ISSN 2599-574X

2024

EU Industrial R&D Investment Scoreboard

Contact information
European Commission – Joint Research Centre
Directorate Fair and Sustainable Economy – Industrial Strategy, Skills & Technology Transfer
Edificio Expo; c/ Inca Garcilaso N° 3
E-41092 Seville (Spain)
Email: JRC-B6-SECRETARIAT@ec.europa.eu
Tel.: +34 661697398

EU Science Hub
https://joint-research-centre.ec.europa.eu

JRC140129

Print	ISBN 978-92-68-22426-7	ISSN 2599-5731	doi:10.2760/9892018	KJ-01-24-165-EN-C
PDF	ISBN 978-92-68-22425-0	ISSN 2599-574X	doi:10.2760/0775231	KJ-01-24-165-EN-N

Luxembourg: Publications Office of the European Union, 2024

How to cite this report: European Commission: Joint Research Centre, Nindl, E., Napolitano, L., Confraria, H., Rentocchini, F., Fako, P., Gavigan, J. and Tübke, A., *The 2024 EU Industrial R&D Investment Scoreboard,* Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/0775231, JRC140129.

Contents

Abstract

The 2024 edition of 'The EU Industrial R&D Investment Scoreboard' in its 21st year, continues to monitor and analyse industrial research and development (R&D) investment trends in the context of the EU's 3% of GDP R&D investment policy target, which is a key indicator of the EU's long-term competitiveness performance. As emphasised in the recent Draghi report, it is crucial for the EU to substantially increase private R&D investments in order to tackle the historical productivity gaps with respect to its main global competitors.

The 2024 Scoreboard analyses the world's top 2 000 industrial R&D investors, responsible for over 85% of R&D performed by the business sector globally, based on the financial information in the latest published audited accounts of firms. Following the introduction, Section 2 analyses the main global trends and benchmarks the EU's top R&D investing companies against global competitors. Section 3 provides details by sector, and Section 4 does a deep-dive on a subsample of the EU's top 800 R&D investing firms. Section 5 analyses R&D productivity in a long-term perspective and, combined with data on Mergers & Acquisitions (M&A), delves into corporate innovation strategies.

Foreword

I am delighted to present the 21st edition of the EU Industrial R&D Investment Scoreboard. This is a crucial tool to monitor industrial R&D investments in our pursuit of European competitiveness and prosperity. These investments are essential to achieving the EU's target of investing 3% of our GDP in R&D.

This year, EU-based companies have surpassed their global counterparts in R&D growth for the first time in over a decade, a testament to Europe's potential for innovation. While this is encouraging news, we need to sustain this momentum to improve our position globally as we trail the US and are closely followed by China in terms of business R&D investment.

This Scoreboard is a call for joint action. As we strive for a more competitive and sustainable Europe, we need to harness the transformative power of R&D investments in critical sectors such as energy, automotive, and information technology. To achieve this, we must create an environment that nurtures EU-based innovators, from startups to established leaders, by attracting and retaining top talent, improving the uptake of R&D, and focusing on strategic technologies.

We also need to mobilise more joint investments with EU Member States and industry, reduce fragmentation and boost Europe's innovative power. I urge policymakers, businesses and innovators to work together to build a more competitive Europe, which turns our strengths into results with a global impact.

I have no doubt that we can achieve this if we put R&D at the heart of our economy, and that by doing so we can deliver on our ambition of a sustainable, resilient, and prosperous Europe.

Ekaterina Zaharieva

European Commissioner for Startups, Research and Innovation

Acknowledgements

The 2024 EU Industrial R&D Investment Scoreboard has been published within the context of the Global Industrial Research & Innovation Analyses (GLORIA) project that is jointly carried out by the European Commission's Directorate General for Research and Innovation Directorate E – Prosperity, and the Joint Research Centre Directorate B - Fair and Sustainable Economy. GLORIA has received funding from the European Union's Horizon Europe research and innovation programme under a specific action for scientific and technical services by the Joint Research Centre (JRC) over the period 2022-2024. The main expected impact of GLORIA is the better understanding of corporate Research & Development (R&D) efforts in relation to the EU's long-term 3% of GDP R&D investment policy target and the EU policy objectives regarding competitiveness, the green deal and sustainability.

The GLORIA project is coordinated by Evgeni Evgeniev (Policy Officer, DG RTD.E1 'Industrial Research, Innovation and Investment Agendas') and Alexander Tübke (Team leader, JRC.B6 'Industrial Strategy, Skills & Technology Transfer') under the leadership of Doris Schröcker and Dominik Sobczak (respectively, Head and Deputy Head of Unit E1 'Industrial Research, Innovation & Investment Agendas', Directorate E, DG RTD) and Asunción Fernández-Carretero and Fernando Hervás (respectively, Head and Deputy Head of Unit B6 'Industrial Strategy, Skills & Technology Transfer').

This edition of the Scoreboard was produced by Elisabeth Nindl, Lorenzo Napolitano, Hugo Confraria, Francesco Rentocchini, Péter Fako, James Gavigan, and Alexander Tübke (JRC.B6 'Industrial Strategy, Skills & Technology Transfer') as the main authors. Dirk Czarnitzki (Katholieke Universiteit (KU) Leuven) drafted substantial sections of Chapter 5. Doris Schröcker, Dominik Sobczak, Evgeni Evgeniev, Constantin Belu, Alex Talacchi, Paolo Panjek, and Guillaume Milot (all from DG RTD.E1 'Industrial Research, Innovation and Investment Agendas') provided substantial comments, inputs and suggestions for improvement on earlier drafts and offered strategic advice related to the structure and policy orientation of the report.

The data underlying this report have been collected by Alberto Cáceres Guillén and his team from Alepro Data Analysis & Consulting.

We are grateful to María Márquez, Marta Rey Ruiz, Estrella Vaca Campayo and Miguel Querol (JRC Directorate B, Fair and Sustainable Economy) for the editorial and communication support; and to Martina Daly, Balint Peter Linder, Marietta Grammenou, and Panagiota Tsitsou (Directorate General for Research and Innovation) also for their support in the communication activities, as well as José Sánchez-Barahona Hermoso, Ricoardo Márquez and Beatriz Pavón for visuals assets. A special thanks goes to Anja Suurland (publication officer, JRC Directorate B, Fair and Sustainable Economy) for supporting the publication of the report.

Authors

Elisabeth Nindl, Lorenzo Napolitano, Hugo Confraria, Francesco Rentocchini, Péter Fako, James Gavigan, and Alexander Tübke.

Executive summary

Published every year since 2004, the EU Industrial Research & Development (R&D) Investment Scoreboard provides financial data and analysis of top global corporate R&D investors, paying specific attention to those with headquarters in the EU. The 2024 edition of the Scoreboard presents data on the top global 2 000 companies investing in R&D, and additional analysis of the top 800 EU-based companies investing in R&D. The global Scoreboard firms account for 85% to 90% of worldwide R&D funded by the business sector. After the introductory chapter, the report presents three chapters on the monitoring and analysis of private R&D investment at the global and EU level. A final chapter analyses trends in R&D productivity and mergers & acquisitions (M&A) activity of top R&D investors.

Policy context

This year's diagnosis of the EU's research & innovation (R&I) challenges remains largely unchanged from last year's Scoreboard (the twentieth anniversary edition). However, the challenges have increased in intensity and gained much more attention in EU policy discussions. Global competitive pressure is growing together with regional conflicts, while policies aimed at technological progress and competitiveness are increasingly used as strategic tools to attain global technological supremacy.

With the European Commissioner started its next 5-year term of office just a few weeks ago and is likely to announce key policy initiatives in its first shortly. Following the Draghi report, R&I policy is expected to feature strongly. Important long-term budgetary decisions also need be made in preparation for the next EU multiannual financial framework (MFF) beginning in 2028. The Draghi report urges the EU to take policy measures to regain global competitiveness and proposes a new competitiveness strategy requiring annual investment of EUR 750 to EUR 800 billion, mostly by the private sector. In line with prior EU R&I and industrial policies, the emphasis remains on strengthening competitive advantage in areas where the EU maintains leadership, as well as forging ahead in emerging technological areas with a strong research base and potential for synergies between industrial strategies and public policies. In addition, the Draghi report advocates directing both R&I efforts and industrial policies towards the same goals.

In the R&I policy context, achieving those goals will involve discussing how to combine different policy agendas (e.g. the European Research Area (ERA), Horizon Europe (HE) or state aid rules) with the European Competitiveness Fund, a Clean Industrial Deal and initiatives for a more circular and resilient economy; boosting productivity through digital tech diffusion; reducing regulatory burden; and making state aid rules more investment-friendly. In some areas, such as strategic technologies within the European security strategy, the coupling of European innovation and industrial policies has already been gaining speed.

Main findings

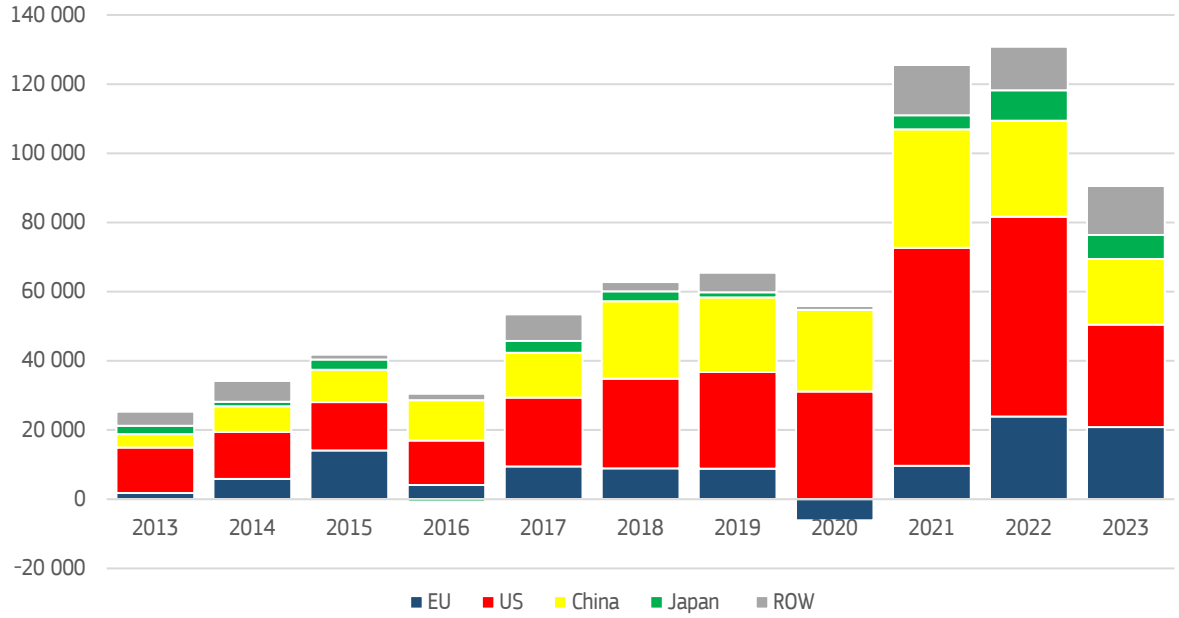
R&D investment continued to grow strongly in 2023, but not quite as vigorously

The **top 2 000 global companies invested a total of EUR 1257.7 billion in R&D in 2023**, **EUR 90.6 billion more than in 2022 (+7.8%)**. However, even that growth was weaker than the strong post-COVID growth spurt in 2021 and 2022 (+13.8% and +12.6% respectively). The US-based company Alphabet tops the ranking with EUR 40 billion, and the top EU company is once again Volkswagen – the only EU company in the top 10, ranking 5th with EUR 22 billion of R&D investment. The threshold for entering this year's Scoreboard at rank 2 000 is EUR 67 million.

Nominal R&D investment by the **322 Scoreboard companies with headquarter in the EU grew by 9.8%**, outpacing the 681 US companies (5.9%) for the second year in a row, and, for the first time, just ahead of the 524 Chinese companies (9.6%). Companies with headquarters in Japan (185 companies) and the rest of the world (ROW, 253 companies) increased their R&D investment by 7.1% and 9.1% respectively.

However, over the past 10 years, R&D investment by the EU Scoreboard companies has been growing more slowly than that of US and Chinese Scoreboard companies (Figure 1).

Figure 1. Break-down of annual R&D investment growth of top 2 000 companies across regions



Notes: The vertical axis displays the change in absolute nominal R&D investment by the 2 000 companies each year (in million euro).

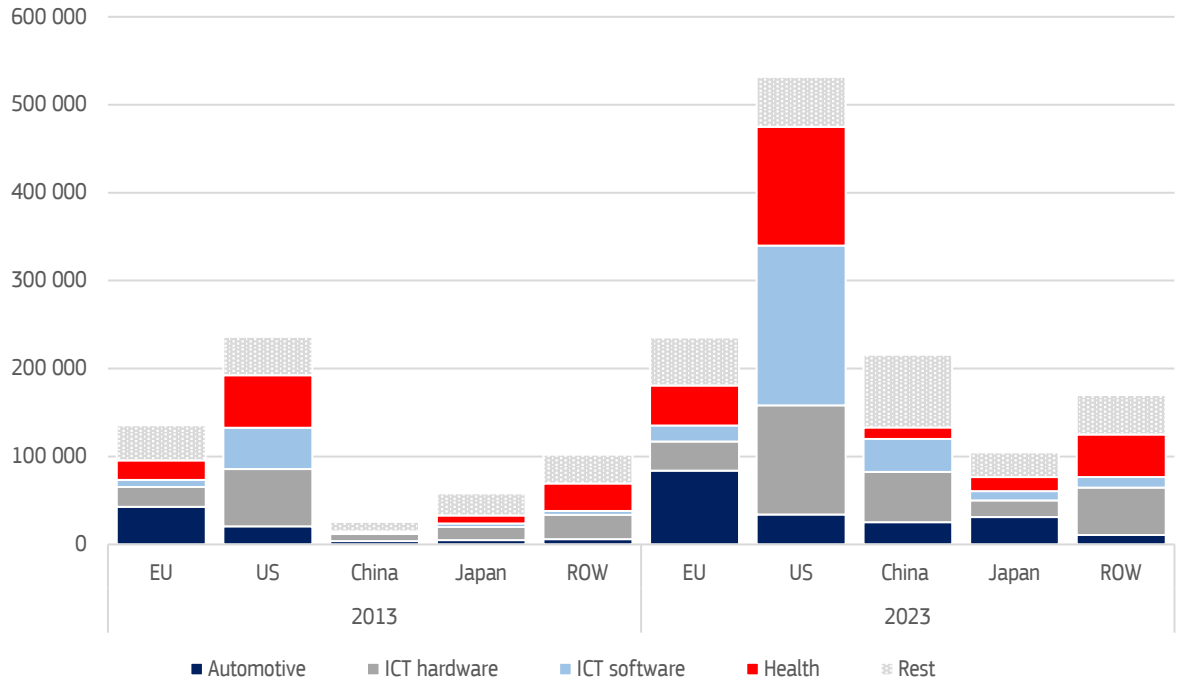
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The top 50 Scoreboard companies (22 US, 11 EU, 5 Chinese, 5 Japanese, and 7 in ROW) invested EUR 504 billion in 2023, which accounts for 40.1% of the total R&D investment by Scoreboard companies, while the top 10 account for 18.4%. This shows a **very high concentration of R&D investment in a relatively small number of companies**, which has persisted over the past two decades. However, the top 50 companies increased their R&D investment by much less than in the previous year (6.5% against 16.9%), and also by somewhat less than the +7.8% for the full set of 2 000 Scoreboard companies.

R&D investment by sector

As in the previous years, 4 sectors – **ICT hardware and software, health and automotive** – are responsible for more than three quarters of Scoreboard global R&D investment. **EU-based Scoreboard companies maintain global automotive R&D leadership,** US-based Scoreboard companies lead in ICT-related sectors and health, while Chinese Scoreboard companies have grown steadily across all sectors over the last 10 years. The main drivers of R&D growth were companies in ICT software, health, and to a lesser extent, ICT hardware. Between 2013 and 2022, the ICT software sector contributed between 27% and 49% of the total global annual increase in R&D; this contribution decreased to 14.7% in 2023. The health sector and ICT hardware contributed on average 21% to the annual increases. While the automotive sector plays an important role, it contributed less to the global dynamics, but stepped up its R&D investment considerably in 2022 and 2023 (Figure 2).

Figure 2. R&D top sectors – R&D investment across regions 2013 and 2023



Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

In the **EU, the automotive sector invests most in R&D** and twice as much as in 2013. In the US, in 2013, ICT hardware companies invested most in R&D, while in 2023, the **ICT software sector was the largest contributor to the aggregate,** leading global corporate R&D by a large margin. With EUR 181.6 billion in 2023, the **US software companies** invested about 10 times more than their EU-based counterparts, while in 2013 this factor was only 5.8. Also, **US health companies** have significantly increased investment since 2013 (by a factor of 2.3) and now spend more than the ICT hardware companies. In the health sector, EU companies rank third, closely behind the ROW companies. The **number of health companies from the EU remained almost unchanged between 2013 and 2023,** while the number of Chinese companies increased almost fivefold, Japan lost over a third of its health companies and the number of ROW companies increased. The **US automotive sector** plays a minor role and developed more moderately, but its R&D investment in 2023 exceeded that of the Japanese companies, while the opposite was the case in 2013. The share of **Scoreboard companies from China has almost tripled since 2013**, but their investment increased considerably faster than in the other regions and is now 8.4 times higher than a decade ago. **Chinese Scoreboard companies now invest more than their EU counterparts in ICT hardware and ICT software, while EU companies are still far ahead of China in health and automotive.**

In 2013, Japanese Scoreboard companies invested 55% of the amount invested by EU Scoreboard companies in R&D, but this proportion had decreased to 45% by 2023. The **automotive sector constitutes the largest sector investing in R&D in Japan**, but its average growth over the past decade is lower than that of the EU, China and ROW – only US automotive R&D investment growth was lower. **Japanese Scoreboard firms in the ICT software sector demonstrated strong performance** over the past decade and slightly reduced the gap with the EU (from 47% of EU companies' R&D in this sector to 57%).

A recent policy brief Joint Research Centre (JRC) analysed venture capital investment by a set of Scoreboard automotive companies (Section 2.2). **Corporate venture capital** (CVC) has become an important tool for **automotive firms** to tap into high-potential start up-driven innovation. The study analysed 1 191 venture capital deals by 25 automotive companies over the period 2010-2023. It revealed that CVC investment by the 5 EU automotive firms is on a par with the 20 other competitors based in other world regions and is mainly **directed at high-risk transformative innovation** (autonomous driving, sensor technologies, etc.). However, **US-based startups are the main beneficiaries of automotive CVC investment** by the companies related to or fully owned by the top 25 Scoreboard automotive mother companies. The EU, Japanese and ROW-based automotive firms invest more in US-based startups than in domestic ones.

EU top 800 companies

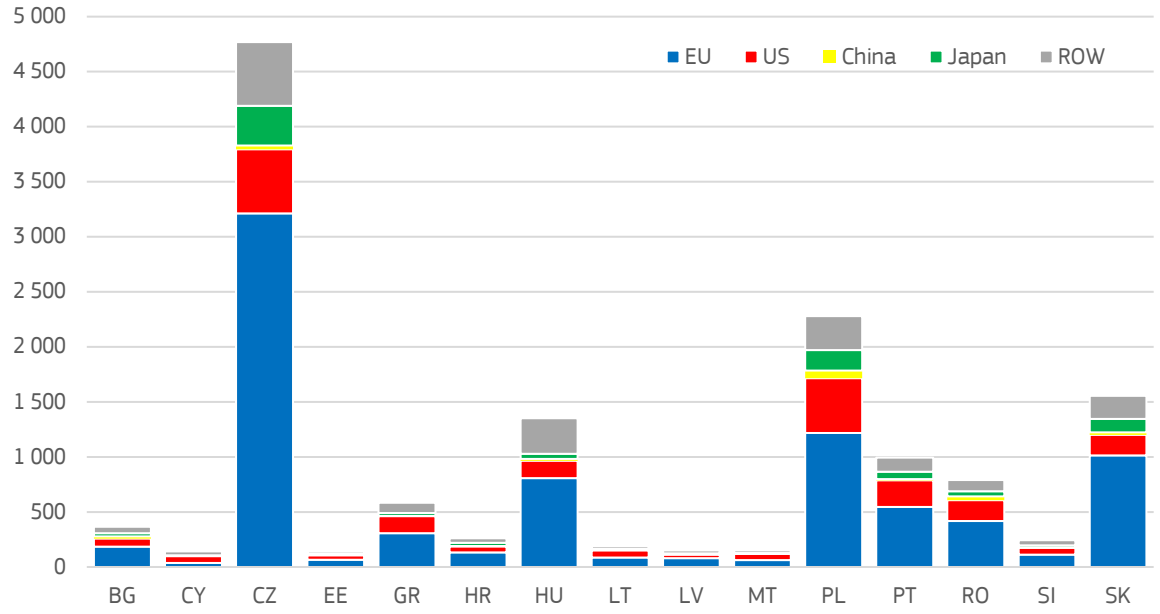
The Scoreboard also includes an extended sample of 800 EU-based companies with the aim of capturing smaller EU-based firms active in R&D. Of these 800 companies, 322 are also in the global top 2 000 companies; the 800 companies are located in 19 Member States and each of them declared R&D investment of EUR 7 million or more in 2023. Collectively, the **EU 800 companies invested EUR 247.7 billion in R&D in 2023 (+8.7%)**. Half of these companies, accounting for 73% of R&D investment, are based in Germany, France and the Netherlands. The **automotive sector has the largest share of EU 800 R&D investment** (34.2%), with the biggest companies in terms of R&D being Volkswagen, Mercedes-Benz, Stellantis and BMW.

Health accounts for the second largest share of EU 800 R&D (19.3%), followed by **ICT hardware** (14%) and **ICT software** (7.8%). These sectors contain EU firms that significantly increased their R&D investment over the last decade, signalling potential new areas of technological leadership. Examples of this are ASML (260% R&D growth over the past decade), NXP (251%) and Infineon (241%) in semiconductors; Forvia (484%) and ZF (215%) in automotive components; and Biontech (5 094%) in biotech/pharma. These changes indicate ongoing diversification in the EU, creating potential for future uptake of growth opportunities.

The 2024 Scoreboard finds that **EU-based companies own the most subsidiaries globally** (36%). US companies follow closely with 34.3% of subsidiaries. Japanese companies own 9.4% of subsidiaries, a lower share than in the past edition, while China has fallen from 9.1% of total subsidiaries last year to 6% this year. In fact, over 90% of subsidiaries are located in 20 countries (71% in the top 5 alone). While **only 4 of the top 2 000 Scoreboard firms have headquarters in one of the 15 EU 'widening countries'[1],** examining the ownership structure of the companies shows that 854 of them own subsidiaries in widening countries, which host close to 14 000 subsidiaries (3.7% of all subsidiaries). Most of these subsidiaries belong to EU-based companies and half of them are in Czechia (34.1%) and Poland (16.6%) – see Figure 3.

[1] https://rea.ec.europa.eu/horizon-europe-widening-who-should-apply_en

Figure 3. Scoreboard subsidiaries located in each widening country, by country of the mother company, 2023



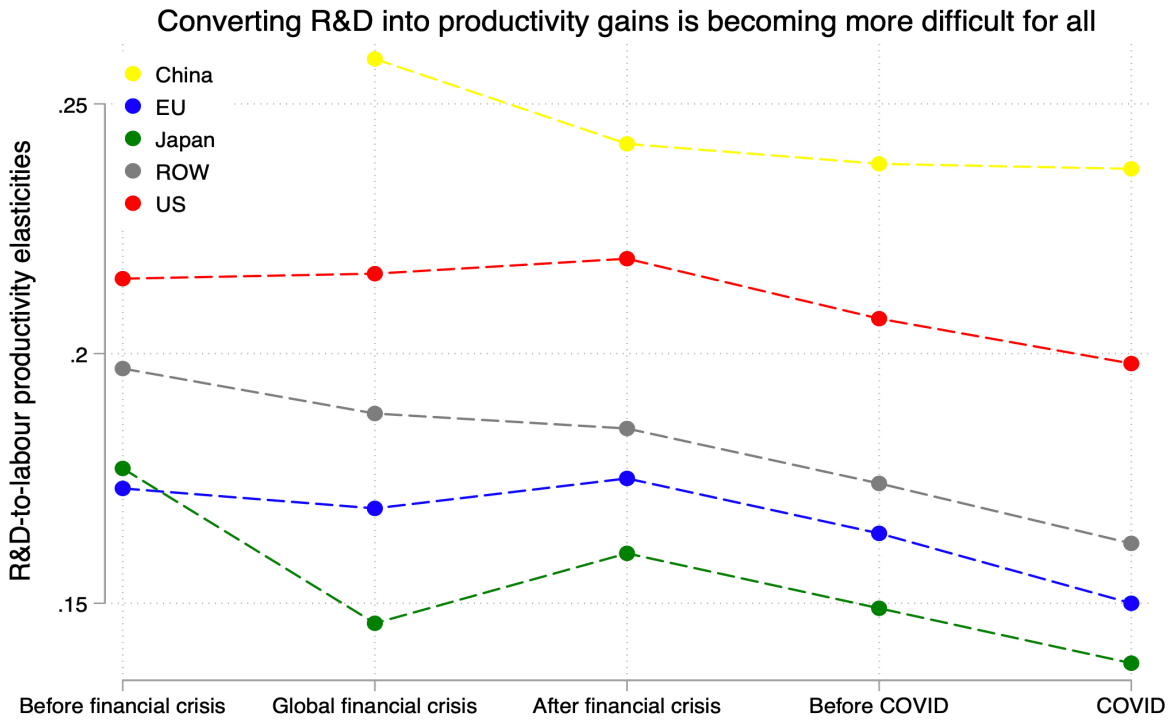
Notes: Data refers to the 854 companies for which data on subsidiaries located in widening countries are available.
Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Among the EU 800 companies, there are **99 SMEs** (firms with less than 250 employees), over two thirds of which are in the health sector. Most are based in Sweden (28.3%), France (27.3%), Denmark (10.1%), and Germany (7.1%). French SMEs account for the biggest R&D investment share with 34% of the total, followed by Sweden at 21.3% and the Netherlands at 16.6%. The SMEs account for 12.4% of the EU 800 companies and invested EUR 2.4 billion in R&D in 2023, a growth rate of 3.7% in nominal terms and -0.8% in real terms. However, this is significantly less than in the US, where 94 SMEs among the top 2 000 companies invested EUR 10.6 billion in R&D in 2023.

R&D productivity and M&A activity of top R&D investors in the EU

A deeper analysis of R&D productivity trends based on a panel of Scoreboard firms reveals that **R&D investment growth has by far outpaced both labour productivity and patent growth**. Although R&D still contributes positively to labour productivity and patenting, the econometric analysis indicates a global trend of diminishing returns on R&D investment for top R&D investors, suggesting that **more and more R&D investment is required** today than in the past in order **to generate marketable products or new ideas** (Figure 4). Even though we find that increases in labour productivity and patents are becoming harder for companies in all regions, EU and US-based Scoreboard firms have seen particularly sharp declines in the number of patents relative to R&D (R&D-to-patent productivity). Japanese, ROW and EU-based Scoreboard firms have also experienced more pronounced drops in labour productivity relative to R&D (R&D-to-labour productivity) over the past decade. These trends suggest that EU-based Scoreboard firms have not only experienced lower R&D productivity levels (in terms of generating new ideas and sales), but are also not catching up with firms from regions that exhibit higher R&D productivity rates, potentially putting them at a competitive disadvantage. This suggests that merely pushing for more R&D investment by the EU private sector is insufficient as a policy measure on its own. Improving R&D routines/processes, attracting and retaining top R&D talent, and crafting highly effective policy instruments to steer R&D incentives towards impactful innovations are also needed.

Figure 4. Estimated R&D-to-labour productivity elasticities across regions and time



Notes: The numbers are estimated R&D-to-labour productivity elasticities. All coefficient estimates of the R&D variables are statistically significant at the 5% level. F-tests on coefficient differences within each region across time show that the visible downward trends are also statistically significant at the 5% level, except for China. Further F-tests reveal that the visible differences between regions are statistically significant in each period except the first one. They should be interpreted as follows: if EU firms would have increased their R&D by 100%, i.e. doubled their investment in the period before COVID-19 they would have got 16% more labour productivity. For China, the relative change in elasticities is calculated from 2008 to 2022 because of a lack of data in the first period.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Examining mergers & acquisitions (M&A) activity of Scoreboard companies and their impact on a range of competitiveness indicators at the company level, it appears that **companies engaging in M&A consistently report higher metrics** across all these indicators (employment, sales, profits, R&D, capital expenditure). M&A-active companies are generally more established, larger in scale, and demonstrate greater intensity in both R&D and capital expenditure than those that are not active in M&A. Moreover, these companies tend to be more profitable, adding to their competitive edge.

Regression results show that, while M&A might drive immediate growth, it does not necessarily bolster productivity overall. However, the **positive link between R&D investment and productivity measures**, specifically labour and total factor productivity, is very clear in aerospace & defence, construction, and ICT software sectors. Geographically, the trend is most apparent among Chinese and US companies, indicating that, in these regions, investment in R&D is effectively translating into more productive operations. This underscores the importance of R&D as a key driver of competitive advantage and productivity, particularly in sectors and regions that are innovation-focused.

Related and future JRC work

As the Commission's science-to-policy service, the JRC will continue to lead activities in support of innovation and industrial policies. These are organised in thematic portfolios in the JRC work programme for 2025-2027 under heading 10 'Drivers of Competitiveness' and 11 'Strategic Technologies'. The 'Conferences on Corporate R&D and Innovation (CONCORDi)' are held every 2 years

at the JRC in Seville to provide an open in-person discussion forum for 250 key stakeholders. The 10th CONCORDi conference is planned for 24-26 September 2025[2].

Quick guide

This report is structured as follows.

Chapter 1: introduction.

Chapter 2 analyses the global 2 000 top firms' R&D investment trends.

Chapter 3 describes the main global R&D trends of the top 2 000 firms by sector.

Chapter 4 focusses on the sample of the top EU-headquartered 800 R&D investing firms.

Chapter 5 analyses the longer-term R&D productivity trends of Scoreboard firms and their M&A activities.

[2] https://iri.jrc.ec.europa.eu/

1 Introduction

The EU Industrial R&D Investment Scoreboard provides economic and financial data and analysis on the top corporate R&D investors from the EU and beyond. It is based on data extracted directly from each company's latest publicly available financial accounts. Since 2004, the Scoreboard has been published annually to monitor and analyse the state of overall corporate research and innovation activity in Europe, particularly in relation to the R&D investment target of 3% of GDP, which remains central to the EU's long-term competitiveness agenda.[3] As pointed out in the recent Draghi report, the effective mobilisation of investments is urgent to close the persistent innovation gaps to main competitors.

The Scoreboard is a reliable, up-to-date benchmarking tool for comparing companies, sectors and geographical areas, as well as for monitoring and analysing emerging investment trends and patterns[4]. In line with the Commission's open science practice[5], the Scoreboard dataset is made publicly available to raise awareness, encourage firms to disclose and increase R&D, and foster its use by the scientific community.[6]

The 2024 EU Industrial R&D Investment Scoreboard provides economic and financial information based on the most recent audited balance sheets of the world's top 2 000 R&D investors, which are responsible for over 85% of R&D carried out by the business sector. It benchmarks companies headquartered in the EU against those in the US, China, Japan and the rest of the world (ROW) through 2023 data, and follows corporate R&D dynamics over the past decade. The Scoreboard also contains a special focus on the top 800 EU-based R&D investing companies. Due to a novel data collection approach in 2024, the number of firms included in this year's Scoreboard is lower than in previous editions.[7] However, the sample size is expected to increase again to the usual level in future editions.

1.1 Setting the scene: the economic context

As 2025 approaches, across the world, geopolitical, economic and trade uncertainties continue to abound. New administrations will take office on both sides of the EU-US transatlantic relationship, while global repercussions from COVID-19, supply chain disruptions and financial market volatilities still remain. In the meantime, compared to this time last year, the overall global economic situation is more positive. Global growth is expected to stabilise at 3.2% in both 2024 and 2025.[8] Inflation has dropped and is close to national targets in most of the OECD as food price inflation comes down and energy and goods price inflation is low or negative. Service price inflation, however, is only coming down slowly. The Autumn 2024 European Economic Forecast[9] predicts that the EU economy is

---

3 Long-term competitiveness of the EU: Looking beyond 2030, COM(2023) 168 final.

4 Examples of 2024 flagship reports: The future of European competitiveness – A competitiveness strategy for Europe (Draghi report), and Science, Research and Innovation Performance of the EU (SRIP) report

5 https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/open-science_en

6 See, https://iri.jrc.ec.europa.eu/data

7 The previous Scoreboards' sample size was 2 500 global and 1 000 EU-based firms.

8 IMF World Economic Outlook, October 2024: Policy Pivot, Rising Threats

9 https://economy-finance.ec.europa.eu/economic-forecast-and-surveys/economic-forecasts/autumn-2024-economic-forecast-gradual-rebound-adverse-environment_en#documents

resuming growth at a subdued pace, with real GDP growth in 2024 forecasted to be 0.9%. Growth in the EU is expected to pick up to 1.5% in 2025 and to 1.8% in 2026, driven by increased consumption. The disinflation process is expected to continue, with headline inflation in the EU falling to 2.6%, from 6.4% in 2023, and expected to continue easing to 2.4% in 2025 and 2.0% in 2026.

1.2 Setting the scene: the policy context

While the economic context might seem a bit more favourable compared to a year ago, the diagnosis of strengths, weaknesses and prospective challenges facing industrial research and innovation in EU firms compared to their global competitors has not changed much.

As the EU institutions transition to the next political cycle (2024-2029), industrial innovation-based competitiveness takes centre-stage as reflected in the Political Guidelines for the next European Commission[10]. A new plan for Europe's sustainable prosperity and competitiveness will advance in the following areas: make business easier and deepen the Single Market, build a Clean Industrial Deal to decarbonise the industry and bring down energy prices, put research and innovation at the heart of the economy; boost productivity with digital tech diffusion, invest massively in sustainable competitiveness, and tackle the skills and labour gap. Moreover, the landmark Letta[11] and Draghi[12] reports are further inspiring the discussion on EU industrial and competitiveness policy. These reports underscore the need to make the EU more innovative by addressing structural issues. They point to technology as the most important factor to boost productivity, especially via high-growth technology sectors. The Draghi report identifies 10 macro sectors[13] and their green, digital and security challenges, and calls for more coherent industrial and trade policies, tailored to the specificities of these strategic sectors.

The EU has already undertaken targeted actions to safeguard competitiveness in specific technologies[14]. However, it remains necessary to put urgently in place concrete actions for strategic technologies, increase private investment, address technological vulnerabilities/autonomy, and make the Green Deal a business opportunity supported by the Clean Industrial Deal for competitive industries and quality jobs, which will be delivered in the first 100 days of the Commission's mandate. And different policies are necessary for established and emerging areas of technologies. The EU has a strong research base in many interesting emerging areas with strong potential for the coupling of industrial strategies and public policies, e.g. greening, deeptech, critical raw materials, aerospace and others.

The Scoreboard shows that, on aggregate, global innovation gaps remain. Stopping the decline and imparting positive momentum is difficult and takes a long time, as experience has shown over the decades since the target of 3% of GDP for R&D investment in the EU was adopted. And it is not merely a question of failure to make use of excellent world-leading technological research. Industrial policies have become increasingly a strategic instrument of many countries and are combined with

---

10 https://commission.europa.eu/document/download/e6cd4328-673c-4e7a-8683-f63ffb2cf648_en?filename=Political%20Guidelines%202024-2029_EN.pdf

11 https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf

12 https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en

13 Energy, CRM, Digitalisation, Advanced tech, Energy intensive Industries, Clean/Net-zero tech, Automobile, Defence, Space, Pharma, Transport

14 e.g. the Chips Act, Net Zero Industry Act (NZIA), Critical Raw Materials Act (CRMA), Temporary Crisis and Transition Framework for State Aid, STEP instrument and sectoral strategies for pharmaceuticals, security, defence, biotech, etc.

trade measures. For example, the US manufacturing partnerships or the Made in China industrial policies, which are used in practice with their respective trade policy instruments. This means the policy context is shifting more and more towards countries using a full toolbox of instruments across policy areas that were formerly regarded as separate domains.

In this context, large firms such as those monitored in the Scoreboard play a key role not only for direct R&D investment, but more so as global actors that are active in different world regions. They search for market access in different countries, ensure on-site production, own technologies, participate in large innovation supply chains, exchange research knowledge, stimulate local ecosystems and allow smaller firms to grow and internationalise via collaboration. These firms can become key targets for innovation and industrial policies if they are working towards the same goals and objectives.

Looking ahead to the new European Commission, a number of initiatives which President von der Leyen has flagged in the Political Guidelines and her mission letters to some of the new Commissioners and which will impinge upon industrial R&D activities in one way or another are worth pointing out:

- A new **European Innovation Act** is proposed to help innovation uptake. This is expected to streamline the regulatory framework to reduce administrative burden and to expand the use of regulatory sandboxes to enable testing of innovative technologies in real-life conditions. It will facilitate access to venture capital for European innovative startups and scale-ups and help smaller firms introduce new solutions and technologies to the market (e.g. via public procurement). Moreover, the new Commissioner for startups, research and innovation will develop an EU Startup and Scale-up Strategy that improves the framework conditions for these companies. This will go together with an expanded European Innovation Council (EIC) which will promote disruptive innovation in strategic fields and create an EU network of trusted investors to foster co-investments with the EIC Fund to grow deeptech startups.
- A **European Competitiveness Fund** will be developed as part of a proposal for a new and reinforced budget in the EU's next multiannual financial framework. This will invest in strategic technologies – from AI to space, clean tech to biotech – to support the development and production of strategic technologies in Europe.
- As part of the Green Deal, a **Clean Industrial Deal** will aim to unlock investment and create lead markets for clean tech and put in place conditions for companies to grow and compete. It will include a **Circular Economy Act** to create markets for secondary materials and waste notably for critical raw materials.
- A new **European Research Area Act** will aim to guarantee the free movement of researchers, scientific knowledge and technology as well as reducing fragmentation of research efforts and accelerate market and societal uptake of R&I results.
- An **Advanced Materials Act** will be drafted to support research and innovation down to manufacturing and deployment.
- A new **Strategy for European Life Sciences** and a new **EU Biotech Act** will aim at unlocking high-value technologies that support the digital and green transition of the society and economy.
- A new **European Strategy for Research and Technology Infrastructures** will be developed, with a particular focus on improving the support for technology development, scale-up and validation to facilitate and accelerate the innovation activities of companies in the EU.

— An **Apply AI Strategy** will be set up and will be followed by a European AI in Science strategy to accelerate uptake for faster scientific discoveries and breakthroughs. Both strategies will pave the way for setting up a European AI Research Council. Access for industry to supercomputers through the AI Factories initiative will be ensured in the Commission's first 100 days.

— To boost high-performance computing and quantum tech, an **EU Cloud and AI Development Act** will be proposed and a long-term quantum chips plan developed following the Chips Act.

— A **white paper on the future of European defence** should be presented within the first 100 days to address defence sector capability issues, industrial competitiveness and investment need.

2 Global R&D investment in 2023 and dynamics

This Chapter provides an overview of the development of the top 2 000 R&D investing companies worldwide. The data collection process has been modified for this edition of the Scoreboard (see Annex 2 for details on the data collection process). The new process came with some trade-offs, which warranted a certain caution in determining the ranking for this year's edition and has resulted in a temporarily reduced sample size.[15] It becomes progressively more difficult to select candidates for the R&D ranking as we approach the bottom of the ranking – in other words, assessing which company is the top R&D investor is easier than determining the 100th, which is easier than choosing the 1 000th. For this reason, the sample size for this edition decreased temporarily from 2 500 to 2 000 global companies (and from 1 000 to 800 EU companies), but is expected to increase in the coming editions. The underlying data is qualitatively unchanged and the current dataset is fully linked to the past. To correctly take into account the smaller sample, we adjusted all comparisons over time to the new sample size of 2 000 companies. As the properties of the reduced sample in terms of distribution of firms and R&D across regions and sectors remain the same as in the larger sample of 2 500 companies, the central insights and conclusions remain unchanged.

The Chapter is structured as follows: Section 2.1 provides an overview of global R&D investment and dynamics, Section 2.2 examines the changes in R&D investment across regions and sectors. Section 2.3 focuses on the firm level and presents the technologies under development by the top 10 contributors to R&D investment growth. Section 2.4 describes key performance indicators of the top R&D investors, and Section 2.5 investigates the subsidiary structure of the Scoreboard companies. Furthermore, the chapter includes two boxes – the first provides an estimate of Amazon's R&D investment, while the second presents insights on corporate venture capital (CVC) investments by automotive corporates. The Section concludes with key points in 2.6.

2.1 2023 R&D investment across countries/regions

The top 2 000 global companies invested a total of EUR 1257.7 billion in R&D in 2023[16], representing an absolute increase of EUR 90.6 billion compared to 2022 (+7.8%).[17] After the strong expansion in 2021 and 2022 with 13.8% and 12.6% globally, the increase in corporate R&D investment slowed down in 2023, but continued to grow at a higher rate than the compound average growth rate since 2013 (7.4%). The growth rate of nominal R&D investment by EU-headquartered Scoreboard companies amounted to 9.8%, well above the US (5.9%), and, for the first time, also slightly higher than China (9.6%). Companies headquartered in Japan and the ROW raised their R&D investment by

---

[15] The sample of firms covered in the Scoreboard varied over time: In the first Scoreboard in 2004 the sample was 500 EU and 500 non-EU companies, in 2005 it expanded to 700 EU and 700 non-EU companies, from 2006 to 2011 it covered 1 000 EU and 1 000 non-EU companies, in 2012 the non-EU sample increased to 1 500 companies, in 2013 it expanded to 2 000 non-EU, and the 2014-2023 Scoreboards covered 2 500 non-EU plus 1 000 EU companies.

[16] The Scoreboard is based on information from the companies' latest published accounts. For most companies, this corresponds to the calendar year 2023. However a significant number of companies' financial years ended on 3 March 2024, in particular for Japanese and UK firms. Few companies have financial years that ended as late as end of June 2024. A small number had accounts available only up to the end of 2022. Therefore, we refer to the data of the last available year as 2023/24 and to the previous year as 2022/23, etc. For reasons of clarity, we refer to the last year as 2023, the previous year as 2022, etc.

[17] The Scoreboard expresses all monetary values at one common exchange rate – in this case the 2023 end-of-year exchange rates to Euro. With this transformation, the 2022 R&D investment is EUR 1 116.7 billion and not EUR 1.215.4 billion when measured at 2022 exchange rates (depreciation of the US Dollar by 3%, the Chinese Renminbi/Yuan by 7.3% and the Japanese Yen by 16.3%).

7.1% and 9.1%, respectively. The minimum R&D investment to enter the Scoreboard for the international ranking this year – i.e. the amount invested in R&D by the company ranked 2 000th – was EUR 67 million. Table 1 gives an overview of the Scoreboard companies by headquarters country in terms of the number of companies and the R&D investment (in nominal terms) for the year 2023. In total, the Scoreboard features companies from 40 countries (41 countries in 2022).

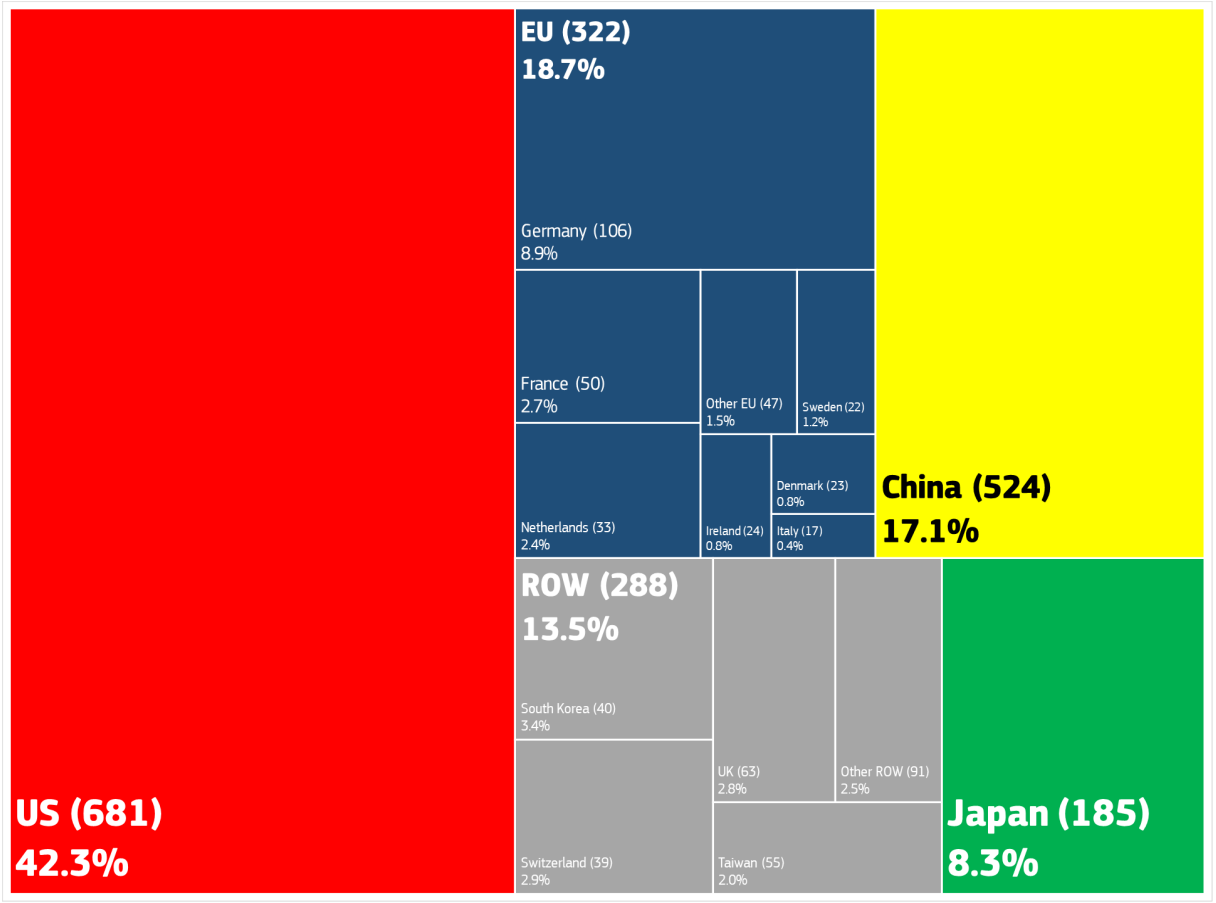
Table 1. Countries: R&D investment and number of companies, 2023

EU countries	Companies in 2023	R&D (EUR bn)	Non-EU countries	Companies in 2023	R&D (EUR bn)
Germany	106 (95)	119.2	**US**	681 (686)	531.8
France	50 (49)	33.7	**China**	524 (507)	215.8
Netherlands	33 (33)	29.8	**Japan**	185 (188)	104.8
Sweden	22 (20)	15.3	**Switzerland**	39 (39)	36.2
Ireland	24 (24)	10.4	**South Korea**	40 (40)	42.5
Denmark	23 (22)	9.8	**UK**	63 (70)	35.4
Finland	9 (9)	5.4	**Taiwan**	55 (61)	24.7
Italy	17 (16)	5.4	**India**	15 (17)	5.5
Spain	11 (11)	5.6	**Canada**	24 (23)	8.2
Belgium	9 (10)	3.2	**Israel**	19 (19)	3.7
Austria	11 (10)	1.9	**Australia**	7 (9)	4.2
Luxembourg	3 (4)	1.9	**Singapore**	8 (7)	2.7
Portugal	1 (1)	0.2	**Brazil**	4 (4)	1.7
Hungary	1 (1)	0.2	**Norway**	2 (2)	0.8
Slovenia	1 (1)	0.2	**New Zealand**	3 (3)	0.4
Malta	1 (1)	0.1	**8 other countries**	8 (8)	2.1
Total EU	**322 (308)**	**235.2**	**Non-EU Total**	**1 678 (1 692)**	**1 022.4**

Note: Figures in brackets show the number of companies in the 2023 edition of the Scoreboard.
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The US is host to the highest number of Scoreboard companies (34.1%), followed by China (26.2%), the EU (16.1%) and Japan (9.3%). The remaining 14.4% are headquartered in countries grouped into the ROW aggregate (including the UK with 3.2% of Scoreboard companies, Taiwan with 2.8%, South Korea with 2%, and Canada with 1.2%). Compared to the previous year, the number of EU firms among the top 2 000 R&D investors increased by 14 (11 of which are based in Germany), the US number reduced by 5, China's increased by 17, and Japan's reduced by 3. Within the ROW group – which contains 23 less companies from 12 countries compared to 2022 – the number for the UK and Taiwan reduced by 6 each, and Australia by 2. Figure 5 shows the number of firms per region/country and the corresponding share in total R&D investment in 2023.

Figure 5. Distribution of companies and R&D investment across regions, 2023



Notes: Figures in brackets show the number of companies per region/country; the percentage share refers to the regions'/country's share in total Scoreboard R&D.

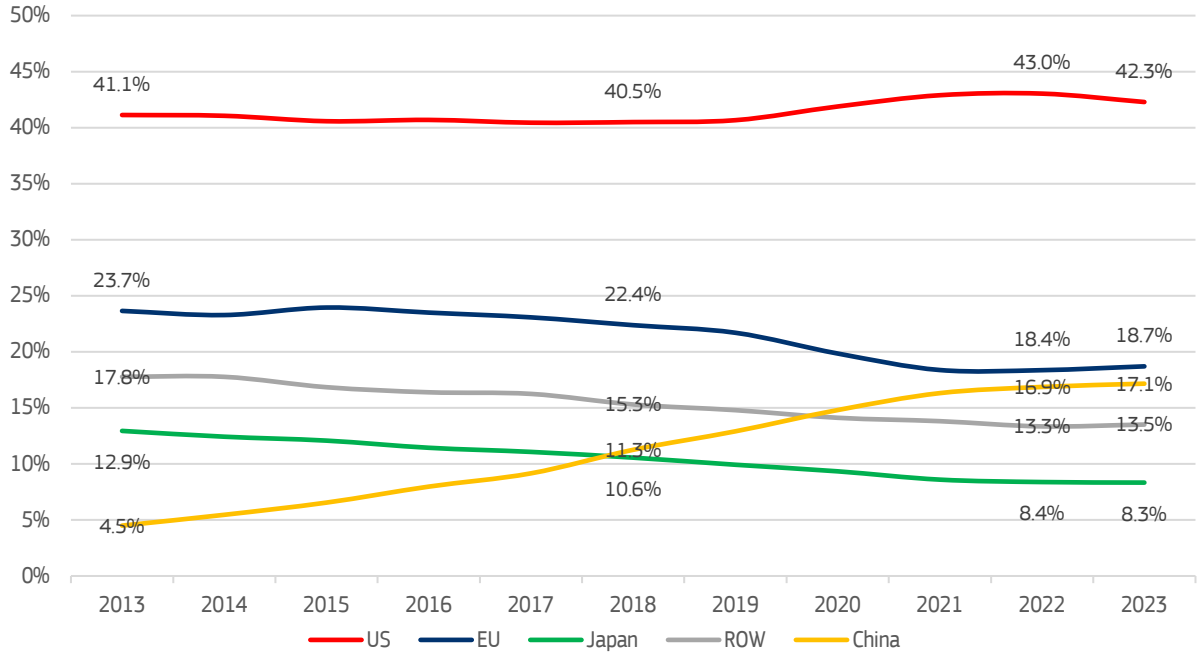
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Figure 6 shows the distribution of nominal R&D investment in euro for each year across the 5 major countries/regions. US companies consistently represent over 40% of total R&D investment, and since the COVID-19 crisis, US companies have even been able to increase their share of the total to over 42%, driven mainly by large R&D investments by companies operating in the ICT and health sectors. EU-headquartered companies accounted for 18.7% of total R&D investment in 2023, slightly up compared to 2021 and 2022, stopping the previous downward trend. The rising EU share relates to strong increases in R&D investment by EU automotive companies that account for 36.5% of the EU's total. Chinese companies continued their upward trend, but at a slower pace than in the past. The R&D investment shares of Japan and ROW remained almost unchanged compared to 2022 at 8.3% and 13.6%.

When interpreting the findings presented in Figure 6, it is important to recognise a limitation associated with changes in the data collection methodology (top 2 000 companies against the top 2 500 from previous editions). This methodological shift had a disproportionate impact on the distribution of R&D investment across regions because EU companies are more prevalent at the higher end of the ranking, while Chinese firms are more numerous at the lower end (see Figure 12 for further insights). As a result, the apparent increase in the EU's share of total R&D investment in the 2024 Scoreboard, compared to the 2023 edition, is partly attributed to this change in data collection scope rather than a substantive shift in investment patterns. Consequently, the small lead of EU companies over Chinese counterparts should be interpreted with caution, as a more extensive

sample would reverse this pattern, as the total potential for R&D investing companies is clearly much larger in China than in the EU due to the sheer size of the Chinese economy.

Figure 6. Top 2 000 R&D investment shares by region/country, 2013-2023



Note: Figures show the share of total nominal R&D investment per year and region, calculated at 2023 exchange rates to the euro.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

State ownership in the Scoreboard

The global ultimate owner of a Scoreboard company is usually the company itself, another corporation (if the mother company is not included in the Scoreboard, or if the companies produce individual accounts), a private person, or a government (see Appendix 1). The global ultimate owner of a company is defined as the entity holding at least 50.01% of shares in the company.

In 2023, 103 Scoreboard companies were owned by a government (state). State ownership is most prevalent in China, with 85 companies (of which 14 are central state-owned enterprises (SOEs)), followed by 10 ROW companies (Saudi Arabia and Abu Dhabi), 6 in the EU, 2 in the US (however, these are companies owned by foreign governments but registered in the US) and none in Japan.

In total, R&D investment by companies that are controlled by states amounted to EUR 66 billion, which corresponds to 5.3% of the total for 2023. However, there are important region- and sector-specific differences. In China, SOEs were responsible for 26.9%[18] (EUR 58 billion) of total R&D investment, while for the ROW it was 3.5% (EUR 5.9 billion). In the EU and the US, the share of SOE R&D is well below 1% (EUR 1.9 billion and EUR 1.1 billion, respectively). If we recalculate the distribution of R&D across countries and consider only non-state-owned companies, the US share would increase to 44.6%, the EU's share would rise to 19.6%, while China, with 13.3%, would then fall behind the ROW with 13.8%, and the share of Japan would rise to 8.8%.

[18] The R&D share of Chinese SOEs is in line with upper estimates of their share in Chinese GDP (see SWD(2024)91).

SOEs are most prevalent in (strategic) upstream sectors that often have high entry barriers, such as energy (with 24 of the 63 companies being owned by governments), construction (14 out of 58), aerospace & defence (5 out of 38) and industrials (26 out of 219), while in all other sectors, and in particular the high-tech sectors ICT hardware, ICT software and health, the share of SOEs is negligible.

