European Commission

SCIENCE FOR POLICY BRIEF

Industrial Innovation & Dynamics series

Where the EU stands vis-à-vis the USA and China? Corporate R&D intensity gap and structural change

HIGHLIGHTS

The EU business sector is still leading in traditional medium-tech sectors, such as automobiles and parts. As for the US and China, they are much stronger in newer high-tech sectors, and have maintained and even increased their strength in the last decade.

For the EU, this causes a lower overall share of net sales and of R&D investment in sectors of high R&D intensity, compared with the full sample (all sectors). Consequently, there is a lower impact on the aggregate (all sectors) result for EU R&D intensity.

The EU has a small number of global players in key sectors of high R&D intensity, such as biotechnology and ICT.

The sample of top EU R&D investing companies is ahead in the production of green patents related to climate change technologies, as compared with the US and China.

The ultimate goal of policies in this area is boosting welfare, sustainable growth and jobs. These goals can be also promoted through tailor-made policies favouring the speed of structural change towards more R&D intensive / high-tech sectors where the international competitiveness race is being played. With such structural change, the EU can also alleviate its vulnerability and reinforce the technological sovereignty in strategic sectors.

Introduction

Industrial innovation has always been key to achieve competitive sustainability in the EU. Its role is even more crucial in the context of the COVID-19 recovery plan, the implementation of the green and digital transitions, and the global sustainability agenda[1].

Investment in research and development (R&D) by companies in the private sector drives industrial innovation. This is what makes it important to analyse differences in R&D intensity across world regions and their trend over time.

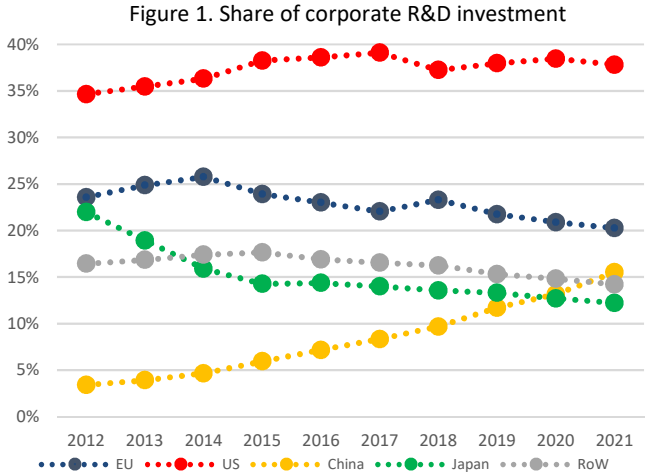
This short article explores the trend in the EU's overall corporate R&D intensity compared with competing economies. It shows how the R&D intensity gap has changed over the last decade and to what extent it is affected by the sectoral composition of the EU economy vis-à-vis its main competitors (US and China). The analysis covers 10 years (2012-2021) and is based on company data freely accessible from the *EU Industrial R&D Investment Scoreboard* website[2].

Evolution of industrial R&D investment

EU companies[3] are today responsible for 20% of world industrial investment in R&D (Figure 1). The EU has managed to maintain its second position of the top world regions for corporate R&D investment over the last 10 years, a period in which industrial R&D global investment grew by 68%.

The trend of shares of R&D in the sample shows China's growth at the expense of Japan (surpassed in 2020) and the EU.

Figure 1. Share of corporate R&D investment



Note: Years refer to different editions of the *EU Industrial R&D Investment Scoreboard*. EU is always EU-27.

If such current tendencies continue in the coming years, China could surpass the EU in 3 or 4 years. The spectacular growth of China in the past 10 years does not threaten US leadership worldwide in private R&D investment.

[1] The relevance of industrial innovation in contributing to these broad transitions and sustainability objectives are reflected in the European Commission Communication *Annual Sustainable Growth Strategy 2021* (European Commission, 2021). https://eur-lex.europa.eu/legal-content/en/TXT/?qid=1600708827568&uri=CELEX:52020DC0575

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

[3] In this article, we always refer to EU-27 being the current EU Member States. Historical data are adjusted accordingly.

