of R&D indicators for **China** referring to years 2019, 2020 and 2021, suppressing the publication of several headline indicators for those years until a number of questions on the coherence of expenditure and personnel data have been effectively addressed.

Indicators for the **United Kingdom** are significantly and provisionally revised compared to previous editions. In the November 2022 publication of R&D statistics by the UK Office for National Statistics (ONS), estimates for R&D expenditure and personnel in the Business enterprise sector and R&D expenditure figures in the Higher education sector were significantly revised upwards. These changes reflect an uplift recalibration to account for under-sampled businesses performing R&D and the adoption of more comprehensive administrative data on expenditures for higher education institutions. While the ONS process of full review and update of data collection and estimation methods is ongoing in 2023, several data series have been temporarily discontinued by ONS.

The OECD has processed and released data for the United Kingdom, submitted to OECD by ONS in February 2023, as follows:

- Revised R&D data for the United Kingdom has been flagged by OECD as provisional (flag 'P') pending the completion of the ONS R&D statistical transformation programme. Data breaks (flag 'B') have been identified at relevant points.
- Revised estimates for business R&D personnel in the business sector for 2018-2020 have not been included in the OECD database pending further clarification that the uplift method used for R&D expenditure can be consistently applied to personnel.
- Temporarily suppressed series have also been suppressed in the OECD data from the point in which the data breaks for the available headline series have been marked, while previous data are maintained. Archived data versions are available to users on request.

Reporting of R&D personnel statistics by the **United States** for all sectors has resumed with new records available from 2020, reflecting the addition of official figures for numbers of researchers and total R&D personnel for the higher education sector and the Private non-profit sector; as well as numbers of researchers for the government sector. The new data revise downwards previous OECD estimates as the OECD extrapolation methods drawing on historical US data, required to produce a consistent OECD aggregate, appear to have previously overestimated the growth in the number of researchers in the higher education sector.

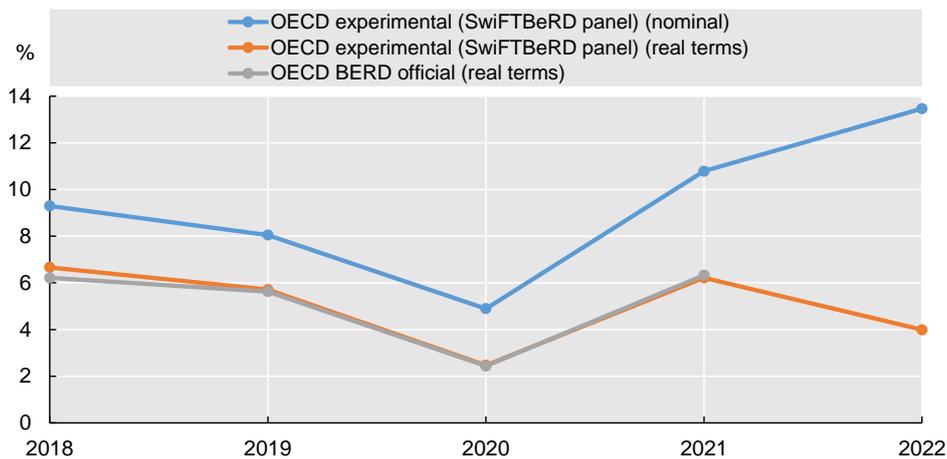
Inflation has eroded nowcasts of nominal growth for R&D investment in 2022 by businesses and governments, pointing to a slowdown in real R&D growth

Although official statistics on R&D expenditures for 2022 will only be available in the first quarter of 2024 for most countries, the OECD develops and monitors several leading indicators to provide more timely insights into R&D investment. To do this, the OECD has developed a preliminary view of R&D spending in 2022, monitoring data from government budgets for R&D, provided by official contacts within countries, in combination with exploratory analysis of published quarterly reports and accounts for a panel of large business R&D investors.