Table 2. State-owned companies & R&D investment in the Scoreboard per sector, 2023

	State-owned companies	of which China	Share state-owned companies*	R&D by state-owned companies	Share R&D by state-owned companies*	of which China
Aerospace & Defence	5	4	13.2%	825	4.0%	87.4%
Automotive	10	9	6.5%	8 229	4.4%	89.6%
Chemicals	8	5	8.9%	2 651	10.7%	18.4%
Construction & Materials	14	13	24.1%	22 627	68.7%	99.7%
Energy	24	16	38.1%	12 118	51.0%	61.7%
Financial	1	0	2.0%	335	1.5%	0.0%
Health	3	3	0.7%	483	0.2%	100.0%
ICT hardware	8	7	2.1%	2 886	1.0%	90.3%
ICT software	4	4	1.3%	4 583	1.8%	100.0%
Industrials	26	24	11.9%	12 210	20.8%	96.9%
Total	**103**	**85**	**5.2%**	**66 954**	**5.3%**	**86.7%**

Notes: R&D in EUR million. The sector group 'others' does not contain any state-owned firms. *the shares refer to all companies/R&D in the respective sector.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I

Table 2 summarises the SOEs per sector and the R&D investment associated with them, and presents China's share in each of these sectors. China is responsible for almost 87% of R&D from SOEs, with the largest (absolute) investments in construction & materials, industrials and energy, as well as automotive. Moreover, 10 of the Chinese SOEs rank among the top 100 R&D investing companies in the Scoreboard, with the highest ranked 36. In China, SOEs play a crucial role in the implementation of national industrial policies, and the Chinese government has the clear intention of making a group of innovative SOEs into local and global market leaders.[19]

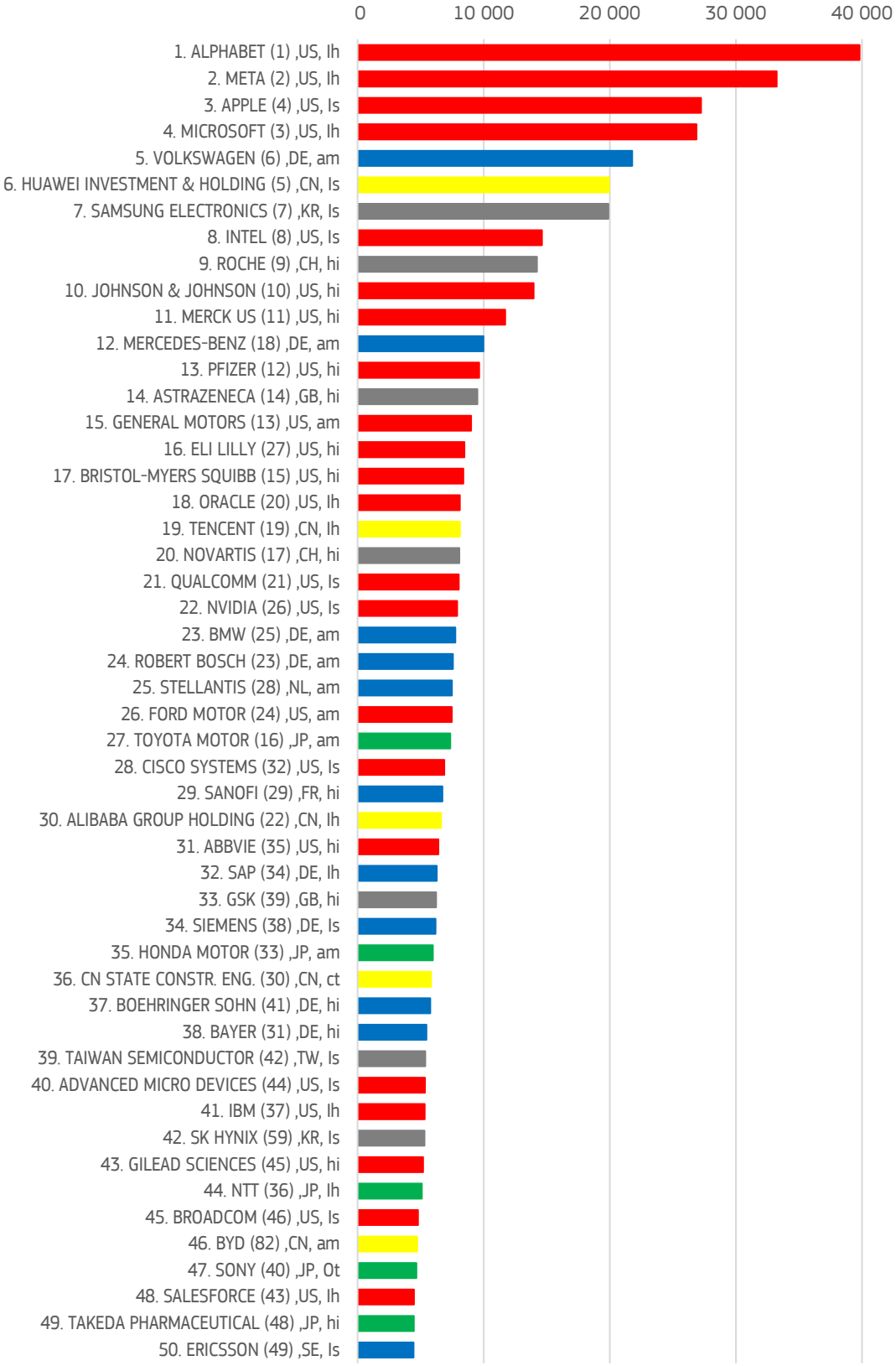
2.2 Top R&D investors – company level analysis

This Section presents changes in the number of companies and in the amount of R&D investment in 2023. It has a regional geographical perspective and a sectoral focus, centred on ICT hardware, ICT software, health, and automotive industries. It describes the dynamics at play in the ranking by assessing the changes involving the subset of companies recorded in the first 2 000 positions of both the 2023 and 2024 Scoreboard rankings, and considering the entries to and exits from the ranking.

[19] For a recent in-depth discussion about SOEs in China, their governance, and their role in pursuing industrial policy and economic goals see SWD(2024)91 https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2024)91&lang=en

2.2.1 The top 50 companies

Figure 7. Top 50 R&D investors in the 2024 Scoreboard



Notes: 2023 Scoreboard ranking in brackets, R&D in EUR million (colours: blue=EU, red=US, yellow=China, green=Japan, grey=ROW), Ih=ICT hardware, Is=ICT software, am=automotive, hi=health industries, ct=constructions, Ot=others

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I

The global top 50 R&D investing companies invested EUR 503.7 billion in 2023, which accounts for 40.1% of the total Scoreboard R&D investment, a one percentage point increase in the share of total R&D investment compared to 2022. US-based companies continue to lead the ranking: 6 out of the top 10, and 22 out of the top 50 companies are headquartered in the US – 13 of them are ICT companies and 7 are in health. EU companies are the second most numerous (11 companies) in the top 50, but occupy lower ranks than their US counterparts, and Volkswagen remains the only EU company in the top 10. With 5 companies each, Japan and China's presence in the top 50 is more moderate, Huawei (ranked 6th) and Toyota (ranked 27th) are their highest ranked companies (Figure 7). Compared to the 2023 Scoreboard, the number of EU and US companies in the top 50 decreased by one each, Chinese and ROW each increased by one, and the number of Japanese companies remained unchanged.

The growth rate of R&D investment in the top 10 was 7.5%, and 6.5% in the top 50 companies in the 2024 Scoreboard compared with that of the previous year (Table 3) – the growth rates for both groups are therefore lower than the overall figure for the top 2 000 companies, which was 7.8%. The growth rates of the top companies in the 2024 Scoreboard are also significantly lower than those of the previous year when they stood at 16.9% for the top 10 and 13% for the top 50 companies. The R&D intensity in the top 10 increased between 2022 and 2023 because of low growth in net sales, and remained unchanged in the top 50 due to a proportional growth of sales and R&D.

Table 3. R&D investment and financial data of the top 10 and top 50 companies, 2023

	R&D	Net sales	Operating profit	Capex	R&D intensity
Top 10					
2024 Scoreboard	231 569	1 759 410	401 917	195 908	13.2%
2023 Scoreboard	215 459	1 698 414	390 375	177 252	12.7%
Growth	7.5%	3.6%	3.0%	10.5%	
Top 50					
2024 Scoreboard	503 682	4 856 968	787 877	403 485	10.4%
2023 Scoreboard	473 055	4 553 942	826 634	350 387	10.4%
Growth	6.5%	6.7%	-4.7%	15.2%	

Notes: R&D, net sales, operating profit and capex are in EUR million. R&D intensity is R&D investment divided by net sales.
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I

Despite the general slowdown in R&D investment growth, several companies in the top 50 significantly increased their R&D investments in 2023. BYD, SK Hynix and Eli Lilly being the most impressive in this respect. Overall, the top 50, and especially the top 10, continue to constitute the largest contributors to R&D growth for the entire Scoreboard sample (Table 4).

Box 1. An estimate of Amazon's R&D investment and its impact on sectoral and regional R&D

In its 2023 annual report, Amazon reported investments of USD 85 622 million under the category 'Technology and Infrastructure'. This category encompasses a broad range of expenses beyond traditional R&D activities as defined by the Frascati Manual (the definition adopted in the Scoreboard), such as infrastructure costs or software development and maintenance, making it difficult to isolate a reliable R&D component that is comparable to those of the other companies in the Scoreboard.[20]

[20] Tou, Y., Watanabe, C., Moriya, K., Naveed, N., Vurpillat, V., & Neittaanmäki, P. (2019). The transformation of R&D into neo open innovation-a new concept in R&D endeavor triggered by Amazon. Technology in Society, 58, 101141.

Amazon is not alone in bundling R&D with other expenses in its annual report. Companies such as Expedia and JD.COM also include infrastructure costs under R&D expenses, challenging the agreed definition of R&D, and leading to their exclusion from the Scoreboard.

To estimate Amazon's actual R&D investment, a detailed financial breakdown would need to be provided by the company. As this is currently lacking, in this box we estimate Amazon's R&D investment by using the average R&D intensity of ICT software companies from the Scoreboard over the past 5 years (2018-2022), which stands at 9.7%. Based on Amazon's 2023 net sales of EUR 523.4 billion, the estimated R&D investment amounts to approximately EUR 50.7 billion. This estimate would put Amazon at the top of the ranking of global R&D investors in 2023, surpassing Alphabet (with EUR 39.8 billion) by a large margin.

However, R&D intensity varies substantially across major ICT software companies. To create a range in which the R&D investment of Amazon might fall, we selected Alphabet (14.29%), and Alibaba (7.56%), two other major players in the e-commerce space. This projects a range of R&D investment of between EUR 39.6 billion (which would result in the 2nd rank) to EUR 74.8 billion, making Amazon the top R&D investor worldwide.

At the lower and upper bound of R&D investment, Amazon's R&D contribution would constitute between 3.1% and 5.9% respectively of total R&D investment by the top 2 000 Scoreboard companies. This shift would have a significant impact on both sectoral and regional distributions of global R&D investment.

— **Sectoral Impact:** With Amazon included, the ICT software sector would increase from 20.6% to 23% or 25.1% for the estimated lower and upper bound.

— **Regional impact:** Amazon's inclusion would boost the share of total R&D investment attributed to the US to 44% (for the lower bound) and 45.5% (for the upper bound).

Determining Amazon's precise R&D investment is challenging as the company includes 'technology and infrastructure' expenses under R&D expenses. Nevertheless, even our conservative estimates point to Amazon being the top R&D performer in the world, with significant ramifications for sectoral and regional R&D trends. However, to ensure methodological consistency within the Scoreboard, Amazon's figures are not incorporated into our analysis, highlighting the need for Amazon (among others) to report their R&D according to the agreed standards.

Biggest contributors to R&D investment growth

Comparing to last year's Scoreboard edition, the increase of R&D investment of the top 10 contributors to global R&D growth is EUR 10 billion lower in 2023. Despite having 2 fewer companies among the top 10 contributors to the absolute change in R&D compared to 2022, US companies still constitute the majority (6 companies), though their share in the additional R&D dropped by 23 percentage points to 62%. The spots were filled by 2 companies from South Korea (Samsung Electronics and SK Hynix – 18% of the total change of the top 10 contributors). For China, BYD replaced Huawei in the list of top contributors. In terms of sectors, the dominance of ICT companies in R&D growth decreased in favour of health companies. In Section 2.2.3 we will briefly outline directionality of the R&D investments of the top 10 companies with the largest absolute additions to R&D.

Table 4. Top 10 contributors to absolute R&D investment increase, 2023 vs 2022

	2024 Rank	2023 R&D	2022 R&D	Difference	% in added R&D	Region	Sector
Alphabet	1	39 804	35 971	3 833	15%	US	ICT software
Apple	3	27 243	23 906	3 337	13%	US	ICT hardware
Volkswagen	5	21 779	18 908	2 871	11%	EU	Automotive
Meta	2	33 229	30 616	2 614	10%	US	ICT software
Samsung Electronics	7	19 890	17 391	2 499	10%	ROW	ICT hardware
BYD	46	4 729	2 374	2 355	9%	CN	Automotive
SK Hynix	42	5 308	3 136	2 172	8%	ROW	ICT hardware
Microsoft	4	26 874	24 766	2 108	8%	US	ICT software
Moderna	53	4 251	2 247	2 004	8%	US	Health
Eli Lilly	16	8 481	6 548	1 933	8%	US	Health
Total top 10		**191 588**	**165 863**	**25 725**	100%		
Total 2 000		**1 257 627**	**1 205 406**	**47 618**			
Share in total		15%	14%	54%			

Notes: R&D investment in EUR million. R&D 2022 and R&D 2023 are measured at 2023 exchange rates, therefore the R&D 2022 figures may differ from those in last year's edition of the Scoreboard.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I

The largest divestments by Scoreboard companies are moderate compared to the largest increases. The highest values (EUR 1.4 billion – Intel, EUR 1.2 billion – Bayer) are substantially lower than the increases by the bottom of the top 10 largest contributors to the growth of worldwide R&D. Of the top 10 contributors to absolute R&D investment decrease, 9 are in the top 500, 2 are in the top 10 and 6 are in the top 50 (including the 2 from the top 10). Half of the companies are in health (pharmaceutical and biotech), and 2 companies are from the EU. The largest R&D decrease is linked to Intel[21], the second largest drop was that of Bayer[22], and the third largest decrease that of Roche. However, this is only an artificial figure and relates to a decrease of intangible assets' amortisation as a result of the impairments recognised 1 year earlier (Table 5).

Table 5. Top 10 contributors to absolute R&D investment decrease, 2023 vs 2022

Company	Region	Sector	2024 Rank	2023 R&D	2022 R&D	Difference	Growth
Intel	US	ICT hardware	8	14 613	15 962	-1 350	-8%
Bayer	EU	Health	38	5 461	6 630	-1 169	-18%
Roche	ROW	Health	9	14 226	15 135	-910	-6%
General Electric	US	Industrials	137	1 737	2 562	-825	-32%
Pfizer	US	Health	13	9 633	10 405	-772	-7%
Alibaba Group Holding	CN	ICT software	30	6 620	7 189	-569	-8%
Novavax	US	Health	689	280	776	-496	-64%
Ginkgo	US	Health	399	529	949	-420	-44%
Ch. State Construction Engineering	CN	Construction	36	5 830	6 217	-387	-6%
Intesa Sanpaolo	EU	Financial	333	652	990	-338	-34%
Total Top 10				**59 580**	**66 815**	**-7 235**	**-11%**
Total 2 000				**1 257 627**	**1 205 406**		
Share in total				5%	6%		

Notes: R&D investment in EUR million. R&D 2022 and R&D 2023 are measured at 2023 exchange rates, therefore the R&D 2022 figures may differ from those in last year's edition of the Scoreboard.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I

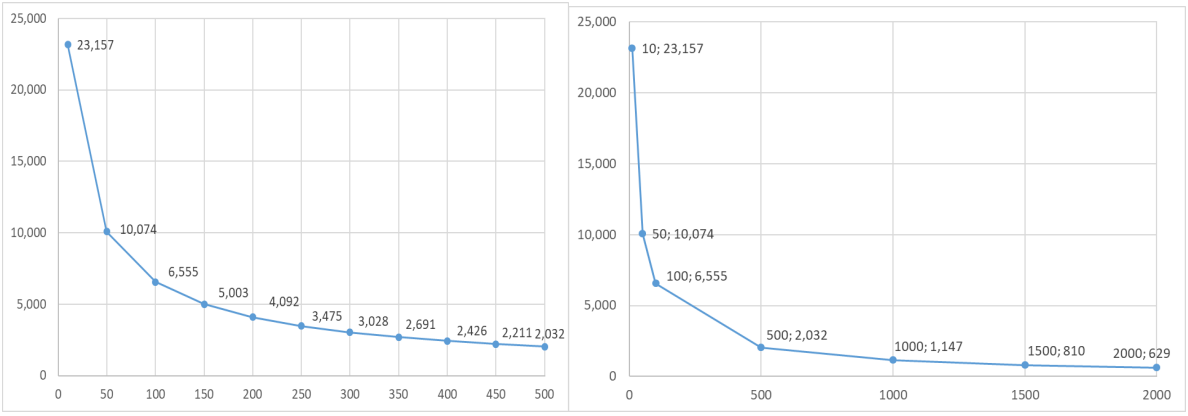
[21] https://www.capacitymedia.com/article/intel-the-chipmaker-too-big-to-fail

[22] https://www.bayer.com/sites/default/files/2024-03/bayer-annual-report-2023.pdf

Concentration of R&D investment in the Scoreboard

The 2023 Scoreboard findings on the concentration of R&D investment remain unchanged: on average, the top 10 companies invest more than double the amount than the top 50 (including the top 10). The top 50 invests on average over 50% more than the top 100, and the latter invest 3.2 times more than the top 500. The differences between the R&D investment of the top quartile (top 500) and the lower quartiles are significantly smaller (Figure 8, left). Likewise, the differences between the R&D investment of the top 100 and the top 150 or the top 200 companies are significantly smaller than the ones between the top 100 and the top 50 (Figure 8, right). The R&D share of the top 100 is around 50% of the total in the Scoreboard, and the top 500 cover 80%.

Figure 8. Average R&D investment of the top 500 companies



Notes: Left panel – the top quartile of the R&D investors, right panel – the entire Scoreboard, the first number of the label indicating the group of companies, such as top 50, top 100, top 500, etc.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG RTD

A total of 1 916 companies appear in the present Scoreboard as well as last year's. These companies invested EUR 1.24 trillion in R&D in 2023, an increase of 8% compared to the previous year. The share of these companies' R&D in the total was 95.5% in 2022 and 98% in 2023, showing that neither the new data collection process nor the entry/exit dynamics had a significant impact on the total R&D collected in the Scoreboard.

2.2.2 Entry and exit from the ranking

Top 50 entries and exits

Like last year, the list of top 50 companies remained mostly stable, with only 2 companies exiting: Amgen (rank 51) and Nokia (rank 52) left the top 50 due to more moderate increases in their R&D investment. The new entrants are BYD and SK Hynix as these companies greatly increased their R&D investment in 2023. The most notable regional and sectoral developments in the top 50 are summarised in Table 6 and below:

- The increase of the EU's top 50 companies' R&D investment was rather modest with at 2%. The Japanese top 50 companies raised their R&D by 4.8%, and the US top 50 raised theirs by 5.5%.
- The Chinese top 50 companies recorded 11% growth, driven mainly by BYD. Thanks to BYD, China holds now 5% of the automotive R&D in the top 50.
- The EU ICT hardware companies' investments fell by EUR 4 billion (26% less compared to 2022) mainly due to the exit of Nokia from the top 50. The remaining 2 EU ICT hardware

companies, Siemens and Ericsson, increased their R&D investment by 4% and 10.5% respectively. This results in a 3 percentage point loss of the EU share in the total top 50 ICT hardware companies' R&D.

- The ROW companies among the top 50 increased their R&D investment by 14.5%: ICT hardware companies increased their R&D investments by 38%, causing a rise in their R&D share of 4 percentage points. The main drivers are the two South Korean companies SK Hynix (up by 69.3%) and Samsung Electronics (up by 14.4%).
- Although EU automotive companies are leading in terms of R&D investment, the growth rate of 12% has proved insufficient to maintain last year's share of R&D, which dropped by 2 percentage points to 61%. The lower R&D share is mainly related to Robert Bosch whose R&D investments grew by only 1.1%, well below the growth rates of the other EU automotive companies.

Table 6. Top 50 – Regional shares and growth rates of R&D investment in the main sectors, 2023

	EU	US	China	Japan	RoW	Total
Automotive	61% (63%)	18% (21%)	5% (0%)	15% (17%)	0% (0%)	100%
Health	14% (15%)	51% (52%)	0% (0%)	4% (3%)	31% (30%)	100%
ICT hardware	8% (11%)	55% (55%)	15% (16%)	0% (0%)	22% (18%)	100%
ICT software	4% (5%)	82% (81%)	10% (11%)	4% (4%)	0% (0%)	100%
Growth y-o-y						
Automotive	12%	3%		3%		15%
Health	-2%	0%		16%	1%	0%
ICT hardware	-26%	8%	2%		38%	9%
ICT services	2%	8%	-1%	4%		6%
Total	2%	6%	11%	5%	14%	

Notes: Values are shares of R&D investment of the top 50 in 2023 (2022 in parenthesis). Summing up the regional figures might differ from the totals due to rounding.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I

Entry/exit in the top 500 companies

R&D investment by the top 500 companies accounted for 80% of the top 2 000 total in 2022 and 2023. The common set of companies in the top 500 in both years numbered 463, leaving 37 companies to enter/exit[23] the ranking between the two years. The share of R&D investment of the 'common set' in the total top 500 was 98% in both editions of the Scoreboard. Of the 37 companies exiting the top 500, 27 companies dropped to lower positions, but are still in the 2024 ranking. Another 7 companies were subject to M&A deals (6 remained indirectly in the ranking as their acquirer is also in the Scoreboard). Finally, the remaining 3 dropped out due to bankruptcy, non-disclosure of R&D, or a significant drop in R&D. The new-entry companies came mostly from lower positions of last year's edition (23 companies). The remaining 14 companies were not included in last year's Scoreboard – however, they are not actual new companies or companies that only recently pushed their R&D over the Scoreboard's lower threshold, but instead their presence relates to improvements in data collection and quality control in the 2024 Scoreboard.

[23] An entry means a company that is present in the ranking in a certain year (here: 2023), but absent from it in the reference year (here: 2022). An exit means a company that is present in the reference year, but no longer in the following year (here: 2023). The number of entries in the Scoreboard corresponds to the number of exits. However, in the quintiles, the two are not necessarily equal, as the exit does not mean exiting the quintile, but disappearing from the full list of 2 000 companies.

Looking at the sectoral and regional structure, entrants to the top 500 are mainly from the EU and China, in both cases in the sector 'Others', while the exits are mostly by US ICT software companies, both in terms of number of companies and R&D investment.[24] The net effect of entry/exit dynamics on the total R&D invested by the 500 largest R&D investors was negligible (Table 7).

Table 7. Top 500 – Entries and exits, number of companies and R&D investment across regions (in EUR million), 2023

	Number of companies						R&D investment					
Entries	**EU**	**US**	**China**	**Japan**	**ROW**	**Total**	**EU**	**US**	**China**	**Japan**	**ROW**	**Total**
Automotive	1		2			3	882		1 008			1 889
Health	1	5	2	1		9	395	2 241	986	1 034		4 657
ICT hardware	1					1	410					410
ICT software			1		1	2			416		396	812
Others	6	3	4		9	22	2 762	3 098	1 975		6 430	14 264
Total	9	8	9	1	10	37	4 449	5 339	4 384	1 034	6 826	22 033

Exits	**EU**	**US**	**China**	**Japan**	**ROW**	**Total**	**EU**	**US**	**China**	**Japan**	**ROW**	**Total**
Automotive		2	1			3		811	399			1 210
Health	2	6	1		1	10	881	3 919	415		432	5 646
ICT hardware		2	1		2	5		851	600		794	2 245
ICT software		4	4		1	9		6 350	1 694		451	8 495
Others	1	2	3	2	2	10	418	1 144	1 328	1 534	827	5 250
Total	3	16	10	2	6	37	1 298	13 075	4 435	1 534	2 505	22 847

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I

2.2.3 Technologies by the top contributors to R&D investment growth

In this Section we briefly describe the main research strands of the 10 companies that contributed the most to R&D investment growth in 2023. The aim of this is to add deeper understanding to the quantitative indicators from Table 4. The technologies at which the R&D investments aim are state-of-the-art and most topical in the area of software programming (generative AI), automotive (electric vehicle production) and pharmaceuticals (vaccination, therapeutic drug research). The most recent technologies and the companies researching them are set out below.

Alphabet

The main driver of R&D investment growth (approximately 50%) was compensation expenses (employee remuneration), primarily for Google DeepMind and Google Cloud[25]. Similarly to the other Big Tech companies, Alphabet primarily targeted AI development. Google DeepMind, a subsidiary active in computer games, language models, and more recently in molecular biology (protein folding[26]) now integrates teams from Google Research focusing on building AI models as announced in April 2024[27]. In 2023, the company continued to develop its Gemini project, which is a multimodal

[24] The US ICT software sector was marked by several important M&A transactions that affect the Scoreboard ranking in the top 500. In particular, VMWare, Activision Blizzard and Splunk were acquired by Broadcom, Microsoft and Cisco

[25] https://abc.xyz/assets/43/44/675b83d7455885c4615d848d52a4/goog-10-k-2023.pdf

[26] https://en.wikipedia.org/wiki/Google_DeepMind

[27] https://www.computerweekly.com/news/366582333/Alphabet-earnings-show-drive-to-boost-Google-Cloud-and-AI-adoption

AI model.[28] The new Gemini 1.5 Pro version announced in December 2023 is a follow-up of Google Gemini 1.0 that will offer advanced features, such as larger context windows, expanded Google App extensions, and real time conversations.[29] Other R&D-intensive projects relate to AI-powered advertising tools such as Performance Max and Smart Bidding. The company sees opportunities in the scale of R&I that they have built up, because it enables them to work on AI horizontally across their subsidiaries such as Search, YouTube, Cloud and Waymo.

Apple

Based on its annual report, Apple's year-over-year growth in R&D investment in 2023 was driven primarily by increases in headcount-related expenses.[30] The company continues to integrate AI and machine learning more comprehensively into its products, two key domains for the company's development. This ranges from Siri enhancements to new features in the iPhones' operating system (iOS) aiming to make the devices 'smarter' and more intuitive.[31] In the area of augmented reality (AR), Apple is developing (i) a platform called ARKit that is used to create AR experience on devices using iOS; and (ii) AR glasses – a potentially revolutionary new product destined for user-interaction with digital content in the real world. Apple is already present in the wellness industry with digital solutions such as Apple Watch, a popular device in personal health monitoring. The company's expanding R&D efforts target early detection of diseases, health metrics, and fitness tracking. Own custom silicon, such as the M1, M2 and the more recently introduced M3[32] chips are intended to ensure industry leadership. Future R&D efforts will probably focus on Apple's most ambitious projects such as the development of: (i) an autonomous electric vehicle (Apple Car) integrating AI, ML and AR; (ii) new products enhancing connectivity, and user convenience in wearable technologies; and (iii) exploring advanced display technologies, such as foldable display and microLED.

Meta

Metaverse[33] investment aims to boost both shorter-term and longer-term state-of-the-art research. Shorter-term project will focus on early Metaverse experiences, with products directed towards the connectivity of people. The company expects to spend half of its Reality Labs operating expenditure on augmented reality (AR), 40% on virtual reality (VR) and mixed reality (MR) projects and about 10% on social platforms. Longer-term projects include the development of neural interfaces using electromyography, letting people control their devices using neuromuscular signals, as well as innovations in AI and hardware for developing next-generation interfaces.[34] However, the focus is on shifting gradually towards generative AI, which the company plans to bring through its Horizon operating system into VR, AR and MR games, apps and creation resources.[35] Meta AI, the company's AI-powered smart assistant software, has been incorporated across Meta's apps like WhatsApp,

---

28 Idem.

29 https://www.techtarget.com/whatis/feature/Gemini-15-Pro-explained-Everything-you-need-to-know

30 https://s2.q4cdn.com/470004039/files/doc_earnings/2023/q4/filing/_10-K-Q4-2023-As-Filed.pdf

31 https://medium.com/quarterscope/apples-23-6-billion-vision-for-the-future-in-2024-376de0c05656

32 https://www.digitimes.com/news/a20231108PD205/apple-m3-chip-ic-design-distribution-chips+components.html

33 What is the metaverse? The Economist explains. The Economist, 11 May 2021.

34 https://d18rn0p25nwr6d.cloudfront.net/CIK-0001326801/c7318154-f6ae-4866-89fa-f0c589f2ee3d.pdf

35 https://techcrunch.com/2024/07/02/meta-plans-to-bring-generative-ai-to-metaverse-games/

Instagram, Facebook, and Messenger[36], as well as in the image-generation software and smart glasses.[37]

Microsoft

According to its 2023 annual report, the company's R&D is focused on three interconnected ambitions. First, it is directing its efforts towards reinventing productivity and business processes. This is supposed to be achieved by continuous innovation of its leading tools and services, such as Microsoft 365, Dynamics 365, LinkedIn and Microsoft 365 Copilot, the latter being the company's generative AI chatbot replacing Cortana. The aim is to better serve customers and employees by optimising business processes and make productivity gains with low-code/no-code tools, robotic process automation, virtual agents and business intelligence. Second, R&D aims at building the Intelligent Cloud and Intelligent Edge Platform. This means investing in high performance computing to meet the growing demand for fast access to the company's services provided by their network of cloud computing infrastructure and data centres. The main tools in this respect are their own products, such as Windows 365, Microsoft Cloud, the Azure AI platform, a long-term partnership with OpenAI, with Azur being OpenAI's exclusive cloud provider, as well as through subsidiaries such as Nuance and GitHub Copilot. Finally, the company is applying its R&D to create more personal computing. The main tools expected to achieve this are Windows 11, Windows Copilot, and Dev Home.

Samsung Electronics

The company's R&D investment is very broad and includes AI, data intelligence, next-generation communications, robot, Tizen (Samsung's common software platform based on Linux and applied to various Samsung devices), life care & new experiences, next-generation media, security, SoC architecture and software engineering.[38] Concerning AI, the company focuses on fundamentals (ML, interaction between users and devices, simulation technologies), language AI, voice and sound AI, as well as vision AI. Data intelligence refers to knowledge graphs, algorithms and models for advertisements and healthcare, as well as data cloud and infrastructure. Within robotics, the company focuses on robot intelligence, robot platform, and on robot mechanism and control. The next-generation digital appliances research division develops innovative solutions that can adapt to global energy regulations and eco-friendliness (e.g. food-tech, air and water filtration technologies). Next-generation communications research is aimed at: (i) 5G-advanced core technologies, new service development, and the development of 5G radio and network technologies; (ii) 6G technologies including cmWave eXtreme MIMO, advanced duplexing, native AI, and communication-computing convergence; and (iii) developing and standardising UWB technology to create location-based service platforms. Display and media research is directed towards: (i) new functionalities accommodating highly realistic media; (ii) advanced AI-based media processing technologies overcoming limitations of signal processing; and (iii) developing natural interaction technologies beyond the current touch screen interaction. Further research is aimed at strengthening major technical items (core OS technologies, standard modules, stability, software, and hardware openness), improving the multi

[36] https://www.nytimes.com/2024/04/18/technology/meta-ai-assistant-push.html

[37] https://www.nytimes.com/2024/04/24/technology/meta-profit-stock-ai.html

[38] https://www.samsung.com/uk/about-us/business-area/r-and-d-center/#:~:text=Core%20research%20themes%20at%20Samsung,next%20generation%20media%2C%20and%20security.

device experience (MDE) user experience, and supporting seamless connection between devices (e.g. IoT connection standards).

Volkswagen

Volkswagen is very keen on CO_2 and environmental impact reduction, which is emphasised throughout its annual report.[39] Their R&D efforts aim at reduced fuel consumption, electrification, as well as recycling of raw materials from vehicles at the end of life. Research is largely following two directions. First, the company is developing a forward-looking vehicle and drivetrain portfolio to improve drive-system efficiency irrespective of the type of engine. For the conventional combustion engine, research is focused on more sophisticated exhaust gas purification, mild hybridisation, aerodynamics optimisation and the reduction of rolling resistance.[40] As part of the electrification campaign and its 'new auto' strategy, the company is concentrating on the Modular Electric Drive Toolkit (MEB)[41] and the Scalable Systems Platform (SSP)[42], as well as its premium and sports brands version called Premium Platform Electric (PPE)[43]. This second-generation electric car platform will replace MEB, and PPE and will serve all electric cars manufactured by Volkswagen Group. The other main strand of research is centred on connectivity and automated driving. Comprehensive mobility concepts, such as modes of transport (also beyond the automobile), the transport infrastructure, and mobility habits are being addressed. The basis of this research strand is provided by new software solutions managed by Cariad, the Group's software subsidiary. The most important developments are a uniform software platform (VW.OS), uniform end-to-end electronics architectures, uniform cloud platform connection, an infotainment platform with an app store, driver assistance systems, automated parking, highly automated driving for private mobility, a data marketplace, as well as the E3[44] 2.0 architecture, which is the basis for the new, software-defined vehicle (SDV) approach and also paves the way towards future autonomous driving functions. Finally, an interesting feature of Volkswagen's innovative activities is the formation of alliances with Ford Motor Company, and through Cariad, with Bosch and ThunderSoft (China).

BYD

BYD's innovation efforts focus on four areas: (i) Automotive innovation in the three core EV technologies – batteries, electric motors and electronic controls. BYD is also the pioneer of the modern plug-in hybrid vehicle (PHEV)[45] with its dual mode technology combining IC engines with electric motors. Another technology developed by BYD is the bi-directional charging/discharging technology, which enables the connection of EVs to the power grid, electrical appliances and to other EVs,

---

39 https://www.volkswagen-group.com/en/financial-reports-18134#2023

40 The number of versions of combustion engines is being reduced to free capacities for the development of electric vehicles.

41 https://www.volkswagen-newsroom.com/en/modular-electric-drive-matrix-meb-3677

42 https://cleantechnica.com/2024/06/10/first-volkswagen-electric-cars-built-on-scalable-systems-platform-will-arrive-in-2028/

43 https://www.electrive.com/2020/04/02/audi-provides-new-platform-details/

44 E3 is the end-to-end electronic architecture used in Volkswagen's electric cars.

45 The history of the electric car: https://www.energy.gov/timeline-history-electric-car#:~:text=World's%20First%20Hybrid%20Electric%20Car%20Is%20Invented&text=Ferdinand%20Porsche%2C%20founder%20of%20the,world's%20first%20hybrid%20electric%20car.

transforming them into mobile power stations; (ii) Rail transit innovation: the company has developed BYD SkyRail[46], which allows full automatic operation, including safe interval tracking, self-diagnosis, automatic wake-up, automatic passenger detection, and facial recognition. It also has a regenerative braking system that can convert kinetic energy into electrical energy and store it in its on-board backup batteries for emergencies; (iii) Battery innovation: the company develops double-glass silicone modules, which are among the first TUV Rheinland-certified modules in the world. These batteries address issues like PID attenuation and snail trail, have longer useful life (40 years) than their conventional counterparts (usually 25 years), and can be used in a wider range of buildings and also in rougher environments; (iv) Electronics innovation: BYD's R&D in this field addresses three technology areas. First, its plastic metal hybrid (PMH) technology solves the antenna signal problem and enables strong, seamless and step-less binding between metal and plastic parts. Second, BYD's 3D glass technology (GMH) allows a seamless connection between 3D glass and metal to achieve the high-level structural integration of products. Finally, in its functional and precision structural ceramics, BYD has developed a material to improve toughness, enabling a large-scale market application of large-size 3D structural ceramics.

SK Hynix

As a semiconductor manufacturer, the company is active in three research areas. It innovates in: (i) memory technologies, such as dynamic RAM (DRAM) scaling and 3D NAND[47]; (ii) new memory technologies, such as a non-volatile memory (NVM) based analogue computing in-memory (ACiM)-cell platform, embedded in CMOS (complementary metal oxide semiconductors) technology, as well as selector-only memory (SOM) materials and integration processes to increase performance, reliability, and scalability compared to conventional 3D cross-point memory; and (ii) next-generation computing, such as quantum computing and neuromorphic computing. In these areas, as a semiconductor company, SK Hynix focuses on concepts such as cryogenic memory, high-capacity high-bandwidth memory, and the need for separate memory devices for neuromorphic computers.

Moderna

The company's research is based on mRNA. They aim to create a new category of medicines and concentrate on five therapeutic areas – infectious diseases (vaccines), immuno-oncology (immunotherapy), rare diseases (missing enzymes), cardiovascular diseases (heart failure patients) and autoimmune diseases (immune homeostasis). The company's mRNA pipeline ranges from vaccines against infectious diseases for adults and children, and latent and public health vaccines, to cancer vaccines and therapeutic medicines, rare-disease intercellular therapeutic medicines, and inhaled pulmonary therapeutic medicines. The company is also active in clinical trials in that it shares its policies and clinical trial data with researchers, patients, volunteers and the public. It also offers expanded access programmes for patients who do not qualify for clinical trials.

Eli Lilly

The company's research focuses primarily on metabolism-related fields such as diabetes (novel therapeutic approaches simplifying glycaemic control), obesity (GLP-1, novel drug targets and in-

[46] With a team of 1 000 engineers, working for 5 years, the R&D phase involved an investment of RMB 5 billion (around EUR 650 million). This undertaking has been done entirely in-house, making BYD the exclusive owner of the IPR of a complete monorail system.

[47] https://www.semiconductors.org/wp-content/uploads/2021/02/Highest-Volume-Mainstream-Memory_Omdia.pdf

combination therapies) and cardiovascular disease (genetic medicines for the full spectrum of CVD), immunology (medicines for immune-related skin, gastrointestinal, and pain issues), neuroscience (mainly Alzheimer's disease), oncology (mainly chemotherapy), as well as unresolved pain (mainly migraine and non-opioid medication). The company's research efforts are aimed at developing both new medicines and expanding the range of use, formulations and therapeutic approaches for existing products. They collaborate with academic institutions and pharma and biotech companies. The company conducts clinical trials for its medicines and invests in external research and complementing technologies through licensing, co-development, co-promotion, joint ventures, acquisitions, and equity investments.

One increasingly popular way of financing research into new technologies is to use corporate venture capital. Box 2 presents a case study for the automotive sector.

Box 2. Corporate venture capital – a tool for automotive companies to tap into high-potential, startup-driven innovation

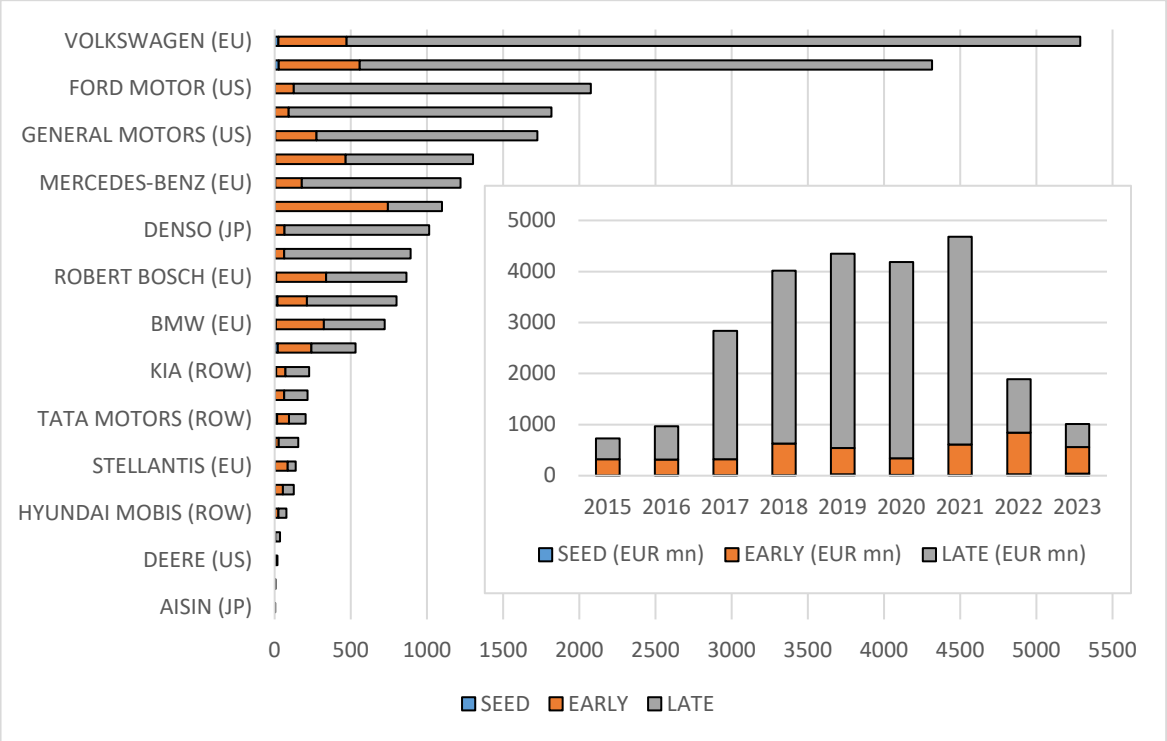
In addition to traditional approaches to innovation such as in-house and collaborative R&D, IP management, innovation procurement, mergers and acquisitions, and joint ventures, automotive companies target new technologies through structured 'Open Innovation' (OI). One prominent form of OI is corporate venture capital (CVC), in which automotive companies acquire equity in innovative startups. A recent policy brief[48] analyses the engagement of Scoreboard automotive companies with new players via corporate venturing. All CVC funds associated with the top 5 R&D investing automotive companies per region (Europe, US, China, Japan, ROW) (henceforth: Auto25) have been assessed.

78.5% of the CVC deals in the sample, encompassing worldwide CVC deals data for 2010-2023, involve two or more investors. Sometimes these other investors are other automotive companies, but often they are private VCs and investors not active in the automotive sector. The dominance of multi-investor deals is indicative of a cooperative CVC approach where either the **technologies are high-risk**, or it makes sense to have **shared technology standards**.

While aggregate automotive CVC has **increased considerably** over the past decade, the **overall level remains significantly lower than internal R&D**. It varies considerably across companies, with a handful of incumbent automotive companies dominating (Figure B2-1).

[48] https://publications.jrc.ec.europa.eu/repository/handle/JRC138139

Figure B2-1. Total Auto25 CVC investment (EUR million) by deal type, 2015-2023

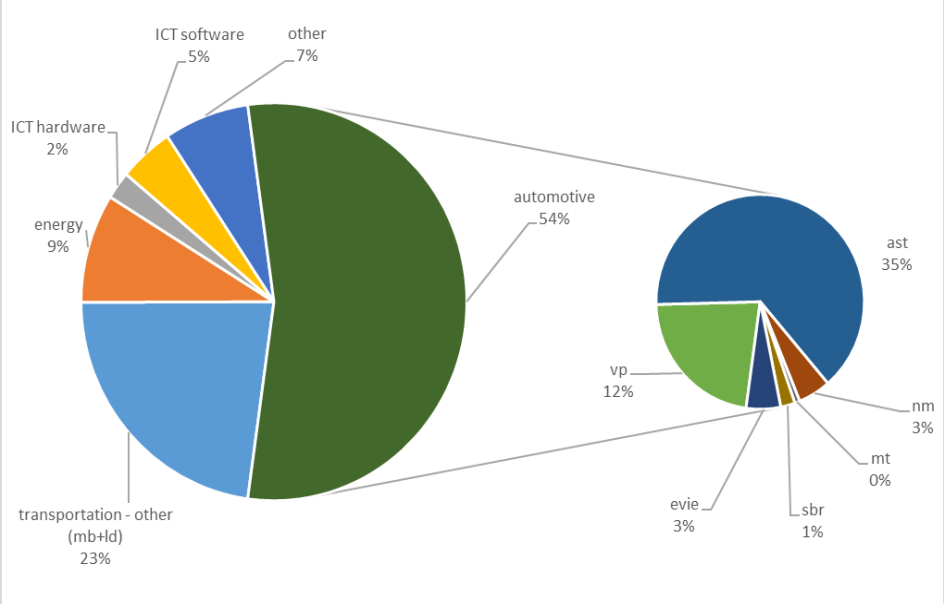


Notes: Data was taken for the top 5 R&D investing companies in each of the 5 regions (EU, US, China, Japan, ROW) based on Scoreboard sector classification. This results in the inclusion of companies like Deere and Caterpillar, but since they have relatively low levels of CVC, the main messages emerging from the data are not affected. We have information on 1 191 VC deals financing 842 startups in which one or more of these 25 companies participated from 2010 to 2023. Most of the deals involve multiple investors, though 23% are single investor deals. The amount of financing is disclosed for 961 of the deals corresponding to 690 startups.
Source: JRC elaboration based on Dealroom.co data

Most investment went to startups active in areas directly or indirectly **related to automobiles**, with 'automotive' and 'other transportation' (encompassing automotive sectors according to Dealroom's taxonomy as well as mobility and logistics/delivery) receiving 77% of the total CVC investment (Figure B2-2). Within the automotive-related CVC expenditure of the Auto25 group, investments in startups developing **autonomous and sensor tech** dominate the landscape accounting for nearly two-thirds of automotive investments (35% of Auto25 CVC). Vehicle production startups are the second largest automotive-related investment of the Auto25 group, with nearly a quarter of automotive investments (12% of total Auto25 CVC expenditure). The lower importance of EV charging investments may be due to the still relatively smaller share of the EV segment on the automotive market. However, the segment is expected to face significant growth in the near future supported by a predicted 6-fold increase in charging in public places (IEA, 2024).[49]

[49] IEA 2024. 'Electricity 2024: analysis and forecast to 2026', https://www.iea.org/reports/global-ev-outlook-2023

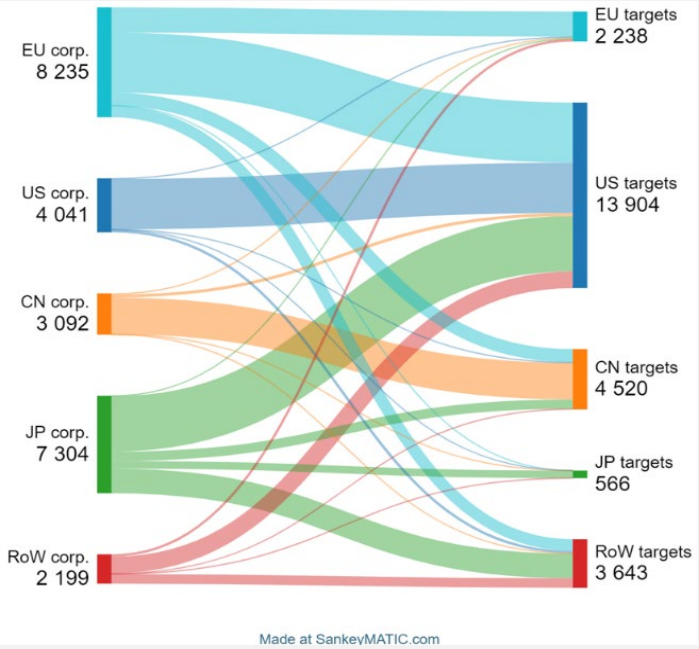
Figure B2-2. Distribution of the aggregate CVC investment by sector of activity of investee startups.



Notes: Distribution of aggregate Auto25 CVC investments and Auto25 CVC investments in automotive sub-industries in 2010-2023, by the sector of activity of the investee startups (ast: autonomous & sensor tech, vp: vehicle production, nm: navigation & mapping, mt: maintenance, sbr: search & buy & rent, evie: EV charging, mb: mobility, ld: logistics & delivery).
Source: JRC elaboration, data source: Dealroom

Automotive CVC activity is typically handled by offices close to the headquarters of the parent company, but most companies also have CVC offices in locations around the world close to talent and venture opportunities. US-based startups are the main beneficiaries of global automotive CVC investment with EU, Japanese and ROW companies investing more in US based startups than in domestic ones. Chinese and US Auto25 investors invest mainly at home. On the other hand, startups located in the EU and especially in Japan get CVC funds mainly from domestic (by HQ) Auto25 firms (Figure B2-3).

Figure B2-3. CVC investment flows to startup investees by headquarter region in EUR million (left).



Domestic CVC investments		Domestic origin of startup funding	
EU corp.	23%	EU startups	84%
US corp.	93%	US startups	27%
CN corp.	89%	CN startups	61%
JP corp.	8%	JP startups	100%
ROW corp	33%	ROW startups	20%

Notes: 'Domestic CVC investments' indicates the CVC amounts invested domestically by Auto25 companies (x) as a percentage of the total investments by these companies in 2010-2023. Domestic origin of startup funding shows x as a percentage of the total CVC investment in startups in a given region (right).
Source: JRC elaboration, data source: Dealroom

To sum up, corporate venture capital by leading EU automotive companies is on a par with competitors and they are investing into the technological innovation transforming the sector. But the fact that most CVC investment by EU automotive leaders goes to US-based startups could be a worrying sign.

2.3 Development of R&D investment 2013-2023

Since its inception in 2004, the Scoreboard ranking has been built on the nominal R&D investments as reported in consolidated company accounts.[50] If reported in the company accounts, R&D investment data is adjusted for R&D undertaken for governments or other companies, and it also excludes the companies' share of any associated company or joint venture R&D investment. However, it includes research contracted out to other companies or public research organisations (see Annex 2 for methodological details). Since the first Scoreboard edition, the sample size has changed several times.[51] In this edition, the JRC started a pilot exercise to collect the data in-house. While this caused a reduction in the sample size, the quality of the data and the coverage of additional financial indicators improved. However, in order to maintain comparability across time we adapted all analyses over time to the new sample with a cut-off at the 2 000th company.

Figure 9 displays the growth rate of worldwide R&D investment by the 2 000 companies in nominal and inflation-adjusted (real) values. For the inflation adjustment we transformed the firm-level data in original currency values using the country-specific GDP deflator[52] of the country in which they are headquartered and then converted to euro values (using the 2023 end-of-year exchange rates). All R&D investment of a company is allocated to the country in which it is headquartered as there is no information available on the actual location of a company's R&D investments. The country-specific inflation rate may therefore not always accurately capture the true increase in prices that a company faced, as the country where it has its headquarters is not necessarily the country where it performs (all) its R&D activities. Moreover, many firms have R&D locations in various countries and are thus exposed to a set of different inflation rates. Depending on the firm, the deflated series might thus over- or underestimate the inflation-adjusted R&D investment.

In the low-inflation period up to 2020, the difference between both series was only 1.4% on average. However, the inflation rate rose to 3.8% in 2021 and 5.0% in 2022, substantially reducing the real increase in R&D investment. In 2023, the average inflation rate decreased to 3.3%, reducing the

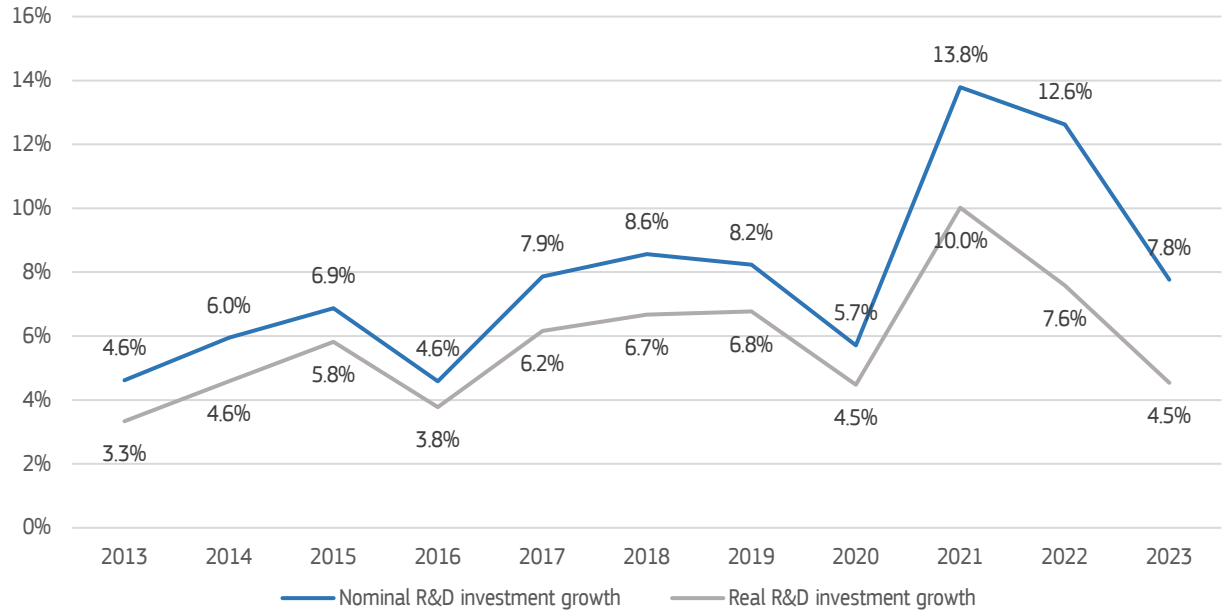
[50] For an review of the genesis and the impact of the Scoreboard in science and policy see: European Commission, Joint Research Centre, Confraria, H., Grassano, N., Moncada-Paternò-Castello, P., Nindl, E. (2024), The impact of the EU Industrial R&D Investment Scoreboard in Science and Policy, European Commission, Seville JRC139008 https://publications.jrc.ec.europa.eu/repository/handle/JRC139008

[51] In the first Scoreboard the sample was 500 EU and 500 non-EU companies, in 2005 it expanded to 700 EU and 700 non-EU companies, from 2006 to 2011 it covered 1 000 EU and 1 000 non-EU companies, in 2012 the non-EU sample increased to 1 500 companies, in 2013 it expanded to 2 000 non-EU, and the 2014-2023 Scoreboards covered 2 500 non-EU plus 1 000 EU companies.

[52] The GDP deflator is defined as the ratio of GDP in current local currency to GDP in constant local currency in linked series; data is taken from the World Bank with the base year set to 2015.

nominal increase in R&D investment from 7.8% to 4.5% when adjusted for inflation (real R&D investment growth). In nominal terms, the 2023 increase is higher than the compound average annual growth rate (CAGR) of 7.4% over 2013-2023, but below in real terms (5.5%).

Figure 9. Nominal vs real top 2 000 companies' R&D investment growth, 2013-2023



Notes: The base year for the inflation adjustment is 2015 (GDP deflator in 2015 = 100).

Source: The 2023 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Since inflation rates have differed across countries, Table 8 displays the growth rates of R&D investment for the main countries/regions in the analysis and compares the nominal to the inflation-adjusted development since 2013.[53] For the **second time in a row, the inflation adjusted R&D investment growth rate of EU Scoreboard companies in 2023 (3.7%) exceeded the US growth rate (2.1%).** This continued improvement by EU companies in a difficult economic environment helps **narrow the EU's R&D gap behind the US** (see also Figure 10), which is also reflected in the increase in the EU companies' R&D share (up from 18.4% to 18.7%, see Figure 5).

The EU's main competitors, the US and China, which massively increased their R&D investment during 2020 and 2021, **had relatively lower growth in 2022 and again in 2023**. US companies increased their R&D investment in nominal terms at the lowest rate since 2016, and in real terms, the 2023 US growth rate is the lowest observed so far in the Scoreboard. The same holds true for China, but on a different level. The Scoreboard records an ongoing decrease in the growth rates of R&D investment by Chinese companies. Figure 9 and Table 8 show that in nominal terms **EU companies increased their R&D investment at about the same rate as the Chinese companies** for the first time in the Scoreboard. For China 2023 is the 6th consecutive year with declining real R&D investment growth (dashed yellow line in Figure 10).

[53] We calculate the growth rates by comparing, e.g. all EU companies in 2023 to all EU companies in 2022. When we instead calculate the growth rates only for the firms included in both years, we get following result (inflation-adjusted values in brackets): total (n=1958) 8% (4.7%), EU (n=319) 9.5% (3.5%), US (n=664) 7.3% (3.5%), China (n=513) 8.2% (8.8%), Japan (n=182) 7.3% (3.5%), ROW (n=245) 9.1% (5%).

