# Competitiveness and innovation in the EU[1]

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## 1. Introduction: Competitiveness, Innovation and Productivity

In his report "The future of European Competitiveness", Mario Draghi calls for decisive action to close Europe's widening innovation gap, accelerate digital transformation, and strengthen its capacities in key technologies domains—from semiconductors to cloud, AI and quantum technologies. At the same time, Draghi highlights the need to address persistent deficiencies in connectivity infrastructures and digital skills, both of which are essential to address the bloc's competitiveness problem.

The competitiveness concept embraced by Draghi clearly and strongly centres on innovation, as opposed to reducing prices by either depreciation in the real exchange rate or decrease in unit production costs. While short-term price-based competitiveness is often unsustainable in the long-run,[3] innovation-based competitiveness leads to increased productivity and economic growth over time.[4] Research and innovation are

[1] Paper predisposto per il seminario su Unione Europea: competitività e innovazione organizzato dalla Fondazione Astrid, Roma, 4 marzo 2026. Una versione riveduta del testo potrà essere elaborata a seguito delle indicazioni che emergeranno dal seminario. La versione definitiva costituirà un capitolo di un libro di Astrid sui nodi cruciali delle politiche europee, in corso di pubblicazione a cura di Giuliano Amato, Franco Bassanini e Marcello Messori.

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[3] Relying on exchange rate depreciation as a means of enhancing trade competitiveness is inherently unsustainable, as its short-term benefits are offset by adverse long-term effects. Depreciation increases the domestic currency cost of imported goods, which in turn raises import prices and fuels inflation. Higher inflation erodes purchasing power and discourages domestic investment, ultimately constraining productivity growth. A more durable approach is to improve competitiveness by reducing unit production costs, thereby enabling exports to gain market share without currency manipulation. Yet, this strategy also faces limits: sustained export expansion can place upward pressure on the exchange rate, gradually eroding the initial cost advantage. Moreover, aggressive cost-cutting risks undermining product quality and curtailing long-term investment, which may compromise the very foundations of competitiveness over time.

[4] Aghion P., Howitt P. (1992) A Model of Growth Through Creative Destruction, in Econometrica, 60(2), 323–351; Aghion P., Howitt P. (1998). Endogenous Growth Theory. This kind of economic growth is supposed to expand the "size of the pie," increasing the potential for shared prosperity and welfare improvements, making it compatible with the idea that relations between countries may be characterised as a "positive-sum game" rather than a "zero-sum game".

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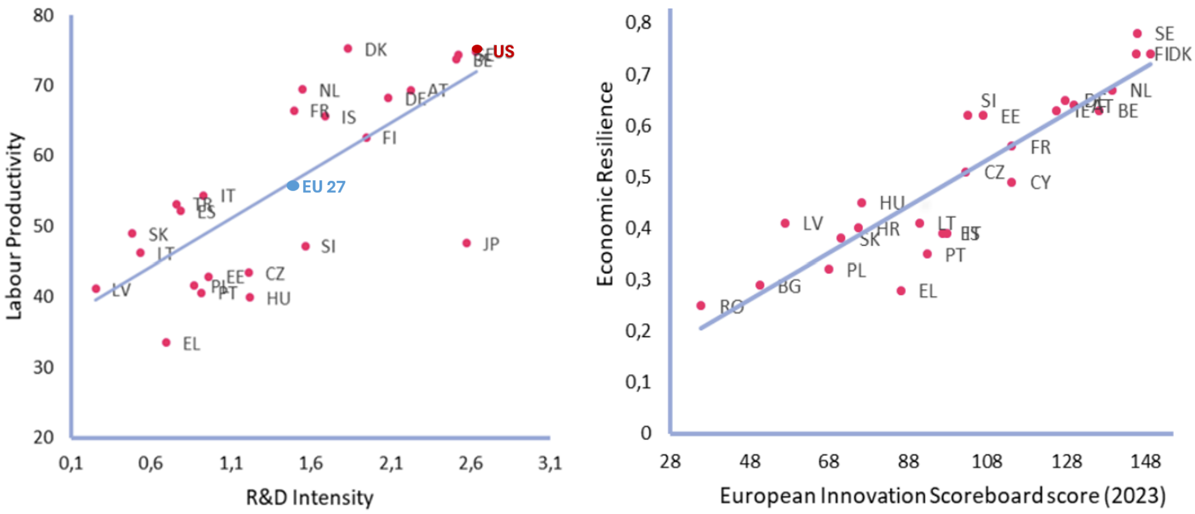
crucial to boost Europe’s (long-term) competitiveness: they are the main drivers of productivity and are directly correlated with economic resilience.[5] (**figure 1**)

**Figure 1 – Research & Innovation impact on productivity and economic resilience**




**Note: Graph on the left: business expenditure in R&D (BERD) measured in percentage of gross domestic product (GDP) 2020 and labour productivity 2021 (based on Eurostat). Graph on the right: Economic Resilience Index 2023[6] and EU Innovation scoreboard[7]**

In this context, EU's labour productivity (LP) (as well as total factor productivity - TFP) is approximately 20% lower than that of the United States, reflecting a downward trend started in the mid-90s.[8] (**figure 2**)

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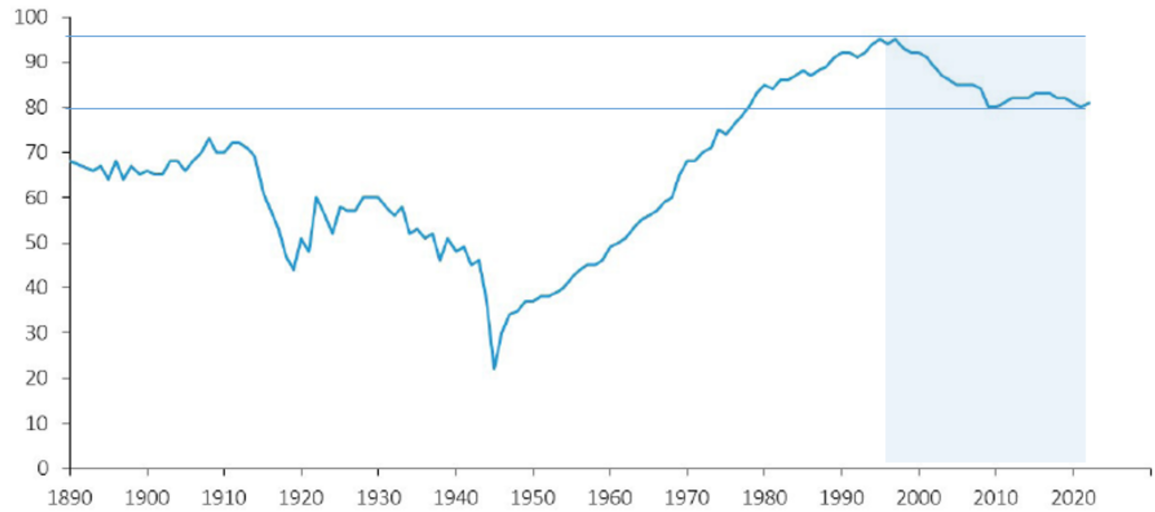
[5] Steeman J-T, Hobza A, Canton E, Di Girolamo V, Mitra A, Peiffer-Smadja O, Ravet J (2024) Why investing in research and innovation matters for a competitive, green, and fair Europe - A rationale for public and private action – EU Commission R&I Paper series.

[6] Zoe Institute for Future-fit Economies (2024) The Economic Resilience Index: Assessing the ability of EU economies to thrive in times of change. This composite index comprises 27 indicators grouped into six resilience dimensions: Economic Independence, Education & Skills, Financial Resilience, Governance, Production Capacity, and Social Progress & Cohesion. These dimensions are derived from 96 resilience characteristics mapped across four provisioning actors (households, businesses, state, and communities) and three resilience capacities (absorption, recovery, and adaptation).