Growth in Business R&D expected to have moderated in 2022 but still outpaced GDP

The OECD Short-term Financial Tracker of Business R&D (SwiFTBeRD) dashboard reports quarterly and annual R&D data for several of the world's major R&D investors, providing company-specific and sectoral insights to deliver the timeliest possible view of R&D data reported by companies. The latest estimates of real growth in R&D expenses for the ensemble of firms in the OECD SwiFTBeRD panel closely map the evolution of official estimates of Business Expenditure on R&D (BERD) in the OECD area over periods in which the latter are available. In particular, the official data in the March 2023 MSTI release aligns closely with the latest SwiFTBeRD estimates for 2020 and 2021. The implied SwiFTBeRD nowcast for 2022 is positive **annual growth in the order of 4% adjusted for inflation, while nominal growth accelerated to 14%**. While this represents a slowdown in inflation-adjusted R&D compared to 6% growth in 2021, it is higher than the OECD Economic Outlook's GDP growth estimate of 2.85% for 2022.

Figure 4. Official and experimental estimates of annual business R&D growth, 2018-22



Note: As several companies revised their R&D data, the 2021 estimate for SwiFTBeRD growth has been revised downwards from 7% on display in the 2022 MSTI release to 6% in the latest data.

Source: OECD calculations, based on OECD Short-term Financial Tracker of Business R&D (SwiFTBeRD) dashboard, March 2023, <http://oe.cd/swiftberd>.

OECD Short-term Financial Tracker of Business R&D (SwiFTBeRD) dashboard

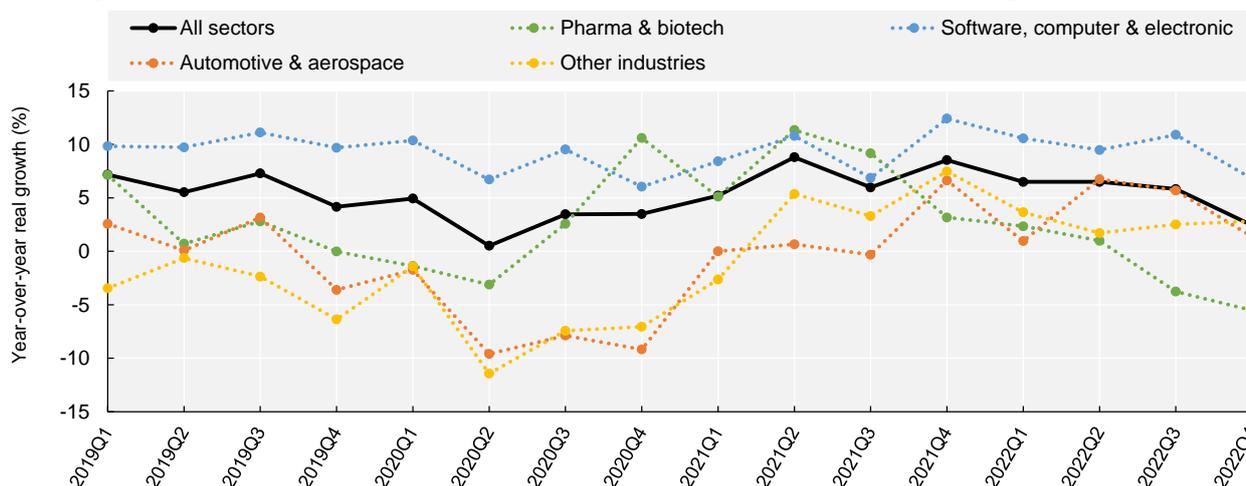
SwiFTBeRD is an initiative of the OECD Directorate for Science, Technology and Innovation that seeks to provide timely business R&D trends indicators based on data publicly disclosed by companies. This new tool complements the OECD reporting of official R&D statistics published in the OECD Research and Development Statistics and the OECD Main Science and Technology Indicators (MSTI) databases. Although official R&D data, principally based on statistical surveys, serve as a basis for the most robust and internationally comparable variable breakdowns and structural indicators, they suffer from a lack of timeliness that results from regular collection and reporting cycles designed to ensure comprehensiveness. R&D figures reported in companies' financial accounts (often reported on a quarterly basis shortly after completion) help provide a timelier picture that can complement insights survey-based data. The SwiFTBeRD data are collected by OECD from companies' financial statements accessed directly from their websites. The SwiFTBeRD dashboard includes data on R&D expenditures and total revenues.