Table 8. Regional R&D investment growth 2013-2023, nominal and inflation-adjusted, top 2 000 companies

	EU		US		China		Japan		ROW	
	nominal	**real**	**nominal**	**real**	**nominal**	**real**	**nominal**	**real**	**nominal**	**real**
2023	**9.8%**	**3.7%**	**5.9%**	**2.1%**	9.6%	10.2%	7.1%	3.3%	9.1%	6.0%
2022	12.6%	**7.0%**	13.0%	**5.6%**	16.4%	14.4%	9.8%	9.4%	8.8%	4.7%
2021	5.4%	2.7%	16.5%	11.4%	25.4%	20.0%	4.8%	5.0%	11.3%	8.5%
2020	**-3.3%**	**-5.2%**	8.9%	7.5%	21.3%	20.7%	**-0.5%**	**-1.5%**	0.9%	**-0.3%**
2019	5.0%	2.9%	8.7%	6.9%	24.1%	22.5%	1.7%	1.1%	4.7%	4.0%
2018	5.3%	3.5%	8.7%	6.3%	33.5%	29.0%	3.5%	3.5%	2.3%	0.9%
2017	5.9%	4.6%	7.2%	5.3%	23.9%	19.1%	4.4%	4.5%	6.9%	4.8%
2016	2.6%	1.6%	4.9%	3.9%	27.3%	26.1%	**-1.0%**	**-1.3%**	1.8%	0.8%
2015	**10.0%**	**8.0%**	**5.6%**	**4.6%**	28.2%	28.5%	3.9%	1.7%	1.3%	1.0%
2014	4.3%	3.1%	5.8%	4.0%	28.7%	27.1%	1.7%	0.1%	5.9%	5.1%
2013	1.3%	**-0.1%**	5.9%	4.1%	18.0%	15.5%	3.4%	3.7%	4.2%	2.9%

Notes: The base year for the inflation adjustment is 2015 (GDP deflator in 2015 = 100). Note that China recorded deflation (negative inflation rate) in 2023.

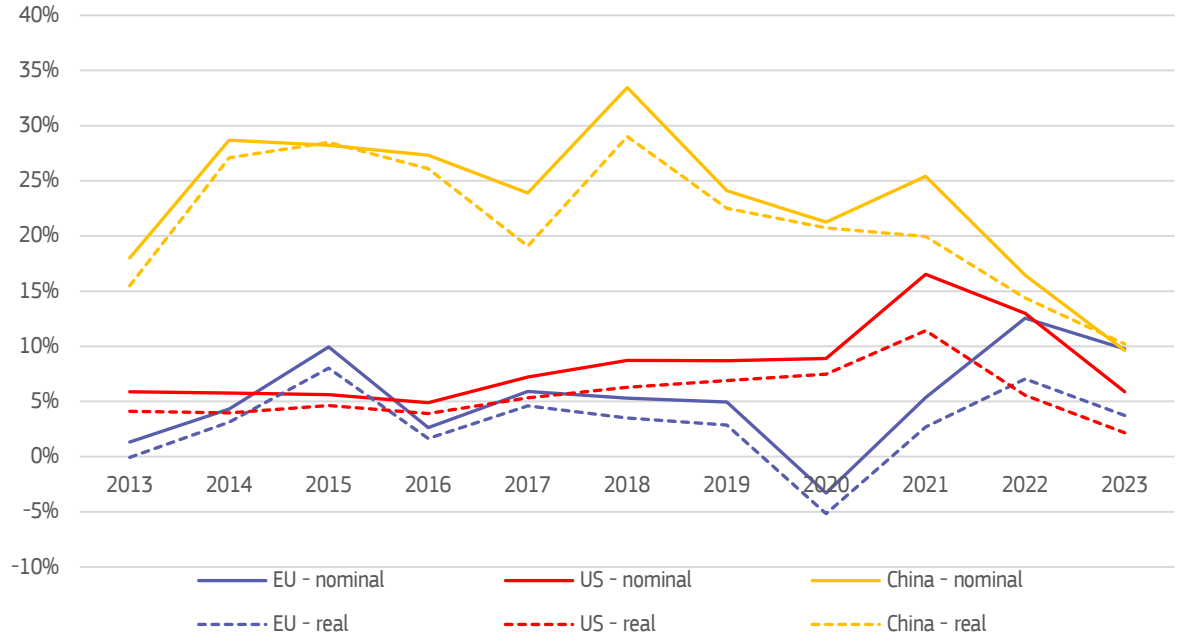
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Japanese Scoreboard companies' positive trend of the previous year continued into 2023, albeit at a somewhat lower speed. After achieving the highest R&D investment growth in 2022 (in nominal and in real terms), the additions in 2023 constitute the second highest in its history. However, while Japanese inflation-adjusted R&D investment growth exceeded that of the EU and also the US in 2022, the real additions are smaller in 2023 due to a rise in inflation. As a consequence, real R&D investment growth is only 3.3%, which is higher than the US growth rate, and somewhat below the EU's.

ROW companies developed strongly in 2023: the nominal R&D investment growth rate of 9.1% is the second highest for this group after 2021, and with 6%, those companies record the highest real additions to R&D investment behind China. The ROW-countries driving the positive development are South Korea (+12.6%), Singapore (+17.6%) and Australia (+10.7%), while UK companies increased their R&D at a lower rate (+6.8%), and companies headquartered in Switzerland reduced their nominal R&D investment by 2.6% compared to 2022.

Figure 10 sets out the nominal and real R&D investment growth rates since 2013 for the EU, the US and China. While for the EU and China, growth in R&D investment is rather cyclical, it followed a steadier trend in the US. The figure also shows that although until 2017 EU and US growth rates were rather similar on average, since 2018 US firms have increased their R&D substantially more than their EU counterparts. However, in the last two years the **EU companies have been able to match and even surpass the growth rates of the US companies**, while the growth rates of the Chinese companies have been slowing down.

Figure 10. Nominal vs real R&D investment growth for the EU, the US and China, top 2 000 companies, 2013-2023



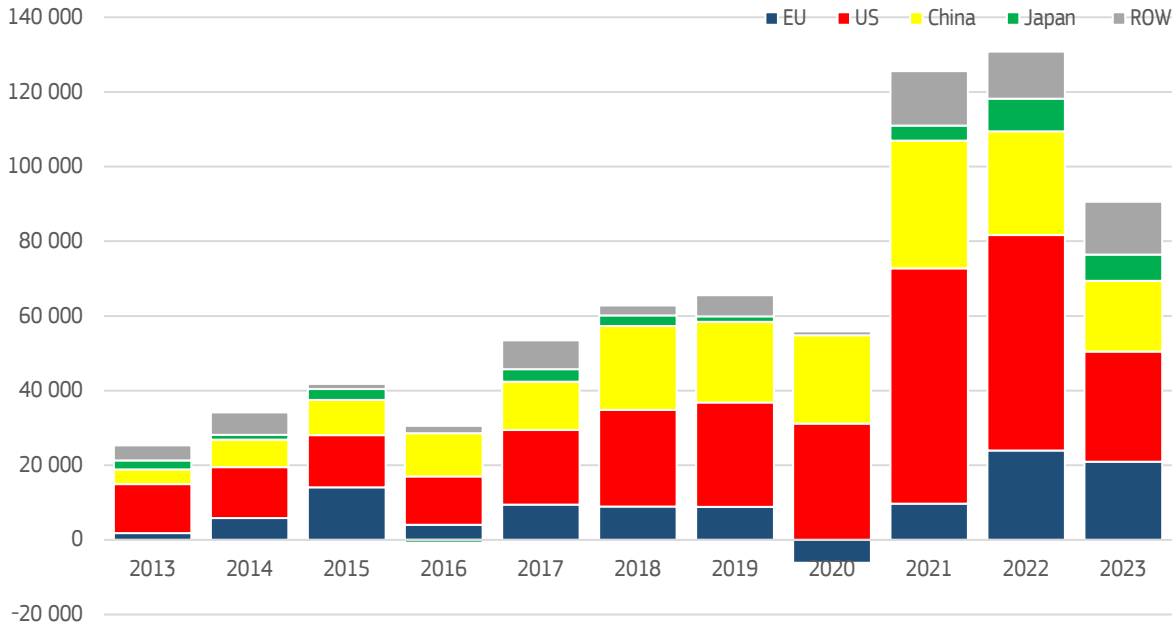
Notes: The base year for the inflation adjustment is 2015 (GDP deflator in 2015 = 100).
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Figure 11 breaks the absolute nominal R&D growth since 2013 down by the main regions/countries. In contrast to 2021 and 2022, absolute additions to R&D investment returned to a more moderate level that appears more in line with the pre-COVID trend. **The contribution of US companies** to the aggregate change **almost halved compared** to the previous year and amounted to EUR 29 billion, followed by EU companies with EUR 20.2 billion, China with EUR 17.2 billion and the ROW and Japan with EUR 10 billion and EUR 6.2 billion, respectively. However, the net additions to total global R&D investment in 2023 were lower in all regions compared to 2022, with EU companies being closest to maintaining the 2022 additions. After the moderate – and in 2020 even negative – contributions of EU-headquartered companies to the aggregate change in corporate R&D investment, **EU companies returned as a driving force on the global scale** in 2023.

Overall, **72.3% of companies reported an increase in R&D investment in 2023** compared to the previous year, somewhat below the average share of 73.5% since 2013. The additional R&D totalled to EUR 119 billion, substantially below the additions in 2022 (EUR 153.6 billion) and 2021 (EUR 146.5 billion), but is the third highest on record, while R&D reduction (sum of negative changes) increased. The country with the highest share of companies reporting an increase in R&D is **Japan with 85.7%, followed by the EU with 79.4%** of the companies. **In the US and China only around 69% of the companies raised their R&D investment** relative to 2022, and in **ROW this share is only 66%.** Compared to the last two years this indicates that the increase in R&D investment in 2023 is less broad and less sustained than in the two years before.

The loss of R&D measured as a share of gain was with 22.4% below the average since 2013 (26.6%), but higher than in 2021 and 2022 (10.8% and 9.7%, against 43% in 2020). This means that in 2023, around 22% of the R&D that was added to the Scoreboard was lost by other companies. Losses were relatively high for Chinese companies at 28.9%, followed by the US and ROW at 24.5% and 23.8% respectively. In contrast, EU companies lost only 14.7% of what other EU companies added, and in Japan this share was even lower (10.6%).

Figure 11. R&D investment growth decomposition by regions, top 2 000 companies, 2013-2023



Notes: The vertical axis displays the change in absolute R&D investment by the 2 000 companies for each year (in EUR million).

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

2.4 Business key performance indicators

In addition to information on companies' R&D investment, we also collect information on key performance indicators (KPIs): net sales, operating profit (profit), capital expenditures (capex), market capitalisation, as well as on employment.[54] Table 9 displays these KPIs and their growth rates (relative to 2022) across the five major regions and adds R&D-specific performance indicators such as R&D intensity (R&D investment divided by net sales), R&D investment per employee (in EUR), profitability (operating profits divided by net sales) and capital intensity (capital expenditures divided by net sales) for 2023. Regional development is compared to the figures for the full sample (column 'Total').

After the strong and broad market expansion in 2021 and 2022, the aggregate picture deteriorated in 2023. **Net sales stagnated** with 0.6% growth for the entire sample, operating **profits decreased** by 8.0% compared to 2022, and **employment fell** by 0.4%. In contrast, companies **raised their capital expenditures** by 9.3%, and **market capitalisation recovered** from the 2022 losses and grew by 21%. These figures are the result of a rather mixed development across regions and sectors, which will be detailed in the following paragraphs and sections (for a more detailed picture on the sectoral level see Sections 3.5 and 3.7).

[54] Compared to the previous years, the coverage of the financial indicators improved. Aggregating the indicators per country and comparing the share of R&D of firms with data on these indicators to total R&D shows that firms with complete data represent over 98% of total R&D, except for employment for ROW (only 66%), and market capitalisation for the EU and China (ca. 82% and 87%).

Table 9. Business key performance indicators, 2023

	EU	US	China	Japan	ROW	Total
Companies	322	681	524	185	288	2 000
R&D investment, EUR bn	235.2	531.8	215.8	104.8	169.9	1 256.6
One-year change	9.8%	5.9%	9.6%	7.1%	9.1%	7.8%
Net sales, EUR bn	5 607	6 277	5 476	2 558	4 555	24 474
One-year change	3.5%	2.5%	7.0%	4.1%	-12.4%	0.6%
R&D intensity	4.2%	8.4%	3.9%	4.2%	3.7%	5.1%
Operating profits, EUR bn	618.2	956.4	368.6	206.3	725.2	2 874
One-year change	13.2%	3.1%	-1.0%	16.7%	-34.1%	-8.0%
Profitability, %	11.0%	15.4%	6.7%	8.1%	16.0%	11.8%
Capex, EUR bn	373.3	400	402.8	156.4	368.9	1 701
One-year change	20.6%	12.3%	-0.7%	12.0%	6.7%	9.3%
Capital intensity	6.7%	8.4%	3.9%	6.1%	8.1%	7.0%
Employment, million	15.2	10.8	15.2	7.6	6.3	55.2
One-year change	3.4%	-0.7%	4.1%	-2.8%	-13.9%	-0.4%
R&D per employee, EUR	15 427	48 593	14 137	13 713	17 706	21 575
Market capitalisation, EUR bn	6 011	23 555	3 556	3 002	7 7981	43 924
One-year change	23.3%	23.7%	0.15%	41.4%	14.0%	21.0%

Notes: Capex stands for capital expenditures. R&D intensity is defined as R&D investment as a share of net sales, profitability is defined as profits as a share of net sales. Measured in nominal values.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Net sales & R&D intensity

EU, US and Japanese companies recorded a moderate expansion of net sales by 3.5%, 2.5% and 4.1% respectively, and Chinese companies a somewhat stronger growth (7.0%), while ROW companies reported a drop in net sales of over 12%, mainly due to the **fall in sales of energy (oil) companies** (-33% for ROW energy companies' resulting from a decline in oil prices) and the ROW ICT hardware producers (-10%). However, even in countries with a positive development, net sales growth slowed down from the double-digit growth recorded in the preceding two years. Overall, the total net sales of 1 945 companies came to EUR 24 474 billion. 55 companies did not generate any sales – 51 of these companies are from the health sector, in particular biotech, and in most cases from the US. Note that in 2019 there were only 25 such companies in the Scoreboard (63 in 2022).

For traditional **energy companies** (responsible for 16.6% of the top 2 000 total net sales) sales decreased strongly (by 15.4%) after 2 years of over 34% annual growth. While the net sales of energy companies in ROW and Japan dropped strongly, the decrease for the EU, China and the US was very small. **Automotive companies** accounted for the second largest share of sales with 15.8%. With an increase of 14.8% these companies recorded a **double-digit increase in sales for the third year in a row**, with the strongest growth in China (+28.2%), followed by Japan (+18.6%), the US (+13%), and the EU and ROW (+10%). The third largest sector in terms of sales is ICT hardware at 14.6% of the total. The sector's sales decreased by 0.9% after the strong increases in 2021 and 2022. While ICT hardware sales by Chinese companies increased by 11% (third year in a row with double-digit growth), EU and Japanese companies' sales stagnated with growth at 2%, while the net sales of US ICT hardware producer decreased by 2%, and those of the ROW companies fell by 10%.

The stronger increase in R&D relative to net sales caused a rise in **R&D intensity** of the global top 2 000 companies from 4.8% in 2022 to **5.1% in 2023, the highest value in the Scoreboard so**

far.[55] The increase occurred across all regions and ranged from 0.1 to 0.7 percentage points, with the lowest increases in China (from 3.8% to 3.9%) and Japan (from 4% to 4.1%), and the largest increase in ROW (from 3% to 3.7%). The R&D intensity of EU companies increased from 4% to 4.2%, the second highest R&D intensity in the sample, but a long way behind the US companies that lead with an average R&D intensity of 8.4% (up from 8.1% in 2022), twice as high as for the EU companies.

Operating profits and operating profitability

Aggregate profits fell by 8% to EUR 2 874 billion, driven by the strong decline in profits of the ROW companies (-34%), again due to the oil- and gas-producers in this group (down from EUR 694.7 billion in 2022 to EUR 346.9 billion in 2023, or a fall of 33%), and the ICT producers that faced a drop in profits of 52% (down from EUR 105.8 billion in 2022 to EUR 50.1 billion in 2023). The profits of companies headquartered in the **EU and Japan increased strongly** (by 13.2% and 16.7% respectively), while US companies' profits grew moderately by 3.1%, and those of Chinese companies even fell slightly for the second year in a row (down 1% in 2023 and 0.7% in 2022). Of the 2 000 companies, 542 did not generate profits, the second highest number after 2022 (with 572).

In the EU and Japan, the automotive companies significantly drove aggregate profits with increases of 19.5% (to EUR 124.5 billion) and 60% (to EUR 71.8 billion) respectively. In the EU, the ongoing high energy prices in 2023 caused the energy companies' profits to surge by 53%, almost surpassing those of the automotive companies'. This was to the detriment of the energy-intensive EU sectors such as chemicals or industrials, where profits fell by 26% and 14% respectively. However, these sectors play a smaller role in the EU aggregate in terms of R&D.

In the US, health sector profits declined by 28%, but this was more than compensated by the 40% increase in profits of the ICT software and service companies, totalling to EUR 281 billion – for the first time exceeding the profits of the ICT hardware sector (EUR 243 billion). US energy sector profits decreased by 1.4%, but remained – after the 143% increase in 2022 – at a record level.

In China, the profits of ICT software and service companies as well as industrial sector companies' fell by 17% compared to 2022. The automotive companies more than tripled their profits, increasing them from EUR 3.7 billion to EUR 11.4 billion. While this is only a fraction of the profits realised by the established EU or Japanese automotive companies, this development shows that this previously nascent sector is becoming more and more profitable.

Overall, **profitability decreased** compared to 2022 from 12.9% to 11.8%; this, as described above, relates mainly to the massive drop in ROW energy company profits (minus EUR 347 billion). In contrast, the **profitability of EU companies increased** by 1 percentage point to 11.0%, and for the Japanese companies it grew from 7.2% to 8.1% – the highest for Japan so far, and the second highest for the EU since 2021. Profitability dropped from 21.1% to 15.9% in the ROW countries, while US companies stood unchanged at 15.4% profitability. With 6.7%, China trails in the profitability ranking, and lost for the second year in a row.

As in the past, the financial sector exhibited the highest profitability at 26.4% and also saw a strong increase in 2023 (up from 20.5% in 2022), followed by ICT software at 17.7% (up from 14.9%) and

[55] The R&D intensity also increased compared to the sample with the 2 500 companies as in the smaller sample we primarily lost firms at the end of the distribution that often had relatively less R&D relative to sales compared to firms higher up in the ranking.

the energy sector (15.9%, down from 19.8% in 2022). The 2023 financial sector figure constitutes the highest profitability for a sector ever recorded in the Scoreboard.

Capital expenditures (capex) and capex intensity

As in 2022, **total capex increased** by 9.3%, driven by companies headquartered in the EU (+20.6%) and to a lesser extent the US (+12.3%) and Japan (+12%). Companies in the ROW increased their capex by 6.7%, while Chinese firms slightly reduced their capex compared to the previous year (-0.7%). For **China**, this development continues the **decrease** from 2022 (-1.3%) and constitutes the second time that capex growth was negative since 2015, while the **EU and Japanese companies recorded the largest increases** ever, and the **US companies increased their capex by double-digit figures for the third year in a row**.

In total, the 2 000 companies invested EUR 1 701 billion in capital assets, 23.5% of which was contributed by US and Chinese companies, 22% by EU and ROW companies, and 9% from the Japanese Scoreboard companies. The fact that four regions/countries invest rather similar amounts in capex, even though the number of companies covered in the Scoreboard is very different, the different sizes of the economies, price levels, and substantial variation in the sector composition is intriguing (this distribution is rather stable over time).

In the **EU**, the **energy sector** contributed the most to capex with EUR 101 billion (27% of total EU capex), an increase of 43%, followed by the automotive companies with EUR 67 billion (+19.5%, 18% of EU capex). In China the largest capex investments also came from the energy companies with over EUR 109 billion (27.1% of Chinese capex) in 2023, an increase of 22% compared to 2022. However, the second largest capex contributing sector in China, ICT hardware (18% of the total), decreased its investment by 35% in 2023 to EUR 75 billion. As in the EU, the Chinese automotive sector also increased capex strongly to EUR 35 billion (+28%).

The biggest **US capex investments** came from the **ICT software companies**, which spent EUR 125.4 billion in 2023 (+5.5%), followed by the ICT hardware with EUR 77.6 billion (-0.6%) – the two ICT sectors are responsible for 50% of all capital expenditures by US Scoreboard companies, emphasising again the importance of this sector to the US economy. US energy companies meanwhile were responsible for only 12.3% of the capex (EUR 49 billion), but this constituted an increase of 58% relative to 2022. The US automotive companies raised their capex by 14.6% to EUR 54 billion, significantly below the EU companies, but ahead of **Japan** (EUR 50.8 billion, +28%), where automotive is responsible for 32.5% of total capex. The second largest sector in terms of capex in Japan is ICT hardware with an increase of 15% to EUR 22.7 billion, while the companies in 'Others' (with companies like Sony or Panasonic) reduced their capex by 2% to EUR 21.9 billion.

In the **ROW** group, the energy companies continued to invest the largest amounts in capex with EUR 101.9 billion (+10%), followed by the ICT producers with EUR 100.5 billion (-5.6%) – these two sectors are responsible for 27.6% and 27.3% of the ROW total capex respectively.

Capex intensity increased from 6.4% to 7% for the 2 000 companies in the sample. China has a capex intensity of 7.4% (a 0.6 percentage points decline compared to 2022). In the EU and the US capex intensity was somewhat lower at 6.7% and 6.4% respectively, but it **increased by almost one percentage point for EU companies** and by 0.6 percentage points for US companies. Capex intensity also increased in Japan from 5.7% to 6.1%. The ROW companies' capex intensity rose by 1.4 percentage points to 8.1% – however, this is related to an increase in capex in occurring parallel

with a strong decrease in sales. The sectors with the highest capex intensity are ICT services (10%), followed by chemicals, energy, and ICT hardware with between 9.6% and 8.8%.

Employment and R&D per employee

Employment fell slightly by 0.2% to 53.9 million employees, with the EU and Chinese companies expanding by 3.7% and 3% respectively, and the companies in the remaining countries/regions reducing their employment – a reduction of 0.7% by US companies, 2.8% by Japanese and 13.9% by ROW companies. However, the decrease in ROW employment also relates to changes of disclosure of some large companies, to some large manufacturing companies disappearing from the ranking, and to missing data.[56] The missing data thus limits the scope of the analysis of employment for ROW.

Large differences in employment exist across sectors – the biggest being ICT hardware (17.1%), automotive (16.6%), and 'Others' (15.2%). In the EU and Japan the automotive sector employs 23.4% and 24.2% or workers respectively, while in the US and China the ICT hardware sectors employ the largest shares at each around 19.3%. In the US, the two ICT sectors together are responsible for 37% of employment, in the EU it is only 14%.

In 2023, **ICT software and services companies reduced employment** by 9%, a consequence of the large additions during the COVID-19 pandemic. ICT hardware companies also reduced employment, but to a lesser extent (2.2%). Large changes in employment were recorded by companies in the financial sector, which increased employment by 18%, after 2 years of significant decreases. The energy companies raised employment, leading to the first increase in aggregate employment by these companies since 2014 (by 5.1%). Automotive sector employment increased by 3.2%, continuing the positive development of 2022 (up by 7.7%).

R&D investment per employee stood at EUR 21 575 on average in the 2024 Scoreboard, corresponding to an increase of EUR 1 500 compared to that of the previous year. Overall, we observe a **strong increase in R&D per employee over time**. While a Scoreboard company spent an average of EUR 11 016 on R&D per employee in 2013, this figure almost has doubled over the past 10 years (adjusted for inflation it increased from EUR 11 357 to EUR 18 207), mainly due to the increase in R&D investment.

US companies led on this indicator with EUR 48 593 per person employed. In 2019, before the COVID-19 pandemic, US companies spent on average was EUR 34 182 per employee, and since then they have increased this amount by approximately EUR 15 000. By contrast, **EU companies invested EUR 15 527** on R&D per employee in 2023. ROW companies come second in this statistic, but long way behind the US, with EUR 17 706 spent per employee, an increase of almost EUR 3 000 compared to 2022. The ROW figure is mainly driven by UK and Swiss health companies, but also by ICT hardware companies in South Korea and Taiwan. China and Japan are at the lower end of the distribution with EUR 14 137 and EUR 13 713 per employee respectively, just behind the EU.

The leading sectors for this indicator are health at EUR 56 189 per employee (an increase of EUR 4 000 compared to 2022) and ICT services at EUR 43 900 on average per employee, up from

[56] The data on employment is complete for the EU and Japan, the US figures are missing one company, and China 2, but for the ROW group data is lacking for 99 companies.

EUR 38 067 in 2022. The ICT hardware sector invested on average EUR 26 694 per employee (around EUR 4 000 more than in the previous year), and the automotive sector EUR 19 603 (EUR 1 800 more).

Market capitalisation

After the drop of 14.8% of 2022, **market capitalisation recovered in 2023, increasing by 21%** to a total of EUR 43 924 billion.[57] The **growth of Scoreboard companies' market capitalisation** thus **exceeded the growth of global aggregate market capitalisation** in 2023, which was around 13%.[58] In the 2024 Scoreboard, the market capitalisation of EU companies increased by 23.3%, and that of US companies by 24.7%. The strongest growth was realised by the Japanese companies with an increase of 41.4%. The companies in the ROW also recorded an increase in their market capitalisation by 14%, while that of Chinese companies stagnated with an increase of only 0.2%. Market capitalisation continues to be highly concentrated: the market capitalisation of US companies is higher than that of all the other regions in the Scoreboard put together and accounted for 53.6% of the total.

In the EU, market capitalisation increased most for the chemicals companies with an increase of 83% in 2023, followed by ICT hardware (+31.2%), and the automotive companies with an increase of over 20%. In Japan, the strong increase was driven by the automotive companies with growth of 78% compared to 2022, the ICT hardware companies with plus 53%, and the ICT service companies with growth of 39%. In the US, the market capitalisation of the automotive companies grew by 46%, that of the ICT software companies by 43.4% and that of the ICT hardware producers by 31.4%. In ROW countries, the sector with the most significant growth was also automotive, up 45%, followed by industrials with an increase of 42%, and ICT hardware and ICT software, with were up 38% and 30.7%, respectively. In China, there was only slow growth for sectors considered major in terms of market capitalisation, such as ICT hardware (4.3%), while others even declined (ICT services down 10.5%). However, China also saw strong growth in the market capitalisation of the automotive sector, up by 23.5%. Across all countries, the automotive companies' market capitalisation grew by 44.9%, the ICT software companies by 33.5%, and the one of ICT hardware companies by 31.4%. Overall, the 4 top sectors in terms of R&D account for close to 65% of the total market capitalisation.

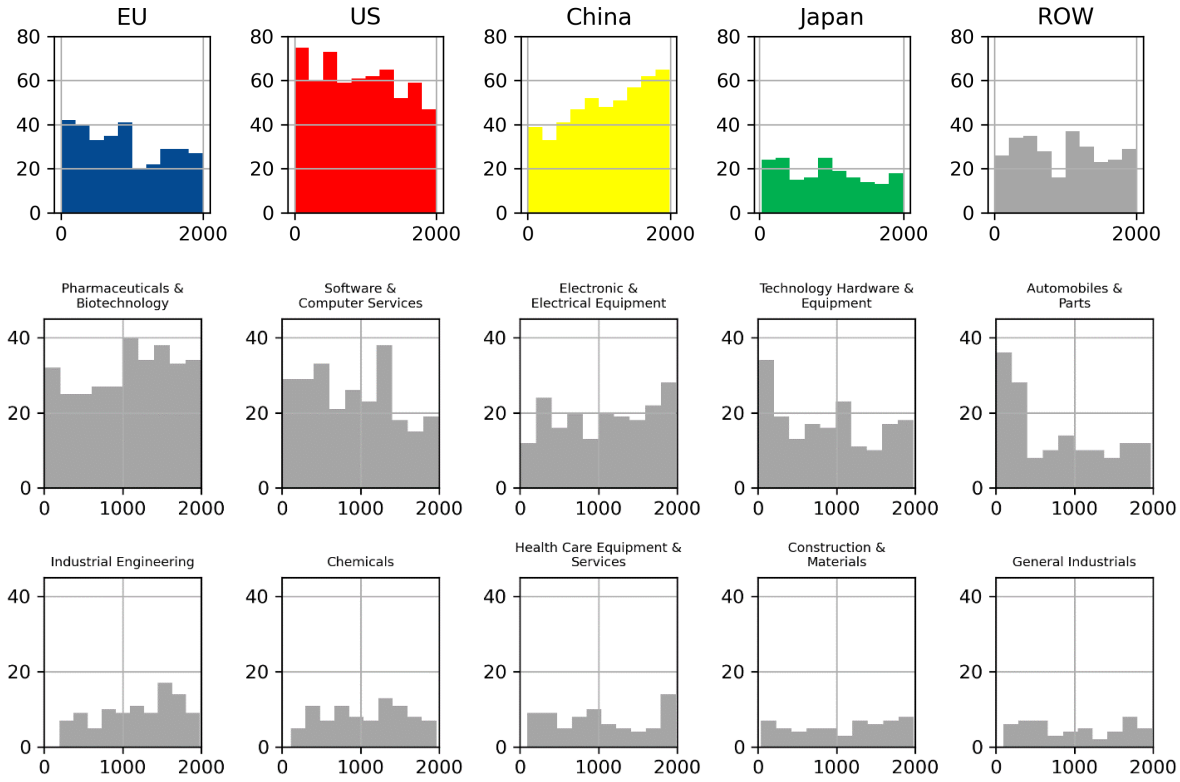
2.5 Subsidiary structure of the Scoreboard firms

In this Section, we focus on the subsidiaries of Scoreboard companies, particularly on the number of subsidiaries by region, country and sector, and set out some comparisons across groups. It should be noted that these groups are not always homogeneous in terms of the number and size of the Scoreboard companies they contain. This could be useful to put into perspective the description of the landscape of Scoreboard subsidiaries that we present below.

[57] Data on market capitalisation is lacking for 78 out of the 322 EU companies, and for 23 companies headquartered in ROW countries, while the series is almost complete for the remaining countries. The reason is that not all companies are listed on the stock market, with prominent examples such as Huawei in China, Robert Bosch and Boehringer Sohn in the EU, or Synamedia and Revolut in the ROW group, while for other companies the data is simply missing.

[58] https://www.statista.com/statistics/274490/global-value-of-share-holdings-since-2000/

Figure 12. Distribution of Scoreboard companies across regions and sectors, 2023



Notes: Data refers to the 1 893 companies for which data on subsidiaries are available. Each bin covers 200 positions in the ranking. The top left panel tells us that the EU places slightly over 40 companies in the first 200 positions of the ranking and 40 between rank 201 and 400. Similarly, the second panel in the top row shows that US Scoreboard companies account for almost 80 of the top 200 companies. In general, the heights of the bars in the i-th in the top row sum to 200. The same is true for the bars relating to sectors.

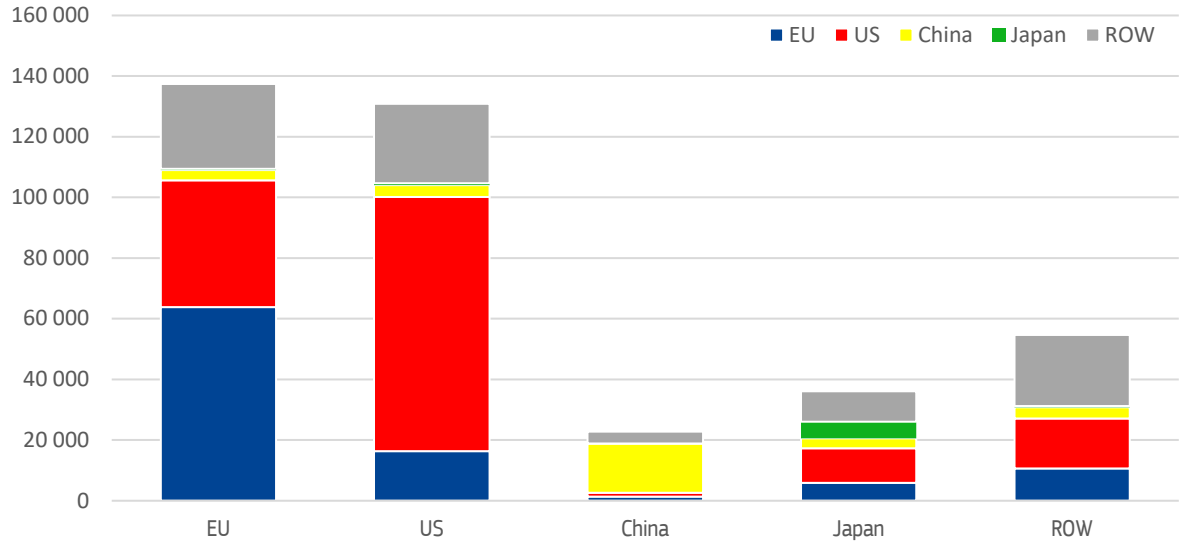
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Figure 12 provides some context for the analysis by showing how Scoreboard companies belonging to a region or a sector are distributed across the R&D ranking. The top row of Figure 12 shows that every region has companies spread across the ranking. China and the US have more companies than all other regions, though concentrated in different parts of the ranking. While China has a comparable number of top-ranked companies to the EU, it has many more towards the bottom of the ranking. On the contrary, the US has by far the largest presence at the top of the ranking and is relatively less represented at the bottom. The bottom two rows of Figure 12 refer to the 10 sectors containing the largest number of companies. It shows that a few sectors (health and software in particular) are much more represented than the others, and have a relatively higher number of companies at the bottom of the ranking. At the same time, ICT hardware and automotive comprise fewer companies, but are concentrated more at the top of the ranking and could, therefore, be on average larger or have more subsidiaries.

The top 2 000 companies control close to 900 000 subsidiaries, of which **380 000 are classified as active corporate subsidiaries**. The headquarters of the companies included in this year's ranking are distributed across 40 countries, and their corporate subsidiaries are located in 200 countries and territories. Overall, the number of corporate subsidiaries covered in this year's

Scoreboard is similar to last year (380 000 compared to 360 000, +5.6%[59]) and their geographical distribution has remained qualitatively similar, too. This means that the industrial structure of the top R&D investors followed a balanced path of expansion during the post-COVID-19 recovery.

Figure 13. Distribution of subsidiaries by country/region of the mother company, 2023



Notes: Data refers to the 1 893 companies for which data on subsidiaries are available.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Figure 13 shows the regional distribution of the subsidiaries of the Scoreboard companies. Contrary to the 2023 edition of the Scoreboard, in which most subsidiaries belonged to US-headquartered companies, in this edition it is **EU-based companies that own the most subsidiaries globally** (36%). US companies follow closely with 34.3% of subsidiaries. Japanese companies own 9.4% of subsidiaries, a lower share than in the past edition, while China fell from last year's 9.1% to 6% of total subsidiaries.

Most subsidiaries of companies headquartered in the EU are in the EU (46.5%), followed by the US (30.4%) and the ROW (20.3%). As in the past, over half of the subsidiaries of companies headquartered in the US are in the US (64%), 20% in the ROW and 12.5% in EU countries. Just over 7 out of 10 subsidiaries owned by Chinese companies are in China (71%). On the contrary, Japanese companies remain the most internationalised, with only 15.1% of their subsidiaries located in Japan.

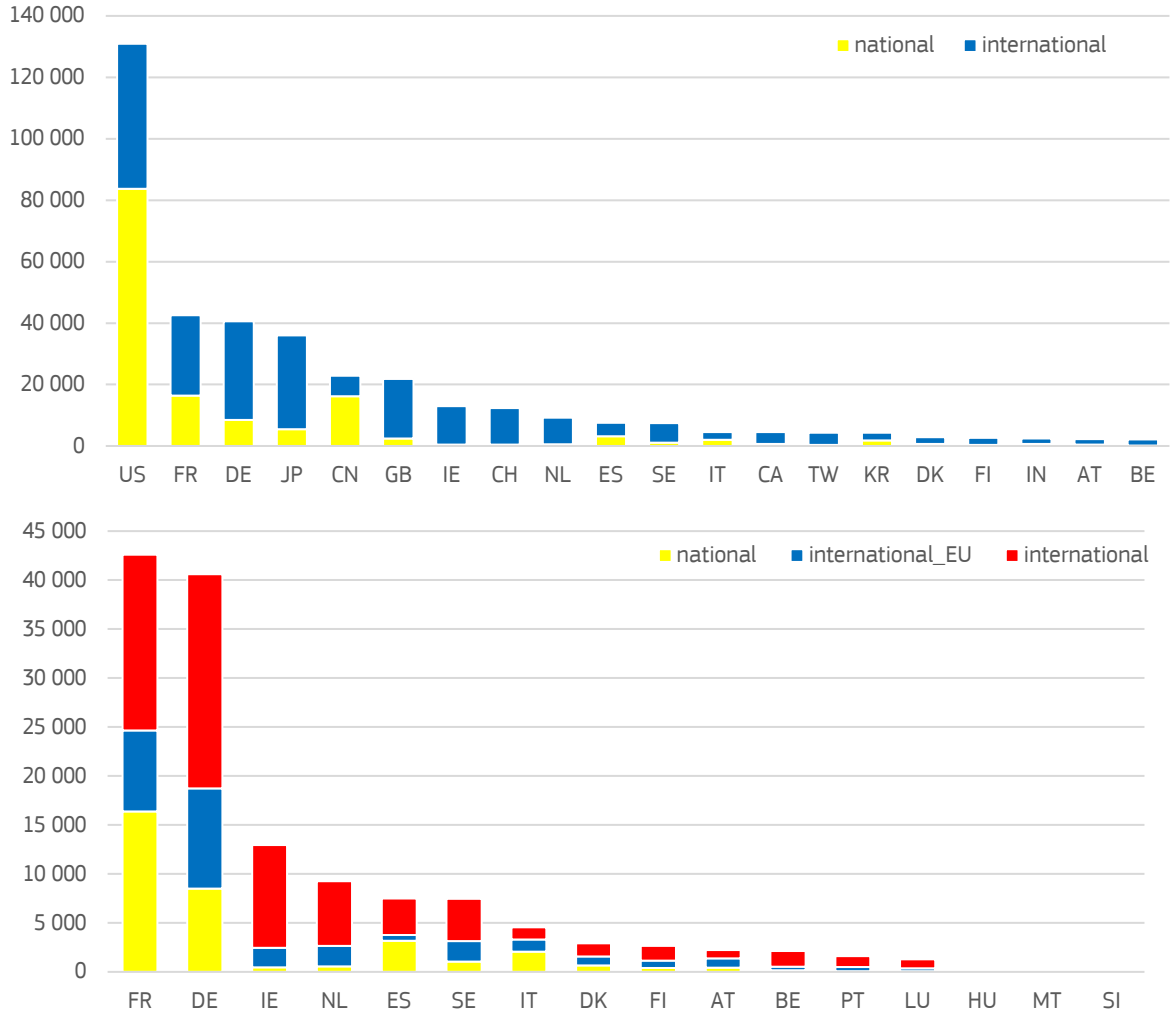
Figure 14 shows that corporate subsidiaries are concentrated geographically despite the large number of locations hosting at least one entity. In fact, **over 90% of subsidiaries were located in the top 20 countries** (71% in the top 5 alone), which represents a sizeable increase compared to last year, when these countries hosted around 74% of all subsidiaries. In line with the distribution of headquarters, the country in which most subsidiaries were located is the US, which accounted for 34.3% of the total, followed by France (11.1%), Germany (10.6%), Japan (9.4%), and China (6%).

The top 5 countries in terms of hosted subsidiaries remained the same in 2023 compared to 2022, though the order changed, with France (5th in 2022) and Germany (4th in 2022) overtaking Japan

[59] Note that due to the new data collection process, the reconstruction of the corporate structures used for this report may not be directly comparable with the past reports, at least in quantitative terms. Nevertheless, the patterns we report in this edition are qualitatively similar to those we reported in the past.

and China (formerly second and third respectively). The figure also distinguishes between subsidiaries located in a different country to that in which the corporate headquarters are located (i.e. international subsidiaries, represented by the yellow bars in the chart) and subsidiaries located in the same country as the parent company (i.e. national subsidiaries; blue bars). It is interesting to note that, with the exception of the US and China, where there is a clear prevalence of national subsidiaries, most countries host many more international than national subsidiaries (e.g. the ratio of international to national is 1.6:1 in Germany, 3.8:1 in France, and 5.6:1 in Japan).

Figure 14. National and international subsidiaries of the top 2 000 companies by location, 2023



Notes: Top: national and international subsidiaries of the top 2 000 companies for the top 20 host countries by location. Bottom: focus on EU countries hosting at least one Scoreboard company; international subsidiaries are divided into within-EU and extra-EU. Corporate subsidiaries are labelled as national if they are located in the same country as their parent company, otherwise they are international. In the bottom panel, which focuses on the subsidiaries of EU-based Scoreboard companies, international EU subsidiaries are located in a different EU-country than the mother company, while international subsidiaries are located outside the EU.

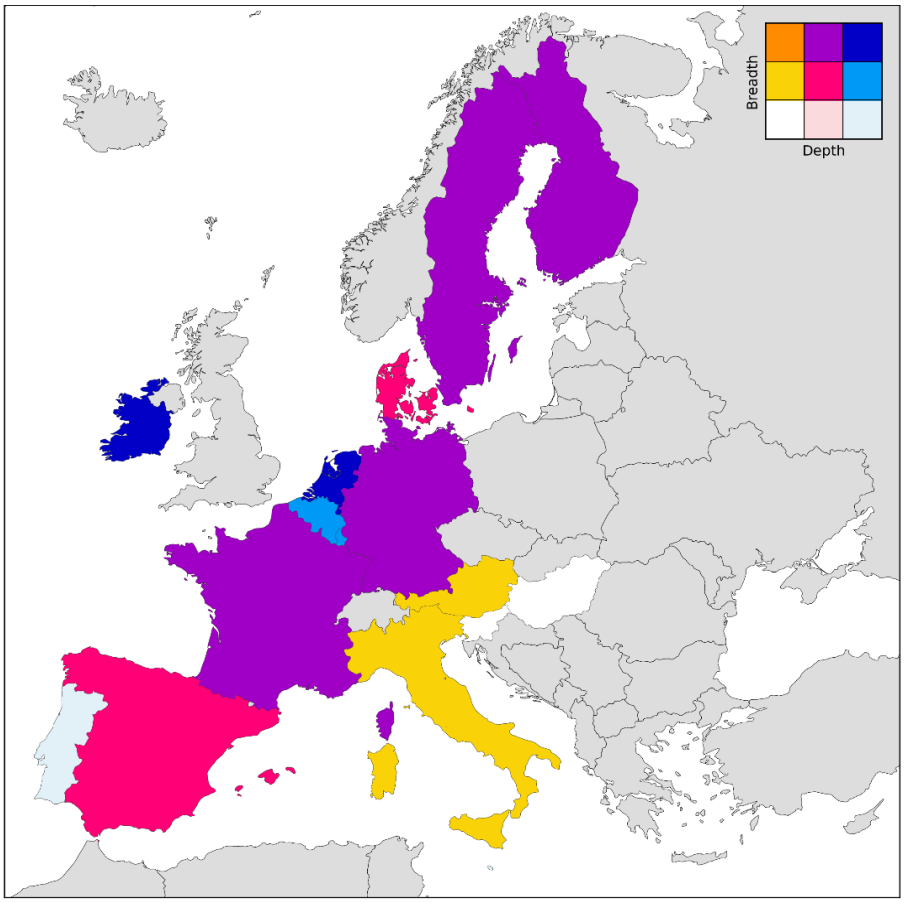
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The bottom panel of Figure 14 focuses on the subsidiaries of EU-based Scoreboard companies and distinguishes between **national subsidiaries** (yellow), **international subsidiaries located in the EU** (blue) and **international subsidiaries located outside of the EU** (red). The panel shows that in the EU subsidiaries tend to be concentrated in few countries. However, using an extended definition of 'domestic' subsidiaries which includes national and within-EU subsidiaries, the prevalence of international subsidiaries becomes much more subtle. For instance, according to this extended

definition, **France, Spain, Italy and Denmark primarily host domestic subsidiaries**, while in Germany the ratio of international to domestic is 1.2:1. This is in line with the prevalence of EU-based subsidiaries belonging to EU-based Scoreboard companies shown in Figure 13.

Figure 15 provides a deeper dive into the international dimension of Scoreboard companies based in different countries by focusing on their **multinational depth and multinational breadth** as defined by Castellani et al (2017).[60] Depth is defined as share of international subsidiaries of all subsidiaries of a Scoreboard company, while breadth is defined as the number of foreign countries in which the subsidiaries of a company are located. It is interesting to delve into this aspect of the multinationality of Scoreboard companies as both depth and breadth have implications for productivity and R&D intensity (see Castellani et al, 2017). The authors find that greater depth is associated with higher productivity, while breadth is associated with lower productivity; with both metrics themselves being positively associated with R&D intensity and, indirectly, productivity.

Figure 15. Multinational depth and breadth of EU Scoreboard companies, by country, 2023



Notes: Data refers to the 1 893 companies with data on subsidiaries.
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

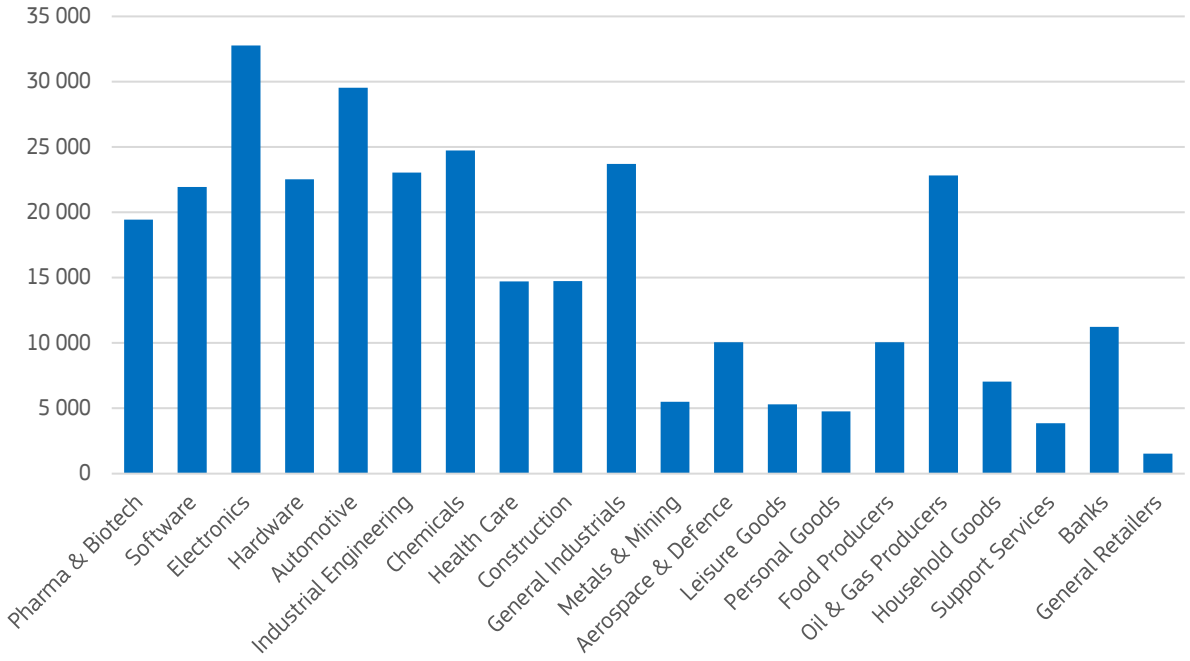
The map shows that Scoreboard companies based in different countries are characterised by different degrees of multinational breadth and depth. Scoreboard companies based in Ireland and the Netherlands (dark blue in Figure 15) had the highest international depth and breadth; companies

[60] Castellani, D., Montresor, M., Schubert, T., Vezzani, A. (2017). Multinationality, R&D and productivity: Evidence from the top R&D investors worldwide. International Business Review, 26, 405-416.

headquartered in these countries not only had the largest share of international subsidiaries, they also had subsidiaries in more countries around the world than the other EU-based Scoreboard companies. At the opposite end of the spectrum, Scoreboard companies located in Slovenia and Hungary (white) were the most domestically focussed in terms of width as wells as breadth. Most EU countries (Finland, France, Germany, and Sweden, coloured in purple in the map) host Scoreboard companies that had a comparable share of international subsidiaries to the ones in the blue countries, but were more concentrated geographically.

Finally, Figure 16 looks at the composition of the Scoreboard from a sectoral viewpoint. The graph considers the 20 sectors containing the largest number of companies and orders them in descending order along the x-axis. In line with last year's edition, companies operating in electronics recorded the highest number of subsidiaries (over 30 000). In contrast to last year, when industrials (now 4th) came in a close second, this year electronics is followed closely by automotive and at some distance by companies in the chemicals sector.

Figure 16. Number of subsidiaries of the top 2 000 companies by ICB 3 sector of the mother company, 2023



Notes: Data refers to the 1 893 companies for which data on subsidiaries are available. The sectors are ordered from left to right in descending order based on the number of Scoreboard mother companies (e.g. pharma & biotech contain the highest number of companies, but they have on average fewer subsidiaries per company than e.g. software companies or electronics companies).

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

2.6 Key points

- **Global R&D investment:** The top 2 000 global companies invested a total of EUR 1 257.7 billion in R&D in 2023, representing an absolute increase of EUR 90.6 billion compared to 2022 (7.8% growth rate). This growth rate is higher than the compound average annual growth rate since 2013 (7.4%).
- **Regional R&D investment growth:** The EU (9.8%) and China (9.6%) had the highest nominal R&D investment growth rates in 2023, followed by the US (5.9%), Japan (7.1%), and the ROW (9.1%). The EU's growth rate was driven by strong increases in R&D investment by EU automotive companies.

— **Top R&D investors:** The top 50 R&D investors invested EUR 503.7 billion in 2023, accounting for 40.1% of the total Scoreboard R&D investment. US-based companies led the ranking, with 6 out of the top 10 and 22 out of the top 50 companies being headquartered in the US.

— **Concentration of R&D:** The top 10 companies invested more than double the amount than the top 50 (including the top 10). The top 50 invested on average over 50% more than the top 100, and the latter invest 3.2 times more than the top 500. The R&D share of the top 100 is around 50% of the total in the Scoreboard, and the top 500 cover 80%.

— **Global R&D share of top 50 companies:** The Scoreboard companies account for ca. 85-90% of global corporate R&D (BES-R&D), and in conjunction with the share of the top 50 companies this implies that 50 companies worldwide control over one third of total global corporate R&D investment.

— **R&D intensity:** R&D intensity (R&D as a share of net sales) increased to 5.1% in 2023, the highest value in the Scoreboard so far. The US companies led with an average R&D intensity of 8.4%, followed by the EU companies and those from Japan with 4.2%.

— **R&D per employee:** The US companies invested on average EUR 48 593 on R&D per employee, significantly more than the EU (EUR 15 427) and all other countries. The sectors with the highest R&D investment per employee were health and ICT services, while ICT hardware and automotive companies invested much less in R&D per employee.

— **Profitability:** Aggregate profits fell by 8% in 2023, mainly due to the strong decline in profits of the ROW companies (-34%), which was largely driven by the decline in oil prices and the resulting lower sales of energy companies.

— **Capital expenditures:** Total capital expenditures (capex) increased by 9.3% in 2023, driven by EU companies (+20.6%), US companies (+12.3%), and Japanese companies (+12%). Chinese companies slightly reduced their capex (-0.7%).

— **Employment:** Employment fell slightly by 0.2% in 2023, with EU companies expanding their workforce by 3.7% and Chinese companies by 3%, while US, Japanese, and ROW companies reduced their employment.

— **Market capitalisation:** Market capitalisation recovered in 2023, increasing by 21% to EUR 43 924 billion, with US companies accounting for 53.6% of the total. The strongest growth was realised by Japanese companies (+41.4%), followed by EU companies (+23.3%) and US companies (+24.7%).

— **Subsidiaries:** The top 2 000 companies control close to 380 000 subsidiaries, with EU-based companies owning the most subsidiaries globally (36%). Over 90% of subsidiaries are located in the top 20 countries (71% just in the top 5). The country where most subsidiaries are located is the US, which accounts for 34.3% of the total, followed by France (11.1%), Germany (10.6%), Japan (9.4%), and China (6%).

— **Multinationality**: Scoreboard companies based in different countries have different degrees of multinational breadth and depth. Japanese companies are the most internationalised, with only 15.1% of their subsidiaries located in Japan. EU companies have a high level of internationalisation, with 46.5% of their subsidiaries located in the EU and 30.4% in the US.

— **Corporate venture capital:** Corporate venture capital (CVC) is becoming an increasingly important means for companies to tap into high-potential, startup-driven innovation. The top 5 R&D investing companies in each of the 5 regions have CVC funds that invest in startups, with 78.5% of deals involving multiple investors. The automotive sector is a key area of focus for CVC investment, with investments in autonomous and sensor technologies dominating the landscape.

3 R&D investment by sector

Large and multinational companies often operate in multiple domains, making it difficult to assign them to one single industrial sector. Therefore, since its first edition, the Scoreboard has assigned companies to their main sector according to the taxonomies provided by the Industry Classification Benchmark (ICB) and its predecessors. The main sector is usually the one indicated by the companies in their annual reports. The ICB 3-digit classifications are grouped into 10 broader categories and the remaining, mostly small sectors are moved into the category 'Others'. Section 3.1 of this report describes the characteristics of these 11 sector groups, section 3.2 looks at the development of R&D investment across the sectors, while Section 3.3 investigates the distribution of companies across the regions. Section 3.4 describes the recent development in the top 4 sectors, and Section 3.5 takes a deep-dive into the key performance indicators for these sectors. Section 3.6 and Section 3.7 repeat the analysis for the sectors outside the top 4, and Section 3.8 concludes with key points.

3.1 Overview of sectors

Table 10 shows the breakdown of the companies in 2023 by ICB 3-digit classification and provides the number of companies and the sector's share of the 2 000 companies. The table also shows each sector's R&D investment and its share of the total Scoreboard R&D, its R&D intensity, and the average R&D investment per company.