[7] EU Commission (2024) European Innovation Scoreboard 2023. The European Innovation Scoreboard (EIS) 2025 provides a comparative assessment of research and innovation performance across 39 European countries using a measurement framework organized around four main pillars—Framework conditions, Investments, Innovation activities, and Impacts—comprising 32 indicators distributed across 12 innovation dimensions.

[8] Bergeaud A. (2024) The past, present and future of European productivity, in European Central Bank Forum report. Moreover, in 1990, the European Union (then comprising 12 member states) accounted

**Figure 2 – EU versus US labour productivity 1890 .. 1995-2022 (US=100)**




**Source: Draghi Report (2024)**

This productivity gap has been considered the long-tail of "*Europe's failure to capitalise on the first digital revolution led by the internet – both in terms of generating new tech companies and diffusing digital tech into the economy*".[9] As underscored in the Draghi Report, over the past two decades, when the ICT sector (i.e., the manufacturing of computers and electronics and information and communication activities) is excluded, labour productivity growth in the EU has largely mirrored that of the US.

Thus, a greater focus on innovation is particularly vital in today's geopolitical and economic landscape, which is increasingly defined by trade frictions, tariff escalations, and strategic decoupling among major economies.[10] In such a setting, price-based advantages are easily eroded by sudden tariff shocks or retaliatory measures, and access to foreign markets can no longer be taken for granted. [11] This elevates the

for 26.5% of global GDP. Today, despite expanding to 27 member states, the EU's share has declined to 16.1%, while the United States has maintained a stable share of approximately 26%.

[9] Draghi Report.

[10] Baba C., Lan T., Mineshima A., Misch F., Pinat M., Shahmoradi A., Yao J., van Elkan, R. (2023) Geoeconomic Fragmentation: What's at Stake for the EU, IMF Working Paper No. 2023/245.

[11] As exemplified by the import tariff policy adopted by the United States under the Trump administration — a policy that was, in fact, preceded and later accompanied by a broader global resurgence of protectionist measures since 2020, perhaps less visible but not necessarily less intense.

strategic value of non-price competitiveness, particularly that one rooted in frontier innovations coupled with consequent widespread and effective diffusions.

Indeed, as international trade relations become increasingly adversarial, countries with strong innovation ecosystems are better positioned to shape global standards, attract investment, and sustain market relevance despite new barriers—often even influencing global demand itself. In this sense, innovation not only enables firms to move up global value chains but also builds economic resilience and reinforces competitiveness, empowering nations to exercise greater bargaining power in geopolitical negotiations. In a world where trade rules are increasingly driven by strategic and power dynamics, long-term, innovation-driven competitiveness emerges as both an economic asset and a geopolitical lever.[12]

These issues become even more critical in the case of General Purpose Technologies (GPTs) - innovations capable of generating broad-based productivity gains and sustained economic growth across virtually all sectors.[13]

This dynamic strongly echoes Enrico Letta's 2024 report "Much More Than a Market", which strongly reaffirms the critical importance of a fully functioning Single Market for Europe.[14] At the same time, it calls for a transformative reconceptualization by placing the free movement of research, knowledge, and innovation at the heart of the European project. Building on the existing four freedoms, this proposed "fifth freedom" is not simply a valuable addition but a transformative force -crucial to enhancing the effectiveness of the others in an increasingly knowledge-based global economy.

Indeed, Europe's "competitiveness crisis" is fundamentally rooted in insufficient innovation capacity and lagging productivity growth. The European Commission itself

[12] Conversely, while raising trade barriers may yield short-term gains in price competitiveness, such protectionist measures tend to generate negative, self-reinforcing spillovers over the longer term — including reduced innovation, slower productivity growth, and heightened risks of global retaliation.

[13] GPTs share three defining features: (i) they are pervasive in their application, (ii) improvable over time, and (iii) able to catalyse complementary innovations that extend their transformative reach. See, Bresnahan T., Trajtenberg M. (1995), General Purpose Technologies: 'Engines of Growth'?, Journal of Econometrics 65, 83-108. Classic examples include electricity and computers, followed by the internet and advanced connectivity. Today, the most transformative GPT is artificial intelligence (AI), which stands at the centre of this analysis as a key driver of Europe's future competitiveness.

[14] Letta's vision fundamentally emphasizes the completion and deepening of the Single Market as an indispensable precondition for innovation-driven competitiveness. Indeed, 60% of exporting from European firms – and 74% from firms with cutting-edge innovation – signal clearly that the intra-EU market fragmentation (due to different national consumer protection standards, value-added tax, labelling, and licensing requirements) is still a big obstacle to business opportunities.

has recently articulated this diagnosis, stating that "*Europe has not kept pace with other major economies, due to a persistent gap in productivity growth. ... The root cause is a lack of innovation. Europe is failing to translate its ideas into new, marketable technologies, and failing to integrate those technologies into its industrial base.*"[15]

The European Union's efforts to enhance competitiveness and drive productivity through digital transformation are currently embodied in a comprehensive policy framework: the EU Competitiveness Compass.[16] The EU Competitiveness Compass (CC) identifies three strategic pillars, of which the first one is a crucial "closing the innovation gap". Moreover, the Compass integrates several flagship initiatives designed to advance the objectives of the Digital Decade, including the forthcoming Digital Networks Act (proposal expected in Q4 2025) and the Cloud and AI Development Act (proposal expected in Q1 2026).

This chapter examines Europe's situation and policy approach to innovation, with particular attention to its mutually reinforcing roles with productivity in sustaining long-term competitiveness. It also evaluates EU's performance across the core drivers of innovation-led competitiveness, benchmarking outcomes against those of the United States

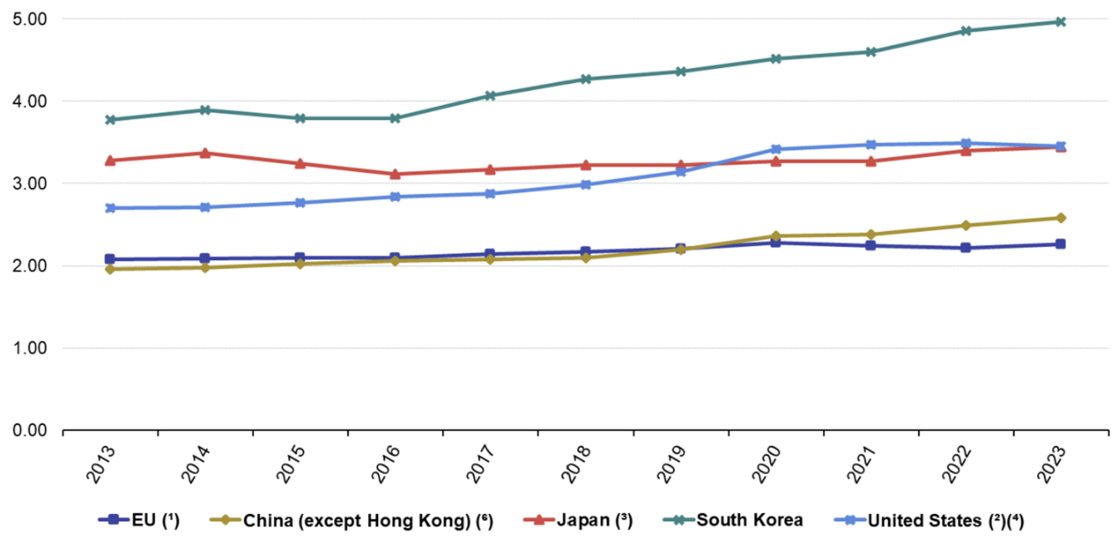
## 2. R&D and Sector Specialisation

It is widely recognized that the European Union faces persistent gaps compared with other major economies in both research and development (R&D) and productivity performance.