Find out more at <http://oe.cd/swiftberd>

Widening gap between ICT and other industries' R&D

Analysis of R&D expense growth in 2022 by the panel of firms in SwiFTBeRD reveals a return to the pre-COVID-19 patterns of differential growth performance between companies in ICT industries and those elsewhere. Companies in ICT are maintaining high inflation-adjusted growth rates for R&D expenses while companies in industries like “pharma and biotech”, which were core to the resilience of business R&D in 2020, appear to have been reducing their R&D spending in 2022. The industries most negatively affected by the crisis are sustaining growth rates at 4%, which implies that the gap with the ICT industries keeps widening, contributing to a deep transformation in the structure of business R&D.

Figure 5. OECD experimental estimates of annual business R&D expense growth, 2018-22

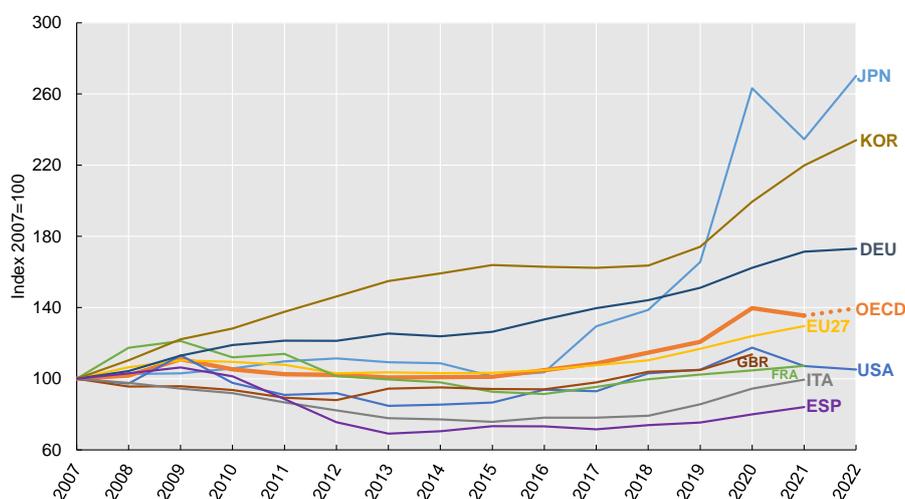


Source: OECD calculations, based on OECD Short-term Financial Tracker of Business R&D (SwiFTBeRD) dashboard, March 2023, <http://oe.cd/swiftberd>.

After a significant correction in 2021, OECD Government R&D budgets in 2022 holding to 2020 levels

Government R&D budget indicators for the OECD area present the amounts that governments agree to allocate for R&D as part of their budgetary processes, rather than actual expenditure reported by R&D performers. In addition to shedding light on governmental R&D funding intentions, these figures provide early insights into R&D performance in sectors that are highly reliant on government support, such as higher education and government research institutions, as it is now confirmed for 2021. After an impressive 15% growth in real terms in 2020, government R&D budgets for the entire OECD area are estimated to have decreased by 3% in 2021 compared to 2020. The outlook for 2022 is still uncertain as several countries have not yet reported data for this year. The OECD appears to have made up for the R&D budget cuts in 2021, with continued reductions in the United States offset by growth in Japan and Korea as well as some European economies, apparently boosted by EU recovery funds.