Table 10. R&D by ICB3 sector classification, 2023

ICB3 sector	Sector classification (ICB4)	Companies, share	2023 R&D (EUR bn), share	R&D intensity	R&D per company (EUR million)
Aerospace & defence	Aerospace; Defence	38 (37) 1.9%	20.7 1.7%	4.1%	544.8
Automotive	Automobiles & parts; Tyres; Commercial vehicles & trucks	154 (150) 7.7%	185.3 14.7%	4.8%	1 203.3
Chemicals	Chemicals; Specialty chemicals; Specialty retailers	90 (98) 4.5%	25.1 2.0%	2.4%	278.6
Construction & materials	Heavy construction; Construction & materials; Building materials & fixtures	58 (48) 2.9%	32.9 2.3%	2.4%	567.9
Energy	Exploration & production; Renewable energy equipment; Oil & gas producers; Electricity; Oil equipment, services & distribution; Alternative energy; Alternative fuels; Conventional electricity; Gas, water & multiutilities; Gas distribution; Integrated oil & gas	63 (58) 3.2%	23.7 1.9%	0.6%	377.1
Financial	Banks; Specialty finance; Financial services; Real estate investment & services; Investment services; Real estate holding & development; Consumer finance; Full line insurance	49 (50) 2.5%	23.2 1.9%	3.3%	473.7
Health	Pharmaceuticals; Biotechnology; Medical equipment; Healthcare equipment & services; Healthcare providers	437 (446) 21.9%	258.1 20.5%	13.5%	590.6
ICT hardware	Computer hardware; Telecommunications equipment; Electronic equipment, Semiconductors; Electrical component & equipment; Electronic office equipment	382 (371) 19.1%	287.3 22.9%	8.2%	752.1
ICT software	Computer Services; Software; Telecommunication services	300 (301) 15.0%	259.6 20.6%	10.9%	865.3
Industrials	General industrials; Iron & steel; Diversified industrials; Industrial machinery; Transportation services; Mining; Coal; Industrial metals & mining; Containers & packaging; Nonferrous metals; Industrial transportation; General mining;	219 (218) 11.0%	58.7 4.7%	2.5%	268.3

	Aluminium; Gold mining; Platinum & precious Metals; Industrial suppliers;				
Others*	Leisure goods; General retailers; Food & drug retailers; Food producers; Household goods & home construction; Travel & leisure; Media; Personal goods; Support services; Beverages; Tobacco; Forestry & paper	210 (222) 10.5%	82.9 6.6%	3.0%	394.7
Total		**2 000**	**1 257.6**	**5.1%**	**628.8**

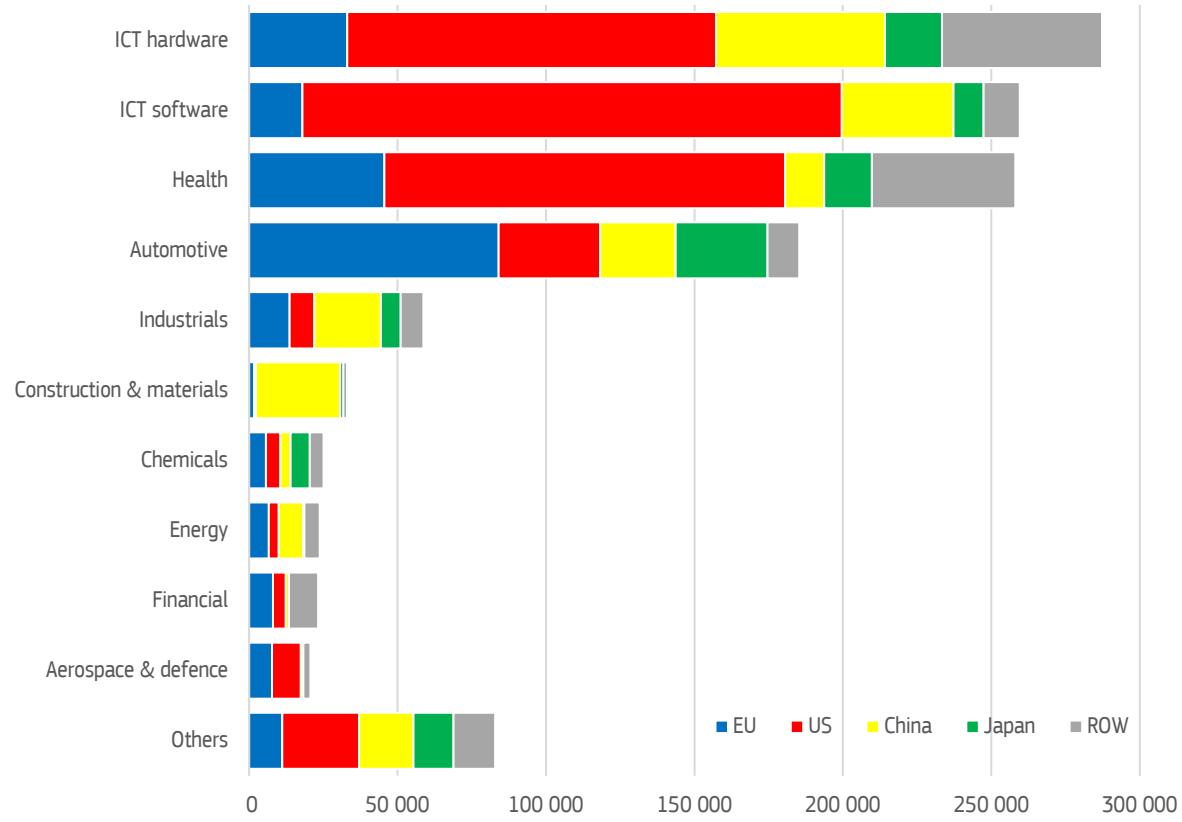
Notes: *Sectors listed under 'Others' are presented at ICB3 digit level. Figures in brackets represent the number of companies in 2022. R&D intensity is defined as R&D investment divided by net sales per sector, R&D investment per company is the average per sector.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Figure 17 shows the distribution of the R&D investment of the 2 000 companies in 2023 by sector and region. Corporates headquartered in the **US made the biggest contribution to the top 3 sectors with the most R&D investment**, namely ICT hardware, health and ICT software, with a particularly high degree of dominance in ICT software (and services). The second largest R&D investment in the ICT hardware sector came from Chinese companies, closely followed by companies located in ROW countries (mainly Taiwan and South Korea), while EU companies rank only fourth and quite far behind. In ICT software, Chinese companies contributed the second largest share of R&D investment after the US, and EU companies are ahead of ROW and Japan. In the health sector, US-based companies dominate as well, followed by ROW countries and EU companies, and ahead of Japan and China. In this sector, the US companies invested over 10 times more in R&D than the Chinese companies. The fourth largest sector, **automotive, is the EU stronghold with 45.4% of the sector's total investment,** and EU companies invested more than twice as much in R&D than their competitors from Japan and the US, and over three times more than Chinese automotive companies. In 2023, for the first time, R&D investment from the US automotive companies exceeded that of the Japanese companies, which until then had been the second most important region in the automotive sector.

The **top 4 sectors** in terms of R&D **accounted for 78.7% of all corporate R&D investment** in the Scoreboard and **represented 63.7% of the companies**. This represents a small decline in terms of R&D share compared to the previous year, but a slight increase in the share of firms (79% and 63.4%, respectively).

Figure 17. R&D investment by sector and country/region, 2023



Notes: R&D investment in EUR million.
Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

3.2 Distribution of companies across sectors and regions

Table 11 gives the share of the number of firms per sector across the 5 countries/regions; each cell contains the number of firms and the share of firms in the respective regional total in 2023. The column 'Total' contains each sector's share of companies in the top 2 000, and the row 'Total' each country's/region's number and share of Scoreboard companies. Comparing the shares (numbers) of companies for each region with the regional total (column total) shows in which sector a region has a larger share than its overall share of firms (marked in bold). This can be interpreted as a regional specialisation.

For each country/region the bold figures indicate those sectors for which the share (number) of companies is larger than its overall share in the Scoreboard. In this relative specialisation pattern we observe that the **EU is over-represented in 7 of the 11 sectors.** However, these 7 sectors are of **medium and low R&D intensity** (see Table 10), and in fact, EU firms are significantly **under-represented in the top 3 R&D sectors:** ICT hardware, ICT software, and health. In terms of numbers, the EU has the second-most aerospace & defence companies and automotive companies, and the largest number of companies in the energy and financial sector.

The **US specialises in 2 out of the 4 top R&D sectors**, ICT software and health, with almost 55% of the Scoreboard companies in these sectors being US companies. Global ICT software and health continue to be dominated by US companies, but while the US share in health firms also increased in 2023, the share of ICT companies fell somewhat from over 57% in the past years to 54.3%. In

addition, the US leads in aerospace & defence in terms of number of companies and with an increasing trend.

Table 11. Distribution of firms across sectors and regions, number and share per region (in brackets), 2023

	EU	US	China	Japan	ROW	Total
Aerospace & defence	**11 (29%)**	**15 (39.5%)**	5 (13.2%)	0	**7 (18.4%)**	38 (1.9%)
Automotive	**37 (24%)**	33 (21.4%)	**40 (25.9%)**	**26 (16.9%)**	18 (11.7%)	154 (7.7%)
Chemicals	14 (15.6%)	17 (18.9%)	**22 (24.4%)**	**26 (28.9%)**	11 (12.2%)	90 (4.5%)
Construction & materials	**7 (12.1%)**	43(5.2%)	**34 (58.6%)**	**8 (13.8%)**	6 (10.3%)	58 (2.9%)
Energy	**23 (36.5%)**	9 (14.3%)	19 (30.2%)	4 (4.8%)	9 (14.3%)	63 (3.2%)
Financial	**18 (36.7%)**	11 (22.5%)	7 (14.3%)	0	**13 (26.5%)**	49 (2.5%)
Health	64 (14.7%)	**238 (54.5%)**	63 (14.4%)	21 (4.8%)	51 (11.7%)	437 (21.9%)
ICT hardware	34 (8.9%)	109 (28.5%)	**123 (32.2%)**	**42 (11%)**	**74 (19.4%)**	382 (19.1%)
ICT software	24 (8%)	**163 (54.3%)**	68 (22.7%)	7 (2.3%)	38 (12.7%)	300 (15.0%)
Industrials	**51 (23.3%)**	26 (11.9%)	**88 (40.2%)**	**25 (11.4%)**	29 (13.2%)	219 (11.0%)
Others	**39 (18.6%)**	57 (27.1%)	**55 (26.2%)**	**27 (12.9%)**	**32 (15.4%)**	210 (10.5%)
Total	322 (16.1%)	681 (34.1%)	524 (26.2%)	185 (9.3%)	288 (14.4%)	2 000 (100%)

Notes: % refer to the row total. Bold figures indicate that the sector has a higher share than the region's overall share of the number of firms in 2023. Share figures in the 'Total' column represent the sector's share in the total Scoreboard.
Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

China and Japan displayed a similar pattern in 2023 in terms of sectoral representation; both countries having an over-proportionate number of firms in sectors with low R&D intensity such as construction & materials or chemicals – indeed, Chinese companies represent over 58% of the Scoreboard firms in the construction & materials sector. At the same time, **China has established a strong basis in ICT hardware** with 32.2% of the sector's companies, as well as in industrials.

However, having a large share of the number of firms does not automatically correspond to a high share in R&D investment, as can be seen when combining the insights to be taken from Table 11 and Figure 17. While China has the largest number of companies in the automotive sector, China's aggregate R&D investment is still considerably lower than that of the other regions, with the exception of ROW (see Section 3.4). Moreover, both, China and the ROW countries have an over-proportionate share of ICT producer firms, but again, their share of R&D is far below their share of companies.

The countries grouped under **ROW** include major R&D locations such as the UK, Switzerland, South Korea and Taiwan, and more emergent innovation locations such as Brazil or Vietnam. This diverse group of countries has an over-proportionate share of **ICT producers** due to their major semiconductor manufacturers, and electric and electronic equipment producers, notably in Taiwan and South Korea. The highest share of ROW-companies falls in the **financial sector**, with large British banks dominating the group. Likewise, the aerospace & defence sector is well represented with major companies from the UK, Canada and Brazil. Also **the largest oil and gas producers** are in the ROW group, mainly from Saudi Arabia and the UK. Finally, the health sector contains large R&D and **research-intensive pharmaceutical companies** headquartered in Switzerland and the UK.

As described in more detail in the 2023 edition of the Scoreboard, the more than threefold increase in the number of Chinese companies in the Scoreboard since 2013 has led to changes in the regional composition. The rise of Chinese firms was at the expense of companies headquartered in the EU, Japan and ROW, while the US maintained and even slightly increased its share among the top-R&D investing companies globally. The **EU's share** of the top 2 000 companies declined from 21% in 2013 to 15.3% in 2021, and but has **recovered** since then **to 16.1%**. As a consequence, the EU only

leads by number of firms in the relatively small sectors energy and financials; both sectors are also small in terms of R&D share (both 1.9%, see Table 10).

3.3 Growth rates across sectors and regions

Table 12 shows R&D investment growth (in %) relative to the previous year since 2013 for each of the 11 sectors, both in nominal values and in inflation-adjusted growth rates (in brackets), as well as the compound annual growth rate per sector during this period. Overall, R&D investment grew in 2023 by 7.8% (4.5% when adjusted for inflation), corresponding to a total increase of EUR 90.6 billion (EUR 46.2 billion). The nominal growth rate in 2023 is therefore higher than the compound average annual growth rate (CAGR) of 7.4% since 2013, and the real growth rate is somewhat below the inflation adjusted CAGR of 5.5%.

In 2023, the **highest relative growth** was in the **energy sector,** with an increase of 20.7% (EUR 4 billion) to EUR 23.7 billion, followed by automotive with a 13.2% increase and 'Others' with a 11.5% increase. The **automotive sector** therefore continues to show **above-average growth,** and increased its R&D investment from EUR 143.3 billion in 2021 to over EUR 185 billion in 2023.

Table 12. Nominal and inflation adjusted growth rates of R&D investment per ICB3 sector in %, 2013-2023

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	CAGR
Aerospace & defence	3.9 (2.4)	2.2 (0.8)	0.5 (-0.3)	2.1 (1.1)	-5.2 (-6.6)	2.4 (0.7)	-0.1 (-1.8)	-15.2 (-16.8)	1.6 (-2.1)	8.8 (2.6)	7.4 (3.4)	0.2 (-1.9)
Automotive	5.5 (4.2)	8.8 (7.0)	7.8 (6.3)	5.4 (4.5)	6.2 (4.7)	7.2 (5.6)	2.8 (1.2)	-3.9 (-5.2)	9.1 (6.0)	14.2 (9.8)	13.2 (8.6)	6.3 (4.3)
Chemicals	3.1 (2.0)	2.0 (0.8)	1.3 (0.7)	0.1 (-0.6)	-1.5 (-2.6)	0.5 (-1.1)	2.0 (0.8)	-3.7 (-4.7)	14.5 (12.0)	6.1 (2.8)	1.7 (-1.6)	2.0 (0.5)
Construction & materials*	25.0 (24.5)	9.7 (8.8)	18.3 (18.7)	14.3 (13.3)	12.3 (9.2)	22.1 (19.0)	20.9 (19.6)	25.1 (24.6)	17.4 (12.7)	14.5 (12.3)	9.0 (9.1)	14.7 (13.2)
Energy**	-2.8 (-4.7)	2.7 (1.4)	-5.9 (-7.1)	-11.8 (-12.1)	4.4 (1.6)	4.8 (4.4)	10.4 (9.5)	1.0 (0.3)	6.4 (2.8)	9.0 (4.6)	20.7 (16.1)	3.5 (1.7)
Financial*	8.5 (7.6)	5.4 (4.4)	39.9 (37.8)	-13.0 (-13.9)	6.3 (4.7)	0.3 (-2.5)	8.5 (6.8)	11.6 (10.0)	4.7 (1.7)	11.4 (5.6)	9.3 (3.6)	7.0 (4.6)
Health	3.3 (2.0)	6.3 (5.1)	8.4 (7.4)	6.1 (5.2)	6.4 (5.0)	6.7 (4.9)	5.9 (4.7)	9.2 (7.6)	16.4 (12.8)	7.0 (1.6)	4.9 (1.3)	7.0 (5.0)
ICT hardware	4.3 (2.8)	5.2 (3.9)	5.2 (4.2)	2.7 (1.8)	10.9 (8.8)	7.1 (4.9)	7.3 (6.0)	5.2 (4.1)	10.8 (6.9)	14.2 (9.5)	8.0 (5.4)	6.9 (5.0)
ICT software	11.9 (10.3)	10.9 (9.3)	11.8 (10.9)	7.4 (6.4)	19.1 (17.4)	19.4 (17.0)	19.0 (17.1)	16.6 (15.4)	20.8 (15.9)	18.3 (11.8)	5.6 (3.1)	13.3 (11.1)
Industrials*	-1.5 (-2.3)	-2.3 (-3.4)	0.9 (-0.2)	6.4 (5.9)	2.0 (0.7)	8.4 (6.7)	9.2 (8.3)	-1.9 (-2.8)	11.8 (8.8)	11.9 (8.2)	5.6 (3.1)	4.6 (3.1)
Others	3.0 (2.0)	5.0 (3.7)	1.9 (0.8)	11.2 (11.1)	1.2 (-0.6)	6.9 (5.6)	7.7 (6.5)	1.9 (0.8)	14.3 (11.3)	10.0 (5.8)	11.5 (8.6)	6.4 (4.8)
Total	**4.6 (3.3)**	**6.0 (4.6)**	**6.9 (5.8)**	**4.6 (3.8)**	**7.9 (6.2)**	**8.6 (6.7)**	**8.2 (6.8)**	**5.7 (4.5)**	**13.8 (10.0)**	**12.6 (7.6)**	**7.8 (4.5)**	**7.4 (5.5)**

Notes: Due to the low number of firms in some sectors growth rates can change considerably due, e.g. to firm entry/exit. Inflation adjusted values are given in brackets. CAGR refers to the compound annual growth rate in the period 2013-2023. *86% of the construction sector R&D in 2023 comes from Chinese companies; given that China experienced a period of deflation, the inflation-adjusted growth rate is higher than the nominal growth rate. *Sector strongly affected by firm entry/exit in 2015 and 2016.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

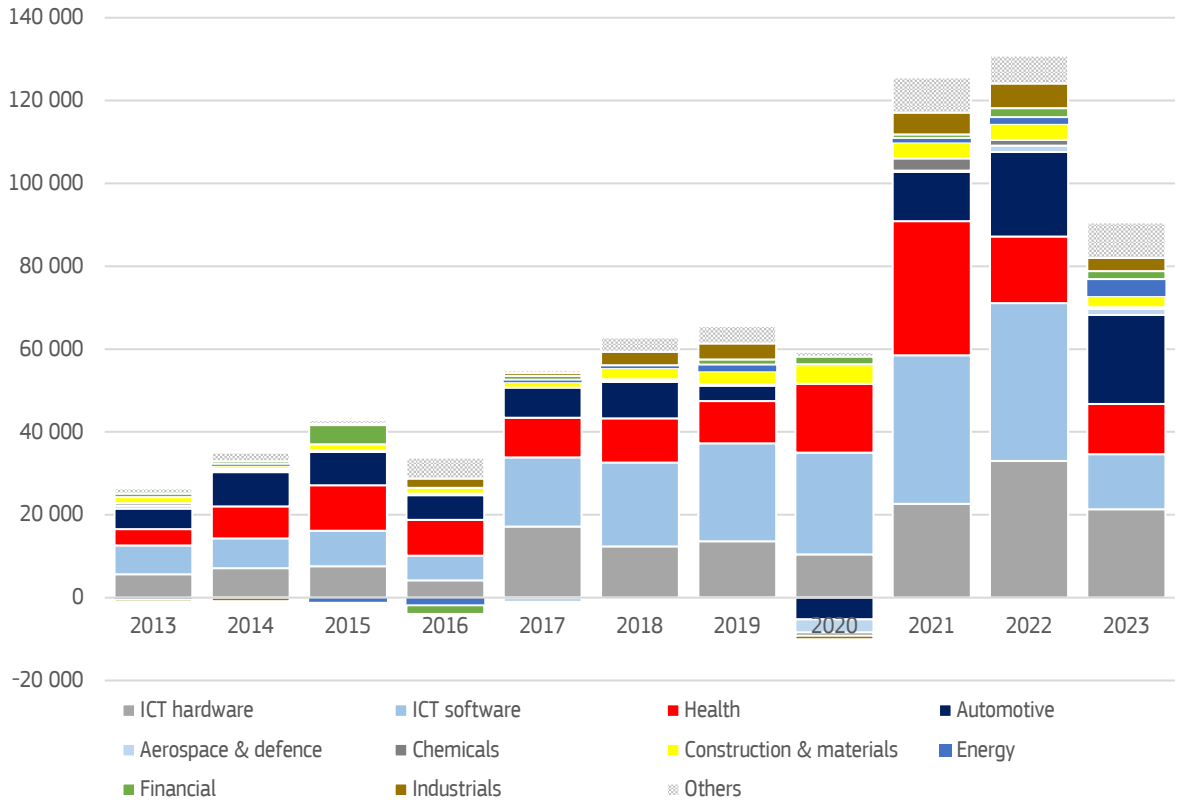
Since 2013, ICT software has been the sector with the highest growth rates (apart from construction & materials, which is driven almost entirely by Chinese SOEs – see Table 2 and Figure 17), and despite the sector's already very high levels of R&D, growth has still accelerated over time. However, in 2023 the **strong growth of ICT software dropped a lot** to a moderate 5.6%, the lowest growth rate

since 2016, and well below the CAGR of 13.3%. The same holds for the other most R&D intensive sectors, ICT hardware and health: **health sector R&D investment growth** already started to fall in 2021, but in 2023 it reached its **lowest rate since 2013** with an increase of 4.9%, well below the CAGR of 7%. Also, ICT hardware companies raised their R&D investment at a lower rate, but the increase of 8% in 2023 still exceeds the long-term growth.

Figure 18 shows the contribution of each sector to the annual nominal increase in total R&D investment in absolute terms. In terms of the contribution to the net change in R&D investment in 2023, the **automotive sector added the most** with an **additional EUR 21.5 billion**, or 23.8% of the total increase of the 2 000 companies combined. It is the first time the Scoreboard has seen additional investments in R&D by automotive companies exceed those of the two ICT sectors individually – the sectors that traditionally dominate aggregate investment. As we will see in Section 3.4, this development is driven by automotive companies around the world, but the EU companies dominate the picture due to their size.

The second largest sector contribution to R&D investment growth comes from **ICT hardware** producers with EUR 21.3 billion (23.5% of the net increase), **followed by ICT software** with an additional EUR 13.3 billion spent on R&D in 2023 (14.7% of the change). The **health sector increased by significantly less** than in 2020 and 2021, its contribution returning to the pre-COVID-19 level.

Figure 18. Annual change in R&D investment by sector in EUR million - Sectoral decomposition, 2013-2023



Source: The 2023 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Since 2013, the two ICT sectors have on average been responsible for almost 50% of total R&D investment growth in the Scoreboard, with an increasing trend in the more recent years. However, in 2023 the ICT sectors' growth contribution is down to 38%, the lowest value so far.

Among the sectors that are smaller in in terms of R&D, the **energy sector stands out** with a net contribution of over EUR 4 billion or 4.5% of the total change. For this sector, 2023 featured the largest absolute amount of R&D invested to date (see Table 10); with **total R&D of EUR 23.8 billion**, the energy sector is ahead of the aerospace & defence sector, and close behind the chemicals sector.

Figure 18 illustrates the substantial increase in the two ICT sectors over time. Even though the ICT sectors were already the largest in terms of R&D, their R&D have expanded activities even more. The third-largest contributor has been the health sector, but in 2022 and 2023, the additional investments of the automotive companies exceeded those of health, and in 2023 also those of the two ICT sectors (when taken separately).

To summarise the development in 2023 by sector and by region, Table 13 presents the growth rates of R&D investment (inflation-adjusted values in brackets) along these two dimensions. The column 'Total' refers to the growth rate of the sector, and the row 'Total' to the growth rate in the specific region/country.

Table 13. Nominal R&D investment growth rates across sectors and regions, top 2 000 (deflated in brackets), 2023

	EU	US	China	Japan	ROW	Total
Aerospace & defence	7.9% (1.2%)	7.6% (3.8%)	180.0% (181.5%)		-13.2% (-14.7%)	7.4% (3.4%)
Automotive	14.3% (7.3%)	4.9% (1.2%)	26.9% (27.6%)	7.1% (3.2%)	22.7% (19.7%)	13.2% (8.6%)
Chemicals	2.1% (-4.0%)	3.0% (-0.6%)	-5.7% (-5.2%)	0.3% (-3.4%)	3.7% (3.5%)	1.7% (-1.6%)
Construction & materials	1.4% (-4.3%)	2.5% (-1.1%)	10.8% (11.4%)	7.1% (3.2%)	-11.7% (-11.1%)	9.0% (9.1%)
Energy	20.9% (15.6%)	22.4% (18.1%)	11.6% (11.1%)	-0.9% (-4.5%)	41.7% (29.0%)	20.7% (16.1%)
Financial	5.9% (0.7%)	0.1% (-3.4%)	-40.2% (-39.9%)		29.8% (21.6%)	9.3% (3.6%)
Health	5.1% (0.6%)	5.3% (1.6%)	0.1% (0.6%)	16.8% (12.6%)	1.7% (-2.1%)	4.9% (1.3%)
ICT hardware	7.0% (0.6%)	6.5% (2.8%)	9.3% (9.9%)	6.9% (3.0%)	11.3% (9.9%)	8.0% (5.4%)
ICT software	7.6% (1.5%)	4.3% (0.6%)	6.6% (7.2%)	11.2% (7.2%)	10.5% (8.4%)	5.4% (2.3%)
Industrials	9.6% (3.8%)	-3.0% (-6.5%)	6.1% (6.7%)	-6.5% (-9.9%)	21.6% (17.8%)	5.6% (3.1%)
Others	12.5% (7.4%)	23.2% (18.9%)	11.6% (12.2%)	5.6% (1.8%)	-1.1% (-2.6%)	11.5% (8.6%)
Total	9.8% (3.7%)	5.9% (2.2%)	9.6% (10.2%)	7.1% (3.3%)	9.1% (6.0%)	7.8% (4.5%)

Notes: The table reports nominal R&D investment growth rates, inflation adjusted growth rates are in brackets. Figures in the 'Total' column represent the sector's R&D investment growth across all regions, and the row 'Total' the region's R&D investment growth. There are no Japanese companies with the main sector classification in aerospace & defence and financials in the Scoreboard.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

In nominal terms, the **EU companies increased their R&D by more than the sectoral average in 8 out of the 11 sectors** (aerospace & defence, automotive, chemicals, energy, health, ICT software, industrials and others), confirming the **broad-based positive development in 2023**. The US, in contrast, only 4 sectors are above the average, in China and ROW 7 sectors exceed the average nominal growth, and in Japan only 2 sectors.

However, taking into account the **increase in prices** shows that **in the EU** the R&D investment growth in the sectors **chemicals** as well as in **construction & materials were actually negative**, while financial, health and ICT hardware basically stagnated in the past year. Even **worse in the US, where 4 sectors recorded negative inflation-adjusted R&D investment growth** – here also the chemicals and the construction sector were negative (but less than in the EU), as well as financials and industrials. In **China**, in contrast, the (relatively) weak development of the economy with lower

consumer spending and **falling prices** (deflation) in 2023 caused real R&D investment growth to exceed the nominal values. Even if Chinese (real) growth rates are slowing down since 2018, the companies continued to expand R&D at high rates – **in 7 sectors the Chinese companies grow faster than the sector average**. In **Japan**, only the **health and the ICT software** sectors **exceed average sectoral growth,** while the other 7 sectors are below. The energy sector as well as industrials reduced their R&D investments, and the chemicals sector turns negative when inflation is taken into account. Finally, in the **ROW group**, **7 sectors grew faster than the average**, while 3 sectors experienced negative nominal growth rates, and the health sector turned negative when inflation is accounted for.

In **aerospace & defence**, EU and US companies developed similarly, while the strong growth for China relates to the increase in the number of companies (from 3 to 5), resulting in a sector total of EUR 804 million. In ROW, the sector lost R&D compared to 2022 due to a net reduction by 3 companies (to a total of 7), and the larger firms (Rolls Royce, Bae Systems) reduced their R&D investments. As the aerospace & defence sector has only 38 companies, changes in a few companies can cause large relative changes.

The **automotive sector** has been the **driver of growth in 2023** with a net addition to R&D investment of EUR 25.1 billion. In particular EU, Chinese and ROW companies raised their R&D investments substantially, while the development in Japan and the US was more modest. In the EU, the largest companies increased their R&D the most, such as Volkswagen (+15%), Mercedes-Benz (+17%), Stellantis (+11%), Robert Bosch (+18%), or Volvo (+16%). In the US, the development was very different – while the US automotive sector R&D expanded by 31% and 15% in 2021 and 2022, respectively, R&D investment growth in 2023 returned to the pre-COVID rates. The largest US automotive company, General Motors, increased nominal R&D by 1% and Ford by 5%, while EV producer Tesla raised R&D investment by 29%. However, another US EV company in the Scoreboard, Rivian, increased R&D by only 0.4%, and Nikola Corporation reduced its R&D by 21%. In China, the automotive sector continued its expansion: EV producer BYD doubled its R&D investment with respect to 2022 (see Section 2.2), Geely Automotive increased it by 70%, and also extended-range EV company Li Auto raised its R&D investment by 60%. In Japan, automotive R&D investment developed more moderately in the post-COVID period. In 2023, the largest company, Toyota Motors, reduced R&D by 2.5% to EUR 7.3 billion (which is one third of the largest in this sector, Volkswagen), while Honda Motor and Nissan Motor increased strongly (up by 12% and 17%). In ROW, the strong growth is driven by the Indian company Tata Motors, increasing R&D by 44% to EUR 2.5 billion, followed by the two South Korean companies Hyundai Motor and Hyundai Mobis with 19% and 17% increases; also the Canadian company Magna raised R&D investment strongly by 32%. Tata Motors became the largest automotive R&D investor in the ROW countries in 2023 (previously Hyundai Motor).

The **chemicals sector R&D investment growth** was **negative** when inflation is taken into account, and only ROW companies reported positive real increases. In the EU, the sector lost R&D due to reductions by the German companies BASF (-6%) and Evonik (-8%), while Dutch company DSM increased by 33% and French L'Air Liquide by 20%. In the US, the largest chemicals company in the Scoreboard, Corteva, raised R&D investment by 9%; in contrast, Dow and Dupont reduced it (down by 2% and 12%, respectively). In China, the aggregate development is influenced by the exiting of 4 firms from this year's Scoreboard; the largest Chinese chemicals company in the Scoreboard, Rongsheng Petrochemical, increased R&D by 39%. In Japan, the stagnation in R&D investment mainly relates to lower R&D investments by Sumitomo Chemical (-2%) and Mitsubishi Chemical (-18%), while smaller companies such as Teijin and JSR stepped up their R&D investment (up by 34% and 18%). Finally, the ROW chemical sector substantially raised its R&D investment. The result is mainly

driven by Saudi Basic Industries which entered the Scoreboard in 2023 with an R&D investment of EUR 400 million.

In the **construction & materials** sector, EU, US and ROW companies' real R&D investment growth rates were negative, but Chinese and Japanese companies continued to raise their R&D investments. However, the **Chinese construction SOEs were considerably slowing down their R&D investment**, from on average 20% in the past decade to only 10% in 2023.

The **energy sector** was the one with the **largest relative increases** in 2023: the companies more than doubled the additions to R&D compared to the previous year, and ROW companies even raised their R&D investment by 41.7% (21.6% when adjusted for inflation). In this group, the highest relative increase came from Brazilian Petrobras that increased its R&D investment over 5 times to EUR 676 million. The largest companies in this sector, Saudi Arabian Oil and Shell, raised their R&D investments by 17% and 19%, respectively. **In the US**, the largest increases related to **companies in solar energies,** with First Solar investing 35% more in R&D, followed by Solaredge Technologies with a 32% increase, but also traditional energy companies such as Chervon, Halliburton and Schlumberger increased strongly (up by 19%, 18% and 12%, respectively). **A similar picture emerges in the EU**, with e.g. German company SMA Solar Technology increasing R&D by 38%, Electricité de France by 25%, the Italian gas transportation company SNAM by 43%, and the Danish newcomer Dong Energy in **offshore wind** adding another EUR 309 million to EU R&D investment in the energy sector. The Chinese energy companies that drive the overall development are Petrochina, the largest Chinese R&D investing energy company (+11%), solar energy company Sungrow Power Supply (+53%) and offshore oil company CNOOC (+20%). Only in **Japan**, the energy R&D investment in 2023 was lower than in 2022 due to the exit of one company in the Scoreboard, while the remaining 3 companies increased their R&D investments.

In the **financial sector**, only ROW companies created real additions to R&D investment in 2023, while in the US and China, the (real) growth rates were negative, and EU companies' real R&D investment remained unchanged. The EU provided a mixed picture in 2023 – some companies strongly increased their R&D (such as Santander with 25% increase) while others reduced it (e.g. Intesa Sanpaolo -34%, Unicredit -9%). In the US, the negative sectoral development related to strong reductions by Mastercard (-40.5%), Paypal (-7%) and Zillow Group (-15%), while smaller companies increased their R&D (such as Naspers Limited, up by 59%). In **China**, the number of companies dropped from 11 to 7 and in addition, most of the remaining companies **strongly reduced their R&D investment**. The **strong growth in ROW** related to **newcomers** to the Scoreboard: The British company Barclays re-entered the Scoreboard with R&D investment of EUR 1 393 million in 2023, and Singapore-based newcomer UOL Group added another EUR 661 million. In contrast, the largest R&D investing company, HSBC Holdings (also with headquarter in the UK), reduced its R&D investment by 13%.

Real R&D investment growth by **health companies stagnated** in all regions **except Japan**, with **negative growth in ROW**. **In the EU, big pharma companies developed rather heterogeneously**, with companies such as Novo Nordisk (+35%), Biontech (+29.7%) or Boehringer Sohn (+14%) raising their R&D investment substantially, while others such as Bayer (-17%) reducing it, and Sanofi, Medtronic and Merck maintaining the level of the previous year. In the **US, similar to the EU,** the development among the big health companies turned out quite heterogeneous, and the changes in R&D investment year-on-year were often substantial. The most significant increases came from Eli Lilly and Modern (see Section 2.2 for details) with 29.5% and 89%, respectively, while Pfizer or Bristol-Myers Squibb reduced their R&D investment by 7% and 3%. In **China**, the health sector is

relatively small and there are **no such large companies as in the other world regions/countries**. The biggest is Beigene with EUR 1 577 million R&D investment (+6%), and it is the only Chinese health company with R&D investment exceeding EUR 1 billion. The aggregate development was thus not as much driven by few big companies as in the other regions. **In ROW,** the health sector R&D investment fell in real terms by 2.1% due to **lower R&D investments by the large Swiss companies** (Roche down by 6%, Novartis down by 2%), while the **big UK companies increased** (Astrazeneca +9%, GSK +10%). Finally, in **Japan**, the health sector bucked the trend and **continued its strong expansion** for the third year in a row (2021 up by 12%, 2022 up by 15%). The incumbent firms such as Takeda (+15.9%), Otsuka (+12%) and Daiichi Sankyo (+7%) continued to increase, and moreover, the Scoreboard now also newly includes Chugai Pharmaceutical, with an R&D investment of EUR 1 034 million.

In **ICT hardware**, the 2023 **growth rates were below** what they were for **the previous 2 years**, only companies in ROW maintained former growth rates. **In the EU, the semiconductor companies** in the Netherlands, ASML Holding, STMicroelectronics and NXP Semiconductors **drove the aggregate** (up by 21%, 17%, and 12%, respectively). Also large EU companies in the field of electronic equipment such Siemens and Schneider raised their R&D investments (+10% each), and only a few (and smaller) firms reduced their R&D investments. However, given the strong increase in prices many EU countries faced in 2023, these additions only led to marginal increases in real R&D investment. **In the US**, Apple is the largest company in this sector in terms of R&D investment and it increased R&D by 14% (19% in the previous year), followed by Intel (-8%), Qualcomm (+7.6%) and Nvidia (+18%); also semiconductor developer Advanced Micro Devices continued its expansion path (up by 17%). These companies realised **impressive dynamics** in the past years (see also Section 3.5 for more details): Advanced Micro Devices increased its R&D investment from EUR 1408 million in 2019 to EUR 5437 million in 2023, and Nvidia from EUR 2 518 million to EUR 7 900 million over the same period; for comparison, the 3 Dutch companies mentioned above together invested EUR 7 666 million in 2023 (up from EUR 4565 million in 2019). Still, even though most firms in the EU and the US continued increasing their R&D investments, the additions in 2023 were below those of 2022. In China, the highest-ranked company in this sector, Huawei, raised its R&D investment by 2% only, while other large companies such as ZTE, Xiaomi or Contemporary Amperex Technologies increased their R&D investment by over 22% each. In contrast to the other countries and regions, the **large Chinese ICT hardware companies** are mostly active in **telecommunications equipment**. In **Japan**, the sector developed well due to increases by Canon (+7%) or Renesas Electronics (+14%), while Hitachi decreased R&D investment by 7%. Finally, in the **ROW** group, the **important semiconductor producers** in Taiwan (Taiwan Semiconductor Manufacturing +11.8%) and South Korea (SK Hynix, +69%) **continued to increase their R&D investments**, and also the largest company, Samsung Electronics on world rank 7, raised R&D by 14.4%.

ICT software, the sector with the highest contributions to R&D investment in the past decade, recorded a **massive slowdown in 2023,** with real growth falling from 12% and 17% in 2022 and 2021 to a mere 0.6% in 2023. This sector is dominated by US firms that account for 70% of the sector's R&D. The **modest performance of the US ICT software sector** was mainly due to **lower R&D growth of the very large companies**, but also the smaller companies increased their R&D at lower growth rates. While Meta raised nominal R&D investment in 2022 by 36%, in 2023 it was only 8.5%, Alphabet's growth rate fell from 25% to 11.2%, and Oracle was down from 19% to 3.3%, and other companies such as IBM or Salesforce even reduced their R&D investments in nominal terms in 2023. In the **EU**, some firms realised substantial increases in R&D investment, such as Spotify, Dassault Systems or Amadeus (each approximately +11%), while the largest company SAP added

only 2% to nominal R&D investment in 2023. In China, Japan and ROW the real R&D investment growth increased by a similar magnitude (7.2% and 8.4%). In China, Alibaba, Baidu and Didi reduced their R&D (down by 7%, 6% and 5%, respectively), while China Mobile raised it by 60% and Tencent by 5%. **In Japan,** in the sector of 7 companies only, the development was driven by the 36.3% increase of **Softbank's R&D investment** (EUR 5 096 million) that **related to its UK subsidiary Arm,** a globally leading semiconductor company. Also Fujistu added 12%, Capcom 14.8% and Konami 13%. In the ROW group **3 Canadian companies dominate** the development in 2023: Shopify (+15.6%), Constellation Software (+28.6%) and Open Text (+31%). Moreover, the number of firms increased from 34 to 38, with new companies from the UK entering the Scoreboard, and contributing to the substantial increase of R&D investment in this group.

In the **industrials** sector, the R&D investment by US and Japanese firms fell compared to 2022, while **EU, China and ROW companies realised increases**. In the **EU**, the aggregate result was driven by the Swedish companies Hexagon (+17.3%) and Atlas Copco (+22.8%), French companies Bruelle (+36%) and Alstom (+8%), and German Knorr-Bremse (+16%). In contrast, in the **US the largest companies decreased their R&D investments**: General Electric (-32%) continued the decline since 2017 (from EUR 4 373 million to EUR 1 736 million), Honeywell down by 1%, 3M by 8% and Lyft by 36%. At the same time, many US industrials companies increased their R&D investments, but these did not compensate for the reductions by the big companies. **In China**, the industrials sector expanded at the **lowest rate since 2013**, and the development among the companies was rather heterogeneous. In **Japan**, the R&D investment of the sector **fell strongly due to the acquisition of Toshiba,** the largest Japanese company in this sector (R&D investment in 2022 EUR 950 million). The remaining companies largely increased their R&D investments, in particular Daikin Industries (up 20.5%). The industrials companies headquartered in **ROW countries increased R&D investment by most**, and the companies driving the sector development were LG Chem, Hanwha and HD Hyundai from **South Korea** (up by 15%, 22.8% and 233% respectively), Swiss ABB (+12%), and UK headquartered Rio Tinto (+222%).

In the residual sector category **'Others'**, US companies raised their real R&D investment the most, followed by China and the EU, while the sector grew only slowly in Japan and was negative in the ROW group. **In the EU**, the largest companies in this sector also increased their R&D investment strongly (L'Oréal up by 12% and Accenture by 15%), and the Irish company Flutter Entertainment even raised R&D by 169%. In the **US,** the sector benefited from **high-ranked newcomers**, Maplebear (rank 111, R&D investment EUR 2 101 million) and Kenvue (rank 530, EUR 363 million). In China, the 'Others' sector R&D investment growth in 2023 was higher than in 2022, driven by 5 new companies in this group and increases by the largest investors such as Midea Group (+17%) and Trip.com (+47%). In contrast, the Japanese companies only marginally increased their real R&D investment. The biggest companies, Sony and Panasonic, raised their nominal R&D investments by 1.5% and 5.2%, while Nintendo stepped up its R&D by 25.9%. Finally, R&D investment in ROW fell due to a reduction in the number of firms, and some of the leading companies only marginally increased their R&D investments (Nestle up by 0.6%, LG Display down by 0.6%).

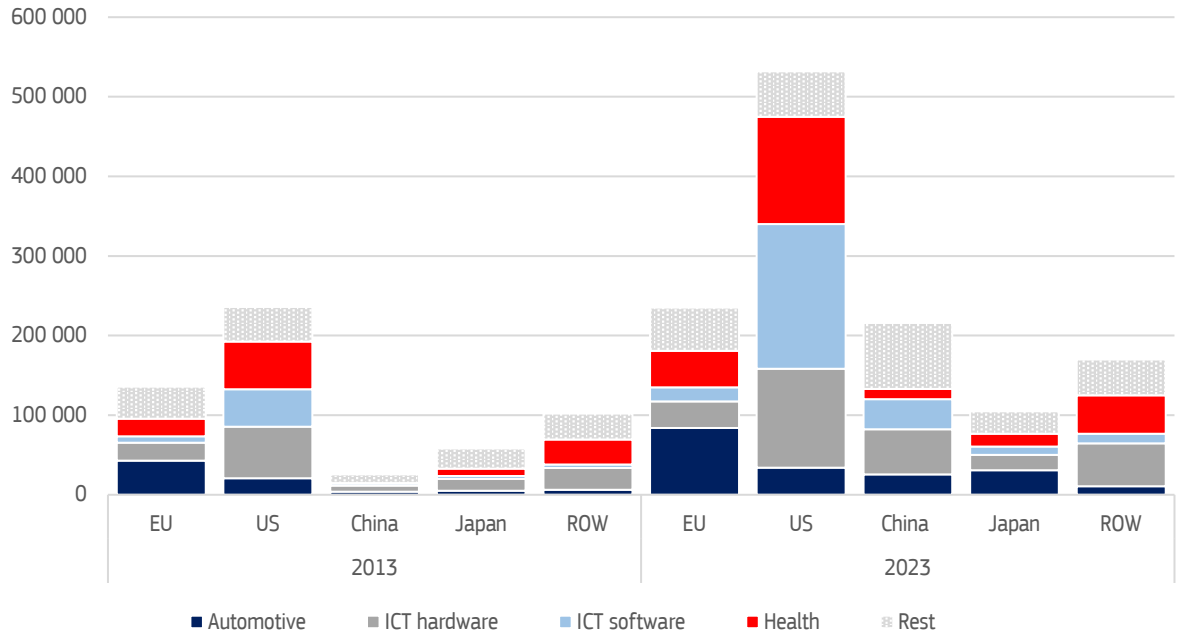
3.4 The top 4 R&D investing sectors in the longer term – 2013-2023

As shown in Table 10, the distribution of firms and R&D across the 11 sectors is highly concentrated: 78.7% of all R&D investment in 2023 (EUR 990 billion) was realised by 63.7% of the firms (1 237

firms) in 4 key sectors, namely ICT hardware, health, ICT software (and services), and automotive.[61] Companies in these 4 sectors develop technologies that are considered critical for competitiveness[62] and the EU's economic security agenda[63].

The distribution of R&D investment across regions and the top 4 sectors in 2013 and 2023 is summarised in Figure 19. The figure clearly shows the **large and growing lead of US companies** in total R&D, and the outstanding contribution of the two ICT sectors. Over that decade, US companies massively increased their R&D investment, and **Chinese companies became globally significant R&D actors**, while the remaining regions – including the EU – developed at a much slower pace. To illustrate this, the US Scoreboard companies invested more in R&D in 2013 than the EU companies in 2023 (EU 2023: EUR 235.2 billion, US 2013: EUR 236.1 billion).

Figure 19. R&D top sectors – R&D investment across regions 2013 and 2023



Source: The 2023 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

As is also illustrated in more detail in Figure 18, the main sectors driving the growth in R&D were ICT software and health, and to a somewhat lesser extent ICT hardware. Since 2013, **the ICT software sector contributed between 27% and 49% of the total global increase in R&D** and only in 2023 did the contribution decrease (to 14.7%). The health sector and ICT hardware contributed on average 21% to the annual increases. While the automotive sector played an important role, it

[61] For the 20th anniversary of the Scoreboard we described these 4 sectors in great detail, including a presentation of the most relevant firms in each sector. In this year's report, we update the development without going into the details of the subsectors. We refer the interested reader to the 2023 Scoreboard for a deeper analysis.

[62] According to the Draghi report, technologies play a crucial role in addressing the innovation gaps versus the US and China. Technologies such as AI or 5G/6G are expected to increase productivity across a wide range of sectors and make the Green Deal a business opportunity, whereas emerging technologies provide opportunities for future EU leadership.

[63] The European Economic Security agenda is a strategy to ensure EU capabilities and prevent vulnerabilities in strategic technologies (advanced semiconductors, artificial intelligence, quantum technologies, and biotechnologies).

contributed less to global dynamics, but stepped up its R&D investments in 2022 and 2023. Table 14 and Table 15 provide more detail on the dynamics underlying Figure 19.

Concentration in the top 4 sectors increased in the period of analysis in terms of number of firms and R&D. Table 14 shows the change in the shares of the top 4 sectors across the 5 regions/countries between 2013 and 2023. While in 2013, 57.2% of the companies in the ranking came from one of these 4 sectors, the number increased by 6.5 percentage points to 63.7%, and the R&D share grew from 73.4% in 2013 to 78.7% (up 5.4 percentage points). The share of firms thus increased by more than the share of R&D of these 4 sectors. However, developments across regions and sectors differ.

Table 14. Top 4 sectors - Distribution of firms and R&D across regions, 2013 and 2023

	Share of firms			Share of R&D		
	2013	**2023**	**PP change**	**2013**	**2023**	**PP change**
EU	44.6%	49.4%	+4.7	70.3%	76.8%	+6.5
US	72.8%	79.7%	+6.9	81.5%	89.3%	+7.8
China	57.6%	56.1%	-1.5	57.3%	61.7%	+4.4
Japan	44.7%	51.9%	+7.2	66.2%	73.0%	+6.8
ROW	54.1%	62.8%	+8.8	67.9%	73.6%	+5.6
Total	57.2%	63.7%	+6.4	73.4%	78.7%	+5.4

Notes: PP stands for percentage points.
Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

The EU exhibits the lowest concentration in terms of the share of companies with only 49.4% in the 4 top sectors, while in the **US the company share is close to 80%**. In terms of R&D, in each region the share of R&D exceeds the share of firms since these 4 sectors are the most R&D intensive. The **EU's R&D share of 76.8%** is much higher than the share of firms, and **in the US the 4 sectors even unite 89.3% of the total US R&D** represented in the Scoreboard. In China, the R&D share of the top 4 sectors is the lowest with less than 62%, and in Japan and the ROW it is approximately 73%. In the following we explore the sectoral and regional dynamics that determine the aggregate results.

Table 15 provides details on the R&D investment in each of the 4 top sectors and the regions for 2013 and 2023. The column 'Total' gives the total per region and year, and the row 'Total' the R&D investment for each sector and year. In addition, 'Factor change' indicates by how much R&D changed over the period for each sector and region, as well as for the regions and sectors in total. The largest R&D investment and the highest change is marked in bold we mark for every row (region/country).

Since 2013 **total R&D investment has increased by a factor of 2.2**, driven by the **ICT software sector** that spent 4 times more on R&D in 2023 than in 2013. While the ICT software sector was the smallest of the top 4 sectors in 2013, it climbed to the second position by 2023. ICT hardware and health companies increased their R&D investment by a factor 2.1, automotive by a factor 2 and the remaining sectors by 1.8.

In the EU, automotive continues to be the most important sector, and its **R&D investment has doubled since 2013.** As in the global total, **ICT software** companies in the EU also increased their R&D investment by relatively more than the automotive companies, but it is still by far the smallest of the top sectors and has **little weight in the EU's aggregate**. EU health sector companies raised their R&D investment at the same speed as the global sector total (factor 2.1), but the total of

EUR 45.5 billion corresponds to just one third that of US companies, and, as mentioned in the Draghi report, merely equals the US National Health Institute budget for R&D funding in 2023 alone.

In the US, ICT hardware companies invested most in R&D in 2013, while in 2023, the **ICT software sector** was the largest contributor to the aggregate. They invested 3.9 times more in 2023 than in 2013 and lead global corporate R&D investment by a large margin. With **EUR 181.6 billion** in 2023, the **US software companies have invested about 10 times more than the EU companies** from this sector, while in 2013 this factor was only 5.8. US health companies have also significantly increased their investments (by a factor of 2.3) and are now spending more than the ICT hardware companies. The **US automotive** sector plays a minor role and has developed more moderately, but its R&D investment in 2023 **exceeded that of the Japanese companies**, while in 2013 the situation was the reverse. Automotive is the only sector where the EU companies increased their lead over the United States – US automotive R&D stood at 48% of that of the EU companies in 2013, and by 2023 it had decreased to 41%. Overall, **the US exhibits a much greater dynamism** than the EU, Japan and ROW, as shown by the increase in the number of firms, R&D investment growth, and changing sectoral composition.

Table 15. Top 4 sectors - R&D investment across regions, 2013 and 2023, in EUR million

Region	Year	ICT hardware	ICT software	Health	Automotive	Rest	Total
EU	2013	22 410	8 130	22 127	**42 814**	40 251	135 735
	2023	33 024	17 983	45 590	**84 090**	54 545	235 233
	Factor change	1.5	**2.2**	2.1	2.0	1.4	1.7
US	2013	**65 093**	46 931	59 790	20 578	43 658	**236 051**
	2023	124 258	**181 630**	134 977	34 082	56 909	**531 858**
	Factor change	1.9	**3.9**	2.3	1.7	1.3	2.3
China	2013	7 941	2 448	625	3 761	**11 019**	25 796
	2023	56 876	37 595	13 177	25 472	**82 692**	215 813
	Factor change	7.2	15.4	**21.1**	6.8	7.5	**8.4**
Japan	2013	14 825	3 849	9 220	21 304	**25 093**	74 293
	2023	19 257	10 219	16 060	**30 980**	28 272	104 790
	Factor change	1.3	**2.7**	1.7	1.5	1.1	1.4
ROW	2013	27 591	4 187	31 408	6 131	**32 697**	102 016
	2023	**53 892**	12 166	48 277	10 676	44 918	169 931
	Factor change	2.0	**2.9**	1.5	1.7	1.4	1.7
Total	2013	137 863	65 547	123 171	94 590	**152 720**	573 892
	2023	**287 309**	259 595	258 083	185 301	267 337	1 257 628
	Factor change	2.1	**4.0**	2.1	2.0	1.8	2.2

Notes: Factor change is R&D investment in 2023 divided by R&D investment in 2013 and shows the relative change over time. Bold: highest value in each row.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

China's economy is developing the fastest; not only has its share of companies in the Scoreboard almost tripled since 2013, but investments have increased at an even faster pace and are 8.4 times higher in 2023 than a decade ago. As set out in Table 11, Chinese R&D-investing companies are less concentrated in the top sectors, so that the remaining sectors ('rest') are responsible for the largest share of R&D. **Chinese R&D increased considerably faster than in the other countries** across all sectors**,** both, due to both improved firm coverage in the Scoreboard and faster R&D investment growth (see Scoreboard 2023 for more details). While in 2013, the EU companies were investing more in R&D in all sectors than the Chinese Scoreboard companies, the situation has now reversed in ICT hardware, ICT software and 'rest', though **the EU companies are still a long way ahead of China in the health and automotive sectors** – at least in terms of R&D investment.

Also the **Japanese Scoreboard companies** are **more diversified** than other countries and regions, as shown by the relatively large R&D investment of the sectors outside the top 4. However, while these sectors (summarise as 'rest') had the highest R&D investment in 2013, it has not changed much since then (increasing only by a factor of 1.1) so that in 2023 the automotive sector constituted the largest sector in Japan. The Japanese automotive companies increased their R&D investment by a factor of 1.5, the lowest relative growth among all regions in this sector. The ICT software sector, however, performed strongly and raised its R&D investment by a factor of 2.7, and thereby narrowed the gap on the EU somewhat (from 47% of EU company R&D investment in this sector to 57%). Overall, while in 2013 R&D investment by Japanese companies was at 55% of the R&D investment of EU companies, this share had fallen to 45% by 2023.

ROW countries increased their R&D investment by a factor of 1.7, which is lower than the global increase over the period 2013-2023. In 2013, the largest contributors were the companies outside the top 4 sectors, but in 2023 the **ICT hardware** sector was leading (with a doubling of R&D investment). Also in the ROW the ICT software companies recorded the largest relative increase of R&D investment, but it ranks only fourth, just ahead of Japan. The EU slightly increased its lead over the ROW – in 2013, ROW companies invested at a level of 75% of EU R&D investment, and in 2023 only 72%.

3.5 Sector KPI for the top 4 in the longer term – 2013-2023

This section dives deeper into the sectors by introducing KPIs for the top 4 R&D investing sectors as well as the remaining sectors and by considering their evolution by country/region and over time. The improvement in data coverage compared to previous Scoreboard editions offers greater insight into the dynamics of the sectors across countries and regions.

ICT hardware

The ICT hardware sector comprises firms producing computer hardware, semiconductors, telecommunications equipment, and electronic and electric equipment (including electronic office equipment). At 22.9%, ICT hardware is the **largest sector** in the Scoreboard for R&D investment. The number of ICT hardware producers in the Scoreboard decreased from 449 (22.5%) in 2013 to 382 (19.1%) in 2023, but **since 2021 the number of firms has been on the increase again** (the minimum was reached in 2020 with 364). The R&D investment share remained rather stable, declining only slightly from 24% in 2013 to 22.9% in 2023. Overall, the sector increased its R&D investment by 6.9% on average per year (5% when adjusted for inflation). Total R&D investment by ICT hardware companies amounted to EUR 287.3 billion in 2023 (EUR 246.4 billion adjusted for inflation). Table 16 presents selected KPIs for the sector by country/region and describe their evolution between 2013 and 2023. The highest value for each KPI and year is marked in bold.

The ICT hardware companies with the largest R&D investments were headquartered in the **US,** and were responsible for **43.3% of the sector's total R&D investment**. In 2023, they **led in every indicator** apart from capex and capex intensity. The US ICT hardware companies recorded **over EUR 1.1 trillion in net sales**; of the top 4 sectors, only US ICT software and EU automotive companies also generate sales of over EUR 1 trillion. The profitability and R&D intensity of the US firms by far exceeded all competitors, and R&D investment per employee was more than twice that of the second, the EU companies. Since 2013, US companies improved every indicator, especially profitability.

Table 16. ICT hardware KPIs, 2013 and 2023, across regions

ICT Hardware	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	53	22 410	18 379	261 027	7 770	7.0%	**8.6%**	3.0%	16 795
	2023	34	33 024	43 225	331 091	21 256	13.1%	10.0%	6.4%	26 785
	growth		47.4%	135.2%	26.8%	173.6%				
US	2013	**178**	**65 093**	**125 077**	**799 002**	38 168	**15.7%**	8.1%	4.8%	**29 955**
	2023	109	**124 258**	**242 966**	**1 193 824**	77 773	**20.4%**	**10.4%**	6.5%	**59 245**
	growth		90.9%	94.3%	49.4%	103.8%				
China	2013	43	7 941	12 066	180 730	13 652	6.7%	4.4%	**7.6%**	8 122
	2023	**123**	56 876	46 559	753 596	72 328	6.2%	7.5%	9.6%	19 319
	growth		616.2%	285.8%	317.0%	429.8%				
Japan	2013	59	14 825	21 952	303 669	17 358	7.2%	4.9%	5.7%	7 078
	2023	42	19 257	36 204	391 057	22 713	9.3%	4.9%	5.8%	9 320
	growth		29.9%	64.9%	28.8%	30.8%				
ROW	2013	116	27 591	50 378	634 869	**42 111**	7.9%	4.3%	6.6%	14 549
	2023	74	53 892	50 172	816 938	**100 511**	6.1%	6.6%	**12.3%**	16 897
	growth		95.3%	-0.4%	28.7%	138.7%				

Notes: n…number of firms, emp….employee. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are computed by dividing profit, sales and capex by net sales, respectively. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023. Bold: highest figure per indicator and year.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

EU companies had the highest R&D intensity in 2013 and in 2023 they were again on par with the US companies. However, the average **R&D investment per employee is much lower** (less than half of the US companies) and it **increased by less than in the US or in China.** Still, the EU companies remained second behind the US in this indicator. In terms of sales, the EU companies' net sales in 2023 were lower than those of all other countries/regions, but profits exceeded those of the Japanese companies and were only slightly lower than those of the Chinese companies.