The EU R&D expenditure (GERD), as a percentage of GDP, remains stagnant and significantly lower than that of the United States and other major economies - a pattern that has persisted for a considerable period (**figure 3**). In 2023, the EU devoted 2.26% of its GDP to R&D, well below the figure recorder in the United States (3.45%), Japan (3.44%), and the global frontrunner South Korea (4.96%). China reached 2.58%, continuing to increase its spending and further widening its positive divergence from the EU.

[15] European Commission (2025) A Competitiveness Compass for the EU - COM(2025) 30 final.
[16] European Commission (2025) A Competitiveness Compass for the EU, cit.

**Figure 3 – Gross domestic expenditure on R&D (GERD) as % of GDP, 2013-2023**




**Source: Eurostat and [OECD database]**

It is important to underline that this EU-US gap in R&D is not due to differences in public investment, but rather to starkly different levels of private sector involvement (Business Expenditure on Research and Development, BERD). In fact, public R&D percentage of GDP was relatively similar in both regions - approximately 0.7% in 2023. However, it is also crucial to note that public R&D funding in the EU is often fragmented across national programmes and lacks the strategic coordination characteristic of federal R&D in the US. As a result, the effectiveness and impact of public R&D investment may differ significantly between the two economies. [17]

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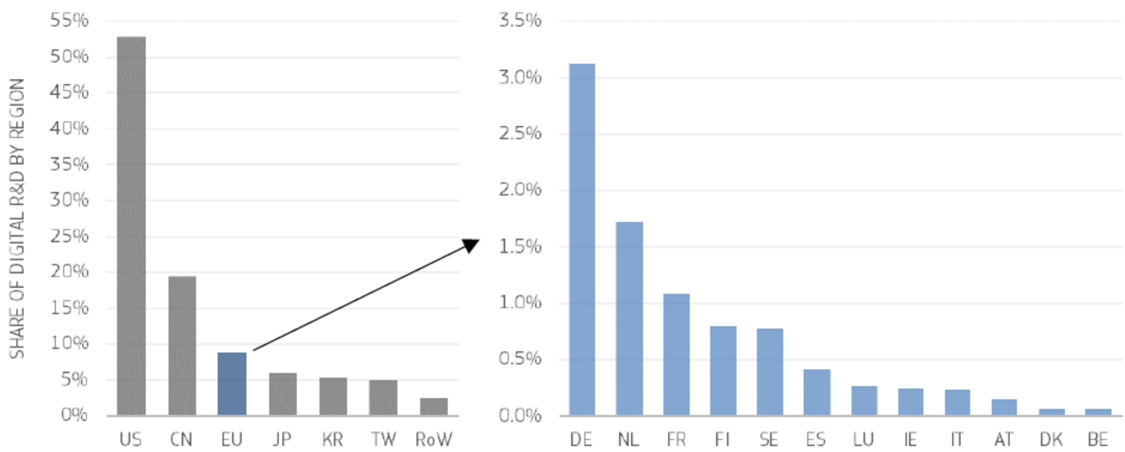
[17] In the United States, almost all public R&D spending is financed directly from the federal budget. In the European Union, by contrast, around 95% in 2021 comes from the budgets of the 27 Member States, with only a small share provided at EU level. Crucially, these national public R&D investments are not systematically coordinated to align with EU-wide strategic priorities, resulting in fragmentation and missed opportunities for scale. In 2023 more than half of the EU member states public R&D budget - 52.47% - is allocated through "undirected funding" aimed at the general advancement of scientific knowledge, enabling researchers to pursue innovative ideas, that may not necessarily align with immediate policy goals or EU-wide priorities. Thus, funding directed towards specific, predefined socio-economic objectives within EU governments accounts for 47.53%. In contrast, the US allocates a staggering 92.15% to such predefined mission-oriented objectives, while China, Japan and South Korea allocate 69.46%, 68.98% and 79.51% respectively. See, Benoit F., Karvounaraki A., Stevenson A., Ravet J. (2025) EU R&D Investments explained – EU commission – R&I paper series.

When examining the world's leading private R&D investors, US-based companies dominate the rankings: six of the top-ten and twelve of the top-twenty firms are headquartered in the United States. In contrast, the European Union counts only one company among the top ten and two among the top twenty. As a result, the aggregate share of global Business Expenditure on R&D (BERD) attributable to US firms is more than twice that of the EU: 42.3% versus 18.7%.

This gap becomes even more striking when focusing the R&D-intensive digital sectors - specifically ICT hardware and software. In terms of private sector investment, US companies account for 53% of total global digital R&D, while the combined contribution of EU-based digital firms amounts to only 8.9% (**figure 4**). China has markedly strengthened its position, increasing its share of global digital R&D from 7.1% in 2014 to 19.4% in 2023. During the same period, the EU's share declined from 13.7% to 8.9%, highlighting a persistent and widening digital innovation gap. [18]

**Figure 4 – R&D investment shares by global region and EU countries in digital sectors, 2023**




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

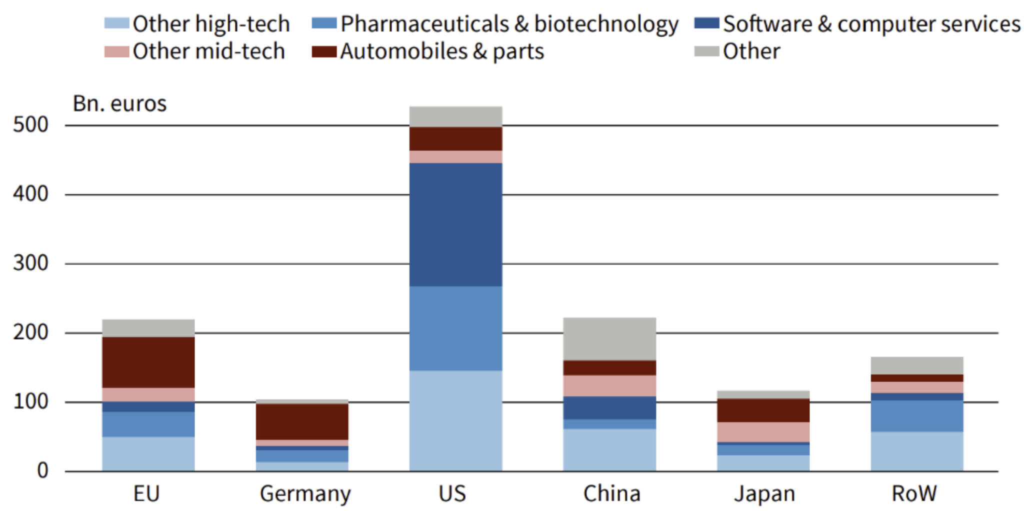
World's top four R&D investors are US-based digital companies - Alphabet, Meta, Apple, and Microsoft - whereas the only two EU companies among the top 20 are in the automotive sector (Volkswagen and Mercedes-Benz).[19] Among the top 50 digital companies, only three are headquartered in the EU: SAP, Siemens, and Ericsson, with Nokia and ASML closely following.

[18] See, Nindl E., Napolitano L., Confraria H., Rentocchini F., Fako P., Gavinan J. and Tuebke, A. (2024) The 2024 EU Industrial R&D Investment Scoreboard, EU Joint Research Centre.