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Structural changes and specialisation of corporate R&D investment

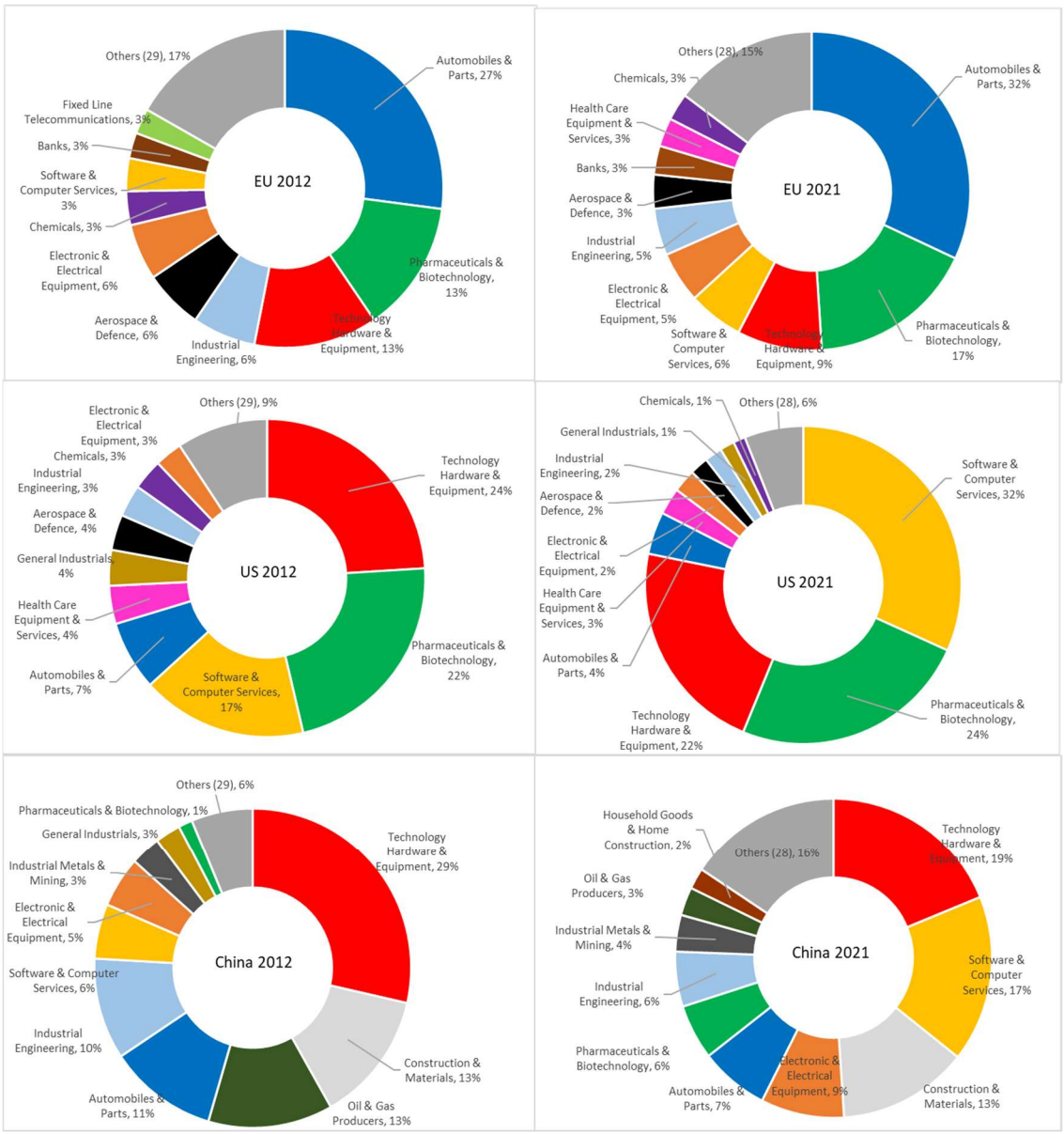
The sectoral changes in R&D investment by EU, US and Chinese companies from 2012 to 2021 - and the resulting specialisation – are reported in Figure 2.

EU companies increased R&D investment shares in Automobiles & Parts – where in 2021 it led worldwide – Pharma and Biotech, and Software & Computer Services. Altogether, these three sectors represent 55% of the total EU corporate R&D investment in 2021. In other sectors, EU corporate R&D investment shares have decreased or remained stable.

US companies raised their already high R&D investment share in Software & Computer Services (nearly doubling it from 2012 to 2021) and in Pharma and Biotech, and almost maintained their specialisation in Technology Hardware & Equipment. Altogether, these three sectors represent 78% of total US corporate R&D investment in 2021.

Between 2012 and 2021, R&D investment shares of Chinese companies shifted considerably in several sectors, demonstrating a fast transformation of the Chinese economy. In 2021, the bulk of their R&D was invested in ICT-related sectors (36%), which together with the Construction & Materials sector represent 49% of the total Chinese corporate R&D investment.