Figure 6. Government R&D budget trends, selected economies, 2007-2022

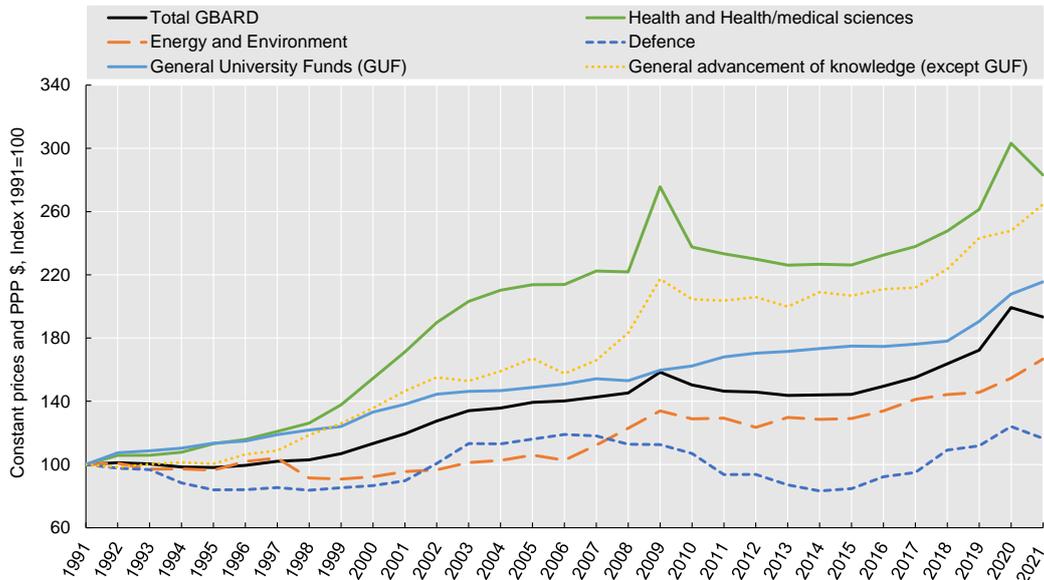


Note: Trend estimates are inflation-adjusted. The OECD estimate for 2022 is based on a reduced number of countries. Source: OECD Main Science and Technology Indicators (MSTI) Database, March 2023. <http://oe.cd/msti>

Re-orientation of government's R&D budgets

While there are no details available about the orientation of government R&D budgets in 2022 for the entire OECD area, data for 2021 indicate that the decline R&D budgets was principally explained by the readjustment to **health R&D**. This year marks the return to growth in undirected R&D funding (general university funds and other funding for the general advancement of knowledge). Defence R&D declined again in 2021. There are also signs that R&D recovery packages in 2021 placed relatively more emphasis on the objectives of **Energy and the Environment**, whose overall growth since 1991 was among the weakest alongside with Defence.