Chinese ICT hardware companies massively **increased R&D intensity and R&D investment per employee,** indicating how this sector has shifted its focus from manufacturing to R&D. The Chinese companies are characterised by a higher capital intensity than all other regions, apart from ROW. All indicators improved, except profitability, which was somewhat lower in 2023 than a decade before. While China was a laggard in 2013, it is now close to the leading US and ROW ICT hardware developing and producing companies.

ROW companies had the **largest capital expenditures** in 2013 and 2023 and showed by far the highest capex intensity in 2023, while R&D intensity and R&D per employee are relatively low (lower than in China). The foundries in the important producer countries, South Korea and Taiwan, are of utmost global relevance in the manufacturing of semiconductors, which is extremely capital intensive. The increased focus on producing hardware can also be inferred from the modest increase in R&D investment per employee, while capex intensity has doubled since 2013.

Japanese companies are mostly active in the **electronic and electrical equipment** subsector, and were **less R&D intensive** than their counterparts headquartered in other regions, as shown by the relevant KPIs in Table 16. As of 2023, Japanese companies had the lowest R&D spending per employee, reaching only about half the level of the second lowest (ROW) and also featuring a relatively low capex intensity.

ICT software

The ICT software and services sector ranks second in terms of R&D investment and accounted for 20.6% of total R&D investment and 15% of companies in 2023. The sector comprises companies that develop software and provide computer services and telecommunication services. In 2023 the ICT software and service companies invested EUR 259.3 billion in R&D (EUR 216.4 billion when adjusted for inflation). This sector is the fastest growing with a **CAGR of R&D investment of 13.3% per year** since 2013 (11.1% when adjusted for inflation), so that R&D investment in 2023 exceeded that of 2013 by a factor of 4. This rapid growth almost doubled the sector's share of total Scoreboard R&D, and the number of companies increased from 231 (11.6%) to 300 (15%).

Table 17. ICT software KPIs, 2013 and 2023, across regions

ICT Software	Year	n	R&D	Operating Profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	33	8 130	34 759	245 403	28 425	14.2%	3.3%	**11.6%**	8 577
	2023	24	17 983	45 827	317 013	34 676	14.5%	5.7%	**10.9%**	20 024
	growth		121.2%	31.8%	29.2%	22.0%				
US	2013	**123**	**46 931**	**116 002**	**491 604**	**40 784**	**23.6%**	**9.5%**	8.3%	**32 973**
	2023	**163**	**181 630**	**281 051**	**1 206 744**	**125 530**	**23.4%**	**15.0%**	10.4%	**92 557**
	growth		287.0%	142.3%	145.5%	207.8%				
China	2013	24	2 448	4 988	31 951	1 597	15.6%	7.7%	5.0%	9 067
	2023	68	37 595	59 412	513 669	45 736	11.6%	7.3%	8.9%	21 600
	growth		1435.8%	1090.9%	1507.6%	2762.2%				
Japan	2013	8	3 849	9 533	118 085	10 775	8.1%	3.3%	9.1%	7 358
	2023	7	10 219	16 920	173 074	18 439	9.8%	5.9%	10.7%	15 644
	growth		165.5%	77.5%	46.6%	71.1%				
ROW	2013	43	4 187	17 949	174 395	20 241	10.3%	2.4%	**11.6%**	3 847
	2023	38	12 166	17 417	168 090	14 058	10.4%	7.2%	8.4%	12 676
	growth		190.5%	-3.0%	-3.6%	-30.5%				

Notes: n…number of companies, emp….employee. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are computed by dividing profit, sales and capex by net sales, respectively. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023. Bold: highest figure per indicator and year.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

In no other sector is the **regional concentration** more pronounced: **70% of total R&D investment comes from US companies.** Even though their level of investment was already very high in 2013, the US companies increased their R&D at a very high rate. Over the past decade, **only China has been able to establish significant own R&D-investing companies** in this sector, while the R&D investment of the EU, Japanese and ROW companies remained marginal on the global scale. In addition, the number of US companies increased by almost 50% since 2013, while all other regions/countries, except China, lost companies. In 2023, the **US ICT software companies** also stood out in terms of **profitability**, which was almost 10 percentage points higher than that of the EU companies, which ranked second highest for profitability.

In 2023, the sales of US companies exceeded EUR 1.2 trillion, slightly more than that of the US ICT hardware companies, and more than all other regions in this sector together. Even though sales were so high, the **US companies** exhibited the **highest R&D intensity (15%)**, more than twice that of Chinese (7.3%) or ROW (7.2%) companies, while EU and Japanese firms had an R&D intensity below 6%. The **R&D intensity of US ICT software and service firms was** almost **3 times** higher than **that of the EU firms** in 2023.

Capex intensity is highest in the EU, slightly ahead of Japan and the US. However, the high capex intensity in the EU is driven by much lower sales compared to the US companies. The **highest capex investments come from US companies** with EUR 125 billion in 2023. While in 2013 the US companies invested EUR 12 billion more in capex than the EU companies, in 2023 this gap rose to EUR 90 billion. The US capital investments relate to data centres and other spending such as AI facilities. The **capital expenditures of Chinese companies tripled** over the same period and by 2023 exceeded those of the EU companies. Only in ROW, capex declined in 2023 with respect to 2013; this lower figure (as well as the reduction in profit and sales) results from the exit of Vodafone from the Scoreboard (included until 2020), as they no longer disclose their R&D figures. While R&D investment was relatively low, their net sales, profits and capex constituted a significant part of the ROW group total.

R&D investment per employee in the US reached over EUR 92 000 in 2023, almost triple the value of 2013, and **the highest of all sectors and countries** in the analysis. This meant that the US ICT software companies **overtook the US health companies,** which had the highest R&D investment per employee in 2013. The Chinese companies had the second highest R&D investment per employee, slightly ahead of the EU, both in 2013 and in 2023. For ROW companies and those headquartered in Japan, R&D per employee was lower than for the EU.

Health

The health sector constitutes the largest sector in the Scoreboard in terms of number of firms and – by a small margin – the **third largest in terms of R&D;** and it changed significantly between 2013 and 2023. The share of firms increased from 15.5% to 21.9%, while its R&D share remained largely constant at around 21% of the total. The number of health companies increased from 309 in 2013 to 446 in 2022, and fell to 437 in 2023. R&D investment in 2023 amounted to EUR 258.1 billion and grew between 2013 and 2023 on average by 7% per year (5% when adjusted for inflation), resulting in a total increase by a factor 2.1 (1.7 when adjusted for inflation). The growing number of firms in combination with an unchanged R&D share is the result of **many younger and smaller but R&D-intensive firms**, mostly **operating in the biotech sector and located in the US** entering the Scoreboard in recent years.[64]

As can be seen in Table 18, the **US led this sector's** R&D investment by a large margin both in 2013 and 2023. The **US hosted 54.5% of the firms** in 2023 and accounted for **52% of the sector's R&D**. While R&D investment increased in all regions, the development in the US was more dynamic and took place on a larger scale. **EU companies rank third**, closely behind ROW companies. The number of companies from the EU remained almost unchanged between 2013 and 2023, the number of Chinese companies increased almost fivefold, the Japanese figure fell by over a third, and the number of ROW firms increased on the 2013 figure.

Similarly to 2013, **operating profits** in 2023 were **highest for the US companies**, followed by ROW and the EU, but the difference across the regions was less pronounced than for R&D. The R&D investment of US companies was almost 3 times higher than for the EU or ROW companies, but the

[64] As presented in more detail in Section 4.4 of this report, there are 92 SMEs from the US health sector in the Scoreboard.

US lead in sales and profits was smaller. **ROW companies led profitability** by a large margin, followed by the EU, while US profitability in 2023 was only fourth after Japan, but ahead of China.

Table 18. Health KPIs, 2013 and 2023, across regions

Health	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	65	22 127	31 442	216 033	10 118	14.6%	10.2%	4.7%	23 056
	2023	64	45 590	49 865	359 025	22 012	13.9%	12.7%	**6.1%**	36 289
	growth		106.0%	58.6%	66.2%	117.5%				
US	2013	**153**	**59 790**	**85 069**	**538 265**	**17 247**	16.0%	11.0%	3.2%	**55 279**
	2023	**238**	**134 977**	**98 611**	**986 926**	**34 284**	10.7%	13.0%	3.5%	**85 616**
	growth		125.8%	15.9%	83.4%	98.8%				
China	2013	13	625	2 673	18 605	1 820	14.4%	3.4%	**9.8%**	4 333
	2023	63	13 177	12 756	181 729	9 685	7.2%	7.2%	5.3%	17 312
	growth		2007.2%	377.2%	876.8%	432.1%				
Japan	2013	36	9 220	7 859	76 076	2 499	10.3%	12.1%	3.3%	32 654
	2023	21	16 060	11 328	103 818	5 051	10.9%	15.5%	4.9%	55 768
	growth		74.2%	44.2%	36.5%	102.1%				
ROW	2013	42	31 408	48 503	217 693	10 256	**22.3%**	**14.4%**	4.7%	51 663
	2023	51	48 277	53 907	283 463	12 857	**19.1%**	**16.9%**	4.5%	71 476
	growth		53.7%	11.1%	30.2%	25.4%				

Notes: n…number of companies, emp….employee. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are computed by dividing profit, sales and capex by net sales, respectively. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023. Bold: highest figure per indicator and year.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Both the **US and China** experienced a substantial **decrease in profitability** between 2013 and 2023. This reflects the fact that after 2013 in both countries, the number of **health companies not making profit** (or with losses) increased significantly. **In the US in 2013, 55% of the companies made losses, and by 2023 this share climbed to 72.6%.** In China, the picture was similar – while all companies in the sector were profitable in 2013, this held only for 61% of companies in 2023. Also in the EU and the ROW the share of firms with losses increased in 2023 relative to 2013, but remained at lower levels (28% in the EU, 39% in ROW, 0% in Japan). However, the presence of firms not making profits can be – to a certain extent – interpreted as a **sign of business dynamism**, **with new, young firms with a high level of R&D investment entering the market,** and either making it (surviving or undergoing acquisition) or disappearing. These firms often have low sales or no sales at all, as well as low levels of employment, leading to (very) high R&D intensity and R&D per employee.

ROW companies had the highest R&D intensity, with leading health companies in Switzerland, the UK and Australia driving the figures for the region. Japanese companies ranked second in terms of R&D intensity, both in 2013 and 2023, followed by US and EU companies, while the R&D intensity of Chinese health companies was by far the lowest of all countries and regions.

The **highest sales** in 2023 were recorded by the **US companies**, which were almost 3 times higher than those of the EU companies in second place. In terms of **capital expenditures, the US firms also led** in 2013 and 2023, but the relatively higher sales resulted in **the lowest capex intensity of all regions**, which did not increase much since 2013, even though capex itself almost doubled. However, this also relates to the large number of young, research-focused firms in the US with low capital expenditures.

EU and ROW companies invested about the same amount in capex in 2013, but in 2023, the **EU companies** invested over 70% more than the ROW companies. This translates into EU companies leading with the **highest capex intensity** in 2023 (in 2013, Chinese firms were first with a capex intensity of 9.8%).

R&D investment per employee was highest in the US in 2023, but the lead over the other countries was smaller than in the 2 ICT sectors. The **US companies** spend on average **EUR 85 000** on R&D per employee, followed by ROW companies with EUR 71 000 and Japan with EUR 55 000. The **EU companies** come fourth and with **EUR 36 000** lie at quite a distance behind the other countries/regions. The Chinese health companies have increased R&D per employee over fourfold since 2013 but remain far behind even the EU companies.

Automotive

The automotive sector comprises firms in the automobiles and parts, commercial vehicles and trucks, and tyres subsectors. Accounting for 14.7% of R&D investment and 7.7% of the companies in 2023, it is the fourth largest sector in the Scoreboard in terms of R&D, but has a lower R&D intensity than the top 3. Since 2013, the number of automotive companies has remained largely stable (155 in 2013, 150 in 2023), but the share of R&D investment declined from 16.5% to 13.8% in 2021, before increasing again to 14.7% by 2023. The automotive sector is the only one of the top 4 in which the **EU led in terms of R&D investment in 2023,** accounting for **45.4% of the sector's total**, compared to 18.4% for the US, 16.7% for Japan, and 13.8% for China. While Japan has experienced a large drop in the number of companies since 2013, the number of US companies has remained almost unchanged. The number of Chinese automotive companies has increased strongly, as has their R&D investment. ROW has played a minor role with only 5.8% of the sector's R&D.

Table 19. Automotive KPIs, 2013 and 2023, across regions

Auto-motive	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	36	**42 814**	**50 714**	**822 685**	**48 004**	6.2%	**5.2%**	5.8%	**16 600**
	2023	37	**84 090**	**124 461**	**1 467 308**	**67 179**	8.5%	**5.7%**	4.6%	18 830
	growth		96.4%	145.4%	78.4%	39.9%				
US	2013	34	20 578	41 126	542 092	29 463	7.6%	3.8%	5.4%	16 011
	2023	32	34 082	54 208	716 467	54 558	7.6%	4.7%	7.6%	**26 962**
	growth		65.6%	31.8%	32.2%	85.2%				
China	2013	22	3 761	5 659	148 919	6 866	3.8%	2.5%	4.6%	4 193
	2023	**40**	25 472	11 435	464 431	35 587	2.5%	5.5%	**7.7%**	12 166
	growth		577.2%	102.1%	211.9%	418.2%				
Japan	2013	**39**	21 304	38 268	516 257	43 571	7.4%	4.1%	**8.4%**	11 902
	2023	26	30 980	71 840	834 756	50 817	**8.6%**	3.7%	6.1%	16 786
	growth		45.4%	87.7%	61.7%	16.6%				
ROW	2013	23	6 131	17 603	221 338	10 151	**8.0%**	2.7%	4.6%	7 524
	2023	18	10 676	31 302	384 182	14 581	8.1%	2.8%	3.8%	13 100
	growth		74.1%	77.8%	73.6%	43.6%				

Notes: n…number of companies, emp….employee. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are computed by dividing profit, sales and capex by net sales, respectively. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023. Bold: highest figure per indicator and year.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

As shown in Table 19, the **EU companies led automotive R&D by a large margin** in 2013 and in 2023. The EU hosts 24% of the automotive companies, but they represent over 45% of the sector's

R&D. Like the US ICT software companies, the EU automotive companies were starting from a high level yet still significantly increased their R&D investment. In 2013, the second most important region for automotive R&D was Japan, slightly ahead of the US – by 2023 this has changed with the **US now leading Japan in terms of R&D**.

Operating profits in 2023 were highest for the EU companies with EUR 124 billion, followed by Japan, a large distance behind (EUR 53 billion). While the EU companies were already realising the largest profits in 2013, they had increased them further by 2023. The second largest profits in 2023 were earned by Japanese companies. The third-ranking region by profit was the US, though it experienced more moderate growth compared to the other regions. The **highest profitability in 2023 was recorded by Japanese** companies, only ahead of the **EU** by a small margin (0.1 percentage points), but no other region had a higher increase in profitability than the EU. In 2013, ROW companies had the highest profitability, but in 2023 they only ranked third. In China, profitability was substantially lower than in the other regions, and it had even decreased compared to 2013. This might relate to a slowing down in sales of new fossil fuel cars and aggressive price cuts for new EVs, despite rising sales, which are aimed at spearheading entry into new markets.[65]

In terms of sales, **no other sector achieved higher sales than the EU automotive** companies in 2023. With **EUR 1.46 trillion** they even exceed those of the US ICT software and US health companies. In view of this enormous sales volume, it is interesting to note that the **EU companies** also **led in terms of R&D intensity**. However, **R&D intensity is far below the other 3 top R&D sectors** in the Scoreboard. The Japanese companies ranked second in terms of sales in 2023, while in 2013 the US companies were still ahead of Japan. The Chinese automotive companies more than doubled their sales and rank in 2023, ahead of ROW companies. In terms of R&D intensity, companies in every region apart from Japan saw an increase. The Chinese companies more than doubled their R&D relative to sales and ranked only slightly behind the EU companies in 2023 (see also Section 2.2.3 on BYD).

In **capital expenditures the EU lead** was smaller than for the other indicators. In 2013, the Japanese companies ranked second, but in 2023 the US automotive companies took the second place behind the EU companies for capex. Behind the **massive growth in capex by Chinese companies** –most probably related to the build-up of EV production capacities – US companies recorded the highest capex growth. These large increases made the **US and Chinese automotive companies the most capex intensive in 2023** – while in 2013 the Japanese companies were leading capex intensity. In the EU, Japan and ROW, capex intensity decreased.

Back in 2013, EU companies had the highest **R&D investment per employee**, but it could not maintain this position. By 2023, **US companies were leading**, and while in 2013 the difference between the US and EU companies was only EUR 600 per employee, in 2023 the **US companies were investing over EUR 8 000 more per employee on R&D than EU companies**. So even though total R&D investment by EU companies did increase substantially, it did not translate into higher investments per employee. As mentioned earlier, the **Japanese companies have always been less R&D intensive**, which can also be seen by their R&D per employee figure, which is below

[65] https://technode.com/2024/04/08/chinese-automakers-post-sharp-annual-profit-drops-as-international-partners-hit-by-domestic-competition/ and https://www.yicaiglobal.com/news/chinese-carmakers-profit-margin-falls-to-nine-year-low-of-5-amid-price-wars

the EU and US in both years. However, the Japanese automotive companies increased their R&D per employee far more than the EU companies (but less than the US), achieving in 2023 the level that EU and US companies had reached in 2013. Looking at the Chinese and the ROW companies, we see that as of 2023 the ROW was still ahead of China, but the gap is closing.

3.6 R&D in the sectors beyond the top 4 in the longer term – 2013-2023

The remaining 6 sectors (plus the residual category 'Others', see Table 10 in Section 3.1 for details) comprised 36.4% of the Scoreboard companies (727) and 21.3% of R&D investment in 2023. Their share of firms declined by 6.5 percentage points since 2013, and the share of R&D by somewhat less (5.4 percentage points).

China is the only region in which the number of firms in these sectors increased, from 75 to 230, leading to a small increase in these sectors' share of Chinese Scoreboard companies (from 42.3% to 43.9%). In all other regions/countries the company-share of the 4 top sectors increased. However, the EU and Japan have a higher share of companies in the sectors outside the top 4 (see Section 3.2 and Table 11).

R&D investment development has been following this pattern: the share of R&D in the sectors outside the top 4 declined in every country/region. It is the highest in China with 38.3% and the lowest in the US with 10%, 23% for the EU-headquartered companies, and 26% for Japanese and ROW companies.

Table 20 summarises R&D investment per sector in 2013 and 2023 and expresses the change over this time period as the ratio of the 2023 to the 2013 value for each KPI (R&D investment in 2023 divided by the 2013 value). The column 'Total' contains the sector total, and the row 'Total' at the bottom of the table reports the regional total for the sectors outside the top 4. As before, the highest values per sector and region are marked in bold.

In 2023, the aerospace & defence sector had the lowest R&D of the sectors presented in Table 20, and it also did not increase R&D relative to 2013. However, aerospace & defence exhibits some peculiarities due to often large R&D projects being financed by the public sector, making the sector only partially comparable to others. Since more and more firms from the sector disclose third party-funding for R&D that needs to be subtracted from the private R&D investment to meet the criteria from the Frascati manual, the disclosed company-owned funding of R&D stagnated. The figures for this sector should therefore be read with caution.

The **R&D investment of the chemicals sector increased only marginally** between 2013 and 2023. While in 2013, the US firms were dominating the R&D investment in this sector, in 2023 the Japanese companies led by a large margin. This shift relates to the (M&A related) fall in the number of US chemicals companies in the Scoreboard. The **EU companies** increased R&D by less than the Japanese or ROW companies and were **second in this sector in 2023**.

Construction & materials was **dominated by Chinese state-owned companies** throughout the period, and they also made the largest increase in R&D. They invested over **86% of the sector total**; in 2023, the construction sector accounted for 13% of total R&D investment by the Chinese Scoreboard companies (in the other regions/countries the share is below 1%). This shows the important role of **infrastructure development in China and abroad**, with the largest R&D investing companies in this sector being railway and power construction corporates. R&D investment in the construction sector increased in all regions apart from the US. Both in 2013 and 2023, the EU companies were responsible for the second largest R&D investments behind the Chinese companies.

Table 20. Outside the top 4 sectors - R&D across regions, 2013 and 2023, in EUR million

Region	Year	EU	US	China	Japan	ROW	Total
Aerospace & defence	2013	**8 283**	7 604	56		4 284	20 228
	2023	7 672	**9 712**	854		2 461	20 701
	Factor change	0.9	1.3	15.1		0.6	1.0
Chemicals	2013	4 766	**6 718**	70	5 060	3 594	20 210
	2023	5 659	4 812	3 498	**6 491**	4 615	25 077
	Factor change	1.2	0.7	49.5	1.3	1.3	1.2
Construction & materials	2013	1 369	698	**3 806**	785	650	7 310
	2023	1 702	591	**28 341**	1 103	1 201	32 940
	Factor change	1.2	0.8	7.4	1.4	1.8	4.5
Energy	2013	**4 240**	4 222	2 864	780	4 220	16 328
	2023	6 630	3 335	**8 176**	501	5 115	23 758
	Factor change	1.6	0.8	2.9	0.6	1.2	1.5
Financial	2013	4 375	1 535	493	109	**4 496**	11 009
	2023	8 073	4 255	1 088		**9 793**	23 210
	Factor change	1.8	2.8	2.2		2.2	2.1
Industrials	2013	**10 477**	10 019	2 698	7 140	5 466	35 801
	2023	13 646	8 320	**22 454**	6 660	7 670	58 752
	Factor change	1.3	0.8	8.3	0.9	1.4	1.6
Others	2013	6 738	**12 859**	1 030	11 216	9 984	**41 830**
	2023	11 159	**25 880**	18 279	13 515	14 060	**82 895**
	Factor change	1.7	2.0	17.7	1.2	1.4	2.0
Total	2013	40 251	**43 658**	11 019	25 093	32 697	152 720
	2023	54 545	56 909	**82 692**	28 272	44 918	267 337
	Factor change	1.4	1.3	7.5	1.1	1.4	1.8

Note: Factor change is R&D investment in 2023 divided by R&D investment in 2013 and shows the relative change over time. Note that we do not have Japanese companies in the sectors aerospace & defence and financials in 2013 and 2023.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

In the **energy sector**, total R&D increased by 50% since 2013, mainly due to large **increases by Chinese companies**, though **EU energy companies also stepped up their R&D** by more than the overall average figure. While in 2013, EU, US and ROW companies were on par in terms of R&D investment, in 2023 **China had a clear lead** in energy R&D, ahead of the EU. In the US and Japan, the R&D investment of energy companies in 2023 was lower than in 2013, while that of ROW companies increased, but at a lower rate than for EU and Chinese companies. With 27% of the sector's R&D in 2023, EU companies were second to China with 34%. The leading companies in China and ROW were oil and gas producers, while **the leading EU energy companies were in electricity and alternative energy**.

In the **financial sector** ROW countries are leading, mainly because of the **UK** (with 7 out of 11 companies in this sector in 2023). R&D investment has more than doubled since 2013, with the strongest increase in the US, followed by ROW and China. The EU companies also increased their R&D investment in this sector and invest almost as much as the ROW companies.

Industrials is the **largest sector** of those outside the top 4, and R&D investment by companies in this sector has doubled since 2013. In 2013, the EU companies led this sector, slightly ahead of the US, but by 2023 Chinese companies were leading by a large margin, with EU companies in second place. The US lost around 20% of industrials R&D in the Scoreboard; R&D investment by Japanese companies also decreased in 2023.

The sectors complied in 'Others' accounted for 6.5% of R&D in 2023, twice as much as in 2013. All regions increased their R&D in this category. The **US continues to lead in these sectors**, followed by China, Japan and ROW, with the lowest R&D coming from EU companies. This group contains a

heterogeneous mix of companies: in the US, the most important in terms of R&D are Netflix, Maplebear and Airbnb; in Japan Sony and Panasonic; in ROW Nestle and Unilever; in China Meituan and Midea Group; and in the EU L'Oréal and Accenture.

3.7 Sector KPI outside the top 4 in the longer term – 2013-2023

As for the top 4 sectors the most important KPIs for the sectors outside the top 4 are presented below. We focus on the countries/regions and briefly compare the changes that occurred between 2013 and 2023.

Aerospace & defence

Throughout the period, US companies led the aerospace & defence sector in terms of number of firms, profit, sales and capex, and, in 2023, they wrested the lead from EU companies in terms of R&D investment from. However, EU companies had the highest R&D intensity in 2013 (apart from China which, however, was present with only one company) and 2023, as well as the highest R&D investment per employee, even though both indicators declined. Overall, the number of firms decreased from 48 to 38, and with this R&D too (in particular in ROW). Interestingly, despite the Russian war of aggression against Ukraine and the related increase in the demand for defence, neither sales nor profits in 2023 were substantially higher than in 2013.

Table 21. Aerospace & defence KPIs, 2013 and 2023, across regions

Aerospace & defence	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	13	**8 283**	7 889	115 841	4 682	6.8%	**7.2%**	**4.0%**	**23 686**
	2023	10	7 672	10 578	148 811	6 701	7.3%	**5.0%**	4.5%	**16 591**
	growth		-7.4%	34.1%	28.5%	43.1%				
US	2013	**18**	7 604	**26 346**	**246 824**	**6 028**	**10.7%**	3.1%	2.4%	9 615
	2023	**14**	**9 712**	**18 651**	**266 977**	**6 964**	7.1%	3.5%	2.6%	13 644
	growth		27.7%	-29.2%	8.2%	8.2%				
China	2013*	1	56	97	740	77	13.1%	7.6%	10.4%	3 998
	2023	5	854	956	20 401	1 032	4.7%	4.2%	**5.1%**	7 943
	growth		1 410.4%	882.8%	2 655.4%	1 236.7%				
ROW	2013	16	4 284	5 705	76 372	3 929	7.5%	5.6%	3.7%	12 968
	2023	7	2 461	6 884	72 871	2 717	**9.4%**	3.4%	2.4%	8 091
	growth		-42.5%	20.7%	-4.6%	-30.8%				

Note: n…number of companies, emp….employment. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are defined as the respective indicator divided by net sales. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023. There is no Japanese company with this (main) sector classification in the Scoreboard. *China 2013: we do not consider the figures in the regional comparison in 2013 as it only includes one company.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Chemicals

The chemicals sector shows a rather heterogeneous pattern across regions/countries and over time. In terms of R&D, US companies invested the most in 2013, followed by Japan, but in 2023, the Japanese companies had invested the most, with EU companies ranking second by this metric. Japanese chemicals companies have the highest R&D intensity, followed by the US.

Table 22 shows that R&D investment per employee decreased in all regions apart from China and the EU, with a dramatic drop in the ROW. This relates to a doubling in employment by ROW chemical companies, mostly due to a single Indian firm entering the Scoreboard. Overall, the volatile pattern

relates to the composition of the sample: the ROW chemicals sector comprises a very heterogeneous set of companies, from the rather small and specialised companies (5 companies with headquarters in Switzerland), to very large companies in India and South Korea.

While the number of chemicals companies decreased in all regions between 2013 and 2023 apart from China, the Scoreboard still more chemicals companies from Japan than from China. ROW company profits are a small margin ahead of the EU. The head-to-head between the EU and ROW is also visible in sales and capex – EU companies registered the highest values for both indicators in 2013, but in 2023 the situation reversed, though EU companies still led on profitability in 2023 (in 2013 the US had claimed the top spot). The highest capital expenditures were those of ROW companies, ahead of China and the EU, but Japanese companies had the highest capex intensity.

Table 22. Chemicals KPIs, 2013 and 2023, across regions

Chemicals	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	19	4 766	20 785	**232 567**	**16 172**	8.9%	2.0%	7.0%	10 197
	2023	14	5 659	22 366	253 188	18 792	**8.8%**	2.2%	7.4%	12 206
	growth		18.7%	7.6%	8.9%	16.2%				
US	2013	29	**6 718**	24 769	201 462	12 041	**12.3%**	3.3%	6.0%	17 046
	2023	17	4 812	11 259	170 818	13 341	6.6%	2.8%	7.8%	**16 141**
	growth		-28.4%	-54.5%	-15.2%	10.8%				
China	2013	2	70	128	4 214	433	3.0%	1.7%	**10.3%**	2 975
	2023	22	3 498	9 056	153 682	20 655	5.9%	2.3%	**13.4%**	11 476
	growth		4 848.2%	6 952.9%	3 546.8%	4 665.8%				
Japan	2013	**34**	5 060	7 426	137 203	7 465	5.4%	**3.7%**	5.4%	13 076
	2023	**26**	**6 491**	7 966	170 961	12 810	4.7%	**3.8%**	7.5%	12 931
	growth		28.3%	7.3%	24.6%	71.6%				
ROW	2013	25	3 594	**22 029**	192 423	14 651	11.4%	1.9%	7.6%	**16 525**
	2023	11	4 615	**23 576**	**299 922**	**36 649**	7.9%	1.5%	12.2%	4 699
	growth		28.4%	7.0%	55.9%	150.2%				

Notes: n...number of companies, emp....employment. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are defined as the respective indicator divided by net sales. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Construction & materials

The construction & materials sector is dominated by Chinese state-owned companies – they led in R&D, operating profit, sales and profitability in 2013 as well as 2023, and in 2023 they also led in R&D intensity and R&D investment per employee. According to the latter metric, Chinese companies invested almost twice as much than those from the second highest ranked region, the ROW.

The Chinese construction sector recorded sales of EUR 1 074 billion in 2023, almost matching the sales of the two US ICT sectors. In 2023, the profits of the Chinese companies were double those of all other countries/regions' profits together; however US companies were ahead in profitability. The leading Chinese companies in this sector (in terms of R&D investment) are in general construction, railway construction, communications and energy/power infrastructure; 9 out of the 10 largest companies in this sector are Chinese, 7 of them owned by the Chinese government, and 1 company comes from the EU (see Chapter 2).

Table 23. Construction & materials KPIs, 2013 and 2023, across regions

Construction & materials	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	**16**	1 369	13 798	218 969	8 782	6.3%	0.6%	4.0%	1 373
	2023	7	1 702	11 526	152 853	6 357	7.5%	1.1%	**4.2%**	3 262
	growth		24.4%	-16.5%	-30.2%	-27.6%				
US	2013	5	698	2 772	26 847	1 121	**10.3%**	**2.6%**	4.2%	**8 137**
	2023	3	591	4 051	29 965	1 206	**13.5%**	2.0%	4.0%	7 080
	growth		-15.3%	46.1%	11.6%	7.6%				
China	2013	14	**3 806**	**15 277**	**321 993**	**10 575**	4.7%	1.2%	3.3%	3 182
	2023	**34**	**28 341**	**51 665**	**1 074 257**	**36 976**	4.8%	**2.6%**	3.4%	**13 687**
	growth		644.6%	238.2%	233.6%	249.7%				
Japan	2013	13	785	2 881	70 116	1 976	4.1%	1.1%	2.8%	3 780
	2023	8	1 103	2 233	76 563	2 685	2.9%	1.4%	3.5%	5 696
	growth		40.5%	-22.5%	9.2%	35.9%				
ROW	2013	9	650	5 160	65 941	3 507	7.8%	1.0%	**5.3%**	2 799
	2023	6	1 201	7 231	71 078	2 702	10.2%	1.7%	3.8%	7 322
	growth		84.7%	40.1%	7.8%	-22.9%				

Notes: n...number of companies, emp....employment. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are defined as the respective indicator divided by net sales. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Energy

The energy sector stands out for its high sales, profit and capex (and capital intensity). In 2023 the sector was responsible for 22.5% of profits, 16.6% of sales and 21.7% of capex – but while sales and profits varied a lot over the years depending on (fossil) energy prices, the capex share remained consistently high.

Table 24. Energy KPIs, 2013 and 2023, across regions

Energy	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	**25**	**4 240**	68 828	979 727	93 277	7.0%	0.4%	9.5%	3 120
	2023	**23**	6 630	106 197	998 837	101 645	10.6%	0.7%	10.2%	6 156
	growth		56.4%	54.3%	2.0%	9.0%				
US	2013	11	4 222	87 608	747 377	90 227	**11.7%**	**0.6%**	**12.1%**	**8 948**
	2023	9	3 335	100 929	599 280	49 323	16.8%	0.6%	8.2%	10 641
	growth		-21.0%	15.2%	-19.8%	-45.3%				
China	2013	6	2 864	46 947	687 732	66 466	6.8%	0.4%	9.7%	2 971
	2023	19	**8 176**	87 383	1 015 010	**109 274**	8.6%	**0.8%**	**10.8%**	6 996
	growth		185.4%	86.1%	47.6%	64.4%				
Japan	2013	14	780	4 106	264 569	17 444	1.6%	0.3%	6.6%	2 892
	2023	3	501	6 307	180 374	6 601	3.5%	0.3%	3.7%	5 231
	growth		-35.8%	53.6%	-31.8%	-62.2%				
ROW	2013	23	4 220	**171 020**	**1 630 210**	**163 196**	10.5%	0.3%	10.0%	3 036
	2023	9	5 115	**346 925**	**1 275 376**	101 912	**27.2%**	0.4%	8.0%	**11 521**
	growth		21.2%	102.9%	-21.8%	-37.6%				

Notes: n...number of companies, emp....employment. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are defined as the respective indicator divided by net sales. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Table 24 shows that ROW companies dominated the sector (especially through large companies from Saudi Arabia and the UK), followed by the US. In terms of R&D, Chinese companies were investing the most in 2023, while in 2013 the EU companies had been in the lead. The companies from the US and Japan invested less in R&D in 2023 than in 2013. The R&D intensity of the sector was very low due to the enormous sales relative to low R&D. In contrast, capital intensity is among the highest in the Scoreboard (after ICT services and chemicals).

The leading companies in China and ROW are oil and gas producers (including the large state-owned corporations from Saudi Arabia, China and Brazil), while the leading EU energy companies are in alternative energy and electricity (but also with state-owned companies). The profits of the oil and gas producing companies by far exceeded those of the EU companies, resulting in ROW companies having the highest profitability in 2023 (much higher than in 2013). These companies managed to more than double their profits compared to 2013, while at the same time sales were about 22% lower.

Financial

Table 25 shows that the EU had the largest number of financial companies in the Scoreboard in 2023, followed by the ROW. ROW companies also had the highest R&D investment in this sector, but the US is ahead in terms of R&D intensity and R&D per employee. However, even though R&D investment increased, both measures decreased between 2013 and 2023. EU companies recorded the highest sales in 2023, followed by ROW, but ROW led in terms of profits. The financial sector is traditionally the Scoreboard leading sector featuring the highest profitability, but aggregate profits were negative in the EU in 2013 due to the large losses of 2 Italian banks negatively affecting the profitability of the entire sector. The EU companies led in capex investment in 2023, but this result was driven by one Spanish bank – otherwise the EU figure would be much closer to that of the other regions.

Table 25. Financial KPIs, 2013 and 2023, across regions

Financial	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	**22**	4 375	-632	227 336	6 663	-0.3%	1.9%	2.9%	4 081
	2023	**18**	8 073	78 098	**309 833**	**18 606**	25.2%	2.6%	**6.0%**	8 136
	growth		84.5%	NA	36.3%	179.2%				
US	2013	9	1 535	6 199	16 352	698	37.9%	**9.4%**	4.3%	**44 699**
	2023	11	4 255	19 460	77 483	1 367	25.1%	**5.5%**	1.8%	**37 112**
	growth		177.2%	213.9%	373.8%	95.8%				
China	2013	2	493	8 913	19 207	1 069	**46.4%**	2.6%	**5.6%**	5 243
	2023	7	1 088	2 157	66 926	1 705	3.2%	1.6%	2.5%	4 848
	growth		120.6%	-75.8%	248.4%	59.6%				
ROW	2013	16	**4 496**	**40 520**	**236 675**	**7 963**	17.1%	1.9%	3.4%	4 757
	2023	13	**9 793**	**83 391**	240 123	14 217	**34.7%**	4.1%	5.9%	13 658
	growth		117.8%	105.8%	-1.5%	78.5%				

Notes: n…number of companies, emp.…employment. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are defined as the respective indicator divided by net sales. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023. As Japan had only 1 company in this sector in 2013 and none in 2023, we decided to omit it from the table.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Industrials

In the industrials sector, the EU had the highest number of companies in 2013. However, while in the EU, the US, ROW and Japan the numbers decreased, Chinese companies entered the Scoreboard and became the most numerous group. This is also reflected in aggregate R&D investment, where the

lead passed from the EU to China, and Chinese firms also had the highest R&D intensity and R&D investment per employee in 2023 (the US was leading in 2013). Additionally, of the 4 Chinese companies in the top 10 R&D investors in this sector, 3 are re state-owned.

In terms of profits, ROW companies led in both periods, even though profits were lower in 2023 than a decade before, while EU had the highest sales in 2013 and China did in 2023. The high profits combined with relatively lower sales resulted in high profitability for ROW companies, followed by the US. The highest profits were earned by multinational conglomerates with headquarters in the UK. ROW companies also led in capex intensity, even though Chinese companies invested slightly more than ROW firms in 2023.

Table 26. Industrials KPIs, 2013 and 2023, across regions

Industrials	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	**82**	**10 477**	23 083	**538 914**	19 928	4.3%	1.9%	3.7%	3 966
	2023	51	13 646	35 857	516 511	28 892	6.9%	2.6%	5.6%	7 714
	growth		30.3%	55.3%	-4.2%	45.0%				
US	2013	42	10 019	33 872	344 907	15 309	9.8%	**2.9%**	4.4%	**8 206**
	2023	26	8 320	26 488	289 151	9 880	9.2%	2.9%	3.4%	9 624
	growth		-17.0%	-21.8%	-16.2%	-35.5%				
China	2013	36	2 698	6 787	159 424	8 187	4.3%	1.7%	5.1%	3 333
	2023	**88**	**22 454**	51 321	**745 451**	**46 756**	6.9%	**3.0%**	6.3%	**10 127**
	growth		732.2%	656.1%	367.6%	471.1%				
Japan	2013	55	7 140	17 560	418 921	15 414	4.2%	1.7%	3.7%	5 777
	2023	25	6 660	20 912	293 539	15 393	7.1%	2.3%	5.2%	6 657
	growth		-6.7%	19.1%	-29.9%	-0.1%				
ROW	2013	50	5 466	**61 462**	425 165	**54 836**	**14.5%**	1.3%	**12.9%**	4 285
	2023	29	7 670	**59 076**	475 128.	45 064	**12.4%**	1.6%	**9.5%**	6 332
	growth		40.3%	-3.9%	11.8%	-17.8%				

Notes: n…number of companies, emp….employment. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are defined as the respective indicator divided by net sales. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

Others

The sectors collected under 'Others' cover a wide spectrum, as described in Section 3.6. The US led this sector by the number of companies, R&D investment, and profits, in both 2013 and 2023. By contrast, the EU companies were fourth in terms of R&D in 2013 and last in 2023. This is also reflected in the low R&D intensity and R&D investment per employee of the EU companies shown in Table 26. In no other region did R&D per employee increase less between 2013 and 2023 than in the EU.

However, EU companies invested the most in capex in 2023 (and co-lead with ROW in 2013) and recorded the highest sales volume in 2023. Behind these figures are large food and drug retailers (with the largest in ROW – Nestlé), luxury goods producers such as LVMH and Christian Dior, and business service providers such as Accenture. These companies were again earning the largest profits in this sector in 2023. In terms of capital expenditures, these luxury good producers are ahead of companies such as Sony or Panasonic.

Table 27. Others KPIs, 2013 and 2023, across regions

Others	Year	n	R&D	Operating profit	Sales	Capex	Profit-ability	R&D intensity	Capex intensity	R&D per emp.
EU	2013	55	6 738	50 719	530 721	**25 323**	9.6%	1.3%	4.8%	2 433
	2023	39	11 159	90 223	**752 982**	**47 168**	12.0%	1.5%	6.3%	3 706
	growth		65.6%	77.9%	41.9%	86.3%				
US	2013	**68**	**12 859**	**87 005**	**588 683**	22 380	14.8%	2.2%	3.8%	7 114
	2023	**57**	**25 880**	**98 690**	739 681=	26 358	**13.3%**	3.5%	3.6%	**16 036**
	growth		101.3%	13.4%	25.7%	17.8%				
China	2013	14	1 030	3 630	22 074	2 806	**16.4%**	**4.7%**	**12.7%**	1 710
	2023	55	18 279	35 900	487 630	23 039	7.4%	3.7%	4.7%	11 186
	growth		1674.3%	888.8%	2109.0%	721.1%				
Japan	2013	58	11 216	23 088	340 809	18 225	4.2%	3.3%	5.3%	**8 054**
	2023	27	13 515	32 598	334 028	21 898	7.1%	**4.0%**	**6.6%**	13 566
	growth		20.5%	41.2%	-2.0%	20.2%				
ROW	2013	51	9 984	60 448	523 019	**25 327**	14.5%	1.9%	4.8%	3 852
	2023	32	14 060	45 297	468 001	23 612	12.4%	3.0%	5.0%	8 393
	growth		40.8%	-25.1%	-10.5%	-6.8%				

Notes: n...number of firms, emp....employment. R&D investment, operating profit, sales and capex are expressed in EUR million. Profitability, R&D intensity and capex intensity are defined as the respective indicator divided by net sales. R&D per employee is expressed in EUR. Growth refers to the growth rate between 2013 and 2023.

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

3.8 Key points

- **Top 4 sectors:** The top 4 sectors in terms of R&D investment are ICT hardware, health, ICT software, and automotive, accounting for 78.7% of all corporate R&D investment. These sectors are considered critical for competitiveness and the EU's economic security agenda.
- **Regional Specialisation:** The analysis highlights regional specialisation patterns, with the EU being over-represented in 7 of the 11 sectors, but under-represented in the top 3 R&D sectors. The US is specialised in 2 out of the 4 top R&D sectors, namely ICT software and health.
- **EU leads in automotive:** The EU leads in automotive R&D investment, accounting for 45.4% of the sector total in 2023, while the US leads in ICT software and health. The EU's automotive sector has seen significant growth, with R&D investment doubling since 2013. The EU companies also have the highest R&D intensity in the automotive sector, with 5.7% of net sales invested in R&D. However, the US companies have the highest R&D investment per employee with over EUR 26 000 in 2023 (EU: EUR 23 000).
- **US dominates ICT hardware**: The US has the largest R&D investment in the ICT hardware sector, with 43.3% of the sector's total R&D, and also leads in every other indicator apart from capex intensity. US ICT hardware companies have improved in every indicator since 2013, particularly in profitability.
- **ICT Software Sector:** The ICT software sector is the fastest-growing sector, with a CAGR of 13.3% per year since 2013. The US dominates the sector, with 70% of total R&D coming from US companies. The sector's R&D investment has increased by a factor of 4 since 2013, and the US companies invested on average EUR 92 000 on R&D per employee. The ICT software sector is also characterised by high R&D intensity, with the US companies having the highest R&D intensity in the sector.

— **Health sector R&D:** The health sector has the largest number of firms, with 437 companies in 2023 (21.9% of the top 2000 companies). The US has been leading the health sector's R&D efforts by a large margin in 2013 and in 2023. The US host 54.5% of the firms of the sector and 52% of R&D in 2023, but the ROW companies lead in R&D intensity (16.9%) and profitability.

— **Aerospace & defence:** The EU companies have the highest R&D intensity in the aerospace & defence sector, but the US companies lead in terms of R&D investment. The sector faces some peculiarities due to often large R&D projects financed by the public sector that is excluded from the Scoreboard.

— **Chemicals sector:** The chemicals sector shows a heterogeneous pattern across regions and time, with Japanese companies investing the most in R&D and having the highest R&D intensity. The EU companies have increased their R&D investment in this sector, and are now second to Japanese companies.

— **Construction & materials:** The construction & materials sector is dominated by Chinese state-owned companies, which led in R&D, operating profit, sales, and profitability. The Chinese construction companies recorded sales of EUR 1 074 billion in 2023, matching the sales of the two US ICT sectors.

— **Energy sector:** The energy sector is characterised by high sales, profit, and capital investments, with Chinese companies investing the most in R&D and ROW companies realising the largest sales and profits. The leading companies in China and ROW are oil and gas producers, while the leading EU energy companies are in alternative energy and electricity. In 2023, the energy companies substantially raised their R&D investment by 20.7%, but the sector's R&D intensity is very low due to enormous sales relative to low R&D.

— **Financial Sector:** The financial sector is traditionally the sector with the highest profitability, with ROW companies leading in 2023 and US companies having the highest R&D intensity. Profitability was highest for ROW companies (34.7%) in 2023, with a significant increase since 2013.

— **Industrials Sector:** The industrials sector is the largest sector outside the top 4, with Chinese companies leading in R&D investment and Japanese companies having the highest R&D intensity. The sector’s R&D investment has doubled since 2013, with Chinese companies driving the growth.

— **Others Sector:** The ‘Others’ sector, which includes companies from various industries, has seen significant growth in R&D investment, with US companies leading in 2023. The sector includes companies from industries such as consumer goods, retail, and media.

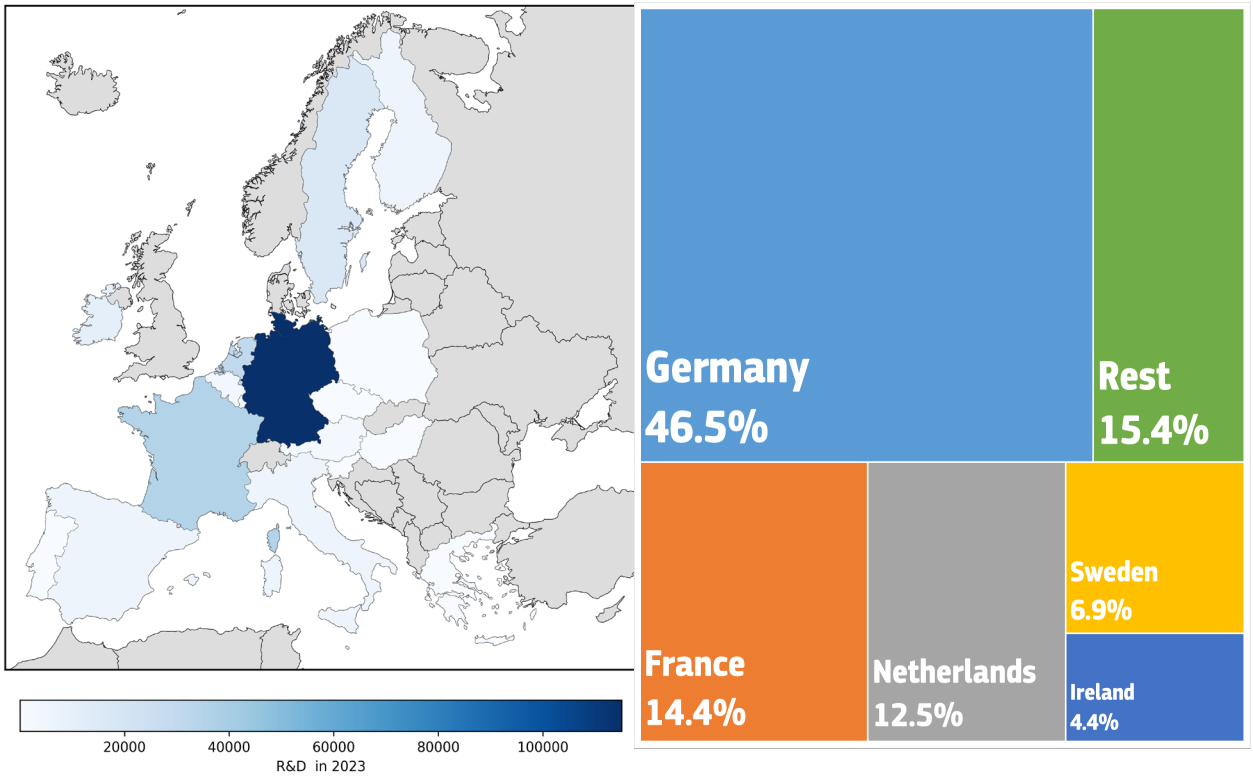
4 A closer look at the EU

This Chapter provides a more detailed analysis of private R&D investment across EU countries, based on data for the 800 companies headquartered in the EU with the highest R&D investment. There are 322 companies with headquarters in the EU in the global top 2 000 ('core group'). In 2023, each company in this core group invested more than EUR 67 million in R&D, averaging EUR 730 million per company. In the same year, the emerging group of additional 478 companies headquartered in the EU invested more than EUR 7 million but less than EUR 67 million on R&D (on average EUR 26.1 million per company). This Section is structured as follows: Section 4.1 gives a country overview, Section 4.2 presents a sectoral overview with a special focus on the four R&D key sectors in the EU core and EU emerging samples, Section 4.3 provides a closer look at the EU countries, Section 4.4 zooms in on the SMEs in the EU 800, and the last section 4.5 concludes with key points.

4.1 Top 800 EU R&D investors – overview

Figure 20 presents the geographical distribution of the EU 800 companies by headquarters location. The EU 800 companies are located in 19 Member States and invested EUR 247.7 billion in R&D in 2023. The 478 companies from the emerging group added EUR 12.5 billion to the EUR 235.2 billion of the core 322 companies (5.1% of the total R&D investment by the EU 800). Nominal R&D investment by the EU 800 increased by 8.7% compared with the previous year, and by 2.7% adjusted for inflation.

Figure 20. EU 800 Map, Treemap of top 5 countries



Notes: Map - colour darkness proportional to R&D investment in 2023 by companies headquartered in the country. Treemap – Top 5 countries representing 84.6% of R&D in the EU 800 sample, the remaining 14 countries are responsible for 15.4% of the total.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Table 28 presents the distribution of the EU 800 companies' headquarters and R&D across 19 EU Member States. Together, the top 3 countries in terms of R&D investment in the EU 800 sample – Germany, France and Netherlands – are home to 51.5% of the companies and 73.3% of R&D investment. The figures for the Netherlands overstate R&D investment in the country, as the list of companies includes some whose main operations are in other countries.[66] (The same is true for Ireland and Luxembourg.) Moreover, Member States not represented by a consolidated headquartered Scoreboard company in the EU 800 also have R&D companies that invest in R&D, but their investment either did not reach the R&D investment of the 800th firm (EUR 7.1 million), or they are affiliates/subsidiaries (see Box 3 below), headquartered in other countries or do not provide sufficient information on R&D investment in their company reports.

Table 28. EU Member States in the EU 800 sample, 2023

	Companies (core/emerging)	R&D (EUR m)	Share of companies	Share of R&D
Germany	233 (106/127)	115 082.1	29.1%	46.46%
France	117 (50/67)	35 599.0	14.6%	14.37%
Netherlands	62 (33/29)	30 903.7	7.8%	12.47%
Sweden	99 (22/77)	17 084.1	12.4%	6.90%
Ireland	37 (24/13)	10 794.2	4.6%	4.36%
Denmark	53 (23/30)	10 488.4	6.6%	4.23%
Finland	41 (9/32)	6 291.1	5.1%	2.54%
Italy	38 (17/21)	6 044.1	4.8%	2.44%
Spain	21 (11/10)	5 898.3	2.6%	2.38%
Belgium	32 (9/23)	3 752.3	4.0%	1.51%
Austria	33 (11/22)	2 407.4	4.1%	0.97%
Luxembourg	18 (3/15)	2 364.0	2.3%	0.95%
Portugal	5 (1/4)	363.5	0.6%	0.15%
Hungary	1 (1/0)	204.5	0.1%	0.08%
Slovenia	1 (1/0)	178.6	0.1%	0.07%
Poland	3 (0/3)	101.7	0.4%	0.04%
Malta	1 (1/0)	94.8	0.1%	0.04%
Greece	4 (0/4)	48.4	0.5%	0.02%
Czechia	1 (0/1)	25.6	0.13%	0.01%
Total	800 (322/478)	247 725.8	100.0%	100.00%

Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800. *: in decreasing order of R&D

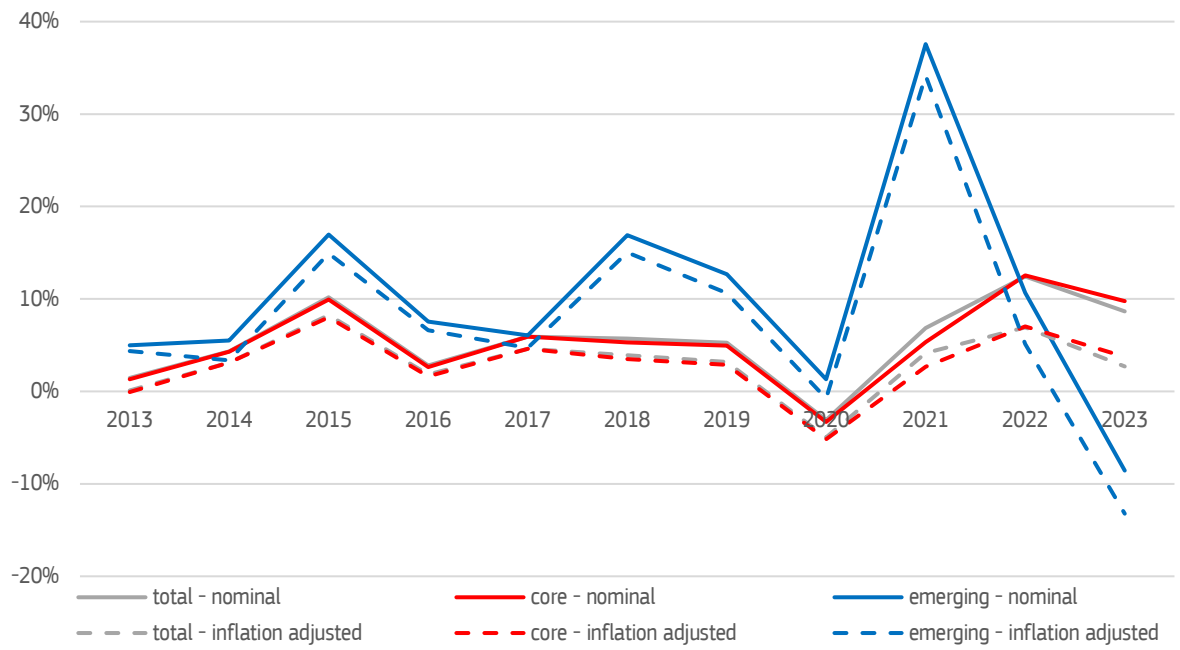
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The annual R&D investment growth rates for the total EU 800, the core and emerging EU samples (nominal and inflation-adjusted) are shown in Figure 21. Given that the companies that also belong to the top 2 000 global R&D investors account for roughly 95% of R&D of the EU 800, the growth rates for the EU 800 and the top companies are broadly similar. The emerging-group companies exhibited the same or higher growth rates throughout the observation period; only in 2022 and 2023 the core group R&D investment growth rates exceeded those of the emerging group. In 2023, R&D investment by the core companies increased by 9.8% (3.7% adjusted for inflation), while the companies in the emerging group invested less in R&D than in 2022 (-8.6%, or -13.2% adjusted for

[66] Several top R&D investors, e.g. Airbus, Stellantis, STMicroelectronics and CureVac, are headquartered in the Netherlands but do most of their business in other countries.

inflation). In nominal terms, the core-group companies spent EUR 20.9 billion more on R&D in 2023 than in the previous year, while the remaining companies invested EUR 1.2 billion less than in the year before. Figure 21 below depicts the nominal and inflation-adjusted growth rates for the EU 800 since 2013, for the total sample, the core group and the emerging group companies.