Figure 2. *R&D investment by EU (top graphics), US (middle graphics) and Chinese (bottom graphics) companies in sectors - 2012 (left) and 2021 (right)*

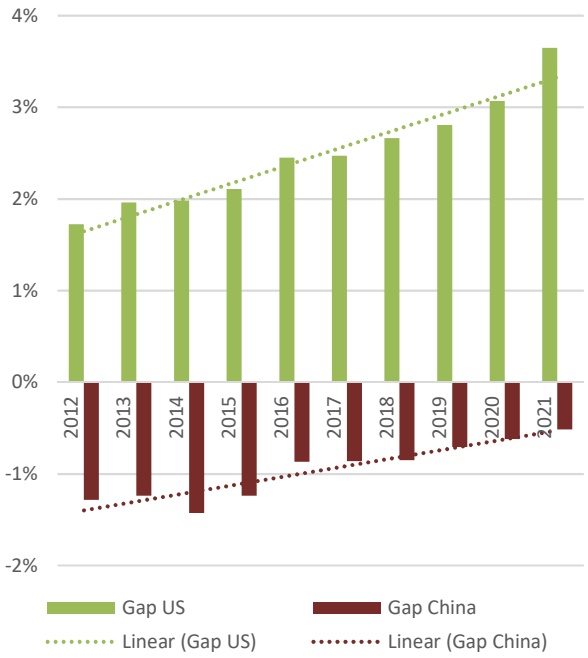


Note: Data from 2012 and 2021 editions of the *EU Industrial R&D Investment Scoreboard*. EU is always EU-27.

The EU corporate R&D intensity gap

Despite the good R&D investment performance of EU companies, the gap with respect to their non-EU counterparts in R&D intensity (R&D investment-to-sales ratio) has not reduced (Figure 3). The EU-US R&D intensity gap has increased almost constantly in the past 10 years. The constant leadership of the US, the relative rise of China and fall of the EU are reflected in the trend of the EU R&D intensity gap vis-à-vis the US and China. At the same time, the EU-China R&D intensity gap, which is actually a surplus from the EU perspective, shrank considerably from 2012 to 2021.

Figure 3. EU corporate R&D intensity gaps



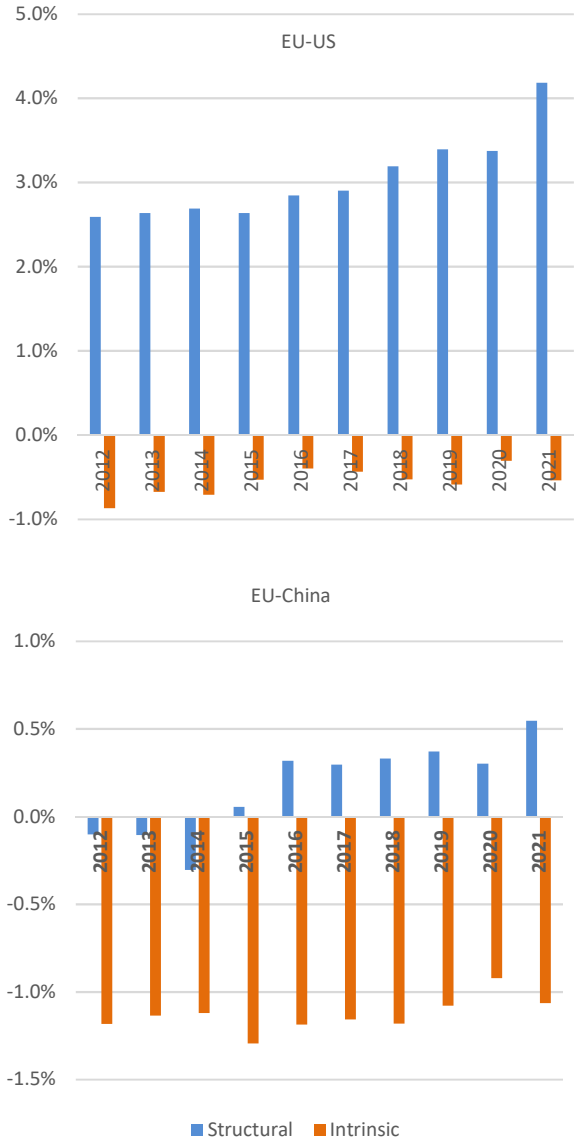
Note: Years refer to different editions of the *EU Industrial R&D Investment Scoreboard*. EU is always EU-27.