[19] In 2023, the automotive sector accounts for 34.2% of total EU business R&D expenditure, representing approximately €73 billion annually, which makes Europe the world's largest investor in automotive, surpassing Japan (€33.6 billion), the US (€33.6 billion), and China (€22.2 billion).

This pattern reflects, firstly, the significantly larger size of US (tech) firms; however, it also points to a broader structural difference in the propensity to invest in R&D across economic sectors. Indeed, the fundamental distinction between Business Expenditure on R&D (BERD) in the two regions is not only quantitative but also sectoral. The United States tends to concentrate its investments in “high-tech” sectors, notably software, computing, and biotechnology, whereas European firms invest more heavily in “medium-tech” industries such as automotive, chemicals, and transportation. [20](**figure 5**).

**Figure 5 - BERD by technology level, top 2500 companies**




**Source: Dietrich et al (2024) based on data from Industrial R&D Investment Scoreboard (2023)**

Due to this situation, the relatively lower aggregate business R&D expenditure in Europe can be explained, in the first instance, by a “structural composition effect”. This effect arises because R&D-intensity (R&D expenditure as a percentage of revenues) is much higher in those high-tech sectors that are underrepresented in the European economy compared to the United States. [21]

[20] Meyers Z. (2025) A framework for understanding EU competitiveness – CERRE Report.
[21] For example, in 2023, private-sector R&D intensity stood at 4.8% in the automotive industry, 8.2% in ICT hardware, and 10.9% in ICT software. See WIPO (2024), Global Innovation Index 2025: Innovation at a Crossroads; and Nindl E., Napolitano L., et al. (2024) cit. A more granular analysis reveals that Cellular and IoT technologies display particularly high R&D intensity - approximately 19.8% - second only to biotechnology. This is highly relevant from an innovation and competitiveness perspective, given Europe’s strong position in Cellular and IoT technologies, where firms such as Ericsson and Nokia rank among the leading global vendors.

However, beyond this structural explanation, there are also evidence of an “intrinsic effect” [22]: EU firms within each industry are characterized by a lower R&D intensity in comparison with their US counterparts.[23] A rational and empirically robust explanation for this is that the R&D stock has a positive impact on productivity that differs markedly between the EU and the US across all macro sectors, as European firms that do invest in R&D tend to face greater difficulty in converting those investments into productivity gains.[24]

As a result, US firms not only benefit from a greater concentration in high-tech industries, which supports the structural effect, but also demonstrate superior efficiency in leveraging R&D investments - not only in high-tech sectors but across the board, even though in the high-tech this gap is much more pronounced.[25]

Thus, the EU faces two intertwined challenges: (i) a lower overall level of business expenditure in R&D, and (ii) weaker productivity returns from R&D spending, regardless of industry. While much of the policy debate has so far concentrated on increasing R&D[26], it must be considered that lower R&D investment may just be a rational response by firms to a lower expected return due to a limited ability to convert R&D into productivity gains. So, merely pushing for more R&D investment by the private (or public) sector - even if probably necessary - may be insufficient.

Importantly, the relatively lower R&D stock among EU firms may be even more significant at the firm level than at the aggregate level. If R&D effectiveness is subject to a “threshold effect”, only large-scale investments are likely to yield substantial

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[22] The basic difference is that structural effects relate to the relative size of industries within the economy, while intrinsic effects focus on how much companies in those industries invest in R&D in each economy.

[23] Ortega-Argilés R., Brandsma A. (2010) EU-US differences in the size of R&D intensive firms: do they explain the overall R&D intensity gap?, Science and Public Policy, Volume 37, Issue 6, Pages 429–441; Moncada-队Paternò-Castello P., Grassano N. (2022), The EU vs US corporate R&D intensity gap: investigating key sectors and firms, in Industrial and Corporate Change, Volume 31, Issue 1, 19–38; Adilbish O-E, Cerdeiro D., et al. (2025) Europe’s productivity weakness: Firm-level roots and remedies – CEPR VOXEU Colums , available at: https://cepr.org/voxeu/columns/europes-productivity-weakness-firm-level-roots-and-remedies

[24] Ortega-Argilés R., Piva M., Vivarelli M. (2014) The transatlantic productivity gap: is R&D the main culprit? Can. J. Econ. 47, 1342–1371.; Nindl E., Napolitano L., Confraria H., Rentocchini F., Fako P., Gavinan J. and Tuebke, A. (2024), cit.

[25] See, Castellani D., Piva M., Schubert T., Vivarelli M. (2019) R&D and productivity in the US and the EU: Sectoral specificities and differences in the crisis, Technological Forecasting and Social Change, Volume 138, 2019, Pages 279-291.

[26] Also, the Draghi report emphasises that "*failure to meet the 3% target for R&D expenditure set by EU leaders over two decades ago is a fundamental reason why the EU lags behind the US and China*".

productivity gains.[27] This consideration also underscores structural constraints within the EU, such as the smaller average scale of firms and the fragmented nature of both public and private R&D funding and industrial policies. [28]

## 3. The EU "Mid-Tech Trap"

As anticipated, US companies invest heavily in high-tech sectors such as software and biotechnology, where R&D intensity and profit margins are high, while European firms remain largely concentrated in mid-tech industries like automotive and mechanical engineering.[29]

In the US, high-tech sectors tend to generate a virtuous cycle: larger market shares lead to more R&D investment, which reinforces technological leadership and global competitiveness. In contrast, Europe's path dependency on mid-tech sectors has led to what has been defined as "middle technology trap", [30] where innovation is mostly made of small incremental improvements and incentives for disruptive high-tech innovation remain weak, ultimately limiting the scale and dynamism of Europe's innovation ecosystem. This situation implies a misalignment between R&D investment and breakthroughs in sectors generating higher value added and where R&D has a higher impact on firms' productivity. [31]

These EU-US divergent trajectories toward high-tech have developed over the past two decades: in 2003, the US and EU both counted automotive companies among their top R&D investors; however, while the US transitioned toward high-tech - by 2022 its top R&D spenders were all software companies, the EU, as well as Japan, remained anchored in mid-tech sectors like automotive. [32]

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[27] See, Castellani D., Piva M., Schubert T., Vivarelli M. (2019), cit.
[28] See, Bianchini N., Ancona, L. (2023) Artificial intelligence: Europe needs to start dreaming again. Schuman Papers n°728.
[29] Meyers Z. (2025) A framework for understanding EU competitiveness – CERRE Report
[30] Fuest C., D. Gros, Mengel P.-L., Presidente G., Tirole J. (2024) EU Innovation Policy - How to Escape the Middle Technology Trap - IEP@BU report.
[31] Ortega-Argilés, R., Piva, M., Vivarelli, M. (2015) The productivity impact of R&D investment: Are high-tech sectors still ahead?, in Economics of Innovation and New Technology, 24(3), 204–222; Czarnitzki D., Thorwarth S. (2012). Productivity effects of basic research in low-tech and high-tech industries, in Research Policy, 41(9), 1555–1564; Kancs, d'Artis, Siliverstovs, B. (2016) R&D and non-linear productivity growth, in Research Policy, 45(3), 634–646.
[32]In 2023, the automotive sector accounts for 34.2% of total EU business R&D expenditure, representing approximately €73 billion annually, which makes Europe the world's largest investor in automotive, surpassing Japan (€33.6 billion), the US (€33.6 billion), and China (€22.2 billion).