Figure 21. EU total/core/emerging R&D investment growth rates (nominal and inflation adjusted), 2013-2023



Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800. The base year for the inflation adjustment is 2015 (GDP deflator in 2015 = 100).

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Note that the EU emerging group consists of smaller EU companies investing in R&D sampled as a 'residual' category, causing more volatility in the aggregate development, as seen in Figure 21. The large spike in 2021 reflects both the broad increase in R&D investment in this year and the addition of 45 companies to the sample of the EU emerging group that were in the EU core group the year before.

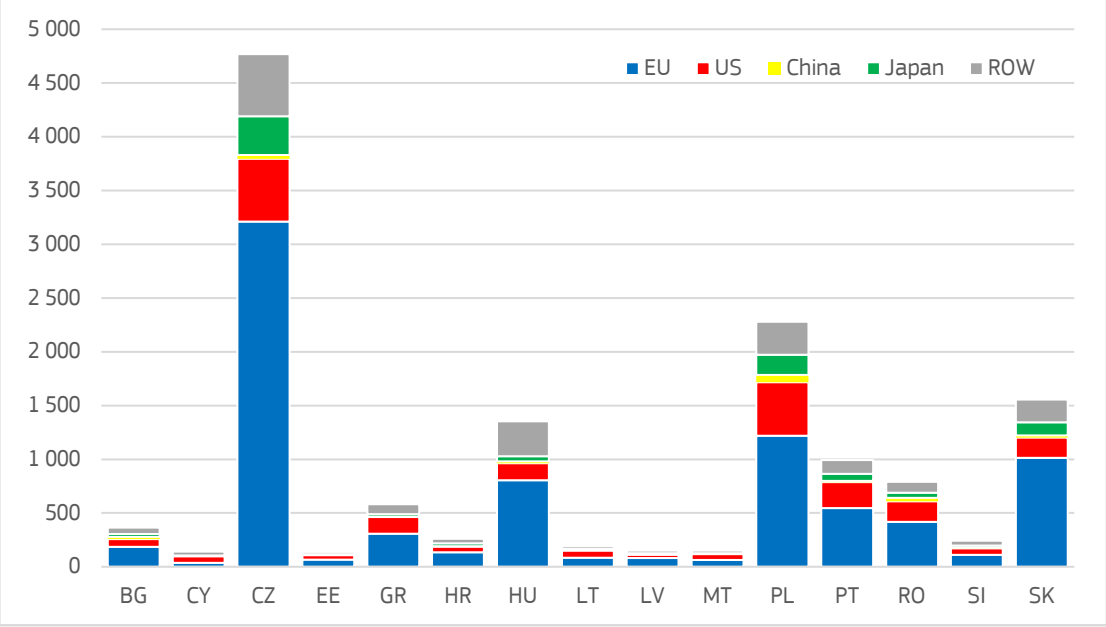
Overall, in 2023, 72.5% of all EU 800 companies reported an increase in R&D investment compared to the previous year, a decrease by 4 percentage points compared to 2022, but above the sample average of 67.4% since 2013. However, the results differ between the EU core and EU emerging samples: for the core group, on average 70% reported a year-on-year increase in R&D investment since 2013, but this was only 65% for the emerging-group companies, and the share in the core group was higher than in the emerging group in every year except 2020. From 2013 until the outbreak of the COVID-19 pandemic, the share of companies increasing R&D was on average only 5 percentage points higher in the core group. This difference subsequently started to widen to an average of 10 percentage points. In 2023, 80% of the core-group companies increased their R&D, compared to only 68% in the emerging group. This is also related to how the sample is collected; for example, an EU core company which reduces R&D investment and drops out of the global top 2 000 ranking will enter the emerging group ranking in a high spot. Nevertheless, it also confirms that R&D investment by smaller EU companies appears to be more volatile. Section 4.4 provides more details on the number of companies with positive and negative development on a country level in Table 30.

Box 3. Top R&D investors' subsidiaries in EU widening countries, 2023

Widening countries[67] are less represented in the Scoreboard ranking than other EU Member States. In fact, in 2023, out of the 2 000 top corporate R&D investors, only 4 have headquarters in one of the 15 widening countries (one each in Portugal, Hungary, Slovenia, and Malta). However, the ownership structure of all Scoreboard companies recorded in this year's ranking paints a more nuanced picture of the relevance of Scoreboard companies in widening countries and by extension in the corporate R&D investment landscape. 854 Scoreboard companies own subsidiaries in one or more widening countries, which between them host close to 14 000 subsidiaries (3.7% of all subsidiaries).

Figure B3-1 shows the number of subsidiaries located in each of the widening countries and breaks them down by the region of the owning Scoreboard mother company. The figure shows a heterogeneous landscape in which two countries (Czechia with 34.1% and Poland with 16.6%) host over 50% of subsidiaries. Unsurprisingly, the majority of subsidiaries hosted in widening countries belong to EU-based companies. However, as we retrieve the information on R&D (and the financial indicators) from consolidated company accounts (at mother-company level), and companies do not report on R&D at subsidiary level, we cannot estimate possible R&D activity in widening countries through subsidiaries of Scoreboard companies.

Figure B3-1. Subsidiaries located in each widening country by country of the mother company, 2023



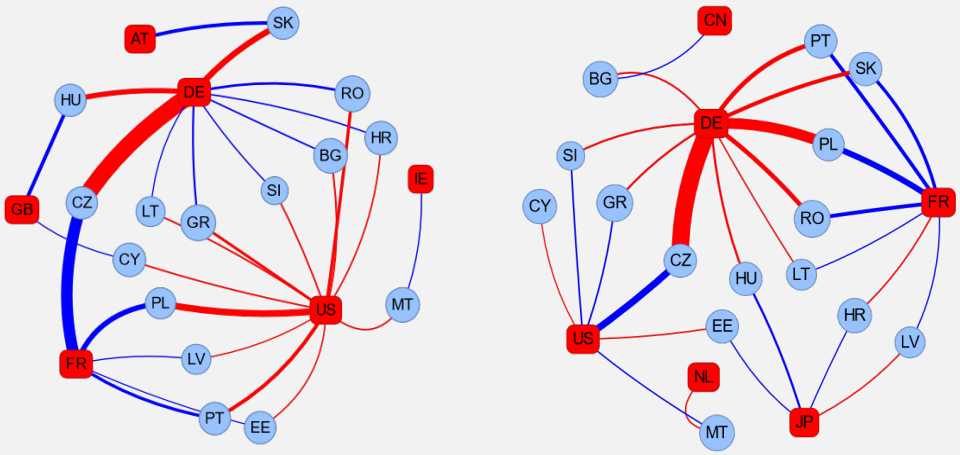
Notes: Data refers to the 854 companies for which data on subsidiaries located in widening countries is available.
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The geographical location of the widening countries and the strong prevalence of ties to EU-based Scoreboard companies may create an assumption that this pattern would also appear when analysing ties at the country level. Figure B3-2 links each widening country to the 2 Scoreboard headquarters countries with which it has the strongest links; the strongest link is shown in red and the second strongest in blue. The left panel refers to all sectors and shows that, while Slovakia,

[67] https://rea.ec.europa.eu/horizon-europe-widening-who-should-apply_en

Czechia and Hungary do indeed have their strongest links within the EU (to Germany), most widening countries host more subsidiaries of US Scoreboard companies than those of any other country. The right panel in Figure B3-2 looks at the automotive sector and paints a slightly different picture, suggesting that sectoral specificities matter. In particular, Germany is much more central in this specific sector, but we also see that China and Japan are present.

Figure B3-2. Network of mother companies and subsidiaries in EU widening countries, 2023



Notes: Data refers to the 854 companies, for which data on subsidiaries located in widening countries are available. Left: network linking widening countries hosting Scoreboard subsidiaries (circles) to the countries hosting company headquarters (boxes). Right: network linking widening countries hosting the subsidiaries of Scoreboard companies operating in the automotive sector (circles) to the countries hosting company headquarters (boxes). In both panels, the thickness of the links is proportional to the number of subsidiaries (only the two strongest links for each widening country are drawn for readability)
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

4.2 EU 800 R&D investors – sectoral overview

The distribution of R&D investment by the EU 800 companies by sector is shown in Table 29. The automotive sector accounts for the largest share with 34.2% of R&D, the health sector for the second largest (19.3%), followed by ICT producers (14%) and ICT services (7.8%). The sectors with the lowest shares are construction & materials, chemicals and energy. Relative to the previous year, the share of automotive R&D increased by 1.5 percentage points and that of the health companies decreased by 0.7 percentage points – these changes are in line with global trends. Compared with the top 2 000, the automotive, aerospace & defence, chemicals, energy, financial and industrials sectors have higher R&D shares in the EU 800, while ICT services, ICT producers and health have (in some cases considerably) lower shares.

Overall, the sectoral concentration of R&D in the EU 800 sample resembles that among the top 2 000 R&D investors. However, in the EU 800 sample, the top 4 sectors account for a smaller proportion of R&D than in the global sample (75.2% compared with 78.7%), and for a substantially smaller proportion of companies (48% against 63.7%). This is because a small number of large automotive companies are responsible for a considerable share of aggregate R&D investment. Moreover, while the EU 800 has the same share of health and ICT hardware companies as the global sample, the share of ICT software companies is only 9.8%, while this sector accounts for 15% of the companies in the global sample. In terms of R&D investment share, the differences are even more striking: the EU 800 ICT software companies are responsible for 7.8% of R&D, while their share in global R&D investment amounts to 20.6%. ICT hardware also accounts for a significantly lower share of R&D

among the EU 800: 14% compared with 22.9% for the global top 2 000, while health accounts for about the same percentage in both samples, and automotive accounts for a much bigger share among the EU 800: 34.2%, some 20 percentage points higher than in the top 2 000 with 14.7%.

Table 29. R&D by sector in the EU 800, 2023

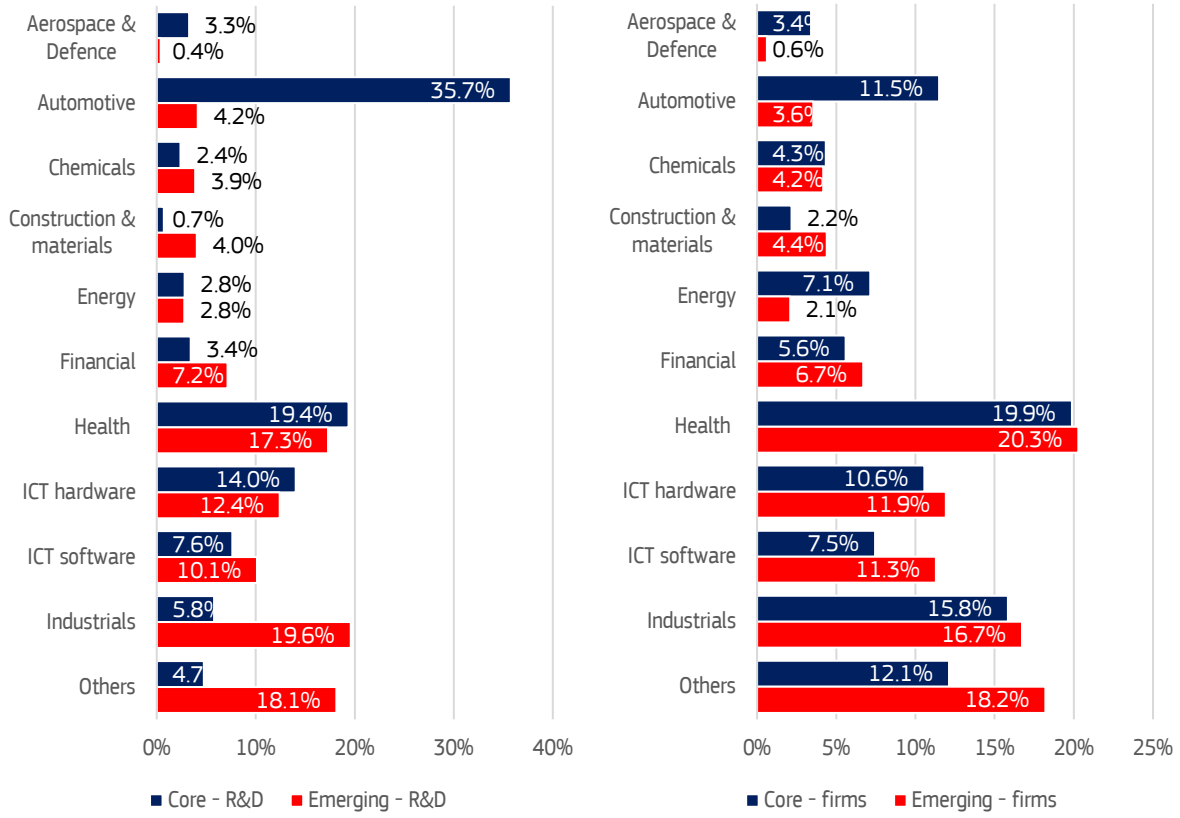
	Countries	Companies	Share of companies	Core group	Emerging group	SMEs	R&D investment	Share R&D
Automotive	9	54	6.8%	37	17	0	84 609	34.2%
Health	14	161	20.1%	64	97	74	47 753	19.3%
ICT hardware	12	91	11.4%	34	57	7	34 575	14.0%
ICT software	13	78	9.8%	24	54	8	19 247	7.8%
Industrials	12	131	16.4%	51	80	1	16 093	6.5%
Others	16	123	15.8%	39	87	4	13 425	5.4%
Financials	12	50	6.4%	18	32	2	8 967	3.6%
Aerospace & defence	6	14	1.8%	11	3	0	7 721	3.1%
Energy	14	33	4.1%	23	10	0	6 978	2.8%
Chemicals	9	34	4.3%	14	20	2	6 144	2.5%
Construction & materials	11	28	3.5%	7	21	1	2 208	0.9%
Total	19	800	100%	322	478	99	245 725	100%

Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800. Countries refers to the number of EU countries with companies in a specific sector. R&D expressed in EUR million. SMEs…small and medium sized enterprises (<250 employees).

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The distribution of EU 800 R&D investment (left panel) and companies (right panel) by sector in 2023 for the core and extended group is shown in Figure 22. The difference in R&D investment by sector between the core and the extended sample firms is considerable. While the automotive sector accounts for close to 36% of R&D investment in the core group, the highest R&D shares in the emerging group are for the industrials, health, and 'others' sectors. The share for the ICT sectors is rather low in both groups, with 21.6% of R&D in the core group and 22.5% in the emerging group, substantially lower than the 43.5% among the global top 2 000. The R&D share for the health sector is closer to the global share of 20.5% for both groups.

Figure 22. Sectoral distribution of EU 800 R&D (left) & companies (right) – EU core vs EU emerging, 2023



Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

In terms of companies (right panel), the distribution across sectors in both groups is quite similar in the health, chemicals, ICT hardware, financial and industrials sectors, while in ICT software and construction & materials the emerging group has more companies. The automotive, aerospace & defence and energy sectors have more weight in the core group, which contains on average much larger companies. However, this does not mean that the companies themselves are automatically smaller in terms of sales or employment, but only that their relative R&D investment is lower.

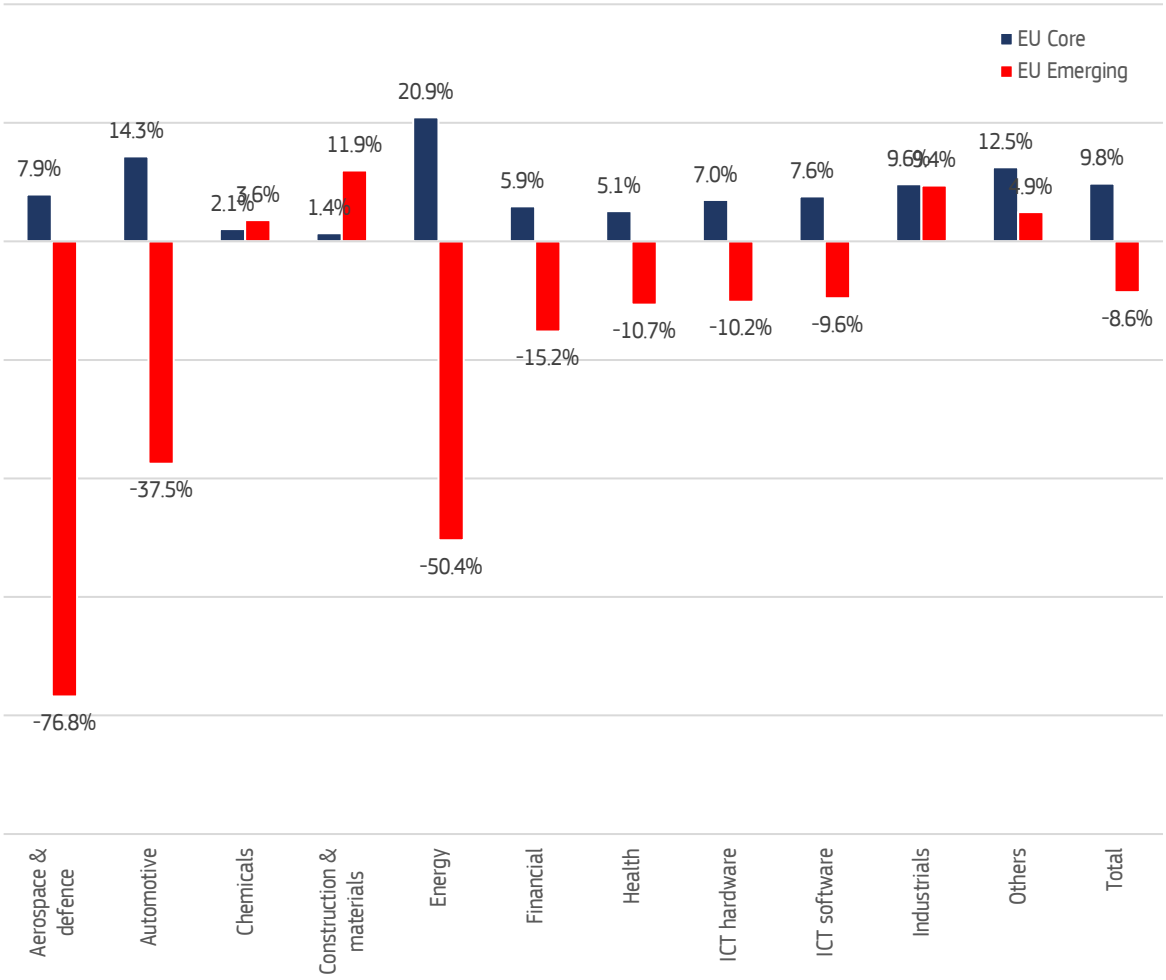
Figure 23 presents the growth rates in nominal R&D investment per sector for both groups since 2022. While in the core group, all sectors increased R&D investment in 2023, in the emerging group 7 sectors recorded decreases and only 4 had (sometimes small) increases. Note that growth rates in the emerging group can be influenced strongly by firms moving up to/down from the core group. We discuss these issues in the text below.

The **aerospace & defence** sector in the emerging group lost 3 out of 6 companies, as one company moved up into the core group and 2 other companies had no accounts available at the cut-off date for the Scoreboard data collection. This explains the strong decline for this sector in 2023. The core-group companies showed healthy growth, but their additions to R&D investment were below the sample average of 9.8%.

In the **automotive sector**, the EU core companies were the drivers of EU growth, and more widely on a global scale with their **net addition of EUR 10.5 billion to R&D.** The **number of companies** in the core group **increased** by 5 as a result of companies moving up from the emerging group (3

German companies and one Spanish company). Another German company was newly included in the modified data collection process. For the emerging group, several companies did not publish accounts and thus could not be observed. Half of the remaining automotive companies increased their R&D investment compared to 2022, while, the other half decreased it.

Figure 23. Growth rate in R&D investment 2023, EU core and emerging, across sectors



Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800. *Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.*

The **chemicals** sector shows small positive growth in both groups, but when inflation is factored in, growth rates turn negative to -4% in the core group and -1.6% in the emerging group. The chemical sector's **R&D share among the EU 800 continued to decline**, falling to just 2.5%, its lowest value so far.

In **construction & materials**, the smallest sector in terms of R&D with 0.9% of the EU total, R&D investment grew strongly among the emerging group, but stagnated among the core group (and even fell in real terms by 4.3%). The increase is due to one company dropping from the core group to the emerging group and some new companies entering the EU emerging group.

The **energy sector** also showed a stark contrast between the two groups: while the EU core group energy companies **increased their R&D investment at the highest rate so far**, the emerging group companies lost 50% of their R&D. In total, 83% of the core group energy companies increased R&D in 2023, and together they added over EUR1 140 million to R&D in 2023. In the emerging group

companies cut R&D investments and the sample shrank by 5 companies. Here again, some companies moved up into the core group, while for other companies no information was available.

In contrast to the global energy sector, the **EU has only a few fossil fuel firms in the Scoreboard** – out of the 33 companies, only 5 are oil & gas producers, and another 4 are mainly in oil equipment, services and distribution, while 10 are electricity companies, and another 6 are in alternative energies (including nuclear). **60% of R&D by EU energy companies** comes from companies in **electricity and alternative from of energy**, and only 20% from oil & gas companies (plus equipment).

The **financial** sector also saw the EU core and EU emerging samples move in different directions. While 72% of the companies in the core group increased their R&D, only 50% did so in the emerging group. In total, the sector lost R&D investment compared to 2022 when adjusted for inflation (-1.6%) and the R&D share decreased somewhat to 3.6%.

Divergent trends were also apparent in the **health sector**, which saw a **moderate increase** in the core group (and a small 0.2% decrease when adjusted for inflation) and a **decrease in the emerging group**. In the core group, 31% of companies reduced R&D, and in the emerging group 38%, the highest percentage in the core group and the second highest in the emerging group, suggesting widespread reductions in R&D investment. Given that this development is **in line with trends at a global scale**, it could be related to re-adjustments after the large increases during the COVID-19 pandemic. On the positive side, the number of health companies in the EU sample fell by only 3, and 3 companies from the emerging group climbed up into the core group.

A similar picture emerges in the **ICT hardware sector**. The number of companies increased by 2, both in the core group. In the core group, 70% of the companies increased their R&D investment, as did as many as 74% in the emerging group. The core group's 7% growth was **slightly below the figure for the global sample** (8%), but when adjusted for inflation the growth rate falls to just 0.6%. The most significant EU company in this sector in the global **semiconductor** value chain, ASML Holdings in the **Netherlands stands out** with an increase of 21% compared to 2022, investing EUR 3.7 billion in R&D in 2023. The other 2 leading EU semiconductor companies headquartered in the Netherlands, NXP Semiconductors and STMicroelectronics, also increased R&D above the sector average – by 12% and 17% respectively. Since 2019, ASML Holding has doubled its R&D investment, NXP Semiconductors has increased its by 50% and STMicroelectronics by 40%. While this growth is certainly impressive, the US company NVIDIA tripled R&D investment during the same period, and Taiwan Semiconductor Manufacturing (TSMC) doubled it. Still, the data shows that the major **EU companies** in the ICT hardware sector, and in particular the semiconductors subsector, **are keeping the pace with global trends in terms of R&D investment**.

Growth rates for **ICT software** evolved similarly to those for ICT hardware, but at a very different level. The EU sample comprises 78 companies, of which 24 are in the core group and 54 are in the emerging group. In the core group, 95% of the companies increased their R&D investment with respect to the previous year, as did 75% of the emerging group companies. The inflation-adjusted growth rate for the 24 companies that are also in the global sample was just 1.2%, and the 54 companies in the emerging group experienced a real reduction in R&D investment of 14% (after -6% in 2021). However, the fall in the number of companies stopped in 2023, with 2 more companies than in the year before. The **EU ICT software sector's total R&D investment is only EUR 19.2 billion**, which is **less than half** of the Scoreboard leader **Alphabet with over EUR 39 billion** in 2023 alone. Developments in the ICT software and services sector continue to be

of concern, as it constitutes the key sector in the structural R&D intensity gap between the EU and the US and China.

In the **industrials** sector, both the core group and the emerging group companies increased their R&D investment with respect to 2022 (by around 3.5% overall, adjusted for inflation). The number of firms in this sector increased by 8, with one additional company in the core group and 7 in the emerging group. In the core, group 88% of the companies increased their R&D investment, as did 77% in the emerging group. In 2023, the industrials sector **became the largest sector in terms of R&D in the emerging group** due to the decrease in the health sector and the growth of the sector's R&D.

The companies in '**Others**' group also increased their R&D investment in 2023 overall, but those in the EU core group raised their R&D by more than twice as much as the companies in the emerging group did –their R&D investment was negative with -1% when inflation is taken into account, even though the number of companies increased. One reason for this is that some companies in the emerging group reduced their R&D investment and left the core group, and are now counted in the emerging group. The other reason is that the growth in R&D investment in the emerging group was less broad based, with only 68% of the companies increasing their R&D investment, while this was the case for 88% of the companies in the core group. In addition to the broad-based increase, the largest R&D investors in this group, Accenture and L'Oréal (the only ones with R&D investment exceeding EUR 1 billion), raised their R&D investment by almost 16% and 12% respectively. The core group companies in this residual sector recorded the **third highest growth at sectoral level** after energy and automotive with an increase of 12.4% in nominal terms, and 7.4% when adjusted for inflation. They therefore represent an important driver of EU R&D investment at a global level.

The top 4 sectors in the EU 800 in the longer term – 2013-2023

While the previous section focused on the most recent developments, this section takes a step back by looking at the trends in the 4 top sectors by total R&D (ICT hardware, ICT software, health and automotive) for the EU core and EU emerging sample companies in 2013 and 2023. Table 30 presents an overview of these sectors for the two samples in 2013 and 2023, reports the factor change (i.e. R&D investment in 2023 divided by the 2013-value), as well as the percentages of the total R&D these sectors account for.

Table 30. Top 4 sectors in the EU 800 – core vs. emerging, 2013 and 2023, in EUR million

EU 800	Year	Automotive	Health	ICT hardware	ICT software	Rest	Total
Core	2013	42 814	22 127	22 410	8 130	40 251	135 735
	2023	84 090	45 590	33 024	17 983	54 545	235 233
	Factor change	2.0	2.1	1.5	2.2	1.4	1.7
Share Core	2013	31.5%	16.3%	16.5%	6.0%	29.7%	100%
	2023	35.7%	19.4%	14.0%	7.6%	23.2%	100%
Emerging	2013	764	573	466	494	2 478	4 777
	2023	519	2 162	1 550	1 263	6 995	12 492
	Factor change	0.7	3.8	3.3	2.6	2.8	2.6
Share Emerging	2013	16.0%	12.0%	9.8%	10.4%	51.9%	100%
	2023	4.2%	17.3%	12.4%	10.1%	56.0%	100%

Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800. Factor change is R&D in 2023 divided by R&D in 2013 and shows the relative change over time. Shares refer to each sector's share in each group in 2013 and 2023

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

In 2013, the 4 top sectors accounted for 70.3% of R&D in the core group and 48% in the emerging group. Over the last decade these shares evolved in different directions – in the core group, the concentration of R&D in these sectors increased to 76%, while it decreased to 44% in the emerging.

The share of companies in the core group increased from 44% in 2013 to 49.4% in 2023; in the emerging group the corresponding figures are 43% and 47% respectively. In both EU samples, R&D and companies are less concentrated in terms of sectors than the global top 2 000 companies (see Section 3.4).

Table 30 also shows the change in the distribution of R&D across the sectors over time: for the core group, the shares of the automotive and health sector increased between 2013 and 2023, the ICT software sector increased by a small amount, and ICT hardware R&D share decreased. In contrast, in the emerging group, the automotive share fell from 16% to 4.2%, health and ICT hardware increased, and the R&D share of ICT software remained unchanged.

While the automotive sector ranks fourth in the global top 2 000, it is by far the most important sector in the EU. The automotive sector accounts for 11.5% of companies in the **EU core group** but only 7.7% in the top 2 000, and for R&D, the respective shares are 35.7% and 14.7%. The health sector accounts for 19.4% of R&D, only slightly lower than in the top 2 000, and also the share of companies at 19.9% is close to the global distribution (21.9% in the top 2 000). The biggest differences relate to the ICT sectors: the share in R&D of EU ICT hardware is 14% (down from 16.5% in 2013), which is 9 percentage points below that of the top 2 000. The corresponding shares of companies are 10.6% in the EU and 19.1% in the top 2 000. The picture is less encouraging in ICT software and services, where the R&D share for the EU core group stands at 7.6% and the share of companies at 7.5%, substantially lower than the corresponding global shares of 15% of companies and 20.6% of R&D.

In the group of **EU emerging companies**, the pattern is somewhat different to the core group companies, but neither resembles that of competing economies such as the US or China. The companies in this is sample are much smaller in terms of R&D investment, and the rationale for looking at them is to learn about the wider situation of corporate R&D investment in the EU. However, a positive trend since 2013 has been the increase in the share of health and ICT hardware R&D, while the ICT software share remained unchanged. In terms of the number of companies, the share of ICT hardware companies remained stable at 11.9% (11.5% in 2013), while the share of health companies increased at a similar rate to the global 2 000, from 14.7% in 2013 to 20.3% in 2023. However, the share of ICT software and service companies decreased from 13.1% to 11.3%. This is a sign that the pool of smaller software companies in the EU is not large, and that the EU lacks a wider base of companies in the digital service sector and in software development.

4.3 EU 800 country focus

Table 31 looks at the EU countries with Scoreboard companies in 2023, and shows the growth rates of R&D investment with respect to the previous year (in nominal and in inflation-adjusted terms), and the share of companies with an increase in R&D in the core and emerging groups. Given the large variation in company size and R&D investment in the EU sample, decisions by individual companies can determine the aggregate trend of a country (or sector). By looking at the share of firms with growing/decreasing R&D investment allows to draw a wider inference of the development in a country. The table shows the growth rates, the number of companies in the core and emerging groups, and for each group the share of companies with positive growth. The last row 'Total' contains the aggregate development.

In 2023, total R&D investment by EU companies increased by 8.7% (2.7% inflation-adjusted). R&D investment by those companies increased in nominal terms in 15 out of 19 countries with Scoreboard company headquarters. However, the ongoing high inflation pressure in many European countries

drove inflation-adjusted growth rates down, so that only 12 countries recorded real increases in corporate R&D by Scoreboard companies. Hungary, Italy and Portugal turn negative when inflation is taken into account.

Overall, 254 of the core group companies raised their R&D in 2023 compared to the previous year (79.4%), but only 324 (67.9%) of the emerging group companies did so. This lower share has two explanations. Firstly, if a company in the core group reduced its R&D investment, it may have moved into the group of emerging companies. Secondly, companies with less R&D investment might regard R&D as less central in their business activities and therefore reduce R&D during an economic slowdown, or their R&D might vary more from project to project.

Table 31. EU 800 companies with positive/negative R&D growth 2023, per country, EU core & EU emerging

	R&D growth	R&D growth deflated	Companies core	share positive growth	Companies emerging	share positive growth
Austria	-4.1%	-10.8%	11	81.8%	22	72.7%
Belgium	-0.1%	-4.0%	9	55.6%	23	78.3%
Czechia	15.3%	6.2%			1	100.0%
Denmark*	14.9%	19.1%	22	68.2%	30	53.3%
Finland	-1.7%	-6.2%	9	66.7%	32	62.5%
France	7.0%	1.4%	49	81.6%	67	59.7%
Germany	8.3%	1.5%	106	80.2%	127	72.4%
Greece	18.6%	13.5%			4	100.0%
Hungary	4.3%	-9.1%	1	100.0%		
Ireland	5.7%	2.7%	24	70.8%	13	38.5%
Italy	0.8%	-4.3%	17	70.6%	20	75.0%
Luxembourg	3.6%	0.2%	3	100.0%	15	93.3%
Malta	12.3%	6.6%	1	100.0%		
Netherlands	12.9%	4.8%	33	90.9%	29	62.1%
Poland	-2.9%	-12.3%			3	66.7%
Portugal	6.7%	-0.4%	1	100.0%	4	
Slovenia	9.8%	0.9%	1	100.0%		
Spain	11.8%	5.5%	11	81.8%	10	40.0%
Sweden	17.5%	11.3%	22	86.4%	77	72.7%
Total	**8.7%**	**2.7%**	**320**	**79.4%**	**477**	**67.9%**

Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800. The table comprises only companies with data for 2022 and 2023. *The fact that real R&D investment growth in Denmark is higher than nominal growth is a statistical effect of high R&D growth and a strong fall in the inflation rate compared in 2023; the high inflation rate in 2022 lowered R&D by much more than in 2023, resulting in a higher rate of growth in inflation-adjusted R&D (starting from a much lower level).

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Aggregate growth rates in R&D may hide very differences: for example, in Austria, total R&D investment in 2023 was lower than in 2022, even though above-average shares of companies in both groups increased their R&D investment. Denmark[68] shows the opposite picture: while total R&D

[68] The fact that real R&D investment growth in Denmark is higher than nominal growth is a statistical effect of high R&D growth and a strong fall in the inflation rate compared in 2023; the high inflation rate in 2022 lowered R&D by much more than in 2023, resulting in a higher growth rate of growth in inflation-adjusted R&D (starting from a much lower level).

increased considerably, fewer firms increased their R&D in 2023 compared to the companies with headquarters in Austria or to the sample average.

The countries with the highest shares of companies with positive growth (excluding the countries with only one company) in the core group are the Netherlands, Sweden, Spain, Austria and Germany (in decreasing order), while in the emerging group the share of companies with positive growth is highest in Luxembourg, Belgium, Spain, Austria, Italy and Germany. Conversely, the countries with the lowest shares of companies with positive growth in the core group are Belgium, Finland, Italy and Ireland. In the emerging group Ireland, Spain, Denmark, France and Finland have a share below the sample average.

The **development of R&D investment at the country level** is thus often determined by a **few large companies**. In the following paragraphs we investigate the cases where a few companies drive the overall development, or where the core and emerging group followed strongly divergent trajectories.[69]

In the case of **Austria**, even though most companies increased R&D, the growth rate in 2023 was negative. This relates to 2 large companies from the ICT hardware sector that reduced disproportionately their R&D investment (AMS-Osram and AT&S). R&D investment in Austria is less concentrated than in other EU countries, and the largest company (in terms of R&D) accounts for 24.5% of Austria's R&D in the Scoreboard.

In **Belgium**, 41% of R&D investment in the Scoreboard related to one company, UCB (health sector), which increased R&D by only 1.9% in 2023; the second largest is Solvay (chemicals), which raised R&D by one third. However, 4 companies in the top group reduced their R&D and one company even left the core group. Overall, this caused a slight negative development in Belgium.

In **Denmark**, in contrast, fewer companies increased their R&D investment, while R&D was considerably higher strongly compared to 2022. This results in part from new companies entering the core group, but also from several health companies that increased their R&D considerably, in particular Novo Nordisk – the company increased R&D by 33% in 2022 and another 34% in 2023. Since 2019, the company has increased its R&D investment from EUR 1.7 billion to EUR 3.9 billion, a factor of almost 2.3; it is by far the largest Danish company in the Scoreboard (37.5% of Danish Scoreboard R&D), over EUR 3 billion ahead of the second, Genmab.

In **Finland**, the aggregate trend was driven by a 5% reduction in R&D by the largest Finnish company, Nokia The share of companies that lowered R&D was higher than for the EU in total, but the reductions were relatively small compared to the impact of Nokia on the country aggregate, which was responsible for 70% of Finland's R&D as measured in the Scoreboard.

The picture in **France** was more mixed. Large increases were recorded for companies in the core group such as Renault (+14%) or Valeo (+36.8%) in the automotive sector, or Safran in aerospace & defence (+21%), as well as large increases by some companies in the energy sector. At the same time, the largest French ICT software company, Ubisoft, reduced R&D investment by 2.5%, and the largest company in France, Sanofi, increased nominal R&D by only 3%.

[69] Note that countries with only one company are not considered here.

Developments in **Germany** were overall very positive. The driving forces were the large automotive companies, increasing their R&D by 15% (Volkswagen), 17% (Mercedes-Benz), 8% (BMW) and 10% (Robert Bosch). The largest absolute decrease relates to Bayer by 17% (down EUR 1.16 billion); beyond that, the German health sector increased R&D strongly, with Biontech increasing R&D by 29.7%, Carl Zeiss by 33%, and Boehringer Sohn with by 14%. The largest ICT software and services company in Germany, SAP, stagnated with 2% nominal increase, and the largest ICT hardware producer, Siemens, increased R&D by 10%. The largest chemicals company, BASF, reduced R&D investment by 6.8%, returning to its 2020 level.

In **Ireland**, R&D investment growth was positive thanks to substantial increases by Accenture (business services) and Aptiv (automotive), both raising R&D by 15% in 2023, while the largest (in Ireland registered) company, Medtronic, kept R&D investment virtually unchanged (up 1.4%). The largest decrease in R&D was recorded by Seagate (ICT hardware), down 29.2%. One company from the core group moved to the emerging group, and Horizon Pharma (aka Horizon Therapeutics Limited) was acquired by the US-company Amgen. This constitutes the largest acquisition of an EU Scoreboard company in 2023.

Nominal R&D investment in **Italy** remained unchanged in 2023, but decreased in inflation-adjusted terms. While most of the companies increased their R&D investment, one company cut R&D by almost 35%, resulting in a modest overall figure. On the positive side, one ICT software and services company moved from the emerging group to the core group. Italy, however, has more and larger companies investing in R&D than reported in the Scoreboard, which is based on country of headquarter, as these companies were either acquired by other companies (e.g. Fiat) or had registered headquarters in other countries (e.g. Ferrari).

The situation is similar in **Luxembourg:** the largest company for R&D investment is Spotify, which is actually a Swedish company, but is responsible for 63% of the total R&D investment of Scoreboard companies in Luxembourg. Arcelor Mittal, the second largest steel-producing company in the world, also has its headquarters in Luxembourg, and is the company with the second largest R&D investment.

The **Netherlands** had one of the highest R&D investment growth rates in 2023. As already mentioned in Section 4.2, the driving forces behind this are the large semiconductor companies, as well as the automotive companies Stellantis (+11.3%), CNH Industrial (+20.4%) and Iveco (+40%). Almost all the core companies increased R&D investment, while fewer of the smaller companies in the emerging group had a positive development. Two health companies moved up from the emerging to the core group, as did one from aerospace & defence, while one retail company moved down.

The companies from **Spain** raised their R&D investment considerably and broadly in the core group, while the emerging group companies mostly reduced their R&D investment. The largest Spanish R&D investing company, Banco Santander, increased R&D by 31.9% to EUR 1.7 billion, and the second largest, Amadeus (ICT software) by 29% to EUR 988 million. These 2 companies are responsible for 45.5% of total R&D investment by Spanish companies in the Scoreboard. Moreover, one company dropped out of the core group, while one moved up.

Sweden registered above-average R&D investment growth. The leading Swedish company Ericsson (ICT hardware) increased R&D by 6% to EUR 4.4 billion, followed by the two automotive companies Geely Sweden Holding, with an increase of 69% to EUR 3.3 billion, and Volvo, up 17% to EUR 2.6 billion. Together, these three companies added over EUR 1.9 billion to R&D. One company left the core group and is now in the emerging group, while three other companies moved up.

Top 3 R&D investors in the top 5 EU countries

Table 32 showcases the top 3 R&D investors from select EU Member States over the years 2003, 2013, and 2023. It provides valuable insights into the R&D trajectories in these countries, their leading companies and the EU as a whole. Overall, the data confirms that the automotive sector remains the powerhouse of R&D investment in Germany and France, while the health sector is more important in Denmark. The Netherlands and Sweden show higher sectoral diversification among their top R&D performers. This diversification is also observed among the EU companies that have experienced the highest absolute R&D growth over the past decade, suggesting potential new areas of technological leadership within the EU (at the end of this Section).

Table 32. EU 800 -Top 3 R&D investors in Top 5 EU Member States, 2003, 2013 and 2023

	2003			2013			2023		
	Company	**Sector**	**R&D**	**Company**	**Sector**	**R&D**	**Company**	**Sector**	**R&D**
Germany	MERCEDES-BENZ	Automotive	5 571	VOLKSWAGEN	Automotive	11 743	VOLKSWAGEN	Automotive	21 779
	SIEMENS	ICT hardware	5 511	MERCEDES-BENZ	Automotive	5 379	MERCEDES-BENZ	Automotive	9 980
	VOLKSWAGEN	Automotive	4 140	BMW	Automotive	4 792	BMW	Automotive	7 755
France	SANOFI	Health	4 068	SANOFI	Health	4 757	SANOFI	Health	6 728
	PEUGEOT	Automotive	2 098	ALCATEL-LUCENT	ICT hardware	2 374	RENAULT	Automotive	2 582
	RENAULT	Automotive	1 737	PEUGEOT	Automotive	1 966	FORVIA	Automotive	2 188
Netherlands	PHILIPS	Industrials	2 617	AIRBUS	Aerospace & Defence	3 581	STELLANTIS	Automotive	7 484
	AIRBUS	Aerospace & defence	2 193	PHILIPS	Industrials	1 829	ASML HOLDING	ICT hardware	3 725
	STMICRO-ELECTRONICS.	ICT hardware	921	STMICRO-ELECTRONICS.	ICT hardware	1 362	AIRBUS	Aerospace & defence	3 634
Sweden	ERICSSON	ICT hardware	3 227	ERICSSON	ICT hardware	3 485	ERICSSON	ICT hardware	4 440
	VOLVO	Automotive	864	VOLVO	Automotive	1 760	GEELY SWEDEN HOLDINGS	Automotive	3 234
	TELIA	ICT software	280	SANDVIK	Industrials	374	VOLVO	Automotive	2 579
Denmark	NOVO NORDISK	Health	563	NOVO NORDISK	Health	1510	NOVO NORDISK	Health	3 941
	NOVOZYMES	Health	101	DANSKE BANK	Financial	281	GENMAB	Health	858
	DANFOSS	Industrials	78	VESTAS WIND SYSTEMS	Energy	241	DANSKE BANK	Financial	547
Other EU	NOKIA (FI)	ICT hardware	3 978	NOKIA (FI)	ICT hardware	3 456	NOKIA (FI)	ICT hardware	4 266
	LEONARDO (IT)	Aerospace & defence	1 227	FIAT (IT)	Automotive	3 362	MEDTRONIC (IE)	Health	2 491
	SEAGATE (IE)	ICT hardware	527	LEONARDO (IT)	Aerospace & defence	1748	BANCO SANTANDER (ES)	Financial	2 197

Notes: The main four sectors are highlighted in different colours. R&D in EUR million

Source: The 2024 EU Industrial R&D Investment Scoreboard. European Commission, JRC/DG R&I.

In Germany, the automotive sector dominates the R&D landscape, with Mercedes-Benz, Volkswagen and BMW consistently among the top 3 investors.

France displays a mix of health industries and automotive companies in its R&D profile. Sanofi's continuous top ranking highlights the central role of pharmaceuticals and healthcare in France's R&D activities. Meanwhile, the emergence of Forvia in 2023 points to evolving dynamics in the French automotive sector, reflecting changes due to mergers or acquisitions.

The Netherlands exhibits more sectoral diversity in its top R&D investors, with a notable presence in the aerospace and defence sector (Airbus) and the industrials sector (Philips), and the emergence of ASML Holding in ICT hardware. The rise of Stellantis as a major R&D investor in 2023 follows from

the merger of PSA Group (previously headquartered in France) and Fiat Chrysler, and reflects the country's business environment attractiveness for multinationals. ASML Holding's strong R&D investment in 2023 underscores the Netherlands' growing importance in the semiconductor industry, which is crucial for many technology sectors.

Sweden's R&D landscape is relatively stable, with a strong presence in the ICT hardware sector through Ericsson and in the automotive sector with Volvo and Geely Sweden Holdings. Ericsson's consistent investment in R&D, although not increasing dramatically, indicates a steady focus on telecommunications and related technologies.

Denmark's R&D investment is strongly driven by the health industries (e.g. Novo Nordisk and Genmab) reflecting the country's strengths in pharmaceuticals and biotechnology. The substantial increase in R&D investment by Novo Nordisk from 2003 to 2023 indicates the company's success in innovation in diabetes care and other therapeutic areas.

In other EU countries, Nokia remains a key R&D investor despite challenges in the smartphone market, maintaining a focus on telecommunications infrastructure. In 2023, there were no longer any Italian companies qualifying for inclusion in the table, potentially signalling challenges in sustaining high R&D levels. In Ireland, Medtronic's ascent to the top in 2023 reflects the country's attractiveness in terms of tax policies and skilled workforce for multinational corporations.

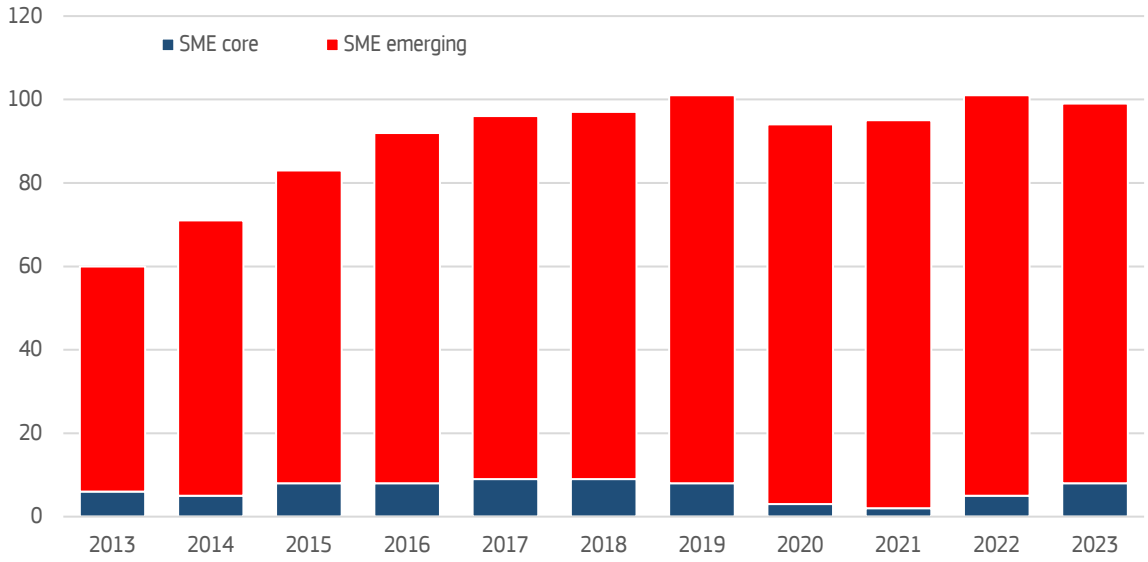
The five largest **absolute increases** in R&D investment between 2013 and 2023 were made by Volkswagen (up by EUR 8 659 million), Mercedes-Benz (up by EUR 4 330 million), SAP (up by EUR 3 975 million), Stellantis (up by EUR 3 819 million), and BMW (up by EUR 3 189 million). This shows that innovation within the automotive sector retains momentum, particularly among Germany's leading companies. In **relative terms**, companies that more than tripled their R&D investment between 2013 and 2023 (with over EUR 1 500 million invested in 2023) include ASML (260%), ZF (215%), Forvia (484%), Biontech (5 094%), NXP Semiconductors (251%), and Infineon Technologies (241%). This points to significant diversification beyond traditional automotive manufacturers, with rising investments in the semiconductor sector (ASML, NXP, Infineon), automotive components (Forvia, ZF), and biotech/pharma (Biontech). These shifts indicate new areas of technological leadership within the EU, which are essential for the region's long-term competitiveness and resilience.

4.4 SMEs in the EU 800

Of the EU 800 companies, **99 are small and medium sized enterprises (SMEs)** with less than 250 employees[70] - 2 fewer than in the previous year. As shown in Figure 24, the total number of SMEs increased from 60 to 99 between 2013 and 2023, marking a **rise in the share of SMEs from 7.5% to 12.4%**. The SMEs are mostly found in the group of emerging companies, and only a few are also among the global top 2 000.

[70] We use the EU definition of SMEs: https://single-market-economy.ec.europa.eu/smes/sme-definition_en. But given that we have no data on turnover or balance sheets, we use only the employment criteria.

Figure 24. Number of SMEs in the EU 800 – core vs emerging group, 2013-2023



Notes: 'Core' refers to the 322 companies in the global top 2 000, 'emerging' refers to the additional 478 companies that form the EU 800.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Together, **the 99 SMEs invested EUR 2.4 billion in R&D in 2023** – 3.7% more than the previous year (-0.8% adjusted for inflation). The growth rate of R&D investment by SMEs in the EU exceeded that of the emerging group companies, though was lower than that of the core companies or the global 2 000.

The distribution of SMEs and their R&D investment across EU countries in 2023 is shown in Figure 25, and the distribution of the number of companies by sector is shown in the Treemap in the right-hand panel of the figure. The distribution differs significantly from the EU 800 total. The largest number of SMEs comes from **Sweden** with 28.3%, followed by **France** with 27.3%, and **Denmark** with 10.1%, while Germany comes only fifth with 7.1%. Czechia, Greece, Hungary, Luxembourg, Malta, Portugal and Slovenia do not have any SMEs in the EU 800. French SMEs account for the biggest R&D investment share at 34% of the total, followed by Sweden at 21.3% and the Netherlands at 16.6%.

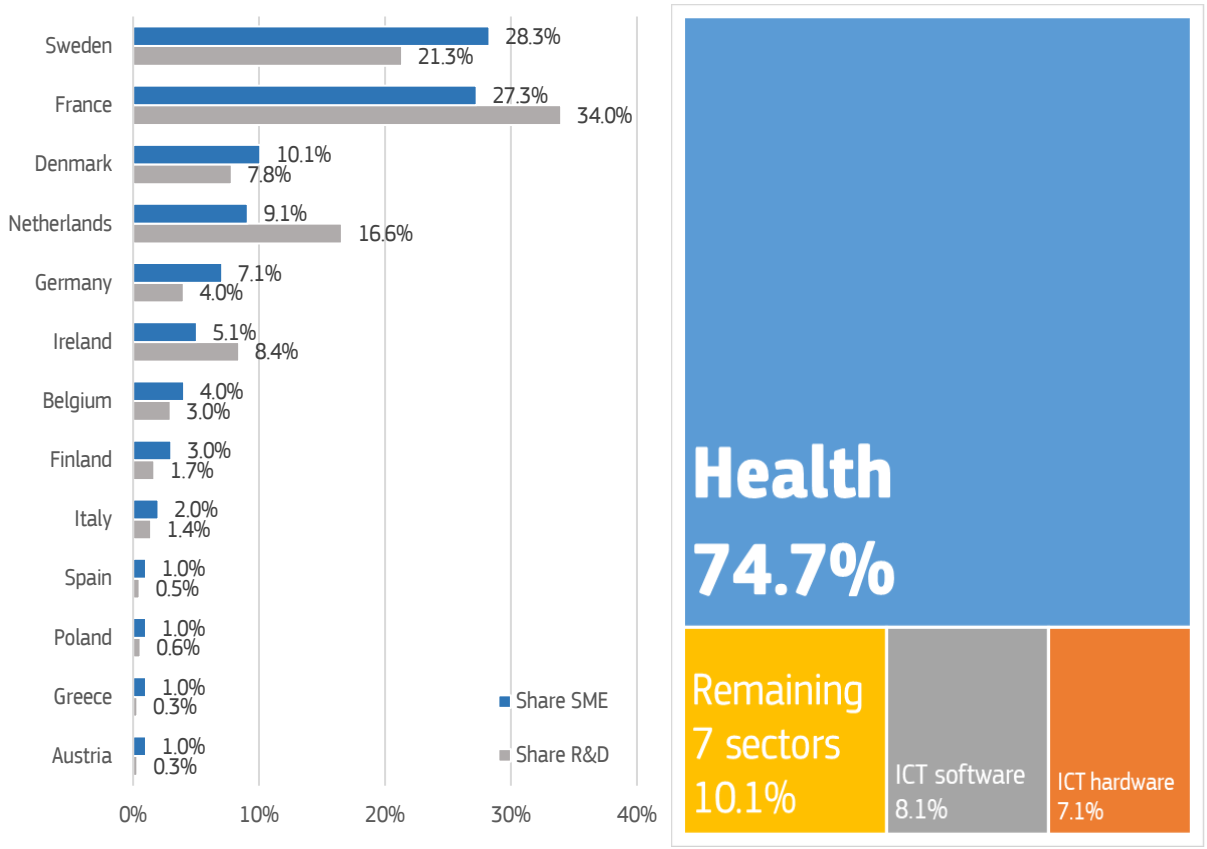
The **health sector** accounts for **83.5% of R&D investment** by the 99 SMEs in the sample and **74.7% of the firms**. Of the 74 health SMEs, 43% are in biotech, 46% in pharmaceuticals and the remaining 11% in other health areas. The second largest sector by SME R&D investment is ICT software with 7.8% of R&D investment and 8.1% of firms. Overall, all sectors except for the automotive, aerospace & defence, and energy sectors have at least one SME, with one each in industrials and construction and materials, 2 each in chemicals and financial, 7 in ICT hardware, and 4 in 'others'.

Of the SMEs, 8 also belong to the EU core group (the top 2 000), 7 are in health (5 in biotechnology, 2 in pharmaceuticals) and one in ICT services. 4 of these 8 top SMEs are located in France, 2 in Netherlands, and one each in Denmark and Ireland. The EU core group SMEs are between positions 234 and 322 in the EU rankings, corresponding to rankings between positions 1 377 and 1 998 in the top 2 000.

Comparing the EU core group SMEs with those from the other world regions/countries shows that the EU has the second highest number of SMEs behind the US, but by a very large margin. In the

Scoreboard **there are 94 US companies with fewer than 250 employees, and they invested EUR 10.6 billion in R&D in 2023**. The EU comes at a distant second with 8 SMEs and a total R&D investment of EUR 746 million, followed by the ROW with 7 SMEs and EUR 679 million, China with 2 (EUR 209 million) and none in Japan. All but 2 of the US SMEs are in the health sector; 75 are biotech companies and 17 are classified in pharmaceuticals. To put this into perspective, the US SMEs' total R&D investment amounted to 84% of the total R&D investment by all companies in the EU emerging group in 2023.

Figure 25. SMEs in the EU 800 – Company and R&D shares across countries, 2023; Treemap: share of companies across sectors



Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

4.5 Key points

- **R&D investment growth in 2023:** The EU 800 companies invested EUR 247.7 billion in R&D in 2023, a growth rate of 8.7% in nominal terms and 2.7% in real terms, with the core group increasing its R&D investment by 9.8% in nominal terms and 3.7% in real terms. The EU emerging group, comprising smaller EU R&D investing companies, exhibited a decrease in R&D investment in 2023, with a negative growth rate of 8.6% in nominal terms and down by 13.2% in real terms.
- **Regional concentration in the EU:** The top 3 countries in terms of R&D investment in the EU 800 sample are Germany, France, and Netherlands, representing 73.3% of the total R&D investment, with Germany accounting for 46.5% of the total. Germany's R&D investment is dominated by the automotive sector, the Netherlands show higher sectoral diversification in their top R&D performers with a strong presence in the semiconductor value chain, while France's R&D investment landscape also has a strong contribution from the health sector.
- **Sectoral distribution:** The automotive sector accounts for the largest share of R&D investment, with 34.2% of the total R&D investment, followed by the health sector (19.3%), ICT hardware

(14%), and ICT software (7.8%). In total, the top 4 sectors accounted for 75.2% of R&D investment in 2023, with the automotive sector accounting for 36% of R&D investment in the core group, but only 4.2% in the emerging group. The majority of the EU 800 companies are outside the 4 top sectors, indicating a broader sectoral base.