Causes of corporate EU R&D intensity gap

If we break down this R&D intensity gap between 'structural' and 'intrinsic'[4] components (Figure 4), we find that what drives growth in the EU-US R&D intensity gap is the structural component. The same goes for the EU-China R&D intensity gap, where we see how China has now surpassed the EU in the structural component. Therefore, what explains the gap increase with the US and decrease with China is not how much single EU firms invest in R&D vis-à-vis US or Chinese competitors, but the structure of the EU economy compared with the US and China.

The decomposition analysis shows that four sectors of high R&D intensity sectors (Technology Hardware & Equipment, Software & Computer Services, Pharma and Biotech and Health Care Equipment & Services) account for the bulk of the negative EU structural R&D intensity gap. On the other hand, the EU Automobile & Parts sector (the biggest R&D investing sector in the EU) offsets this negative structural effect[5].

Figure 4. Decomposition of EU vs US (top) and EU vs China (bottom) corporate R&D intensity gaps



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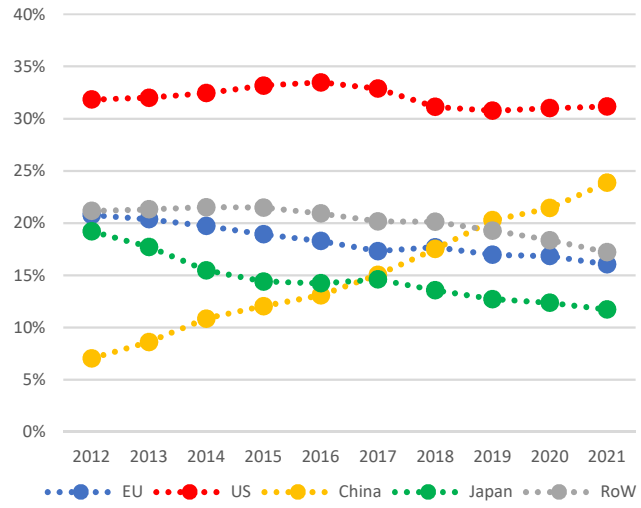
[4] The difference in R&D intensity between two economies can be due either to the differences in their structures (i.e. the majority of firms in one economy operate in sectors characterised by higher/lower R&D intensity compared with those in the other economy) or to inherent higher/lower R&D intensity of firms in one economy compared with those in the other economy (no matter the sectoral composition of the economy). The first cause is known in the literature as structural effect, the second as intrinsic effect. The overall R&D intensity difference can be broken down into these two effects.

[5] For more details of the R&D intensity breakdown at sector level, see Figure A1 in the annex.

Figure 5 shows how the presence of Chinese firms among the top 2 500 R&D investors worldwide has grown considerably and consistently in the 10 years reviewed. This increase is partially due to a better data coverage of Asian (and especially Chinese) companies in recent years, but it mostly arises from the organic growth of companies investing in R&D in China.
This growth arose mainly at the expense of Japan and the EU, which have seen a substantial decrease in the number of companies investing enough to enter the rankings.

In absolute terms, from 2012 to 2021, the number of EU companies among the top 2 500 R&D investors worldwide fell from 519 to 401, US companies from 796 to 779, and Japanese companies from 480 to 293. In contrast, the number of Chinese firms rose from 176 to 597 in the same period.

Figure 5. Share of total number of top R&D-investing firms

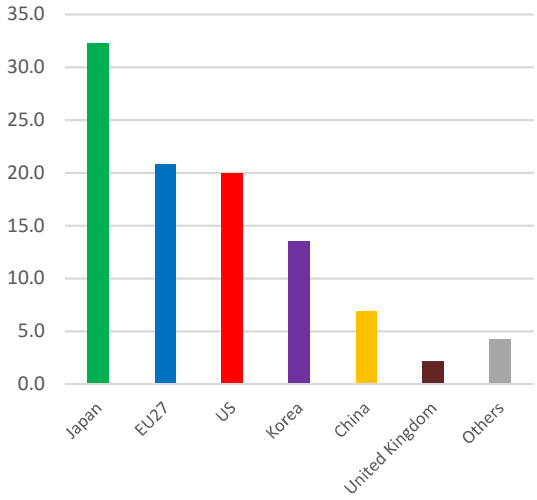


Note: Years refer to different editions of the EU Industrial R&D Investment Scoreboard. EU is always EU-27.