**Figure 6 - Top-3 R&D spenders and their industries compared over time**

| | 2003 | 2013 | 2023 |
|---|---|---|---|
| **EU** | Mercedes-Benz (auto)<br>Siemens (electronics)<br>Volkswagen (auto) | Volkswagen (auto)<br>Mercedes-Benz (auto)<br>Bosch (auto) | Volkswagen (auto)<br>Mercedes-Benz (auto)<br>BMW (auto) |
| **US** | Ford (auto)<br>Pfizer (pharma)<br>GM (auto) | Microsoft (software)<br>Intel (hardware)<br>Merch (pharma) | Alphabet (software)<br>Meta (software)<br>Apple (hardware) |
| **JPN** | Toyota (auto)<br>Panasonic (electronics)<br>Sony (electronics) | Toyota (auto)<br>Honda (auto)<br>Panasonic (electronics) | Toyota (auto)<br>Honda (auto)<br>NTT (telecom) |

**Source: Data from the EU Industrial R&D Scoreboard (2024)**

The US was able to shift its industrial base toward higher-growth and higher-margin sectors, counteracting the typical path dependencies that characterise innovation and industrial specialisation, [33] while the EU remained locked into its historical trends.

This transformation was mainly driven in the US by strong total factor productivity (TFP) growth in the ICT and software-producing sectors, further amplified by the positive externalities generated within R&D-intensive clusters. These clusters — comprising large corporations, startups, universities, and venture capital firms—played a pivotal role in fostering innovation. Not only did they stimulate entrepreneurship[34],

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[33] See, e.g, Acemoglu D. (2023) Distorted innovation: does the market get the direction of technology right?, AEA Papers and Proceedings, in American Economic Association 113; Aghion P., Antonin C., Bunel S. (2021) The power of creative destruction: Economic upheaval and the wealth of nations; Aghion P., et al. (2016) Carbon taxes, path dependency, and directed technical change: Evidence from the auto industry, in Journal of Political Economy 124.1 (2016): 1-51. Melitz M., Redding S. J. (2021) Trade and Innovation - NBER Working Paper No. w28945.

[34] Delgado, M., Porter, M. E., Stern, S. (2010) Clusters and entrepreneurship, in Journal of economic geography, 10(4), 495-518.

but they also enabled firms to rapidly acquire cutting-edge technological capabilities, particularly in emerging fields often rooted in university research.[35]

Such a dynamic and integrated environment facilitated the rapid development and diffusion of digital technologies in the United States, in stark contrast to the more cautious and incremental innovation patterns observed in much of Europe. In contrast, Europe's innovation system lacks comparable scale-driven loops, constraining the emergence of global technology champions and dampening incentives for high-risk, frontier investment.

On the other side, the EU outperforms the US in terms of productivity within mid-tech sectors. This advantage reflects the higher concentration of EU firms (and larger firms) operating in mid-tech industries, and their higher physical capital expenditure (**figure 13**). Capex has a greater impact on productivity in low- and medium-tech firms than in high-tech ones, as higher levels of output per worker (Labour Productivity) are often driven by tangible capital deepening, such as increased investments in machinery, equipment, and physical infrastructure aimed at enhancing workforce efficiency.

## 4. Access to finance for R&D and scaling of innovative firms

This industrial pattern is also closely aligned with the structure of corporate financing in Europe, where firms rely predominantly on debt financing - an instrument naturally suited to supporting tangible, physical investments that can serve as collateral. By contrast, debt is inherently ill-suited for early-stage innovation and generally inadequate for large-scale, high-risk investment projects. This marks a significant transatlantic divergence in the financing of innovation[36]: compared with their U.S. counterparts, European firms face greater constraints in accessing equity financing and venture capital. As underscored by both Draghi and Letta, these structural disadvantages in accessing deep, long-term "patient capital" [37] have resulted in a

[35] Mohnen, P., Hoareau, C. (2003) What type of enterprise forges close links with universities and government labs? Evidence from CIS 2, in Managerial and decision economics, 24(2-3), 133-145; Valero, A., & Van Reenen, J. (2019) The economic impact of universities: Evidence from across the globe, in Economics of Education Review, 68, 53-67.

[36] Aghion L., Howitt P., Levine R. (2018) Financial development and innovation-led growth, in Handbook of finance and development (pp. 3-30); Garcia-Macia D. (2017) The financing of ideas and the great deviation - International Monetary Fund paper No. 2017/176.

[37] In this context, "patient capital" refers to investment that is willing to accept longer payback periods and higher uncertainty in order to support breakthrough R&D and the scaling of innovative companies. This type of financing — prevalent in the US, where large venture funds and capital markets sustain multi-year innovation cycles, and in China, where state-backed investment plays a similar role — is far less accessible in Europe. The result is that promising European firms often struggle to secure the

persistent shortfall for Europe in developing and scaling new technologies to their full commercial potential. By contrast, firms in the United States benefit from substantially greater access to equity financing and venture capital[38], which are more appropriate for funding high-risk, intangible-intensive innovation: indeed, being able to raise equity finance makes firms, on average, 13 percentage points more likely to innovate.[39]

As specified later for the automotive, the sector specialisation and the structure of financial system are interdependent self-reinforcing factors in the mid-tech trap: in facts, over 80% of venture capital investment by EU based large companies—which are unlikely to be financially constrained—finance US-based startup.[40] In addition, there is a huge gap in financing for later-stage growth between the EU and the US.[41]

EU scale-up firms have raised, on average, 50% less capital than their US counterparts in the last ten years. [42] As a result, many EU-originated innovative firms, especially start-ups and scale-ups, turn to U.S. venture capital and view expansion into the vast, unified American market as a more attractive and feasible growth strategy, rather than facing the substantial challenges of operating across the fragmented landscape of the European Union.[43]

The result, as well known, is a striking scale deficit: by their tenth year, European digital scale-ups have raised 50% less capital than their Silicon Valley peers and the

resources needed to compete globally, leading in some cases to relocation abroad or acquisition by non-European players

[38] The average market capitalisation of US companies has historically been much higher than that of European companies, with the gap having widened significantly since 2010. In 2022, US companies achieved, on average, a market capitalisation that was 3.3 times higher than that of EU companies. See Gati Z., Lambert C., Ranucci D., et al, (2024), Examining the causes and consequences of the recent listing gap between the United States and Europe, European Central Bank, available at: https://www.ecb.europa.eu/press/fie/box/html/ecb.fiebox202406_07.en.html.

[39] European Investment Bank (2025) Investment Report 2024/2025: Innovation, integration and simplification in Europe

[40] Gros D., Mengel P-L, Presidente G. (2024), cit.

[41] Quas A., Mason C., Compañó R., Testa G., Gavigan J. P. (2022) The scale-up finance gap in the EU: Causes, consequences, and policy solutions, in European Management Journal, 40(6), 833-844

[42] Fratto C., Gatti M., Kivernyk A., Sinnott E., van der Wielen W. (2024) The scale-up gap: Financial market constraints holding back innovative firms in the European Union, at: https://doi.org/10.2867/382579; European Investment Bank (2025), cit.