Figure 6. Government R&D budget trends, by key policy objectives, 1991-2021

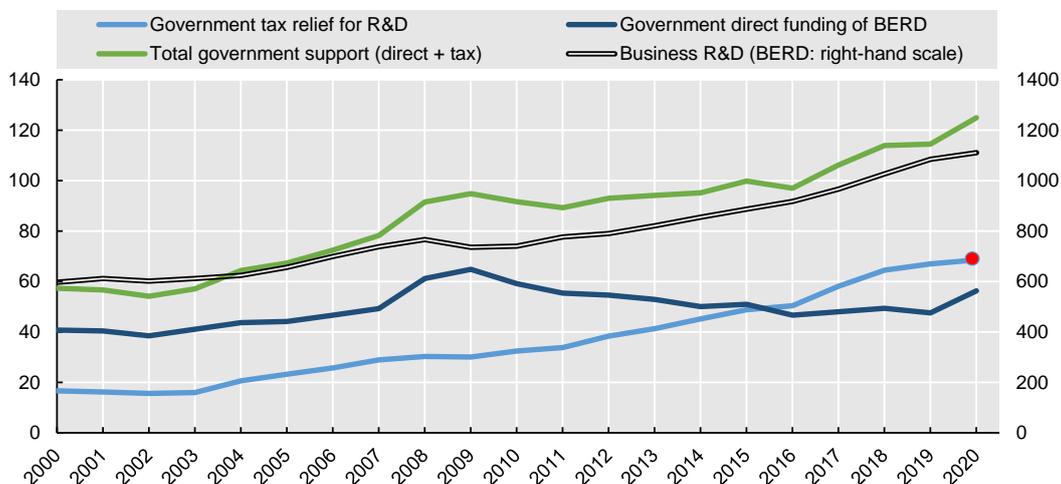


Source: OECD Main Science and Technology Indicators (MSTI) Database, March 2023. <http://oe.cd/msti>

The COVID-19 crisis slowed down the growth in government tax support for R&D in 2020 while direct government support recovered to 2010 levels

After more than a decade of spending cuts, the level of government direct funding for business R&D rose sharply in 2020, at a rate not seen since the 2008 crisis. The OECD Indicators on R&D tax incentives, published concurrently to MSTI, show in their latest edition that as business R&D growth slowed down in 2020, so did demand for tax relief for R&D. Growth in total measured support, combining both direct funding and tax support elements, outpaced business R&D.

Figure 7. Government tax and direct support for business R&D, OECD-38 area, 2000-2020
USD billion in constant PPP prices



Note: Preliminary OECD estimate of government tax relief for R&D expenditures (GTARD) for 2020.

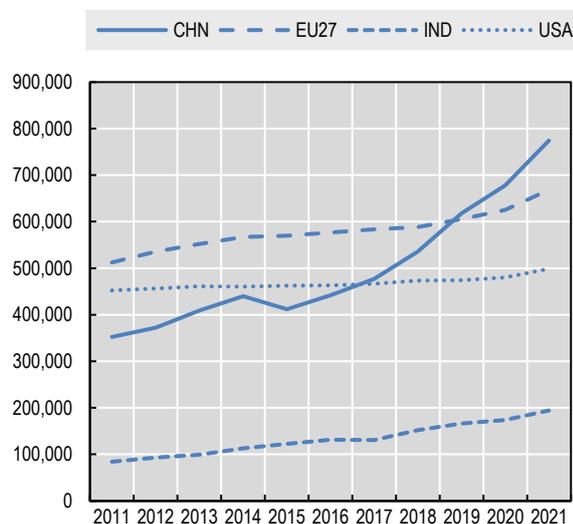
Source: OECD R&D Tax Incentives database, March 2023. <http://oe.cd/rdtax>

Data on scientific publications reveals major shifts in science landscape throughout the COVID-19 pandemic

OECD analysis of scholarly scientific publications up until 2021 shows that scientific publishing output experienced a marked and widespread acceleration throughout the COVID-19 pandemic (Figure 8.A). China's position as largest producer of globally top 10% most cited publications consolidated after catching up with the EU27 in 2019 and the United States in 2020 (Figure 8.B). For the first time since records are available, the rate indicating what proportion of documents published by authors affiliated to institutions in China are in the global top 10% most cited did not increase but slightly declined in 2021, owing to a slight decline in average citation rates (Figure 8.C). India's ascent in terms of volumes of highly-cited scientific output is also noticeable as it has caught up with Germany and is fast approaching the United Kingdom, propelled by increases in average domestic rates of highly cited publications. Scientific collaboration also continued its net growth trajectory during the COVID-19 crisis, even when measured on a fractional count basis. However, China's rate of collaboration with the rest of the world declined in 2021, in contrast with a sharp increase for India and the United Kingdom, while it remained relatively stable for the EU27 and the United States (Figure 8.D).