Evidence, as we have seen, indicates that most of this gap is due to structural factors. These are linked to specific sectors and reflect a much smaller number of leading innovative companies in the EU in key high-tech sectors compared with the US and China. This is particularly the case of ICT industries, where EU companies invest much less in R&D than their counterparts (e.g. 4.7 times less in 'Technology Hardware & Equipment' and 10.6 times less in 'Software & Computer Services' than US companies). This result has to be taken into consideration by policies aiming to foster the digital side of the twin transitions.

On the other hand, if we look specifically at the green side of the twin transition, EU R&D Scoreboard companies play a pivotal role in its achievement. They own 70% of the IP5[6] patent families in 'Climate change mitigation or adaptation' technologies filed in the period 2016-2018 (EC-JRC & OECD report, 2021)[7].

Figure 6. Location of inventors of climate change mitigation or adaptation



Source: EC/JRC-OECD, COR&DIP© database v.3., 2021

Looking at the location of the inventors of these patents in Figure 6, the relative majority are located in Japan. The EU represents a fifth of the total, slightly ahead of the US[8].

Conclusions

The empirical evidence emerging from 10 years of R&D investment trends indicates that the EU business sector is still strong in traditional medium-tech sectors, but is losing ground in some of them. Conversely, competing economies are much stronger in newer high-tech sectors, and have maintained and even increased their strength in the last decade. In fact, the EU shows a small number of global players in key sectors of high R&D intensity, such as biotechnology and ICT. This causes a lower overall EU share of net sales and of R&D investment in sectors of high R&D intensity compared with the full sample (all sectors). Consequently, there is a lower impact on the aggregate (all sectors) result for EU R&D intensity. The monitoring of industrial trends and competitiveness is a key indicator for policy analysis.[9]

[6] IP5 are: US Patent and Trademark Office (USPTO), European Patent Office (EPO), Japan Patent Office (JPO), Korean Intellectual Property Office (KIPO), and National Intellectual Property Administration (CNIPA) in China.

[7] EC-JRC & OECD (2021). *World Corporate Top R&D investors: Paving the way for climate neutrality*. Report EUR 30884 EN, Publications Office of the European Union, Luxembourg. ISBN 978-92-76-43373-6, doi:10.2760/49552, JRC126788.

[8] For more details on the EU position on green invention, see Chapter 4 in 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. For more details in patenting trends in climate change mitigation technologies, see Chapter 4 in Grassano, N., Hernandez Guevara, H., Fako, P., Tübke, A., Amoroso, S., Georgakaki, A., Napolitano, L., Pasimeni, F., Rentocchini, F., Compaño, R., Fatica, S. and Panzica, R. *The 2021 EU Industrial R&D Investment Scoreboard*, EUR 30902 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-44399-5, doi:10.2760/559391, JRC127360.

[9] For example: the Annual Single Market Report's set of key performance indicators (KPIs) to support innovation - COM(2021) 350 final -*link*).

In the perspective of the digital and green transitions, while losing ground compared with the US and China on corporate R&D investment in ICT, the EU is ahead of these two economies in the production of green patents such as those related to climate change technologies.

Therefore, when taking action to bridge the EU R&D intensity gap, policymakers should not only consider horizontal policy options across all sectors and firm typologies. Tailored policies should also be implemented to foster the speed of the structural (sectoral) change towards more R&D intensive sectors, including some emerging ones, for example artificial intelligence or renewable energies. Doing this will help the creation and growth of more firms in such sectors. This is crucial for the successful twin transitions and for archiving technological sovereignty in key sectors.

From a global R&I competitiveness perspective, the overarching policy challenge is, firstly, to prevent further structural erosion of EU positioning (especially in key sectors, such as ICT and health, recently further exacerbated by the COVID-19 crisis leading to a demand for R&I-based solutions). In addition, the challenge is to tackle the transformation of the EU R&I automobiles stronghold, also further challenged recently by the COVID-19 crisis, which reduced travel, and by the longer-term sustainability requirements.

FURTHER READING

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[10] The IAP is a data-driven knowledge platform that provides novel insights into industrial development worldwide and high-quality data-driven commentary and intelligence on related topics. *https://urldefense.com/v3/__https://iap.unido.org__;!!DOxrgLBm!W-BX1skSd8ZNhrnhh0IWyfEQ0YPh_pltrS0Mko5m6W6DmizXVTIOVv5O06yFESEYiCdGUU41CRefCFriye3Rkw$*

Annex

Figure A. 1 R&D intensity breakdown by sectors that are most accountable for the positive or negative gap. EU v US 2012 and 2022 (top quadrants) and EU v China 2012 and 2021 (bottom quadrants).

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