[43] Weik S., Achleitner A-K., Braun R. (2024), Venture capital and the international relocation of startups, in Research Policy, Volume 53, Issue 7; Arnold, N. G., Claveres, G., & Frie, J. (2024) Stepping Up Venture Capital to Finance Innovation in Europe - IMF Working Paper No. 2024/146

number of "unicorns" established in the EU, in 2024, has reached 286 units, still lagging significantly behind China (397) and the US (1687).[44]

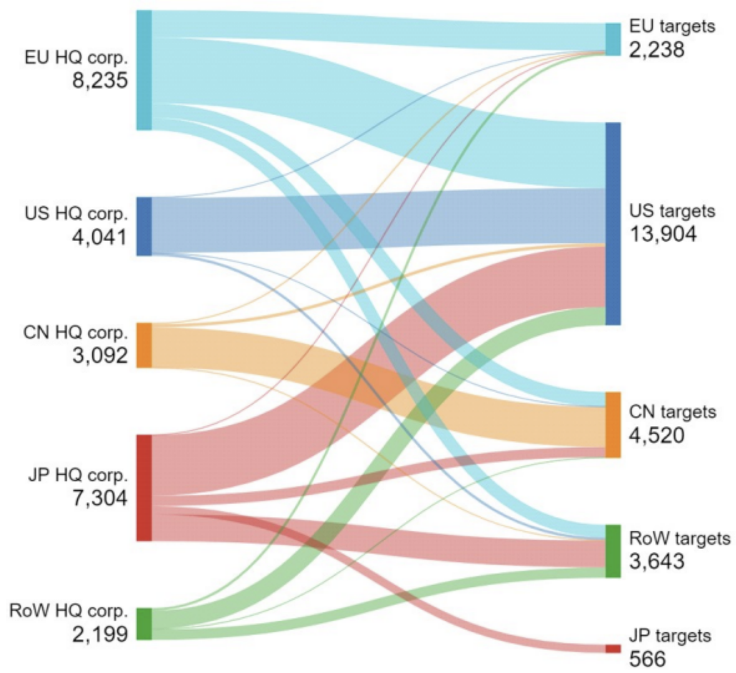
The EU automotive sector provides a complementary and instructive perspective on this dynamic. In response to the digital and technological transformation impacting the industry, companies are directing investments toward the technological innovations reshaping the sector: autonomous driving, advanced sensor technologies, and related digital capabilities. This is done through several strategies, prominently including Corporate Venture Capital (CVC).[45]

EU automotive leaders are deploying CVC at levels comparable to their Japanese competitors and higher to US and Chinese ones. Notably, high-tech newcomers to automotive, such as Tesla and BYD (respectively headquartered in US and China), are primarily recipients of venture capital financing, including corporate VC, rather than themselves deploying venture capital into other startups – this also explains the reduced magnitude of US and Chinese VC financing from the automotive leaders.

A clear and meaningful pattern emerges when examining where automotive CVC investors, organized by their headquarters' regions, are allocating capital to fund startups. The overwhelming majority of global automotive CVC flows to US-based startups, including investments by both EU and Japanese automotive leaders (**Figure 7**).[46] In contrast, CVC from leading Chinese and US automotive firms is invested predominantly domestically.

[44] European Commission (2025) Digital Decade in 2025: progress and outlook – Commission Staff Working Document, SWD(2025) 290 final.
[45] Gavigan J., Fákó P., Compañó R. (2024) Corporate Venture Capital in the Automotive Sector - JRC Working Papers on Corporate R&D and Innovation (CoRDI) No 02/2024
[46] Gavigan J., Fákó P., Compañó R. (2024), cit. The analysis is carried out considering those VC deals involving the top five R&D investing automotive companies by corporate HQ location for EU, US, China, Japan and ROW (rest of the world)

**Figure 7 - CVC investment flows between regions, EUR million**




**Source: Gavigan et al. (2024)**

These geographic dynamics reveal two critical insights:

- First, consistency across sectors. The CVC-to-VC ratio between the US and EU for automotive mirrors the broader pattern across all sectors. From 2010 to 2023, automotive companies invested 6.21 times more CVC capital in the US than in the EU- virtually identical to the 6.27x ratio for total VC investment across the two economies during the same period. This suggests the VC gap is not automotive-specific but structural, reflecting the EU's problematic functioning of equity financing.[47]
- Second, reinforcement of the mid-tech trap. EU and Japanese automotive firms' decision to invest their CVC predominantly outside their home regions, rather than in their own innovation ecosystems, risks deepening their domestic mid-tech trap. By channelling capital to US-based ventures rather than funding domestic high-tech startups, European automotive companies (i) further incentivise the systemic transfer of EU innovative start-up to US; and (ii) cause

[47] Ibidem.

a transfer abroad of those capitals that are specifically meant to reallocate resource from mid-tech to high-tech.

## 5. R&D, Patents and the Innovation Chain

The concentration of EU R&D investment in the automotive and other medium-technology industries, combined with the relatively lower effectiveness of this spending, has a compounding negative effect on innovation performance and widens the technological gap in productivity-enhancing technologies, particularly in digital domains.[48]

Beyond its impact on productivity, the contribution of R&D to innovation-based competitiveness is typically assessed by examining how efficiently private and public organisations transform R&D investments into viable "new ideas," notably patents.[49] Looking specifically at the percentage of ICT-related patents[50] (**figure 8**), it is evident how the EU, with 19.7% of its total IP5 patent families,[51] lags significantly behind other major economies, as well as the OECD average.

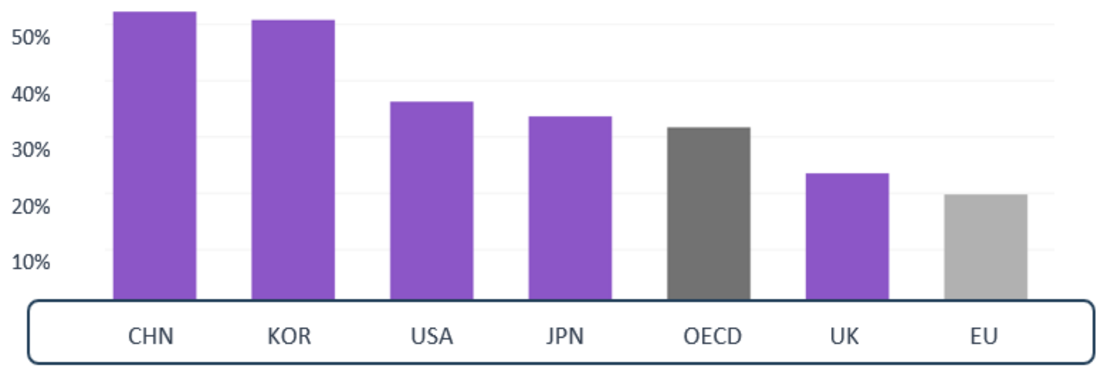
[48] European Commission (2024) Science, Research and Innovation Performance of the EU 2024. A competitive Europe for a sustainable future

[49] See, Nindl E., Napolitano L., Confraria H., Rentocchini F., Fako P., Gavinan J. and Tuebke, A. (2024), cit. Although patents, as well as labour productivity assessed in the previous section, is imperfect output indicators of R&D effectiveness (since not all ideas and inventions are patented) they aserve as useful proxies for the expected results of R&D investment. More broadly, patents are constantly used as one of the main indicators for "innovation intensity" both in academic reserach and policy reports. As mere exemples: OECD (2009) Patent Statistics Manual; Griliches, Z. (1990) Patent Statistics as Economic Indicators: A Survey, in Journal of Economic Literature, 28, 1661-1707; Acemoglu D., Akcigit U., Kerr W. (2016) Innovation Networks, NBER Working Paper 22783; Aghion, P., Bloom, N., Blundell, R., Griffith, R., Howitt, P. (2005) Competition and Innovation: An Inverted-U Relationship, in Quarterly Journal of Economics, 120(2), 701-728.

[50] ICT patents are identified using International Patent Classification (IPC) codes that encompass thirteen areas: (i) high-speed networks, (ii) mobile communication, (iii) security (e.g. encryption), (iv) sensors, (v) high speed computing, (vi) high capacity data storage, (vii) large capacity information analysis (e.g. big data analytics), (viii) Cognitive computing, (ix) Human interface technologies, (x) Imaging and sound technology, (xi) Information and communication processing technology, (xii) Electronic measuring (e.g. radio navigation), and (xiii) Others (e.g. hybrid computers).