— **Investment gap in ICT software:** The EU is a long way behind the US in the ICT software and services sector, with the US investing EUR 143.6 billion in R&D in this sector in 2023, compared to the EU's EUR 19.2 billion. Moreover, the sector showed a decrease in R&D investment in the emerging group, with a decrease in R&D investment by 6% in nominal terms and 14% in real terms, and a small increase in the core group, with a growth rate of 1.2% in nominal terms and down by 2.4% in real terms.

— **Electricity and renewable energy companies**: In the energy sector, developments were heterogeneous, with the core group increasing its R&D investment by 15.6% in nominal terms (8.5% in real terms), and the emerging group decreasing its R&D investment by 50% in nominal terms (56.4% in real terms). In contrast to the global energy sector, the **EU has only few firms in fossil fuel in the Scoreboard**, while most are electricity companies or in alternative energy (including nuclear). **60% of R&D by the EU energy companies** relates to companies in **electricity and alternative energies**, and only 20% to the oil & gas companies.

— **Health sector development:** The health sector showed a moderate increase in the core group, with a growth rate of 2.1% in nominal terms and down by 0.2% in real terms, and a decrease in the emerging group, with a negative growth rate of 10.4% in nominal terms and 14.2% in real terms.

— **EU R&D investment diversification:** The Netherlands and Sweden stand out for their diversified top R&D investors, particularly in semiconductors and telecoms, diverging from the EU's traditional automotive and health focus. Companies like ASML and Biontech, that more than tripled R&D investments during the last decade, also signal shifts towards new areas of innovation in EU's economy.

— **SMEs in the EU 800:** There are 99 SMEs in the Scoreboard, with over two thirds of them in the health sector. The SMEs account for 12.4% of the EU 800 companies and invested EUR 2.4 billion in R&D in 2023, a growth rate of 3.7% in nominal terms and down by 0.8% in real terms. However, this is substantially less than in the US, where 94 SMEs among the top 2 000 companies invested EUR 10.6 billion in R&D in 2023.

5 R&D productivity and M&A activity of top R&D investors

Concerns about the EU's competitiveness, low productivity growth and weak longer-term growth outlook have again come under the spotlight recently (Draghi, 2024; Fuest et al., 2024). Against a background of large structural challenges such as population ageing, climate change and heightened geopolitical risks, calls for action have highlighted several key barriers to EU competitiveness, such as poor commercialisation of innovation, low business dynamism, lack of risk capital and high regulatory burdens.

In this context, private R&D plays a critical role in securing long-term competitiveness and productivity growth (Griliches, 1979; Hall et al., 2010). R&D fuels the creation of new knowledge, cutting-edge technologies and breakthrough innovations that enhance production processes and help the EU to rise to societal challenges. While productivity in the widest sense is measured as the ratio of outputs to inputs over a given time, R&D productivity specifically evaluates how efficiently organisations convert R&D investment into viable new ideas (e.g. patents) or marketable products (e.g. sales).

Europe's technological landscape has been characterised by an innovation profile caught in a 'middle-tech trap' (Fuest et al., 2024) – producing neither high-tech innovations nor profiting from high-volume, low-tech manufacturing. This situation poses a significant threat to R&D productivity, as it implies a misalignment between R&D investment and breakthroughs in sectors generating higher value added. This is consistent with earlier firm-level research, which tends to find that R&D investment has a greater impact on firm productivity in high-tech sectors than in low-tech sectors (Czarnitzki & Thorwarth, 2012; Kancs & Siliverstovs, 2016; Ortega-Argilés et al., 2015).

Against this backdrop, mergers and acquisitions (M&A) emerge as a potential strategic solution for bypassing these constraints and achieving rapid technological advancement. In recent years, M&A transactions have surged both in volume and in value, particularly among large multinational companies.[71] M&A activity offers an alternative path to in-house R&D investment, allowing companies to rapidly access proprietary technologies, skilled human capital and strategic resources that would be costly and time-consuming to develop internally. This strategic use of M&A to integrate advanced technologies or to enter new high-tech markets is particularly relevant in the EU context, where structural barriers limit the scale and impact of individual companies' innovation activities.

Research has shed light on various aspects of M&A and its effect on firm performance and innovation. For instance, M&A can consolidate resources, enhance economies of scale and improve access to new technologies and markets, which may drive growth and increase R&D productivity (Andrade et al., 2001; Phillips and Zhdanov, 2013). By acquiring firms with complementary technologies or integrating innovative capabilities, companies can accelerate their expansion into high-tech domains or optimise existing processes (Cassiman et al., 2005). Moreover, by merging with or acquiring high-tech firms, companies in middle-tech sectors can diversify their R&D portfolios, benefiting from synergies that improve R&D productivity and ultimately ascending the value chain (Stiebale and Trax, 2011). Finally, cross-border M&A transactions can lead to significant value creation, particularly when the acquiring firm has strong corporate governance (Kim and Lu, 2013). This can be especially relevant in the EU

[71] https://imaa-institute.org/mergers-and-acquisitions-statistics/

context, where M&A can help firms overcome the limitations of their domestic markets. This supports the notion that M&A can be an effective strategy for overcoming technological gaps.

While the potential benefits of M&A are significant, their success is not guaranteed. Existing studies have highlighted that the outcomes of M&A are highly variable and depend on various factors, including the strategic fit between the firms, the integration process, and the broader economic environment (Bena and Li, 2013; Seru, 2014). Moreover, M&A activity can disrupt innovation by increasing organisational complexity, creating integration challenges, or by diminishing competition and thus reducing incentives for innovation at the aggregate level (Federico et al., 2017).

In this chapter, we first analyse dynamic changes in R&D productivity among companies featured in the EU Industrial R&D Investment Scoreboard over the last two decades, focusing on differences between firms from various global regions. Second, we characterise the Scoreboard companies with respect to their M&A activities and assess the potential role of M&A on firm growth (sales, employee, profit) and productivity (labour and total factor productivity). Our analysis will address three key questions.

1) Is the R&D productivity of leading global R&D investors declining?
2) How do leading EU R&D investors compare to R&D investors from other global regions?
3) What effects has M&A activity had on firm growth and productivity?

The first question is motivated by recent research that indicates a substantial rise in research effort accompanied by declining research productivity (Bloom et al., 2020; Goldin et al., 2024). This has important policy implications because it implies that to have more 'innovations', or 'ideas', ever more R&D investment and talent is needed to generate new units of innovation. While most research on this productivity decline focuses on the US, it is pertinent to investigate whether similar trends exist in the EU (research question 1) and whether gaps between the EU and other leading regions are emerging (second question). The third question examines M&A activity by Scoreboard companies and their potential role in fostering company growth and productivity.

5.1 Is the R&D productivity of leading R&D investors declining?

For this section, all annual Scoreboards have been compiled to a firm-level panel comprising a total of 3 846 different firms for which there is data from 2004 to 2022, including yearly firm data on R&D investment, net sales, employees and capital expenditures. As not every firm is observed in every year, the panel is slightly unbalanced, resulting in a total of 44 480 firm-year observations.

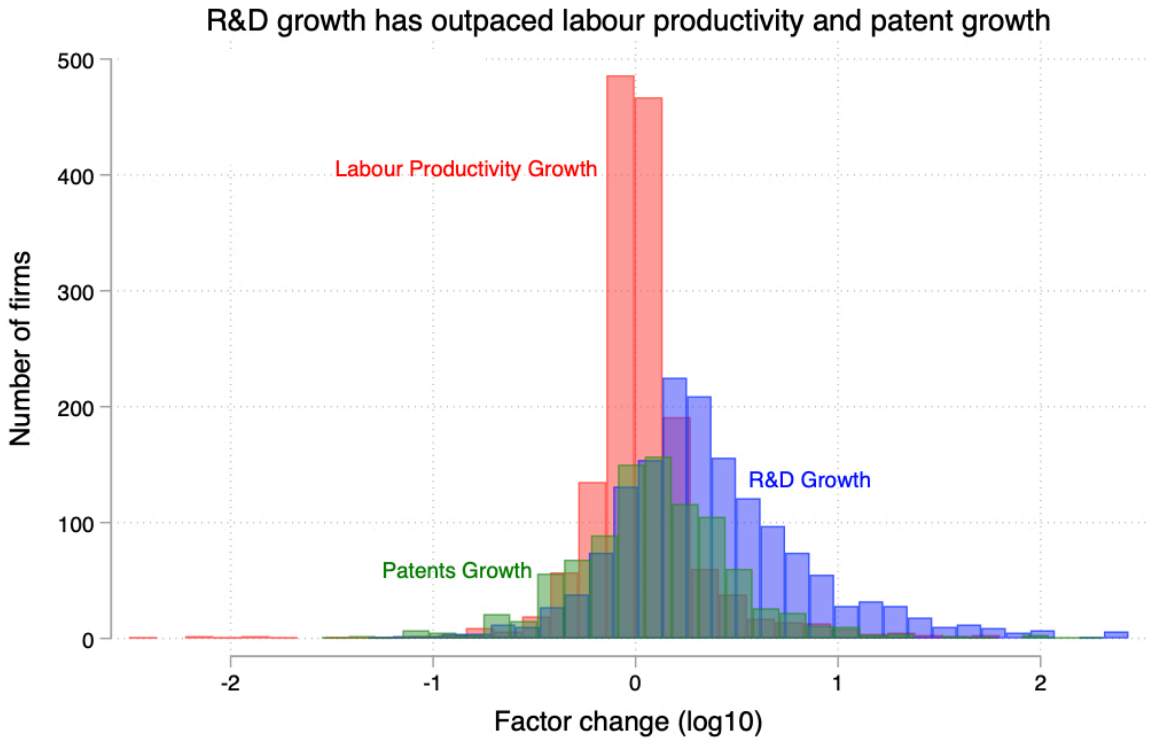
The Scoreboard panel is supplemented with patent data collected from the PATSTAT database to measure 'ideas'. We look beyond simple patent counts by counting high-value inventions filed as patent families in at least two major global IP offices (USPTO, EPO, JPO, KIPO, and CNIPA). This approach reduces potential bias such as home-country bias where firms might protect minor inventions locally but not internationally due to limited commercial viability. As patent data is recorded in the database only with a considerable time lag (patent applications are only published after 18 months and only entered in the database some time after that), the patent analysis can only cover the years from 2004 to 2019. To collect the patent data, records of patent applicants were searched for Scoreboard companies on a consolidated list, along with their subsidiaries. Out of the 3 846 firms in the panel, 2 382 different firms (62%) patented at least once.

For the purpose of analysis, we divided the 2004-2022 timeframe into five distinct periods to capture the effects of major economic events:

- pre-financial crisis (2004-2007)
- global financial crisis (2008-2010)
- post-financial crisis (2011-2015)
- pre-COVID-19 pandemic (2016-2019)
- COVID-19 pandemic (2020-2022)

By averaging data over these periods, we can mitigate short-term volatility and discern long-term trends. All firms included in our baseline sample had reported positive values for R&D, net sales, patents, and employment in each period and must have ranked within the top 2 500 in world rankings at least once between 2013 and 2022. Labour productivity is calculated by dividing each firm-period average net sales per average employment. Descriptive statistics for R&D investment, patents, and labour productivity by region and period are presented in Figures 26, 27, and 28.

Figure 26. Distribution of growth in R&D, labour productivity and patents of Scoreboard firms for two decades



Notes: The x-axis represents the factor changes in growth, calculated as the logarithm base 10 of one plus the growth rate (log10(1+x)). The y-axis denotes the proportion of Scoreboard firms exhibiting specific levels of growth in one of the variables. Growth rates are calculated between the pre-financial crisis (2004–2007) and COVID pandemic (2020–2022) for R&D and labour productivity, and between the global financial crisis (2008–2010) and pre-COVID pandemic (2016–2019) for patents due to data limitations.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Our initial analysis in Figure 26, compares the growth of R&D investment (R&D input) against the growth of patents and labour productivity (R&D outputs) for each firm, comparing the earliest and latest available periods. Although patents and labour productivity are imperfect output indicators of

R&D productivity (since, for example, not all inventions are patented, and some industries are more capital-intensive), they serve as useful proxies for the expected results of R&D investment.[72]

Figure 26 reveals that, for the analysed Scoreboard firms, R&D growth has by far outpaced labour productivity and patent growth ('ideas'). While the median firm increased R&D investment by 102% (0.3 factor change), the median growth in labour productivity was only 2% (0.01 factor change), and the median growth in patents was 23% (0.09 factor change). The median firm exhibited minimal growth in labour productivity and number of patents, in stark contrast to R&D investment growth. To put it in a distinct perspective, the shift to the right on the R&D investment growth distribution (in blue) is not matched by similar shifts in labour productivity (red) and number of patents (green).

In Section 5.1.1., we delve deeper into these observations through econometric analysis. However, this initial descriptive result indicates that despite substantial increases in R&D investment, labour productivity gains have not kept up, indicating diminishing returns on R&D investment for top-performing firms.[73] These findings align with Bloom et al. (2020), who suggest that while R&D remains essential for innovation, the productivity gains per unit of R&D investment have been declining. This pattern implies that sustaining R&D-driven productivity growth may become increasingly challenging in the future.

Several factors may explain the slowdown in R&D productivity (transformation of R&D investment in labour productivity or patents). One hypothesis suggests that large (software) companies have come to dominate the economy, overshadowing more innovative smaller businesses and startups. These leading firms often focus on defending market share through strategic acquisitions, rather than pursuing radical innovations. As a result, the economy loses business dynamism, which limits productivity growth (Akcigit, 2024; De Ridder, 2024). Another explanation points to the 'burden of knowledge' hypothesis. As scientific and technological progress accumulates, fewer 'low-hanging fruit'-breakthrough ideas remain, making each new breakthrough increasingly complex and resource-intensive (Jones, 2009). Consequently, firms and researchers must navigate vast bodies of knowledge, slowing the pace and raising the cost of high-value discoveries. Another explanation is simply that it is taking time for our current wave of new technologies to diffuse fully. Brynjolfsson et al. (2017), for example, argue that digital technologies are still relatively recent, and productivity gains may become more apparent as these technologies are adopted across the economy, and complementary investment take place.

5.1.1 How do EU leading R&D investors compare with those in other global regions?

It has long been debated whether the EU suffers from an innovation and commercialisation gap in R&D. This section examines the potential R&D productivity gap between the EU and other industrialised regions, with a focus on how effectively R&D investments translate into 'ideas' and

---

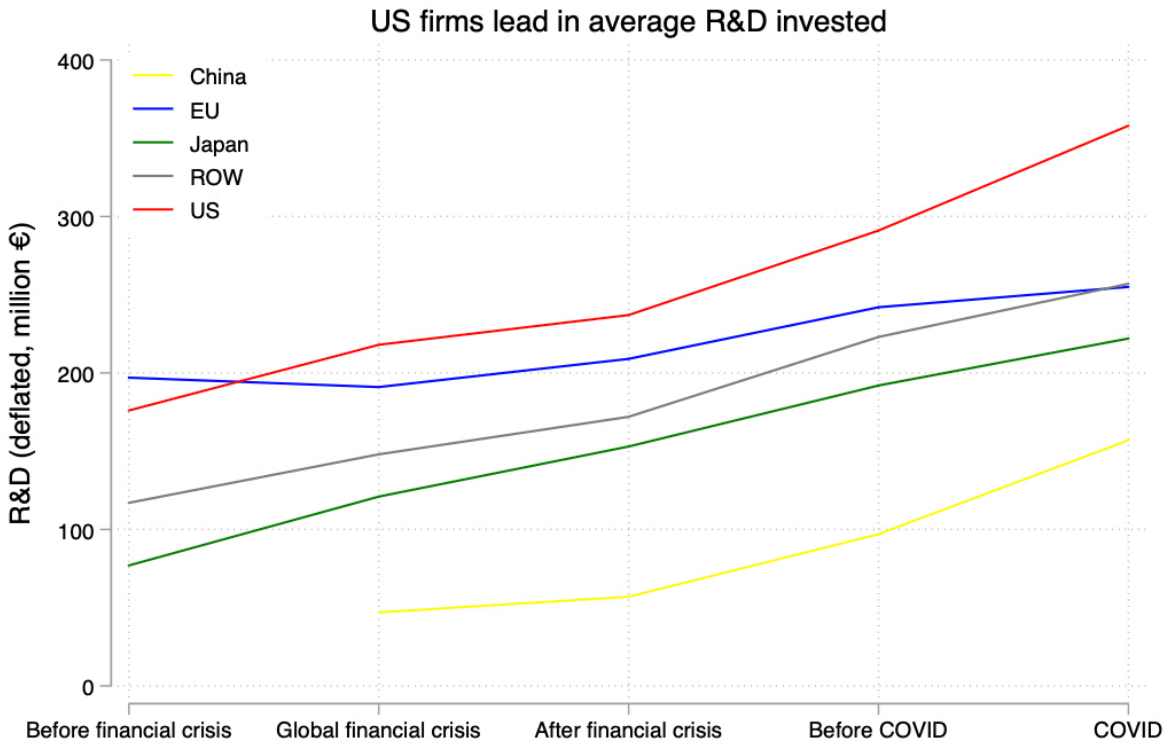
[72] While both variables can be influenced by a range of factors unrelated to R&D, since in our econometric regressions we are controlling for size, firm and year fixed effects, these indicators allow to evaluate how effectively a company turns R&D investment into high-value inventions and commercial success.

[73] We also analysed the differences between net sales growth and R&D growth across firms. The median net sales growth was 64%, and its distribution closely resembles that of R&D growth. This suggests that the gap between R&D growth and labour productivity growth is largely due to increased employment among firms with high R&D growth. In other words, firms that have invested heavily in R&D have also expanded their workforce significantly, which has offset the gains in labour productivity that might otherwise have resulted from R&D investment alone.

labour productivity. We assess R&D productivity using two indicators: (1) 'R&D-to-ideas' elasticities, which measure the efficiency of R&D investment in generating new patents (used as proxies for ideas), and (2) 'R&D-to-labour productivity' elasticities, based on net sales per employee as a measure of labour productivity.

Initial descriptive analysis reveals some notable differences in average R&D investment patterns among leading firms across global regions over time. As shown in Figure 27, firms that have their headquarters based in the US have substantially outpaced their EU counterparts in recent years. Before the financial crisis, the EU led in average R&D investment per firm (EUR 197 million against EUR 176 million in the US), but this changed during the financial crisis when US firms began to invest more in R&D than EU firms, since then the gap that has continued to grow. During the COVID-19 pandemic, US firms were spending on average EUR 358 million on R&D, compared with EUR 255 million in the EU. Remarkably, even firms in the ROW[74] surpassed EU firms with EUR 257 million on average, followed by Japan (EUR 222 million) and China (EUR 157 million).

Figure 27. Average Scoreboard firm R&D investment across regions



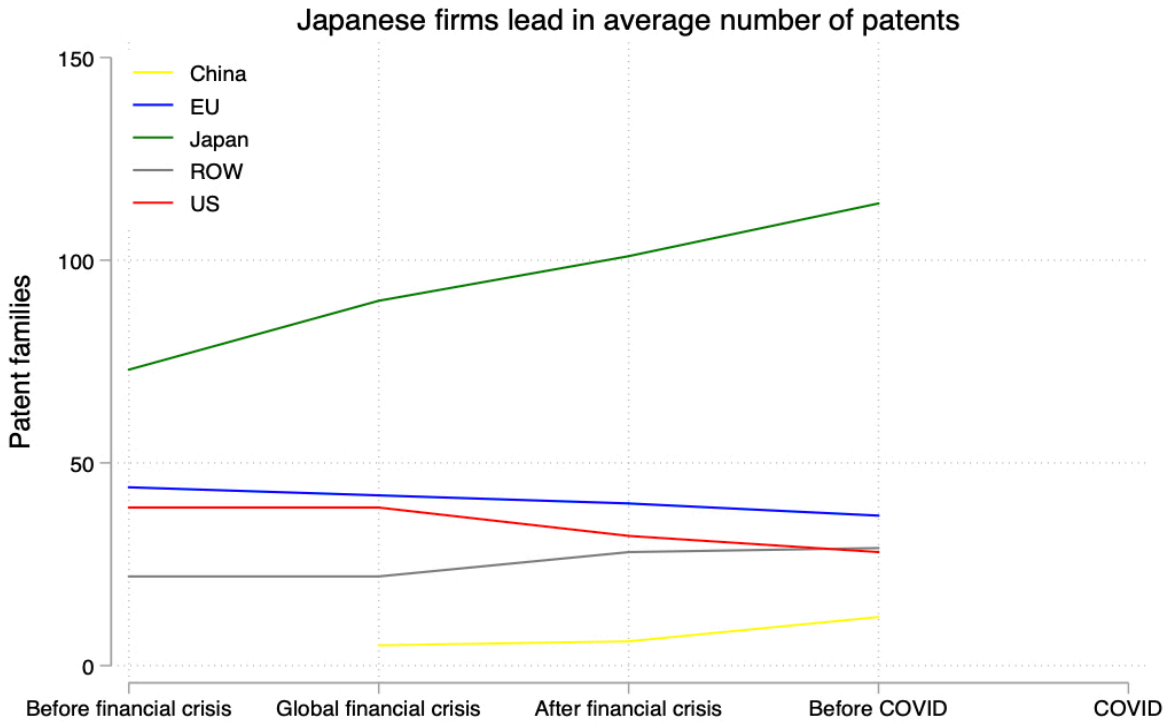
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

As shown in Figure 28, Japanese firms consistently lead in patent family filings, partly due to distinct patenting behaviour. Japanese firms often file individual patents for each minor innovation, resulting

[74] ROW ranks as the second-smallest region in terms of the number of firms in this comparison, surpassing only Japan. Some ROW firms are large pharmaceutical companies, headquartered in Switzerland or the UK, such as Roche, Novartis, GSK, and AstraZeneca, which significantly raise the average R&D investment for firms in this region. Additionally, prominent R&D investors from ROW have markedly increased their R&D, e.g. Mediatek from Taiwan and Tata Motors from India have expanded their R&D investment by more than tenfold over the past 20 years.

in many patents with single claims (Sakakibara and Branstetter, 1999). In contrast, firms in other regions tend to consolidate claims into fewer patents per invention. Therefore, instead of comparing absolute patenting levels, our focus here is on changes in patenting over time. Remarkably, firms in China, Japan and the ROW have increased their patent family filings, while firms in the EU and the US have shown a decline. In the EU, the average Scoreboard firm filed patents for 44 inventions per year before the financial crisis; in the period up to the COVID-19 pandemic, this dropped to 37. Similarly, in the US, filings fell from 39 to 28 patent families per year.

Figure 28. Average Scoreboard firm patenting across regions

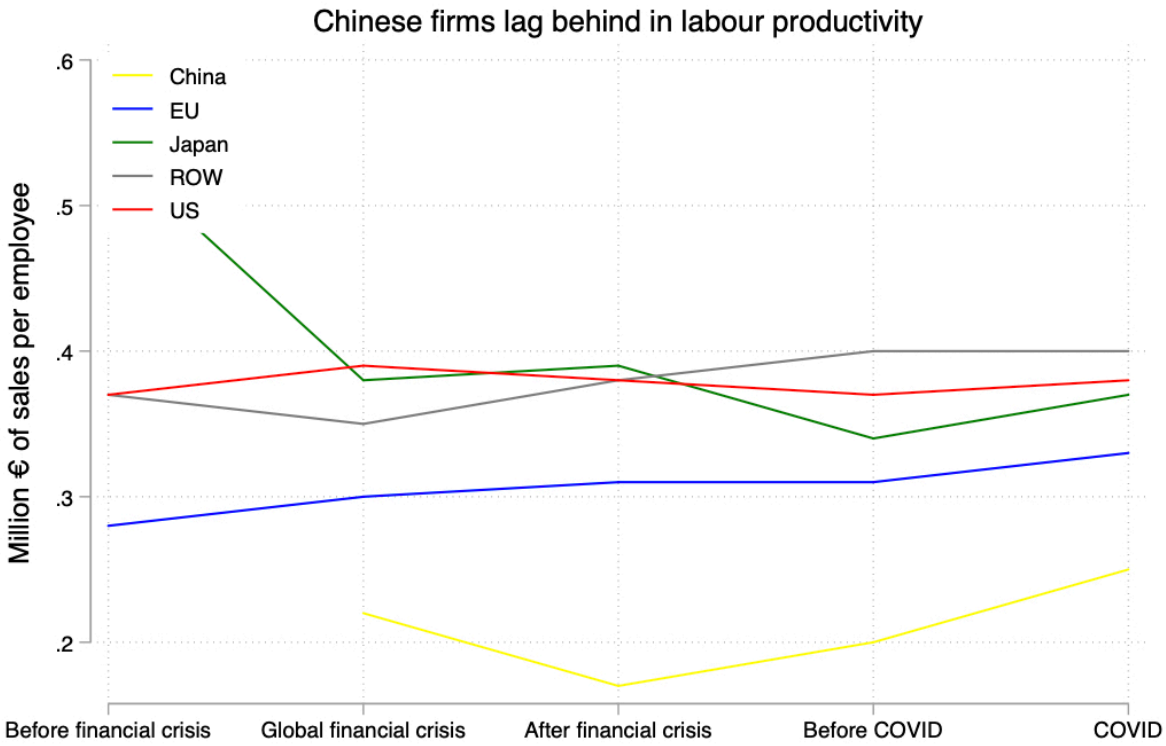


Notes: Patenting is measured as the number patent families, i.e. the number of inventions (not just patent documents) that have been filed with a least 2 of the large 5 global patent offices (USPTO, EPO, CNIPA, JPO, KIPO) to avoid bias due to different national patenting behaviour.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Turning to labour productivity (Figure 29), measured as net sales per employee, EU Scoreboard R&D companies have consistently shown lower labour productivity since the 2000s. Before the financial crisis, the labour productivity of EU firms was EUR 0.28 million per employee, rising only slightly to EUR 0.33 million by the COVID-19 period. Chinese firms had even lower labour productivity levels, while Japanese firms, which once led, have seen declines over the long-term. More recently, firms in the ROW and the US have shown the highest labour productivity.

Figure 29. Average Scoreboard firm labour productivity across regions and time



Notes: The numbers show the average sales per employee in EUR million.
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

5.1.2 Econometric analysis – R&D productivity, ideas and commercialisation

Following these descriptive results, an econometric regression analysis is implemented to investigate how R&D relates to patents ('ideas') and to labour productivity ('commercialisation') across different global regions. The objectives are first to understand if R&D investments contribute positively to new ideas and labour productivity. Secondly, to understand how this relationship has changed in time. Thirdly, whether there are gaps (or differences) between EU firms and firms from other leading regions. Figure 30 presents the estimated 'R&D-to-ideas' elasticities[75] across regions and time, revealing two major findings.

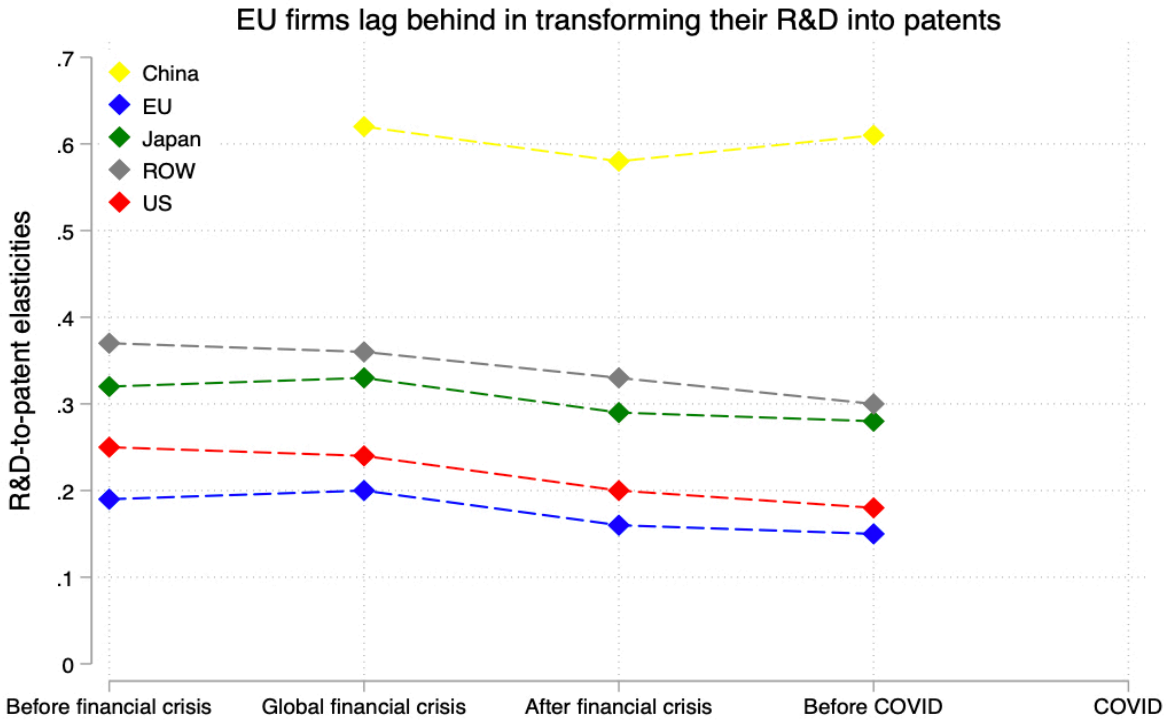
First, the findings support a concerning trend: ideas are becoming harder to find across all global regions. Over the observed time periods, 'R&D-to-ideas' elasticities have declined, indicating diminishing returns on R&D investment in generating new ideas. The EU and the US have seen particularly steep declines in this metric, down 24% and 26%, respectively. By contrast, the ROW, Japan and China have experienced smaller declines (of 18%, 12%, and 2%, respectively). This pattern suggests that other regions have been more successful in adapting their R&D efforts toward emerging, high-potential fields of technology. In contrast, firms in the EU may be constrained by

[75] In order to obtain the R&D-to-ideas" elasticities, Quasi-Maximum-Likelihood Poisson models with firm-level fixed effects have been estimated. The firms' patent family filings have been regressed on their R&D investment that have been interacted with 5 time dummy variables. The models control for employment and patents per employee.

structural reliance on established industries, where innovation yields are lower and breakthroughs less frequent.

Second, EU firms show relatively low 'R&D-to-ideas' elasticities, suggesting a weaker conversion of R&D investment into patentable inventions compared to firms in other global regions. This may be partly due to the prevalence of mature industries and old incumbents in the EU sample, where incremental innovation is common and ground-breaking discoveries are less frequent. By the last period analysed (2016-2019), the EU displayed the lowest R&D-to-patent elasticity with 15%, compared to 18% in the US, 28% in Japan, and 30% in the ROW. China, which started from a low baseline of patenting, achieved a much higher elasticity of 61%. Thus, increases in R&D investment yielded higher relative gains in patents.

Figure 30. Estimated R&D-to-ideas elasticities across regions and time



Notes: The numbers are estimated R&D-to-ideas elasticities. All coefficient estimates of the R&D variables are statistically significant at the 5% level. F-tests on coefficient differences within each region across time show that the visible downward trends are also statistically significant at the 5% level, except for China. Further F-tests reveal that the visible differences between regions are statistically significant in each period. They should be interpreted as follows: if EU firms had increased their R&D by 100%, i.e. doubled their investment, in the period before the financial crisis they would have achieved 19% more patents. For China, the relative change in elasticities is calculated from 2008 to 2019 because of lacking data in the first and last periods.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

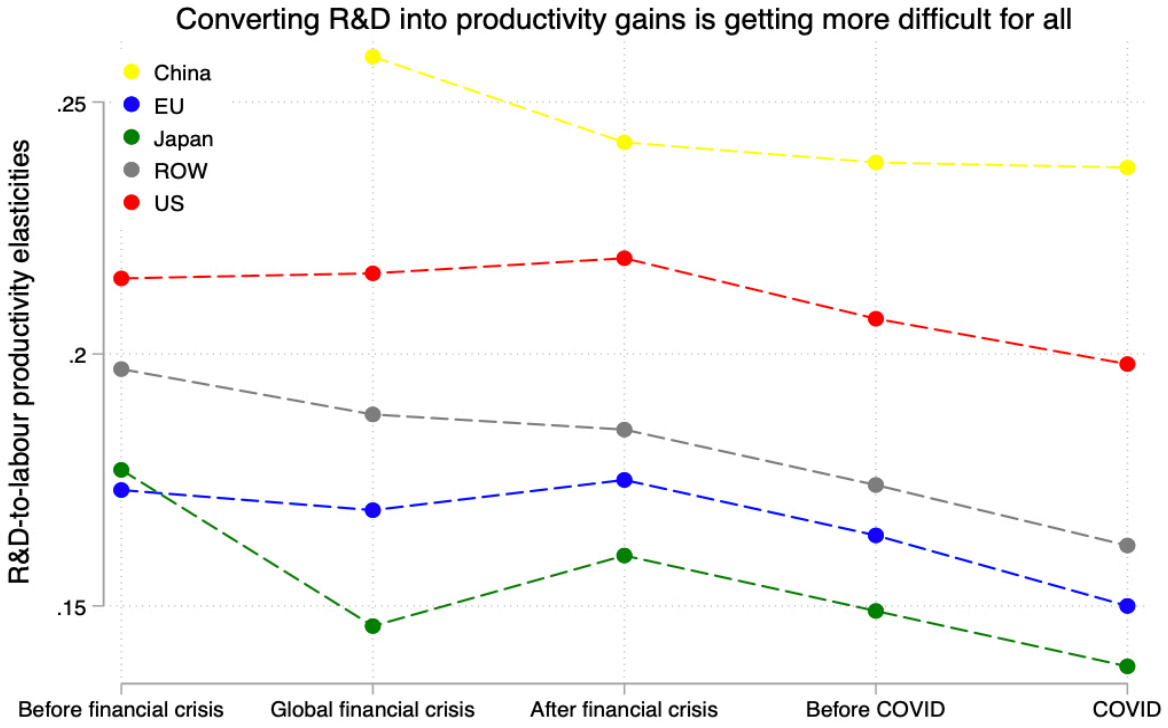
Figure 31 presents the estimated R&D-to-labour productivity elasticities[76] across regions and time. It also reveals concerning results for the EU firms. They have the second-lowest labour productivity-

[76] In order to obtain the labour productivity-R&D elasticities, Quasi-Maximum-Likelihood Poisson models with firm-level fixed effects have also been estimated. The firms' labour productivity (net sales per employee) have been regressed

R&D elasticity, slightly above Japanese firms only. This suggests that companies in China, the US and the ROW are significantly more effective at translating R&D investments into commercial outputs, as measured by net sales per employee. In the latest period (2020-2022), if EU firms had doubled their R&D investment, they would have achieved only a 15% increase in net sales per employee – considerably lower than firms in the US and China.

A downward trend is also evident in R&D-to-labour productivity elasticities across all regions, indicating increasing challenges for Scoreboard firms in converting R&D investment into productivity gains. Japan experienced the largest decline in R&D-to-labour productivity elasticity (17.7% to 13.8% = 3.9 percentage points), while the US showed the smallest decrease (1.7%), suggesting that US firms have continued to do better at translating R&D investments into labour productivity. EU firms' R&D-to-labour productivity fell by 2.3%, closely mirroring China's decrease of 2.2%. These findings reveal a dual challenge for EU firms: they not only have lower R&D-to-labour productivity levels but are also not catching up with firms from regions that exhibit higher R&D-to-labour productivity elasticities, reflecting a competitive disadvantage.

Figure 31. Estimated R&D-to-labour productivity elasticities across regions and time



Notes: The numbers are estimated R&D-to-labour productivity elasticities. All coefficient estimates of the R&D variables are statistically significant at the 5% level. F-tests on coefficient differences within each region across time show that the visible downward trends are also statistically significant at the 5% level, except for China. Further F-tests reveal that the visible differences between regions are statistically significant in each period except the first one. They should be interpreted as follows: if EU firms had increased their R&D by 100%, i.e. doubled their investment, in the period before COVID-19 they would have achieved 16% more labour productivity. For China, the relative change in elasticities is calculated from 2008 to 2022 because of lacking data in the first period.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

on their R&D investments that have been interacted with five time dummy variables. The models account for common macroeconomic trends.

Overall, these findings underscore the challenge facing all top R&D investors in maintaining R&D productivity, both in terms of ideas and labour productivity. For EU firms, the challenge appears even greater and shows no signs of diminishing. This widening gap in R&D productivity and commercialisation capabilities has long-term implications for EU competitiveness at global level, as recently highlighted by the Draghi report. The EU's predicament is compounded by structural factors, including a fragmented domestic market, regulatory barriers, industrial specialisation patterns and a more risk-averse investment culture, which may limit the region's ability to capitalise on emerging technologies as effectively as the US or China (Nindl et al., 2023).

While solutions to these problems are complex, since EU firms are yielding fewer R&D outputs per unit of R&D input compared to firms in other regions, what seems clear is that merely pushing for more R&D investment by the private sector is insufficient. Other solutions related to improving R&D routines (e.g. better management processes or incorporating cutting-edge technologies), attracting and retaining top R&D talent, and crafting more effective policy instruments to steer R&D incentives (potentially towards breakthroughs or societal challenges) should be prioritised (European Commission. 2022).

5.2 The effects of M&A activity on firm growth and (R&D) productivity

The analysis of declining R&D-to-patent and R&D-to-labour productivity elasticities, especially evident among EU firms, highlights an urgent need to understand the strategic responses firms are adopting in response to these challenges. As traditional R&D investment yields diminishing returns, firms are increasingly exploring alternative strategies to maintain competitiveness, with M&A emerging as a prominent pathway. The weakening relationship between R&D spending and innovative outputs raises questions about how firms are adapting their innovation strategies, and M&A offers a potential route for revitalising productivity and efficiency within the R&D process.

Research suggests that M&A activities can indeed play a transformative role in addressing these R&D productivity issues, particularly by enabling firms to benefit from synergies between acquiring and target companies. For example, Cassiman et al. (2005) argue that the effectiveness of M&A outcomes is closely tied to the technological and market relatedness between merging firms, as complementary technologies can improve R&D productivity post-merger. This aligns with the broader view of M&A as a way to optimise resource allocation and organisational performance, as observed by Maksimovic and Phillips (2001), who note that M&A can foster efficiency gains by reconfiguring resources across merged entities. Devos et al. (2009) further emphasise that value generated through M&A arises primarily from operational synergies rather than merely from market consolidation or tax benefits. Existing empirical studies also highlight the range of impacts that M&A can have on innovation and firm performance. For instance, research underscores that M&A transactions can yield productivity and market power gains (Andrade et al., 2001; Phillips and Zhdanov, 2013), particularly in cross-border cases where M&A enables firms to transcend domestic market limitations, a particularly relevant factor for EU-based firms. Also, cross-border M&A has been shown to create significant value, especially when acquirers possess robust corporate governance structures (Kim and Lu, 2013), positioning M&A as a potential strategy to bridge technological or competitive gaps within the EU market.

While M&A holds promise as a response to declining R&D productivity, it is crucial to acknowledge the variability in M&A outcomes. The success of M&A efforts depends significantly on factors such as strategic alignment, integration quality, and prevailing economic conditions, as documented by Bena and Li (2013) and Seru (2014). This highlights the importance of a carefully tailored M&A

approach to address the unique productivity challenges EU firms face in sustaining innovation and enhancing labour productivity. By closely examining these dynamics, we can gain a clearer perspective on whether M&A offers a viable mechanism for counterbalancing negative trends in R&D and labour productivity, thereby enabling firms to better compete and innovate in an increasingly demanding global market.

To further explore this, the following section will examine the M&A activity of key firms within the Scoreboard, analysing whether M&A serves as a strategic response to the productivity challenges identified in earlier analyses, and how firms might use M&A to navigate the pressures of innovation and global competition.

5.2.1 M&A activities by Scoreboard companies: trends, and sectoral and regional heterogeneity

The sample for the analysis of M&A activity of Scoreboard companies is different from the one in the previous section. This is due to the need to rebuild the ownership structure for the Scoreboard companies given the change driven by M&A. The starting point is again the EU Industrial R&D Investment Scoreboard Panel dataset (Nindl et al., 2023), which encompasses information on 6 216 distinct companies between 2003 and 2022. Among these, a substantial number – 4 901 companies – have secured a position at least once within the top 2 500 firms worldwide and are those retained for the following analysis.[77] These companies are linked to corresponding information on their M&A activities taken from Moody's ORBIS M&A data source.[78] Data from Moody's is available over the period 2008-2020 and allows us to match 4 886 companies. For the purpose of this work, an M&A deal is defined as a strategic transaction where one Scoreboard company acquires 50% or more of the ownership of another company's assets.[79]

Figure 32 displays the time trend of M&A activity. The graph shows the proportion of companies engaging in M&A each year throughout the specified period. [80] A pronounced decline in M&A transactions is evident at the beginning of the financial crisis (2009), reflecting the broader economic downturn of the period. Subsequently, we witnessed a consistent rise in M&A activity, persisting until 2015. However, the trend has taken a downward turn since then, with an even more marked decrease following the COVID-19 crisis, reflecting a decrease in the share of companies participating in M&A operations. It is worth noting that the trajectory identified within this work bears resemblance to

[77] The EU Industrial R&D Investment Scoreboard Panel dataset includes data on the top 2 500 companies globally and the top 1 000 EU companies during the period 2003-2022 (Nindl et al., 2023). For comparability purposes, we exclude from the analysis companies that were part of the top EU 1 000 but not the top global 2 500.

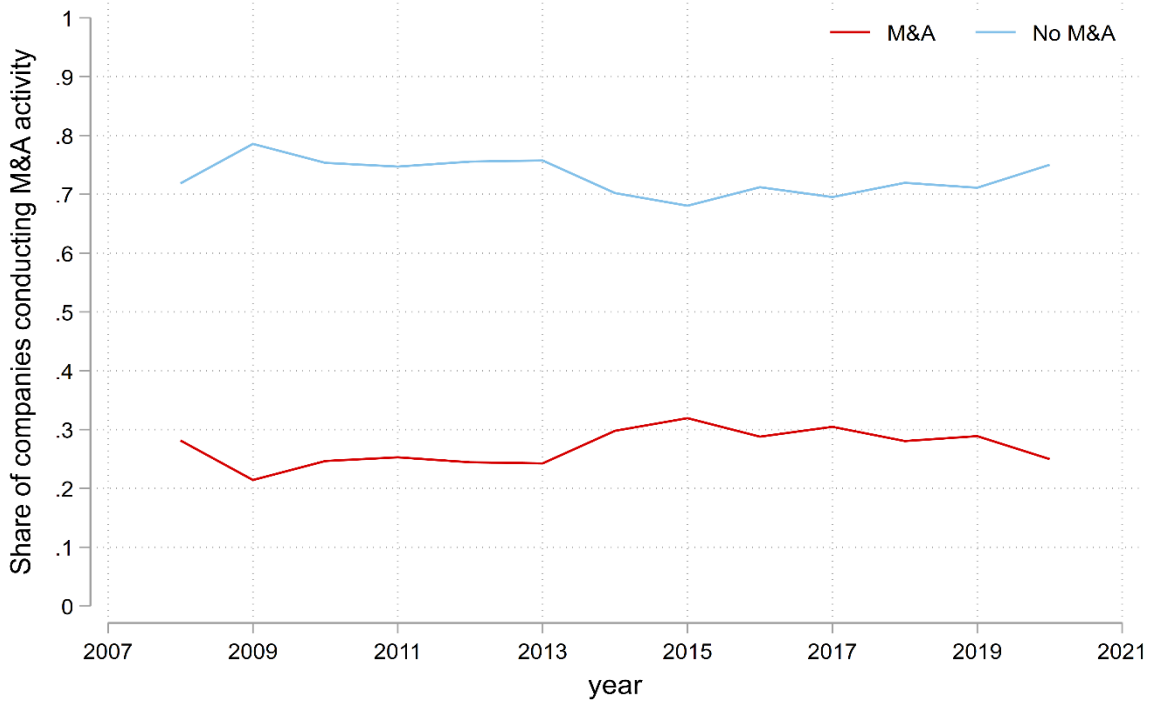
[78] Moody's ORBIS M&A database, managed by Bureau van Dijk, is a leading global resource for company data, including M&A activities. It tracks mergers, acquisitions, joint ventures, and other corporate transactions. It records details on the deal value, parties involved, and other relevant transaction information.

[79] This form of acquisition constitutes a substantial transfer of control, with the purchasing entity obtaining decision-making authority over the acquired firm's assets and management. By focusing on acquisitions where the controlling entity secures a minimum of 50% ownership, this definition captures the transactions that most significantly affect competition, innovation, and market dynamics.

[80] Even though not shown here, a similar trend in M&A activity is observed when plotting the average number of M&A deals per year.

patterns reported by the Institute for Mergers, Acquisitions and Alliances.[81] This parallel reinforces the validity of the observed trends, suggesting a broader applicability of the findings beyond the confines of top R&D investors as observed in the Scoreboard.

Figure 32. Trends in M&A activity over time of Scoreboard firms



Notes: The M&A measure indicates whether the company engaged in M&A activity in a specific year
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Figure 33 provides a detailed breakdown of the prevalence of M&A activities across different sectors, depicting the total number of companies and the share of companies having conducted M&A transactions. For the purposes of our analysis, a company is categorised as active in M&A if it acquired another company at least once between 2008 and 2020.

A close examination of the sector-specific data reveals that the health and financial sectors display a relatively low tendency towards M&A activities. This could be due to the stringent regulatory environments or the complex nature of operations in these sectors, which may act as barriers to the propensity to carry out M&A activity. Moreover, the health sector shows the lowest share of M&A activity, which may be attributed to the sector's composition. Firstly, the health sector does not consist entirely of only biotech and large pharmaceutical companies – both known for a higher propensity toward M&A activity – although they do make up a large majority in the Scoreboard. It also includes companies in healthcare equipment and services, which typically have a lower propensity to engage in M&A. Secondly, the median company size in the health sector is considerably smaller than in other sectors (e.g. 120 employees compared to 925 in ICT software and 7 166 in the automotive sector).

[81] Available here https://imaa-institute.org/mergers-and-acquisitions-statistics/#:~:text=Number%20%26%20Value%20of%20M%26A%20Worldwide,4%25%20to%203.8%20trillion%20USD accessed on 14/10/2024.

This suggests that the health industry includes a greater proportion of small companies, which are generally less likely to undertake M&A activity. Finally, the observed difference may stem from the value of M&A deals being on a different scale in the health sector, rather than from the number of companies engaging in M&A – a factor we are unable to verify due to a lack of relevant data on the value of deals.

Conversely, construction, industrials, and the two ICT sectors – hardware and software – emerge as the sectors with a conspicuous prevalence of M&A activities. Companies in these sectors are more likely to engage in M&A as a strategic tool for growth and expansion. This high level of activity may be attributed to the dynamic market conditions for ICT sectors, and the drive for operational scale for the construction and industrials sector.

Figure 33. M&A propensity by sector

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Similarly to the industry breakdown, Figure 34 extends our analysis by illustrating the geographical distribution of M&A activities. Although the EU has one of the lowest absolute number of companies conducting M&A (second only to Japan with 501 vs 306 companies respectively), a striking feature of the geographical analysis is the pronounced M&A propensity within the EU. The data indicates that companies based in the EU are more likely to engage in M&A activities compared to their global counterparts. This could be a reflection of the EU's recent increase in market integration, supportive regulatory frameworks, and the strategic imperatives of firms operating within this market (Coeurdacier et al., 2009). The propensity for M&A in the EU may also stem from businesses seeking to capitalise on the single market advantages, fostering cross-border collaborations and expansions to enhance competitiveness (Moschieri and Campa, 2009).

In contrast, Chinese companies exhibit one of the lowest shares of M&A activity. This may be attributed to a range of factors, from different business practices and cultural attitudes towards M&A

to distinct regulatory and governmental influences that may affect the propensity to engage in such activities. This low share for Chinese companies can also be attributed to the low representation in the initial years of the Scoreboard, with good representation (more than 50 companies) from 2011 onwards.

Figure 34. M&A propensity by geographical region

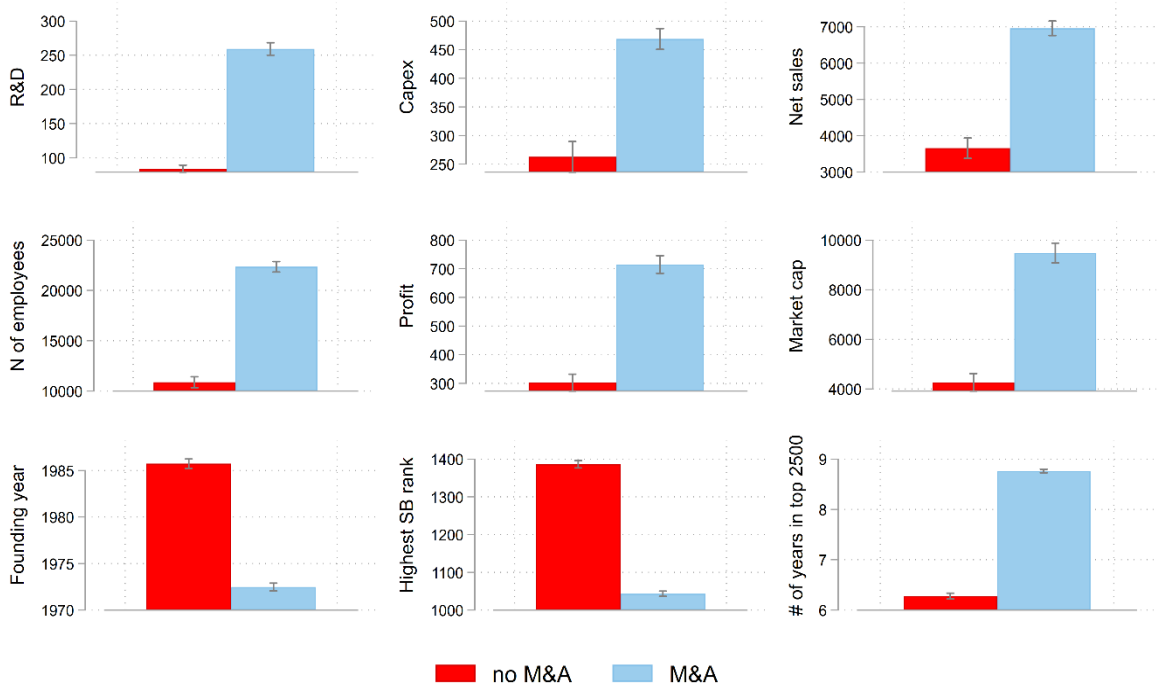
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

5.2.2 M&A activity and competitiveness

Figure 34 provides a comparative insight into the competitive stance of companies that engage in M&A activities versus those that do not. The concept of competitiveness, in this context, is multifaceted, extending across a spectrum of metrics including R&D investment, capital expenditures, net sales, employment, operating profit, market capitalisation, founding year, highest rank attained in the Scoreboard and the duration of presence within the top 2 500 companies featured in the Scoreboard.

The evidence presented in Figure 35 indicates that companies engaging in M&A activities consistently report higher metrics across all the measures of competitiveness. This pattern suggests a distinct profile of M&A-active firms: they are generally more established, larger in scale, and demonstrate higher investment in both R&D and capital. Moreover, these companies tend to be more profitable, adding to their competitive edge.

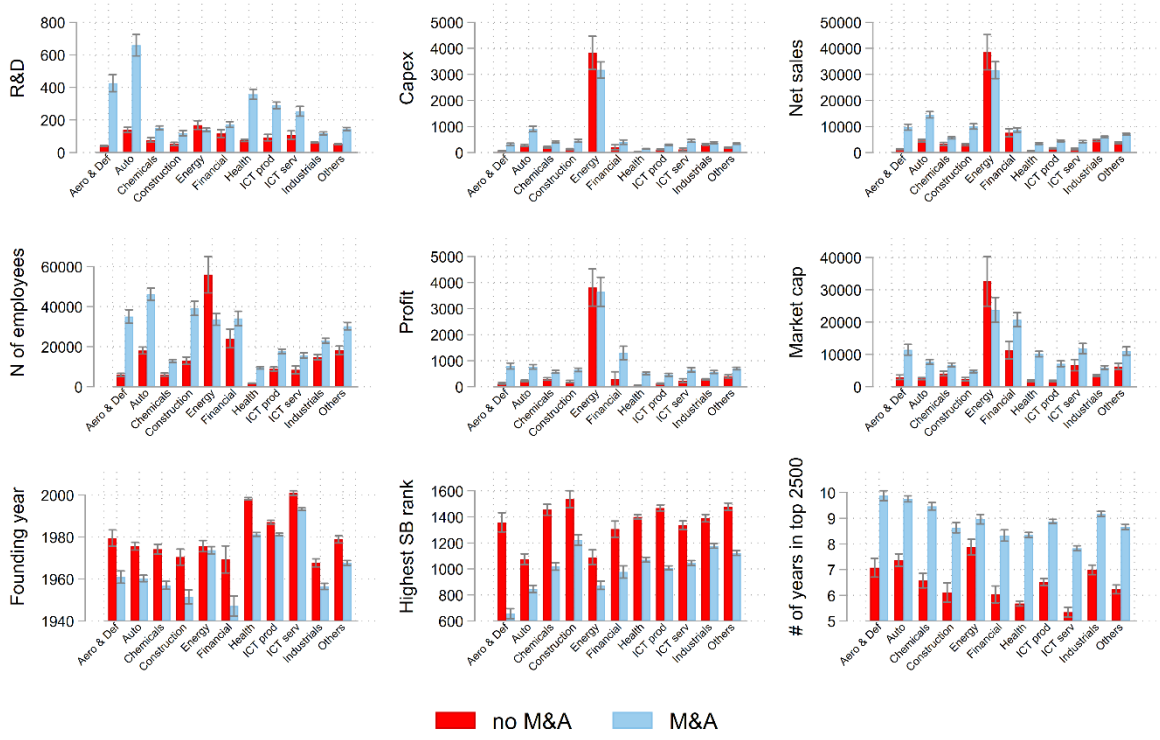
Figure 35. M&A activity and firm competitiveness



Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Figure 36 provides a sectoral comparison, juxtaposing M&A-performing companies with their non-M&A counterparts in relation to the various competitiveness metrics previously outlined. These figures afford a nuanced view of the competitive landscape, taking account of sector-specific dynamics. Figure 36 uncovers a substantial degree of heterogeneity across sectors concerning the competitiveness of firms engaged in M&A activities. Sectors such as automotive and aerospace & defence stand out, with companies in these sectors demonstrating the highest values in R&D, capital expenditures, net sales and longevity within the Scoreboard's top 2 500. This suggests that in these capital-intensive sectors, where economies of scale and technological advancements are crucial, M&A activities may play a critical role in fuelling competitive advantages and securing a firm's position within the industry.