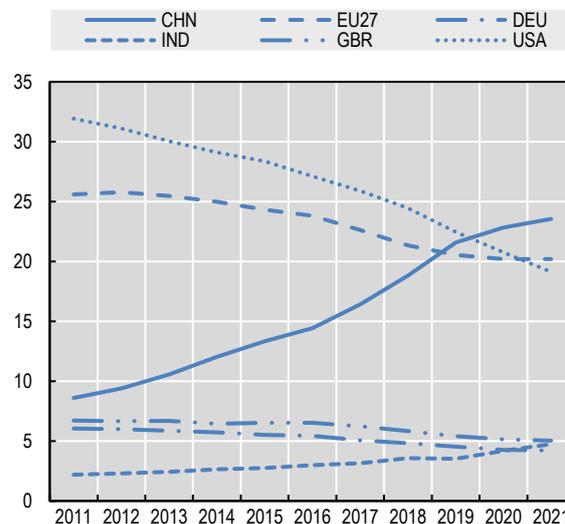
Figure 8. Major trends in scientific publishing and collaboration, 2011-21

A. Scientific publication output trends, major economies



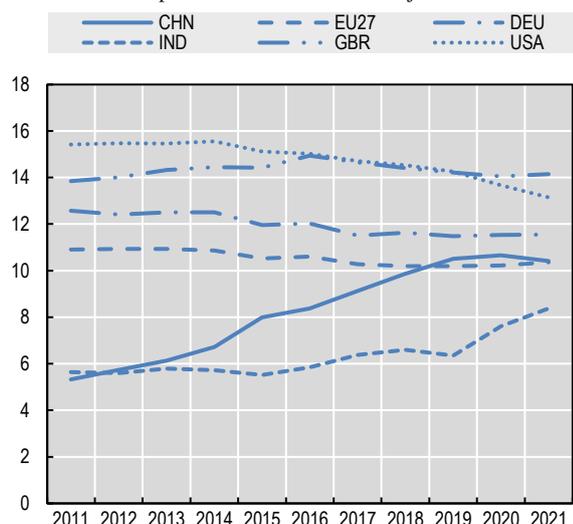
[Link to chart and data](#)

B. Distribution of global 10% top-cited publications, major economies



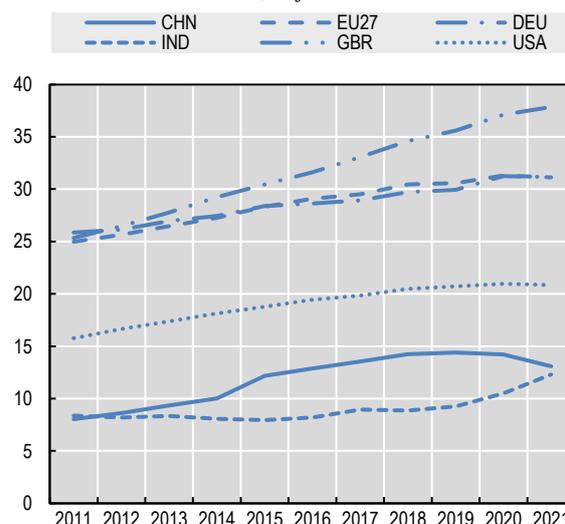
[Link to chart and data](#)

C. Rates of 10% top-cited documents within major economies



[Link to chart and data](#)

D. International collaboration rates, major economies



[Link to chart and data](#)

Source: OECD calculations based on Scopus Custom Data, Elsevier, Version 1.2023, March 2023; and Scimago Journal Rankings.