[51] A patent family is a group of patent applications filed in multiple jurisdictions for the same invention, usually based on the priority date of the first filing. An IP5 patent family means the invention has been protected in all five major jurisdictions (EPO – European Patent Office; USPTO – United States Patent and Trademark Office; JPO – Japan Patent Office; KIPO – Korean Intellectual Property Office; CNIPA – China National Intellectual Property Administration). Filing in all IP5 offices is expensive and usually indicates high strategic and commercial value and thus reserved for technologies with large potential markets and long-term strategic importance.

**Figure 8 – ICT patents as a share of total IP5 patent families – 2020 data**




**Source: elaboration on OECD STI Micro-data Lab**

The EU's weaker performance in ICT patenting, consistent with the "mid-tech trap" narrative, may point to a broader and persistent weakness in innovation-driven competitiveness. Since ICT and digital technologies serve as multi-layered general-purpose technology (GPT), the EU's underperformance in ICT-related patenting is likely to have wider repercussions, affecting its position in advanced technologies and deep-tech domains.

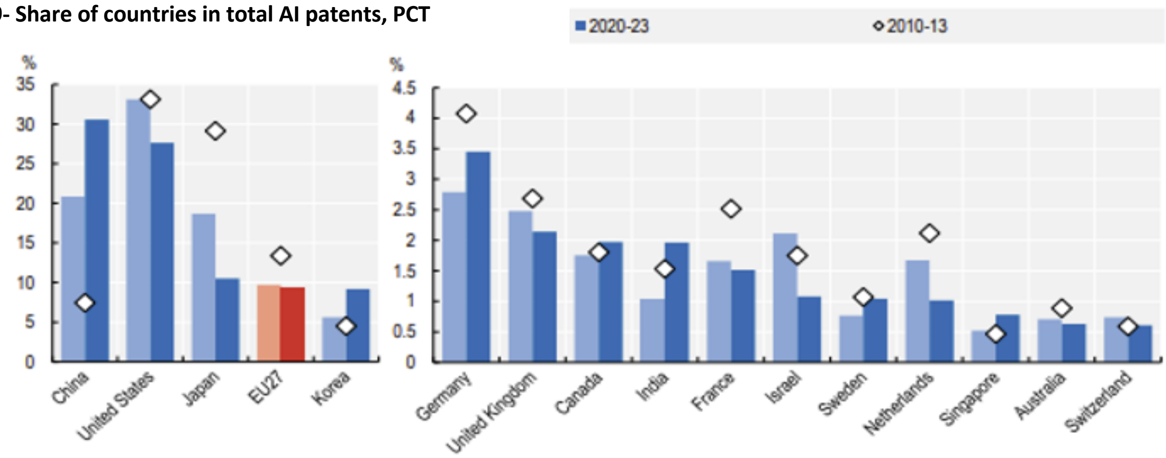
Indeed, also when examining artificial intelligence (AI), data on patent applications in AI-related technologies[52] reveal a pronounced geographical concentration of innovation, with the United States and China accounting for the overwhelming majority of filings. By contrast, both Japan and the European Union lag considerably behind[53] (**Figure 9**). Between 2020 and 2023, inventors from China and the United States accounted for almost 60% of all AI patents. China's share has risen sharply since the early 2010s, making it the global leader with 30.6% of total AI patents. By contrast, the United States had a small decline from 33% in 2010–13 to 27% in 2020–23. Japan's contribution fell significantly, from 29% in the early 2010s to 10.5% in the most recent

[52] Only filling under the Patent Cooperation Treaty (PCT) are considered, in order to eliminate jurisdictional misalignments. The Patent Cooperation Treaty (PCT), administered by the World Intellectual Property Organization (WIPO), is an international treaty that streamlines the process of seeking patent protection in multiple countries. Rather than filing separate national or regional patent applications, inventors and applicants can submit a single "international" application under the PCT, which is legally recognised by over 150 contracting states. This simplifies the initial procedural and administrative requirements for protecting an invention globally.

[53] OECD (2025) Identifying emerging AI technologies using patent data: a semi-automated approach – Technical Paper - September 2025; Filippucci F, Gal F, Jona-Lasinio C, Leandro A, Nicoletti G (2024) The impact of Artificial Intelligence on productivity, distribution and growth: Key mechanisms, initial evidence and policy challenges - OECD Artificial Intelligence Papers n 15

period. The EU27 experienced a decline of about four percentage points compared with 2010–13.

**Figure 9- Share of countries in total AI patents, PCT**




**Source: elaboration on OECD, STI Micro-data Lab**

This pattern highlights an expanding technological divide in AI innovation further reinforcing the impression that sustained ICT R&D investment is associated with a stronger ability to generate new frontier patents.

The results of this international benchmark on AI patents contrast sharply with another typical indicator of innovation - namely, the number of scientific publications related to AI. In this respect, the European Union demonstrates a strong research base, ranking second worldwide in AI-related scientific output, between China (leading) and the United States (third).[54]

This asymmetry indicates, as well recognised, that the innovation pipeline in the EU's digital and ICT sectors weakens in subsequent stages of development, since much of the knowledge generated by European researchers fails to translate into patents and/or remains commercially underexploited.[55] This is consistent with the EU relatively low 'R&D-to-patent' elasticity, indicating a weaker conversion of R&D investment into patentable inventions compared to firms in other global regions.[56]

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[54] European Commission (2024) Science, Research and Innovation Performance of the EU 2024. A competitive Europe for a sustainable future.
[55] Draghi (2024); Letta (2024).
[56] See, Nindl E., Napolitano L., Confraria H., Rentocchini F., Fako P., Gavinan J. and Tuebke, A. (2024), cit.

A key factor behind this dynamic is that high-tech R&D in Europe tends, on average, to be less integrated into "innovation clusters" able to enhance capacity to transform research first into patents and then into marketable outcomes as it happens in the US. Such clusters typically include large tech firms, networks of smaller innovators and start-ups, as well as universities and venture capital actors, which play a pivotal role in supporting commercialization and scaling.[57]

In partial contrast to this general trend, between 2000 and 2023, the EU ranked second worldwide in quantum patenting with around 16% of the total, behind the US (32%) but ahead of Japan (13%) and China (10%). This strong performance likely reflected the prioritisation and coordination at EU level of investments in quantum technologies - €7 billion of public money allocated so far, second only to China's public funding. However, private investment remains a critical weakness. In sharp contrast to the US and China, where corporate funding drives much of the momentum, none of the world's top ten technology companies by quantum investment are based in the EU: five are American and four are Chinese.

Another innovative yet consolidated industrial segment, where Europe has been traditionally leading, is advance connectivity, cellular and IoT technology. As stressed by both Draghi and Letta, this industrial segment is crucial for the EU due to a few reasons. Firstly, advanced connectivity is a foundational GPT and thus is one of the core drivers and multipliers for innovation and economic growth. Moreover, leadership in connectivity technologies and equipment matters not only in economic terms, but also under public interest and geopolitical viewpoints, as it is key for cyber-resilience and protection of citizens' data as well as strategic to Europe's collective security. Finally, EU-based technology firms, such as Nokia and Ericsson, are very well positioned in the innovation development and global supply of telecom equipment and devote a very high share of their revenue to R&D – around 19-21% R&D intensity, highlighting that cellular and IoT technology is one of the few high-tech sector where Europe has maintained a global competitive positioning. Each of these is crucial for innovation-based competitiveness as well as fundamental for securing Europe's competitive edge in such a crucial standard-based industry.[58]

[57] Draghi (2024); Letta (2024).