Figure 36. Competitiveness scores of M&A vs non-M&A companies by sector

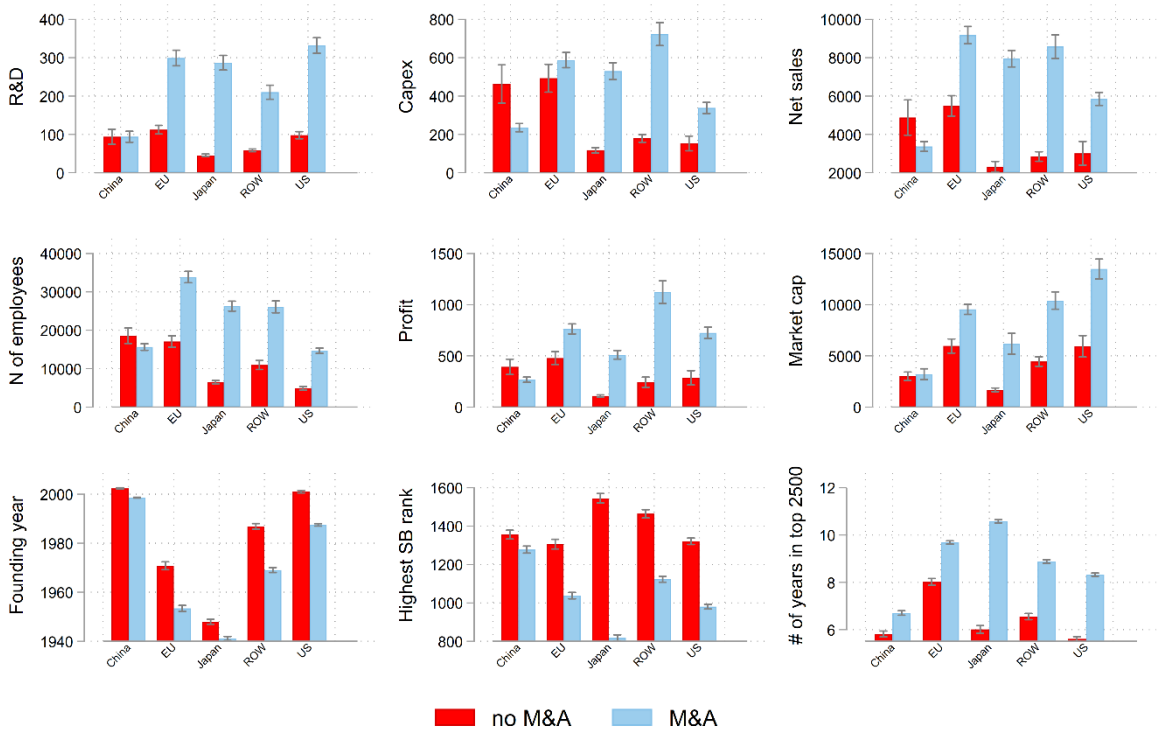


Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The comparative analysis of M&A activities is extended to different regions in Figure 37, which scrutinises the performance of M&A and non-M&A companies across different world regions based on the previously defined competitiveness indicators.

Figure 37 shows that within the EU, US and Japan, companies engaging in M&A activities stand out with respect to their average investment in R&D. For capital expenditures and net sales, the leading regions are Japanese and ROW. This subset may reflect a diverse group of economies in which M&A activities make a signficant contribution to firms' operational scale and market reach, further solidifying their competitive standings. In contrast, Chinese M&A performers have a smaller leads over their non-M&A-performing counterparts. It may be that Chinese firms derive less competitive benefit from M&A activities or simply engage less in M&A as a strategic mechanism compared to their global counterparts.

Figure 37. Competitiveness scores of M&A vs non-M&A companies by region



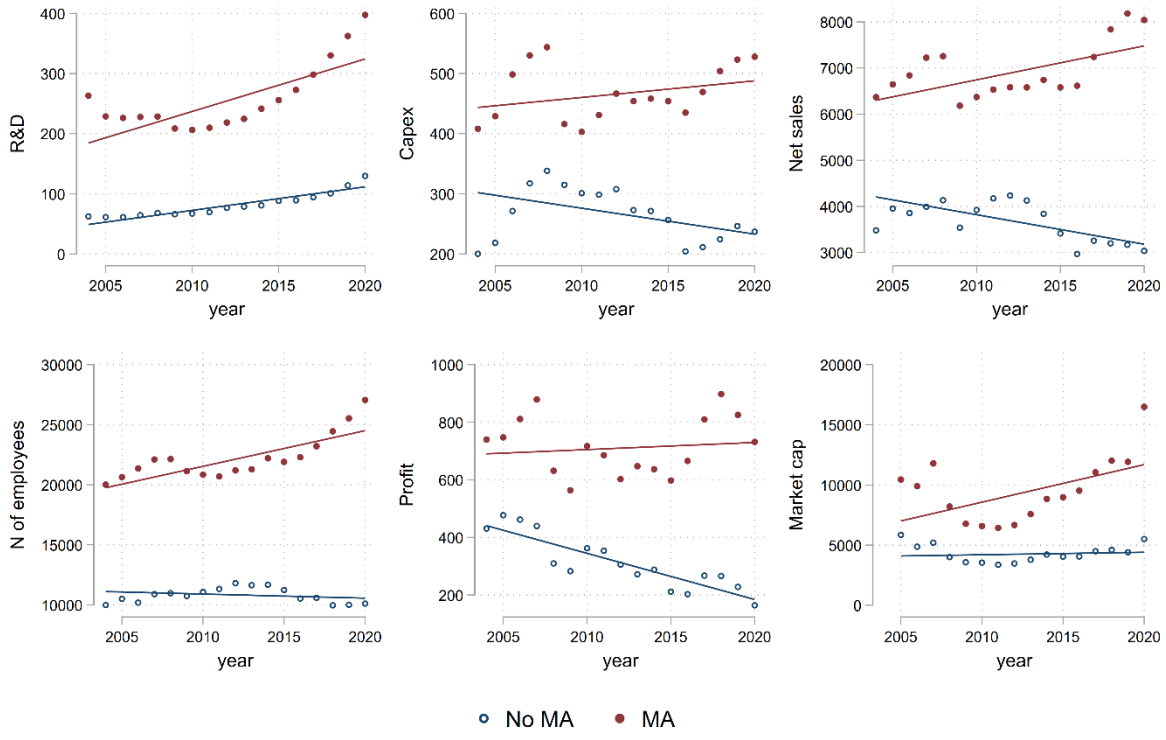
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Figure 38 provides an analysis of competitiveness by delineating trends over time, contrasting M&A-performing companies with their non-M&A counterparts. This longitudinal perspective allows us to observe the evolution of the competitive differences between these two groups.

We observe a pronounced divergence in the trajectory of M&A-performing versus non-performing companies over time. On the one hand, those engaged in M&A activities exhibit a positive trend across a range of competitiveness measures, including R&D, capital expenditures, net sales, number of employees, profits, and market capitalisation. This upwards trend suggests that M&A may facilitate sustained improvements on various aspects of firm performance over time.

The trend for non-M&A-performing companies is markedly different – relatively flat in terms of R&D, the number of employees and market capitalisation, indicating stability but limited growth. More concerning, however, are the indicators for of capital expenditures, net sales and profits, where non-M&A companies display a flat or even negative trajectory. This indicates potential challenges in scaling operations, generating sales, and maintaining profitability in the absence of M&A strategies.

Figure 38. Time dynamics of selected competitiveness scores - M&A vs non-M&A companies



Notes: Figure shows unconditional binscatter plots of the average values of R&D investment, capital expenditures, net sales, number of employees, profit and market capitalisation, separately by year. From the full sample of 4 886 companies, we created 50 bins of roughly equal sample size; some of the bins have no variation and are combined into a single data point. Slope estimated from a bivariate regression of the relevant variable on the year dummy in the full sample.
Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Table 33 presents the list of the top 20 companies made the highest yearly average number of M&A deals during the period from 2008 to 2020. This list includes the prominent 'Superstar firms'—a term often associated with the leading companies in the ICT sectors, such as Microsoft, Apple, META, and Alphabet (Jin et al., 2023). Their presence on the list underscores the ICT industry's significant emphasis on M&A activities in recent years. The dominance of the ICT sector is further highlighted by its strong representation, with both, ICT services and ICT producers filling 13 of the top 20 spots.

From a geographical standpoint, the predominance of US-based parent companies is evident, with 13 companies in the ranking. This reflects the strategic importance of M&A in the growth strategies of US companies. The EU also showcases a strong performance, with 6 companies making the list, including Accenture and Assa Abloy, securing positions within the top 5.

Interestingly, the table reveals a lack of clear correlation between the number of M&A deals and the growth rates for certain competitiveness measures, such as R&D, capital expenditures, and net sales. This heterogeneity indicates that a prolific M&A strategy does not uniformly translate into higher growth rates across these metrics, suggesting that the outcome of M&A activities is influenced by a variety of factors and may vary considerably among individual companies.

A further observation is that companies exhibiting high growth rates tend to be those founded after the 1990s and operating predominantly within the ICT software sector. Firms like Constellation Software, META, Salesforce, Alphabet, and X exemplify this trend, indicating that the growth strategies

of relatively young firms in the fast-evolving ICT sectors often successfully leverage M&A activities (Veugelers and Cincera, 2010).

Table 33. Top 20 companies by average number of M&A deals per year

Company	Region	Sector	M&A	Foundation year	R&D	Capex	Net sales
			Mean		*CAGR*	*CAGR*	*CAGR*
ACCENTURE	EU	Business services	9.14	1989	0.06	0.03	0.05
MICROSOFT	US	ICT software	6.71	1975	0.04	0.17	0.07
IBM	US	ICT software	6.07	1911	-0.01	-0.05	-0.05
APPLE	US	ICT hardware	5.43	1976	0.22	0.23	0.23
ASSA ABLOY	EU	Construction & materials	5.14	1994	0.12	0.02	0.06
CISCO SYSTEMS	US	ICT hardware	4.79	1984	0.02	-0.01	0.03
HEXAGON	EU	Industrials	4.36	1992	0.21	0.14	0.08
CONSTELLATION SOFT	ROW	ICT software	4.00	1995	0.24	0.17	0.24
META	US	ICT software	3.93	2004	0.23	0.72	0.60
TRIMBLE	US	ICT hardware	3.71	1978	0.10	0.08	0.09
INTEL	US	ICT hardware	3.57	1968	0.05	0.06	0.04
ALTABA	US	Financial	3.50	1995	0.04	0.04	-0.23
AMAZON.COM	US	Others	3.43	1996	0.00	0.46	0.26
VERITAS	EU	ICT software	3.14	1828	-0.07	0.13	0.17
SALESFORCE	US	ICT software	3.14	1999	0.42	0.36	0.35
RATOS	EU	Financial	3.00	1933	0.17	-0.16	0.00
ALPHABET	US	ICT software	2.93	1998	0.30	0.30	0.30
ATLAS COPCO	EU	Industrials	2.79	1873	0.05	-0.06	0.03
X	US	ICT software	2.71	2007	0.40	0.63	0.60
AMETEK	US	ICT hardware	2.71	1930	0.10	0.06	0.07

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

5.2.3 M&A activity and R&D investment for company growth and productivity

Table 34 and Table 35 present the results of regression models that analyse growth and productivity as functions of various company characteristics and behaviours, including R&D investment and M&A activity.[82]

The models are meticulous in their design, excluding firms with M&A activity in the first 3 years of observation to mitigate the effects of unobserved prior M&A activities. This criterion narrows the sample down to 3 759 unique companies. Further refinement to include only entities with at least 6

[82] M&A activity is defined as a company's decision to undertake M&A in the year of its first M&A during the observation period. The indicator is assigned a value of 1 in the initial year when a company conducts M&A activity, and it remains at this value until the end of the period, with a value of 0 in the years prior to the first M&A event. This definition of M&A activity, combined with the inclusion of company-level fixed effects, facilitates an examination of the effect of a company's decision to engage in M&A on its growth and productivity, allowing a comparison of pre- and post-M&A growth and productivity metrics. Similar results are obtained when the variable is instead defined to take a value of 1 in each year that the company conducts M&A activity and 0 otherwise.

years of data ensures enhanced temporal stability, resulting in a final sample of 2 348 unique companies observed over the period from 2008 to 2020.

The growth models in Table 34 employ 1-year growth rates of sales, employment, and profit as dependent variables, regressing them against R&D investment, against whether the company has conducted M&A and against the interaction term of R&D and M&A. These models account for initial year levels and capital intensity, with a comprehensive set of fixed effects controlling for time invariant heterogeneity, such as managerial capability and time-specific shocks, including financial crises and time varying effects at the region and sector levels.

Table 34 also presents robustness checks in the even-numbered columns, where companies with pre-2008 M&A activity are excluded, leaving a control group of firms that have never engaged in M&A. This approach allows for a more distinct comparison between firms that have and have not pursued M&A strategies.

The models in Table 35 focus on productivity, specifically labour and total factor productivity[83], using the same independent variables as in Table 34. These models control for capital intensity and prior-year employment levels, and also employ the same set of fixed effects as before.

The results in Table 35 illuminate several key findings. Companies with lower initial values in sales, employment, or profits tend to experience higher growth, suggesting that smaller firms have greater potential for rapid expansion. Both R&D investment and M&A activity show a positive and significant association with growth rates, reinforcing the value of these activities in driving firm growth. However, a negative and significant association between the interaction of R&D and M&A on growth rates indicates a potential substitution effect, where the combined effect of R&D and M&A does not equate to an additive contribution to growth and may indeed be detrimental.

The negative association found between the interaction term of R&D investment and M&A activity on growth rates can be interpreted through several theoretical frameworks, in particular relating to killer acquisitions and market power dynamics (Akcigit, 2024). The concept of killer acquisitions is discussed in the context of how established firms may acquire innovative startups not to integrate their innovations but to eliminate competition. This behaviour can stifle innovation and reduce overall industry growth. Cunningham et al. (2021) highlight that a significant percentage of acquisitions may fall into this category, particularly when the acquiring firm possesses substantial market power. Research indicates also that increased market concentration leads to a decline in business dynamism, characterised by fewer new business entries and reduced competitive pressures. This dynamic can negatively affect innovation and growth across industries (Decker et al., 2016). The relationship between M&A activity and market power is crucial in understanding how these factors interact with R&D investments. The implications of M&A on economic growth are further explored in literature that

[83] Labour productivity is calculated as net sales over the number of employees. Values of total factor productivity are calculated as the residual from a Cobb- Douglas production function that includes net sales, capital expenditures and the number of employees. A set of fixed effects is included in the analysis: sector, year, region, as well as interactions between year and sector, and year and region (Benassi et al., 2021). Due to the lack of data on output and materials, it is not possible to estimate either a value-added production function (with value added as output and labour and capital as inputs) or a revenue production function (with revenues as output and labour, capital and materials as inputs). Instead, the analysis is constrained to a hybrid model that combines aspects of both approaches. While this may not provide a complete picture, it still offers insights into the interplay of various factors within the constraints of the dataset.

examines how consolidation can lead to inefficiencies, reduced competition and ultimately lower growth rates. This is particularly relevant in industries where firms heavily invest in R&D but may prioritise consolidation over innovation post-acquisition (Bessen, 2022).

The regression results resonate with the existing evidence above, where different relevant mechanisms might be at play. First, a substitution effect may be at play: companies conducting M&A may allocate substantial financial and managerial resources to it, potentially at the expense of R&D activities. Since the effect of R&D on growth is generally positive (see the positive and significant coefficient of R&D in Table 34) but resource-intensive, diverting resources to M&A could dilute R&D's effectiveness. Second, the results may signal a less than optimal resource allocation problem. The negative interaction effect may suggest that while R&D investments are beneficial, they become less effective when combined with M&A activity that leads to resource misallocation. Third, it might point to a problem of self-selection. The negative association may signal that companies with decreasing R&D-growth patterns decide to conduct M&A. Larger firms may engage in M&A for defensive reasons, which could dampen competitive pressures and stifle innovation. Finally, M&A activity might trigger organisational adaptation costs; R&D departments are notoriously affected by the 'not invented here syndrome', namely the reluctance of organisations to adopt or integrate externally developed innovations due to a preference for internal solutions, leading to inefficiencies and potential loss of competitive advantage (Katz & Allen, 1982). This phenomenon can hinder collaboration and knowledge sharing, ultimately affecting the overall effectiveness of R&D efforts post-merger (Bstieler, 2006). Overall, the findings might indicate a need for regulatory antitrust scrutiny regarding M&A activities, especially in sectors with high R&D investment.

Table 34. The interplay between R&D and M&A on firm growth

	(1) Sales growth - 1y	(2) Sales growth - 1y	(3) Employment growth - 1y	(4) Employment growth - 1y	(5) Profit growth - 1y	(6) Profit growth - 1y
net sales (log) -1	-0.387**	-0.394**				
	[0.018]	[0.019]				
# of emp (log) -1			-0.295**	-0.298**	0.163**	0.165**
			[0.023]	[0.025]	[0.025]	[0.026]
operating profit (log) -1					-0.644**	-0.648**
					[0.016]	[0.018]
R&D (log) -1	0.103**	0.114**	0.070**	0.074**	0.090**	0.109**
	[0.013]	[0.014]	[0.010]	[0.011]	[0.020]	[0.021]
M&A -1	0.115**	0.116**	0.117**	0.117**	0.294**	0.296**
	[0.030]	[0.031]	[0.026]	[0.026]	[0.065]	[0.066]
R&D -1 x M&A -1	-0.023**	-0.024**	-0.025**	-0.026**	-0.058**	-0.060**
	[0.007]	[0.007]	[0.005]	[0.005]	[0.015]	[0.015]
Capital intensity (log) -1	0.132	0.183	3.351**	3.603**	1.602**	1.966**
	[0.237]	[0.257]	[0.470]	[0.503]	[0.540]	[0.552]
Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes
FE firm	Yes	Yes	Yes	Yes	Yes	Yes
FE year	Yes	Yes	Yes	Yes	Yes	Yes
FE reg x year	Yes	Yes	Yes	Yes	Yes	Yes
FE ind x year	Yes	Yes	Yes	Yes	Yes	Yes
N	20 340	18 360	20 663	18 681	15 091	13 523

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

The analysis of R&D, M&A and productivity in Table 35 reveals that smaller, more capital-intensive companies tend to be more productive. A strong positive association between R&D investment and

productivity metrics underscores the critical role of R&D in fostering competitiveness. However, no significant association is found for M&A and the interaction between M&A and R&D, suggesting that M&A activities alone do not have a direct observable association with productivity measures.

Table 35. The interplay between R&D and M&A on firm productivity

	(1)	(2)	(3)	(4)
	Labour prod	Labour prod	TFP	TFP
R&D (log) -1	0.021**	0.023**	0.009*	0.009*
	[0.004]	[0.004]	[0.003]	[0.004]
M&A -1	-0.009	-0.009	0.000	0.000
	[0.009]	[0.009]	[0.008]	[0.008]
R&D -1 x M&A -1	0.002	0.002	-0.000	0.000
	[0.002]	[0.002]	[0.002]	[0.002]
Capital intensity (log) -1	0.277*	0.245*	-0.610**	-0.597**
	[0.122]	[0.118]	[0.148]	[0.161]
# of emp (log) -1	-0.038**	-0.040**	-0.022**	-0.022**
	[0.007]	[0.007]	[0.006]	[0.006]
Clustered SE	Yes	Yes	Yes	Yes
FE firm	Yes	Yes	Yes	Yes
FE year	Yes	Yes	Yes	Yes
FE reg x year	Yes	Yes	Yes	Yes
FE ind x year	Yes	Yes	Yes	Yes
N	20 354	18 403	20 233	18 294

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

Overall, these findings contribute to a nuanced understanding of the interplay between R&D, M&A and firm growth and productivity, with implications for strategic decisions and regulatory oversight, particularly in high-investment R&D sectors.

The broader findings from the growth and productivity regression models are further nuanced by investigating sectoral and regional heterogeneity in a series of additional analyses.[84] While the smaller sample for these specific regressions limits the statistical robustness, several notable trends emerge that warrant mention. The most salient industry and regional specificities that contribute to the overall results are highlighted below.

The first noteworthy findings pertain to Europe. The negative association between the combined effect of R&D and M&A on growth is not observed in Europe. In this region, the only significant effect is the positive impact of R&D on growth, but not on productivity.

The observed negative association between the combined effect of R&D and M&A on growth is predominantly influenced by firms within the ICT hardware sector and by Chinese companies. Chinese parent companies, in particular, exhibit a trend where M&A activity is positively correlated with growth in sales, employees, and profit. However, when M&A is considered in tandem with R&D, the effect turns negative. This may suggest that these ICT hardware companies or Chinese companies employ a strategy geared towards expansion through acquisition, without a concurrent enhancement in R&D capabilities. In other words, while acquisitions might drive immediate growth, they do not necessarily bolster research and innovation, which are essential for sustained long-term development.

[84] The results are omitted for the sake of brevity, as they would require 2 tables per industry and geographical area, resulting in a total of 36 additional tables, but are available from the authors upon request.

This finding is of particular significance in the context of the European Commission's strategic priority for open strategic autonomy, where there is a clear need for improved and timely monitoring of M&A activity by companies in foreign regions. The objective is to ensure acquisitions contribute positively not just to immediate growth metrics but also to the broader innovation ecosystem, enhancing the capacity for internal R&D and maintaining competitiveness.

From a sectoral perspective, the positive link between R&D investment and productivity measures, specifically labour and total factor productivity, is strongly evident in the aerospace & defence, construction and ICT software sectors. Geographically, the trend is most apparent among Chinese and US companies, indicating that in these countries, investment in R&D is effectively translating into more productive operations. This underscores the importance of R&D as a key driver of competitive advantage and productivity, particularly in sectors and regions that are innovation-focused.

5.3 Key points

- **EU middle-tech trap:** Recent discussion about the EU's competitiveness has highlighted how EU firms are caught in a 'middle-tech trap', producing neither high-tech innovations nor benefiting from high-volume, low-tech manufacturing.
- **R&D and productivity:** R&D is still crucial for increases in competitiveness and productivity, but some studies have highlighted that R&D's positive effect on new breakthroughs and labour productivity have been declining, with diminishing business dynamism seen as one factor deterring R&D productivity.
- **R&D diminishing returns:** We observe that globally R&D growth has outpaced the growth in high-value patents and labour productivity, indicating diminishing returns on R&D investment for top R&D investors.
- **EU firms face more difficulties:** On average, EU firms struggle more than firms from other regions in converting R&D investment into high-value inventions, and they are not catching up with other global regions. EU firms also face challenges in translating R&D investments into labour productivity, with companies in China, the US, and the ROW being significantly more effective at translating R&D investment into commercial outputs, as measured by net sales per employee.
- **Pushing for more proves insufficient:** We argue that while solutions to these trends are complex, and potentially related to structural disadvantages of EU firms, it seems clear that merely pushing for more R&D investment by the private sector is insufficient to deliver greater R&D productivity.
- **M&A-active Scoreboard companies:** Scoreboard M&A-active firms are more established, larger in scale and invest more in both R&D and capital, indicating that M&A could be leveraged as a strategic tool for firms to augment their market position.
- **M&A in different sectors:** Sectors such as construction, industrials, and ICT exhibit higher levels of M&A activity, potentially due to dynamic market conditions and the drive for operational scale.
- **Regional propensity for M&A:** EU companies are more likely to engage in M&A activities than their global counterparts, reflecting the increase in EU's market integration, regulatory frameworks and strategic imperatives.
- **Characteristics of M&A active firms:** Scoreboard M&A-active companies consistently report higher metrics across various measures of competitiveness, such as R&D investment, capital expenditures, net sales, and market capitalisation.
- **M&A, R&D and firm growth:** While both R&D investment and M&A activity are positively associated with firm growth rates, the interaction between the two shows a negative association with

growth. This could indicate a substitution effect or resource allocation issues when companies engage in both activities simultaneously.

— **R&D and productivity:** there is a strong positive link between R&D investment and productivity.

— **M&A and productivity:** There is no significant direct association between M&A and productivity measures, suggesting that M&A alone may not lead to observable productivity gains.

References

Akcigit, U. (2024). The innovation paradox. IMF September 2024, available at https://www.imf.org/en/Publications/fandd/issues/2024/09/the-innovation-paradox-ufuk-akcigit

Andrade, G., Mitchell, M., & Stafford, E. (2001). New evidence and perspectives on mergers. Journal of economic perspectives, 15(2), 103-120.

Benassi, M., Grinza, E., Rentocchini, F., & Rondi, L. (2022). Patenting in 4IR technologies and firm performance. Industrial and Corporate Change, 31(1), 112-136.

Bessen, J. (2022). The new goliaths: How corporations use software to dominate industries, kill innovation, and undermine regulation. Yale University Press.

Bloom, N., Jones, C. I., van Reenen, J., & Webb, M. (2020). Are ideas getting harder to find? American Economic Review, 110(4), 1104–1144.

Bstieler, L. (2006). Trust formation in collaborative new product development. Journal of product innovation management, 23(1), 56-72.

Brynjolfsson, E., Rock, D., & Syverson, C. (2017). Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics (Working Paper 24001). National Bureau of Economic Research.

Cassiman, B., Colombo, M. G., Garrone, P., & Veugelers, R. (2005). The impact of M&A on the R&D process: An empirical analysis of the role of technological-and market-relatedness. Research policy, 34(2), 195-220.

Coeurdacier, N., De Santis, R. A., & Aviat, A. (2009). Cross-border mergers and acquisitions and European integration. Economic Policy, 24(57), 56-106.

Cunningham, C., Ederer, F., & Ma, S. (2021). Killer acquisitions. Journal of political economy, 129(3), 649-702.

Czarnitzki, D., & Thorwarth, S. (2012). Productivity effects of basic research in low-tech and high-tech industries. Research Policy, 41(9), 1555–1564.

Decker, R. A., Haltiwanger, J., Jarmin, R. S., & Miranda, J. (2016). Declining business dynamism: What we know and the way forward. American Economic Review, 106(5), 203-207.

Devos, E., Kadapakkam, P. R., & Krishnamurthy, S. (2009). How do mergers create value? A comparison of taxes, market power, and efficiency improvements as explanations for synergies. The Review of Financial Studies, 22(3), 1179-1211.

De Ridder, M. (2024). Market Power and Innovation in the Intangible Economy. American Economic Review, 114(1), 199–251

Draghi, M. (2024). The future of European competitiveness: Part A - A competitiveness strategy for Europe. European Commission. https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en

European Commission (2022): Directorate-General for Research and Innovation, Study on factors impeding the productivity of research and the prospects for open science policies to improve the ability of the research and innovation system – Final report, Publications Office of the European Union, 2022,

Nindl, E., Confraria, H., Rentocchini, F., Napolitano, L. et al. (2023). The 2023 EU industrial R&D investment Scoreboard, Publications Office of the European Union, Luxembourg, 2023, https://data.europa.eu/doi/10.2760/506189

Federico, G., Langus, G., & Valletti, T. (2017). A simple model of mergers and innovation. Economics Letters, 157, 136-140.

Fuest, C., Gros, D., Mengel, L.-P., Presidente, G., & Tirole, J. (2024). EU Innovation Policy: How to Escape the Middle Technology Trap (EconPol Policy Reports).

Goldin, I., Koutroumpis, P., Lafond, F., & Winkler, J. (2024). Why Is Productivity Slowing Down? Journal of Economic Literature, 62(1), 196–268.

Griliches, Z. (1979). Issues in Assessing the Contribution of Research and Development to Productivity Growth. Bell Journal of Economics, 10(1), 92–116.

Hall, B. H., Mairesse, J., & Mohnen, P. (2010). Measuring the Returns to R&D. Handbook of the Economics of Innovation, 2, 1033–1082.

Jin, G. Z., Leccese, M., & Wagman, L. (2023). How do top acquirers compare in technology mergers? New evidence from an SP taxonomy. International Journal of Industrial Organization, 89, 102891.

Jones, B. F. (2009). The Burden of Knowledge and the "Death of the Renaissance Man": Is Innovation Getting Harder? Review of Economic Studies, 76(1), 283–317.

Kim, E. H., & Lu, Y. (2013). Corporate governance reforms around the world and cross-border acquisitions. Journal of Corporate Finance, 22, 236-253.

Kancs, d'Artis, & Siliverstovs, B. (2016). R&D and non-linear productivity growth. Research Policy, 45(3), 634–646.

Katz, R., & Allen, T. J. (1982). Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D Project Groups. R&D Management, 12(1), 7-20.

Maksimovic, V., & Phillips, G. (2001). The market for corporate assets: Who engages in mergers and asset sales and are there efficiency gains? The Journal of Finance, 56(6), 2019-2065.

Moschieri, C., & Campa, J. M. (2009). The European M&A industry: A market in the process of construction. Academy of Management Perspectives, 23(4), 71-87.

Ortega-Argilés, R., Piva, M., & Vivarelli, M. (2015). The productivity impact of R&D investment: Are high-tech sectors still ahead? Economics of Innovation and New Technology, 24(3), 204–222. https://

Pammolli, F., Magazzini, L., & Riccaboni, M. (2011). The productivity crisis in pharmaceutical R&D. Nature Reviews. Drug Discovery, 10(6), 428–438.

Phillips, G. M., & Zhdanov, A. (2013). R&D and the incentives from merger and acquisition activity. The Review of Financial Studies, 26(1), 34-78.

Sakakibara, M., & Branstetter, L. G. (1999). Do stronger patents induce more innovation? Evidence from the 1988 Japanese patent law reforms. The RAND Journal of Economics, 32 (1). 77-100.

Seru, A. (2014). Firm boundaries matter: Evidence from conglomerates and R&D activity. Journal of financial economics, 111(2), 381-405.

Stiebale, J., & Trax, M. (2011). The effects of cross-border M&As on the acquirers' domestic performance: firm-level evidence. Canadian Journal of Economics/Revue canadienne d'économique, 44(3), 957-990.

Veugelers, R., & Cincera, M. (2010). Europe's missing yollies. Bruegel Policy Brief 2010/06, August 2010.

List of abbreviations and definitions

Abbreviations	Definitions
AI	Artificial intelligence
CVC	Corporate venture capital
DG RTD	European Commission, Directorate-General for Research and Innovation
EV	Electric vehicle
EC	European Commission
EIC	European Innovation Council
ERA	European Research Area
EU	European Union
HE	Horizon Europe
ICT	Information and communication technology
IMF	International Monetary Fund
JRC	European Commission, Joint Research Centre
M&A	Mergers & acquisitions
MFF	Multiannual financial framework (long-term EU budget & Next Generation EU)
OECD	Organisation for Economic Co-operation and Development
R&D	Research & development
R&D&I	Research, development and innovation
R&I	Research & innovation
ROW	Rest of the world
Scoreboard	EU Industrial R&D Investment Scoreboard
SME	Small and medium-sized enterprises
UK	United Kingdom
US	United States of America
VC	Venture Capital

List of boxes

List of figures

List of tables

Annexes

Annex 1. General information on the Scoreboard

Investment in research and innovation is at the core of the EU policy agenda. The Europe 2020 growth strategy includes the Innovation Union flagship initiative[85] with a 3 % headline target for intensity of research and development (R&D)[86]. R&D investment from the private sector plays also a key role for other relevant European initiatives such as the Industrial Policy[87], Digital Agenda and New Skills for New Jobs flagship initiatives.

The project "Global Industrial Research & Innovation Analyses" (GLORIA)[88] supports policymakers in these initiatives. The Scoreboard, as part of the GLORIA project, aims to improve the understanding of trends in R&D investment by the private sector. The Scoreboard identifies main industrial players in key industrial sectors, analyse their R&D investment and economic performance and benchmark EU companies against their global competitors.

This report monitors and analyses the company data and provides additional information on the positioning of Scoreboard companies in relation to other key indicators of relevance for industrial innovation policy. The annual publication of the Scoreboard intends to raise awareness of the importance of R&D for businesses and to encourage firms to disclose information about their R&D investments and other intangible assets.

The data for the Scoreboard are taken from companies' publicly available and audited accounts. As in more than 99% of cases these accounts do not include information on the place where R&D is actually performed, the company's whole R&D investment in the Scoreboard is attributed to the country in which it has its registered headquarter. This should be borne in mind when interpreting the level classifications and analyses.

The Scoreboard's approach is, therefore, fundamentally different from that of statistical offices or the OECD when preparing business enterprise expenditure on R&D data, which are specific to a given territory. The R&D financed by business sector in a given territorial unit (BES-R&D) includes R&D performed by all sectors in that territorial unit. **Therefore, the Scoreboard R&D figures are comparable to BES-R&D data only at the global level.**

The Scoreboard data are of interest for those concerned with private sector R&D investments and positioning and benchmarking company commitments and performance (e.g. companies, investors and policymakers). BES-R&D data are primarily used by economists, governments and international organisations interested in the R&D performance of territorial units defined by political boundaries.

---

85 The Innovation Union flagship initiative aims to strengthen knowledge and innovation as drivers of future growth by refocusing R&D and innovation policies for the main challenges society faces.

86 This target refers to the EU's overall (public and private) R&D investment approaching 3 % of GDP (http://ec.europa.eu/europe2020/pdf/targets_en.pdf).

87 The Industrial Policy for the Globalisation Era flagship initiative aims to improve the business environment, notably for small and medium-sized enterprises, and support the development of a strong and sustainable industrial foundation for global competition.

88 GLORIA builds on the IRIMA project (Industrial Research and Innovation Monitoring and Analysis). See: http://iri.jrc.ec.europa.eu/home /. The activity is undertaken jointly by the Directorate General for Research & Innovation (DG R&I E; see: http://ec.europa.eu/research/index.cfm?lg=en) and the Joint Research Centre, Directorate B. Fair and Sustainable Economy (JRC-Seville; see: https://ec.europa.eu/jrc/en/science-area/innovation-and-growth).

The two approaches are therefore complementary. The methodological approach of the Scoreboard, its scope and limitations are further detailed in Annex 2 below.

Scope and target audience

The Scoreboard is a benchmarking tool which provides up-to-date information on corporate R&D investment and other financial data, with a unique EU-focus. The 2 000 companies listed in this year's Scoreboard account for 85% to 90% of worldwide R&D funded by the business enterprise sector and the Scoreboard data refer to a more recent period than the latest available official statistics. Furthermore, the dataset is extended to cover the top 800 R&D investing companies in the EU.

The data in the Scoreboard, published since 2004, allow long-term trend analyses, for instance, to examine links between R&D and business performance.

The Scoreboard is aimed at three main audiences.

- **Policymakers, government and business organisations** can use R&D investment information as an input to industry and R&D assessment, policy formulation or other R&D-related actions such as R&D tax incentives.
- **Companies** can use the Scoreboard to benchmark their R&D investments and so find where they stand in the EU and in the global industrial R&D landscape. This information could be of value in shaping business or R&D strategy and in considering potential mergers and acquisitions.
- **Researchers, investors, and financial analysts** can use the Scoreboard to assess investment opportunities and risks, as well as analyse investment trends.

Furthermore, the Scoreboard dataset has been made freely accessible to encourage further economic and financial analyses and research by any interested parties. See https://iri.jrc.ec.europa.eu/data

Annex 2. Methodological notes

Data collection process

The data for the 2024 Scoreboard have been collected from companies' annual reports and accounts by Alepro Data Consulting. Potential R&D investing companies were identified using past Scoreboard editions (and the related data set published in 2023), a search in the Orbis flatfile (Bureau van Dijk – A Moody's Analytics Company), as well as direct company contacts. Each firm's annual reports were searched for figures on R&D expenditure, additions to intangible assets, amortisation/ depreciation/impairments, grants, R&D funded by third parties, restructuring costs, R&D expenditure from discontinued operations, engineering costs, net sales, capital expenditures, operating profits and employment. Data on market capitalisation was taken from the Orbis data base directly. The source documents, annual reports and accounts, are public domain documents, allowing independent replication of the Scoreboard. All data is consistent with previous Scoreboard editions, only the sample size decreased from 2 500 to 2 000 in the present edition.

Main characteristics of the data

The data correspond to companies' latest published accounts, intended to be their 2023 fiscal year accounts, although due to different accounting practices throughout the world, they also include accounts ending on a range of dates between late 2023 and mid-2024. Furthermore, the accounts of some companies are publicly available more promptly than others. Therefore, the current set

represents a heterogeneous set of timed data. However, around 70% of companies closed their accounts in December 2023.

In order to avoid double counting, the consolidated group accounts of the ultimate parent company are used. Companies which are subsidiaries of another company are not listed separately. Where consolidated group accounts of the ultimate parent company are not available, subsidiaries are included.

In the case of a demerger, the full history of the continuing entity is included. The history of the demerged company can only go back as far as the date of the demerger to avoid double counting of figures. In case of an acquisition or merger, pro forma figures for the year of acquisition are used along with pro-forma comparative figures if available.

The R&D investment included in the Scoreboard is calculated as the cash investment which is funded by the companies themselves. It excludes R&D undertaken under contract for customers such as governments or other companies. It also excludes the companies' share of any associated company or joint venture R&D investment when disclosed. However, it includes research contracted out to other companies or public research organisations, such as universities. Where part or all of R&D costs have been capitalised, the additions to the appropriate intangible assets are included to calculate the cash investment and any amortisation eliminated.

More precisely, R&D investment is calculated as the R&D expenditure adjusted for additions to intangible assets, amortisation/depreciation/impairments (subtraction), grants (subtraction), R&D funded by third parties (subtraction), restructuring costs (subtraction), R&D expenditure from discontinued operations (addition), engineering costs (subtraction), and other costs (subtraction). However, if firms do not publish this information, R&D expenditure is taken at face value. Note that ca. only one third of the companies published these data in their annual reports.

Companies are allocated to the country of their registered office. In some cases this is different from the operational or R&D headquarters. This means that the results are independent of the actual location of the R&D activity.

Companies are assigned to industry sectors according to the NACE Rev. 2[89] and the ICB (Industry Classification Benchmark). In the Scoreboard report we use different levels of sector aggregation, according to the distribution of companies' R&D and depending on the issues to be illustrated.

Limitations

Users of the Scoreboard data should take into account the methodological limitations, especially when performing comparative analyses (see Box A2 below)

The Scoreboard relies on disclosure of R&D investment in published annual reports and accounts. Companies which do not disclose figures for R&D investment or only figures which are not material enough are not included in the Scoreboard. Due to different national accounting standards and disclosure practices, companies of some countries are less likely than others to disclose R&D investment consistently. There is a legal requirement to disclose R&D in company annual reports in some countries.

89 NACE is the acronyme for "Nomenclature statistique des activités économiques dans la Communauté européenne".

In some countries, R&D costs are often integrated with other operational costs and can therefore not be identified separately. For example, companies from many Southern European countries or the new Member States are under-represented in the Scoreboard, while UK companies could be over-represented. For listed companies, country representation improves with IFRS adoption.

The R&D investment disclosed in some companies' accounts follows the US practice of including engineering costs relating to product improvement. Where these engineering costs have been disclosed separately, they are excluded from the Scoreboard. However, the incidence of non-disclosure is uncertain and the impact of this practice is a possible overstatement of some overseas R&D investment figures in comparison with the EU. Indeed, for US companies, the GAAP accounting standards are always used because they are the official, audited ones, however non-GAAP results may give a more realistic view of true R&D investments.

In implementing the definition of R&D, companies exhibit variability arising from a number of sources: i) different interpretations of the R&D definition; ii) different companies' information systems for measuring the costs associated with R&D; iii) different countries' fiscal treatment of costs. Some companies view a process as an R&D process while other companies may view the same process as an engineering or other process.

Interpretation

There are some fundamental aspects of the Scoreboard which affects the interpretation of the data. The focus on R&D investment as reported in group accounts means that the results do not indicate the location of the R&D activity. The Scoreboard indicates rather the level of R&D funded by companies, not all of which is carried out in the country in which the company is registered. This causes inputs such as R&D and capital expenditures to be related to outputs such as sales or profits only at the group level.

The data used for the Scoreboard differ from data provided by statistical offices, e.g., the R&D expenditures funded by the business enterprise sector and performed by all sectors within a given territorial unit (BES-R&D). The Scoreboard refers to all R&D financed by a particular company from its own funds, regardless of where that R&D activity is performed. In contrast, BES-R&D refers to all R&D activities funded by businesses and performed within a particular territory, regardless of the location of the business's headquarters. Therefore, the Scoreboard R&D figures are directly comparable to BES-R&D data only at the global level, i.e. the aggregate of the 2 000 companies R&D investment can be compared with the global total BES-R&D.

The Scoreboard collects data from audited financial accounts and reports. In contrast, BES-R&D typically takes a stratified sample, covering all large companies and a representative sample of smaller companies. An additional difference concerns the definition of R&D intensity, BES-R&D uses the percentage of value added, while the Scoreboard measures it as the R&D/Sales ratio as value added data is not available at a micro-level

Sudden changes in R&D figures may arise because a change in company accounting standards. For example, the first time adoption of IFRS[90], may lead to information discontinuities due to the different

[90] Since 2005, all listed companies in the EU are required to prepare their consolidated financial statements according to IFRS (International Financial Reporting Standards, see: http://www.iasb.org/).

treatment of R&D, i.e. R&D capitalisation criteria are stricter and, where the criteria are met, the amounts must be capitalised.

For many highly diversified companies, the R&D disclosed in their accounts relates only to part of their activities, whereas sales and profits are in respect of all their activities. Unless such groups disclose their R&D investment additional to the other information in segmental analyses, it is not possible to relate the R&D more closely to the results of the individual activities which give rise to it. The effect of this is that some statistics for these groups, e.g. R&D as a percentage of sales, are possibly underestimated and comparisons with non-diversified groups are limited. By allocating all companies to a single sector, the R&D of diversified companies is allocated to one sector only leading to overstatement of R&D in that sector and under-statement of it in other sectors.

For companies outside the Euro area, all currency amounts have been translated at the Euro exchange rates ruling at 31 December 2023 as shown in Table A2.1. The exchange rate conversion also applies to the historical data. The result is that over time the Scoreboard reflects the domestic currency results of the companies rather than economic estimates of current purchasing parity results. The original reporting currency data can be derived simply by reversing the translations at the rates above. Users can apply their own preferred purchasing parity transformation models.

Definitions of key terms

Research and Development (R&D) investment in the Scoreboard is the cash investment funded by the companies themselves. It excludes R&D undertaken under contract for customers such as governments or other companies. It also excludes the companies' share of any associated company or joint venture R&D investment. However, it includes research contracted out to other companies or public research organisations, such as universities. Being that disclosed in the annual report and accounts, it is subject to the accounting definitions of R&D. We use the definition set out in International Accounting Standard (IAS) 38 "Intangible assets" and is based on the OECD Frascati manual. **Research** is defined as original and planned investigation undertaken with the prospect of gaining new scientific or technical knowledge and understanding. Expenditure on research is recognised as an expense when it is incurred. **Development** is the application of research findings or other knowledge to a plan or design for the production of new or substantially improved materials, devices, products, processes, systems or services before the start of commercial production or use. Development costs are capitalised when they meet certain criteria and when it can be demonstrated that the asset will generate probable future economic benefits. Where part or all of R&D costs have been capitalised, the additions to the appropriate intangible assets are included to calculate the cash investment and any amortisation eliminated.

R&D expenditures funded by the business enterprise sector (**BES-R&D**), provided by official statistics, refer to the total R&D performed within a territorial unit that has been funded by the business enterprise sector (private or public companies).

Net sales follow the usual accounting definition of sales, excluding sales taxes and shares of sales of joint ventures and associates. For banks, sales are defined as the "Total (operating) income" plus any insurance income. For insurance companies, sales are defined as "Gross premiums written" plus any banking income.

R&D intensity is the ratio between R&D investment and net sales. At the aggregate level, R&D intensity is calculated only with those companies for which data exist for both R&D and net sales in the specified year. The calculation of R&D intensity in the Scoreboard is different from that in official statistics, e.g. BES-R&D, where R&D intensity is based on value added instead of net sales.

Operating profit is calculated as profit (or loss) before taxation, plus net interest cost (or minus net interest income) minus government grants, less gains (or plus losses) arising from the sale/disposal of businesses or fixed assets.

Capital expenditure (capex) is expenditure used by a company to acquire or upgrade physical assets such as equipment, property, industrial buildings. In accounts capital expenditure is added to an asset account (i.e. capitalised), thus increasing the asset's base. It is disclosed in accounts as additions to tangible fixed assets.

Number of employees is the total consolidated average employees or year-end employees if average not stated.

Market capitalisation is defined as the total value of a company's outstanding shares of stock. It is calculated by multiplying the current market price (at end of each financial year and measured in US Dollars) of the company's stock by the total number of outstanding shares.

Growth rate is the percentage change over the previous year of a variable: One-year growth = 100*((C/B)-1); where C = current year amount and B = previous year amount.

Box A2. Methodological caveats

Users of Scoreboard data should take into account the methodological limitations summarised here, especially when performing comparative analyses:

A typical problem arises when comparing data from different currency areas. The Scoreboard data are nominal and expressed in Euros with all foreign currencies converted at the exchange rate of the year-end closing date (31.12.2023). The variation in the exchange rates from the previous year directly affects the ranking of companies, favouring those based in countries whose currency has appreciated with respect to the other currencies. In this reporting period, the exchange rate of the Euro appreciated by 3% against the US dollar, by 16.3% against the Japanese Yen, by 7.3% against the Chinese Yuan/Renminbi, and depreciated 2.6% against the Pound Sterling, respectively. However, ratios such as R&D intensity or profitability are based on the ratio of two quantities taken from a company report where they are both expressed in the same currency and are therefore not affected by currency changes.

The growth rate of the different indicators for companies operating in markets with different currencies is affected in a different manner. In fact, companies' consolidated accounts have to include the benefits and/or losses due to the appreciation and/or depreciation of their investments abroad. The result is an 'apparent' rate of growth of the given indicator that understates or overstates the actual rate of change. For example, this year the R&D growth rate of companies based in the Euro area with R&D investments in the US is partly understated because of the 'losses' of their overseas investments due to the depreciation of the US dollar against the Euro (from USD 1.06 to USD 1.09). Conversely, the R&D growth rate of US companies is partly overstated due to the 'gains' of their investments in the Euro area. Similar effects of understating or overstating figures would happen for the growth rates of other indicators, such as net sales.

When analysing data aggregated by country or sector, in some cases, the aggregate indicator depends on the figures of a few firms. This is due, either to the country's or sector's small number of firms in the Scoreboard or to the indicator dominated by a few large firms.

In most cases, companies' accounts do not include information on the place where R&D is actually performed; consequently the approach in the Scoreboard is to attribute each company’s total R&D

investment to the country in which the company has its registered office or shows its main economic activity. This should be borne in mind when interpreting the Scoreboard's country classification and analyses. In some cases where company are headquartered in countries for fiscal reasons with little R&D or other activity in that country, a misleading impression may be received.

Growth in R&D can either be organic, the outcome of acquisitions or a combination of the two. Consequently, mergers and acquisitions (or de-mergers) may sometimes underlie sudden changes in specific companies' R&D and sales growth rates and/or positions in the rankings.

Other important factors to take into account include the difference in the various' countries' (or sectors') business cycles, which may have a significant impact on companies' investment decisions, and the initial adoption or stricter application of the International Financial Reporting Standard (IFRS).[91].

Table A1 1. Euro exchange rates

Country	As of 31 Dec 2023	As of 31 Dec 2022
Australia	1.62 AUD	1.56 AUD
Brazil	5.34 Brazilian Real	5.63 Brazilian Real
Canada	1.46 CAD	1.44 CAD
China	7.89 Yuan Renminbi	7.35 Yuan Renminbi
Denmark	7.45 Danish Krone	7.43 Danish Krone
Hong Kong	8.63 HKD	8.31 HKD
Hungary	383.14 Forint	400.87 Forint
India	90.13 Indian Rupee	84.17 Indian Rupee
Indonesia	17107.64 Indonesian Rupiah	16519.82 Indonesian Rupiah
Japan	163.51 Yen	140.66 Yen
Malaysia	4.69 Ringgit	4.69 Ringgit
New Zealand	1.80 NZD	1.67 NZD
Saudi Arabia	4.14 Riyal	4.02 Riyal
Singapore	1.45 SGD	1.43 SGD
South Korea	1424.78 Won	1344.09 Won
Sweden	11.09 Swedish Kronor	11.12 Swedish Kronor
Switzerland	0.92 Swiss Franc	0.98 Swiss Franc
Taiwan	33.96 TWD	32.72 TWD
Thailand	37.81 Baht	32.72 Baht
Türkiye	32.55 Turkish lira	19.96 Turkish lira
UK	0.84 British Pound	0.88 British Pound
US	1.09 USD	1.06 USD
United Arab Emirates	4.05 Dirham	3.91 Dirham
Vietnam	27063.6 Dong	25279.90 Dong

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I.

[91] Since 2005, the European Union requires all listed companies in the EU to prepare their consolidated financial statements according to IFRS (see: EC Regulation No 1606/2002 of the European Parliament and of the Council of 19 July 2002 on the application of international accounting standards at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002R1606:EN:HTML).

Annex 3. Global share of business enterprise sector R&D represented by the Scoreboard

The share of business enterprise sector R&D (BES-R&D) represented by companies in the EU Industrial R&D Investment Scoreboard is an important metric, often referenced in scholarly work.[92] This metric enables users to trust in the representativeness of Scoreboard data for aggregate R&D activity across sectors and countries, offering assurance that the R&D figures in the report capture most business R&D activities worldwide.

However, the R&D data used for the Scoreboard is constructed differently from the R&D data provided by statistical offices, e.g. the R&D expenditures funded by the business enterprise sector and performed by all sectors within a given territorial unit (BES-R&D). The Scoreboard refers to all R&D financed by a particular company from its own funds, regardless of where that R&D activity is performed. In contrast, BES-R&D refers to all R&D activities funded by businesses and performed within a particular territory, regardless of the location of the business's headquarters. Thus, for any given territory, Scoreboard data include outward R&D expenditures of companies headquartered there, while BES-R&D figures from statistical offices focus on intramural R&D, encompassing R&D by both local and foreign entities operating within the region (see Annex 1 and Annex 2).

Therefore, direct comparisons between the R&D Scoreboard and BES-R&D are meaningful primarily at the global level. However, even global comparisons require caution due to data limitations for certain regions. For instance, BES-R&D data are unavailable for key countries such as India and Taiwan that have many Scoreboard firms, as well as for all countries in Latin America, Southeast Asia and Africa. Consequently, any direct global comparisons of Scoreboard data with BES-R&D may overstate the proportion of R&D represented by Scoreboard companies.

To assess how Scoreboard R&D figures compare with territorial R&D statistics, we analysed R&D data from both, the Scoreboard and Eurostat, for the period 2012–2022[93], comparing 3 scenarios: (1) the top 2 500 Scoreboard companies, (2) the top 2 000 companies, and (3) a modified top 2 500 that excludes companies from countries without BES-R&D data. This comparison offers a perspective on the approximate proportion of business R&D captured by Scoreboard firms over the last decade.

The comparison in Figure 38 shows that Scoreboard companies account for between 80% and 95% of total BES-R&D, with the scenario typically used on previous Scoreboard editions[94] (the top 2 500) yielding an average share of 89%. The top 2 000 companies (used in the current edition) yield a similar share, averaging 87%, suggesting that the bottom 500 companies contribute only marginally (around 2%) to total BES-R&D. The scenario that excludes countries without BES-R&D data is the lower of all with an average share of 85%. This happens because we are reducing the numerator due to the exclusion of large R&D investors, such as TSMC and Foxconn in Taiwan or Tata Motors in India. This reduced share underscores the impact of the limited regional BES-R&D data coverage at the global level. The trends across these scenarios are consistent, with a noticeable increase in 2021,

---

92 Confraria, H., Grassano, N., Moncada-Paterno-Castello, P. Nindl, E., The impact of the EU Industrial R&D Investment Scoreboard in Science and Policy, European Commission, 2024, JRC139008.

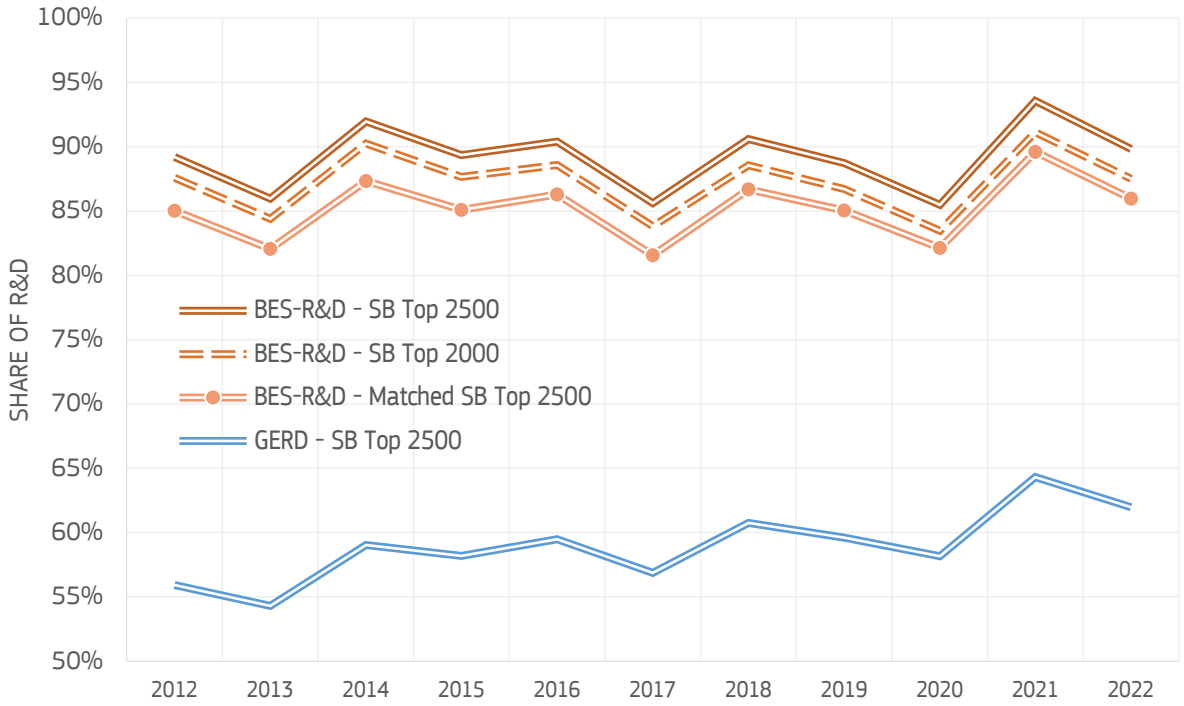
93 Note that the most recent BES-R&D data is for 2022.

94 For example: Grassano, N., Hernandez Guevara, H., Tuebke, A., Amoroso, S., Dosso, M., Georgakaki, A. and Pasimeni, F., The 2020 EU Industrial R&D Investment Scoreboard, EUR 30519 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978- 92-76-27418-6, doi:10.2760/203793, JRC123317.

likely due to a global reduction in R&D alongside a surge in health-related R&D investments by large pharmaceutical companies during the COVID-19 pandemic, which are all included in the Scoreboard.

Figure 39 also presents the proportion of gross domestic expenditure on R&D (GERD) represented by Scoreboard firms over time. We observe a trend that increases from 56% in 2012 to 62% in 2022, indicating that top R&D investors constitute a growing share of global R&D (both public and private).

Figure 39. Share of BES-R&D and GERD represented by the R&D Scoreboard between 2012 and 2022



Notes: BES-R&D refers to Business enterprise R&D (Source of funds: Business enterprise sector; Sector of performance: All sectors). GERD refers to Gross domestic expenditure on R&D (all sectors and source of funds). The ratios of Scoreboard R&D over BES-R&D and GERD were calculated in million Euros.

Source: The 2024 EU Industrial R&D Investment Scoreboard, European Commission, JRC/DG R&I. Eurostat (rd_e_gerdfund).

In summary, the analysis confirms that the R&D Scoreboard reliably represents a substantial majority of the global business enterprise sector R&D, with coverage ranging from 85% to 90%. Additionally, the Scoreboard's scope of representation within the gross expenditure on R&D has been expanding, with its share growing from 56% in 2012 to 62% in 2022. These findings affirm the Scoreboard's utility for analysing business R&D trends globally.

Getting in touch with the EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

— by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

— at the following standard number: +32 22999696,

— via the following form: european-union.europa.eu/contact-eu/write-us_en.

Finding information about the EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

Science for policy

The Joint Research Centre (JRC) provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society

EU Science Hub
Joint-research-centre.ec.europa.eu

Publications Office
of the European Union