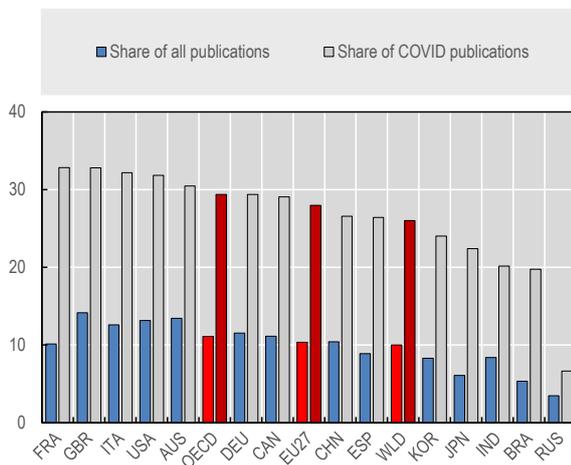
The COVID-19 pandemic transformed the scientific publication landscape

OECD estimates indicate that, globally, Scopus-indexed scientific publications on COVID-19 (as identified through selected key terms) rose from 1.9% of total publications in 2020 to 4% in 2021. Scientific publishing on COVID-19 was pervasive across most scientific domains, from the natural to the social sciences. Within science fields and countries, COVID-19 scientific publications are more likely to be highly cited than other publications (Figure 9.A). Worldwide, COVID-19 publications released in 2020 had a 36% chance to be among the world’s 10% most cited, significantly above the 10% global benchmark for all publications. In 2021, as the number and share of COVID-19 publications increased, this indicator of citation advantage declined but was still as high as 26% for the world, close to 30% for OECD.

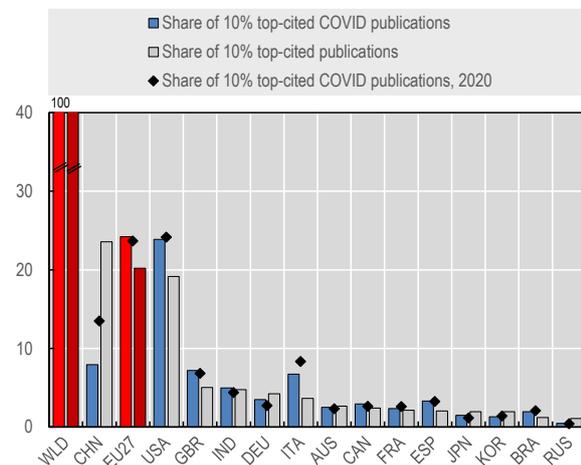
The largest contributing economies to top-cited COVID-19 publications in 2021 were the European Union and the United States, each with close to 24% of the total, followed by China and the United Kingdom, each with over 7% of the total (Figure 9.B). China’s share in 2021 significantly declined compared with 2020, when it accounted for the largest share of highly cited scientific output on COVID-19 at close to 13%. In the case of China, its highest cited scientific output is relatively less focused on COVID-19, while the opposite holds for the United States, the EU and the United Kingdom.

Figure 9. Distinctive COVID-19 scientific publishing and citation patterns, 2021

A. Percentage of scientific publications within economies among the world’s 10% top-cited – COVID-19 vs all publications compared, 2021



B. Distribution of 10% top-cited publications as percentage of world total 10% top-cited, COVID vs all publications, 2021



Note: Results based on ad hoc analysis looking specifically at COVID tagged documents. Panel A shows domestic documents in global 10% top-cited as a percentage of all domestic documents. Panel B shows 10% top-cited as a percentage of the world’s top-cited total. Source: OECD calculations based on Scopus Custom Data, Elsevier, Version 1.2023, March 2023.

The STI.Scoreboard and STI indicators

The OECD **STI.Scoreboard platform** (<http://www.oecd.org/sti/scoreboard.htm>) allows retrieving, visualising and downloading MSTI indicators alongside several other statistical indicators of science, technology and innovation (STI) systems across OECD countries and several other economies.

A selection of **OECD bibliometric indicators**, also released in March 2023, are available in the STI.Scoreboard. These comprise measures, at the level of national STI systems, of scientific publication output, volumes and rates of highly cited documents, international collaboration by institutional co-authorship, and implied scientist mobility from changes in authors’ institutional affiliations. Indicators are also available for selected fields. For more information on these indicators and complementary, more detailed sources, see the metadata accompanying the indicators on the STI.Scoreboard platform. See also <http://oe.cd/scientometrics>.

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