[58] "*Europe's competitiveness, technological sovereignty, ability to reduce dependencies and protection of EU values … will also depend on how successful European actors are in standardisation at the international level.*" See European Commission (2022) An EU Strategy on Standardisation – COM (2022) 31 final. Standards definition in the ICT sector is necessary to develop and take advantage of strong economies of scale and network effects. Nevertheless, ICT standardisation has become a core geopolitical lever and European leadership in global standard-setting has been one of the continent's few enduring advantages in digital technologies, particularly in mobile communications, although

This overall context underscores the need to maintain an intellectual property rights (IPR) framework that enables firms to invest in research and development and foster innovation in such a crucial sector. This is even more critical in the EU, because, as noted above, European innovators have a lower expected returns on R&D investments compared to US; and the EU financial system does not adequately support high-risk, long-term innovation projects.

## 6. The EU Policy (re)action: the EU Competitiveness Compass

Considering the current geopolitical context and the EU's economic and industrial position, the European Commission has recently designated competitiveness as a structural and strategic priority. In 2025 a European Commission's Communication[59] introduced a Competitiveness Compass (CC): a guiding framework for the future EU industrial policymaking to address the EU's persistent decline in productivity growth and its erosion of technological leadership in comparison with major global competitors such as the United States and China.

Several interlinked challenges are at the base of such a policy framework. First, Europe possesses strong assets, including a skilled workforce, a large single market, and a stable legal environment, yet it has remained constrained by long-standing structural barriers such as low levels of innovation commercialisation, fragmented markets, and high regulatory burdens.

At the same time, while the EU is confronted with intense global competition in innovation and industrial leadership from the United States and China, its position is further weakened by dependence on non-EU and highly concentrated parts of important supply chains, which leave it vulnerable to disruptions and geopolitical pressures.

Moreover, many of the key levers that shape competitiveness, such as taxation, labour policy, and industrial strategy, are still primarily in the hands of national governments. To match the scale and strength of other major global players, the CC aims to align EU and national policies.

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China has embraced a strategic state-led approach to broaden its influence. See, Mi-jin Kim, Doyoung Eom, and Heejin Lee (2023) The geopolitics of next generation mobile communication standardization: The case of open RAN, 47 Telecommunications Policy 102625; Faaborg-Andersen S., Lindsay Temes L. (2022) The Geopolitics of Digital Standards.

[59] European Commission (2025) A Competitiveness Compass for the EU - COM(2025) 30 final.

The CC identifies three transformative imperative pillars: (i) closing the innovation gap; (ii) a joint roadmap for decarbonisation and competitiveness, recognizing that decarbonisation policies can drive growth when well-integrated with industrial and economic policies; (iii) reducing strategic dependencies and increasing Security, addressing supply chain vulnerabilities, promoting trade diversification, and strengthening defence industrial capabilities.

Among the three pillars, the first one, i.e., closing the innovation gap, stands out as the main driver for achieving an innovation-led competitiveness, directly looking at economic growth, productivity, and the capacity to generate and scale cutting-edge technologies. Indeed, it aims at addressing Europe's productivity challenge through measures (ia) facilitating start-up creation and scaling, (ib) introducing a 28th legal regime for innovative companies,[60] (ic) enhancing venture capital markets, and (id) providing a targeted support for advanced technologies like AI, quantum computing, and biotechnology.

In addition, the Compass proposes five horizontal enablers to support competitiveness across all sectors: (i) simplification, aiming to reduce reporting burden by 25% for all companies and 35% for SMEs, as well as introducing comprehensive regulatory screening and modernization efforts; (ii) Single Market Integration, aiming to remove residual barriers and preventing fragmentation to maximise continental scale benefits; (iii) financing, by developing a Savings and Investments Union and refocusing the EU budget through a European Competitiveness Fund; (iv) skills and quality Jobs, by creating a Union of Skills addressing labour market transformation and skills gaps; and (v) policy coordination, by implementing a Competitiveness Coordination Tool to align EU and national industrial and research policies.

From a broader perspective, the horizontal enablers in the Competitiveness Compass are crucial for enhancing both the efficiency and the effectiveness of the EU's economic and political systems. By targeting overregulation, Single Market integration, financing, skills, and policy coordination, the CC aims to address the main structural weaknesses that have long constrained Europe's competitiveness. Yet, these

[60] In the EU policy context, the "28th regime" refers to a legal or regulatory framework offered at the EU level as an optional alternative to national laws, rather than replacing them. The term "28th" was coined back when the EU had 27 national regimes, so the EU framework was effectively the "28th option." Even after Brexit, the concept is still used metaphorically. Initially used in debates on the European Contract Law, European Company Statute, and EU-wide IP rights, etc. – the Letta report revived and reframed it for today's context. Letta argued for an EU-level optional legal framework (effectively a "28th regime") for sectors where fragmentation blocks competitiveness — especially in energy, capital markets, digital, and defence. In his framing, it's a tool for faster integration without waiting for unanimous harmonisation.

areas are marked by entrenched path dependencies and institutional inertia, which will make structural reform very difficult to achieve. It is nevertheless highly positive that the Compass not only recognises these systemic bottlenecks but also elevates them to core priorities alongside its three transformational imperatives.

The Compass incorporates key digital initiatives to advance in the pursuit of the Digital Decade objectives, namely: (i) the AI Factories Initiative and Apply AI Strategy support the Digital Decade's targets for AI adoption across enterprises; (ii) the EU Cloud and AI Development Act contributes to digital infrastructure development; (iii) Data Union Strategy facilitates the data sharing essential for digital transformation; (iv) Digital Networks Act addresses connectivity targets by improving market incentives for digital infrastructure investment. Also, the third pillar of CC, i.e., reducing strategic dependencies and increasing security, relates closely to the deployment of ICT and the development of digital ecosystems, as it confronts Europe's reliance on extra-EU technology companies and seeks to strengthen digital sovereignty.

## 7. Conclusions: key-findings and policy recommendations

This chapter has examined the European Union's innovation ecosystem and digital transformation through the lens of competitiveness, revealing a complex interplay between structural constraints and policy design shortcomings that continue to hinder EU innovation and productivity growth. To this end, it assessed the EU's performance on the principal drivers of innovation-led competitiveness and benchmarked these outcomes against those of the United States.

In pursuing this analysis, the paper addressed a crucial cross-cutting policy question: what are the principal causes of the EU's innovation gap, and to what extent are current EU policies contributing to close it?

This chapter highlights that EU competitiveness deficit stems not only from the lower quantity of R&D investment, but more importantly from its limited capacity to translate research and innovation into productivity-enhancing outcomes. Large-scale investments are likely to yield more substantial productivity gains, which is calling for consolidating the fragmented nature of both public and private R&D funding and industrial policies. In addition, the weaker performance in ICT patenting may underscore a broader perspective weakness in innovation-driven competitiveness, which should be addressed by maintaining an effective and balanced IPR framework system that incentivise innovation and support competitiveness. While the Competitiveness Compass offers a broad and ambitious policy agenda, for the moment it still falls short of adequately addressing the chronic failure to convert R&D efforts into measurable productivity gains.

Drawing on the key findings and the overall analysis, the following policy recommendations are proposed:

**i) Rebalance public R&D funding toward high-impact innovation in high-tech sectors**

To address current funding patterns that disproportionately benefit established, medium-technology sectors, the EU should (i) reallocate public R&D subsidies toward mission-oriented innovation in high-tech sectors, and (ii) strengthen coordination of R&D efforts among member states, concentrating funding to support breakthrough innovation with greater systemic and cross-sectoral impact.

**ii) Foster cross-sectoral financing partnerships for market-oriented high-tech R&D**

Facilitate structured partnerships between EU mid-tech and EU high-/deep-tech firms to develop joint financing vehicles, such as corporate venture funds or co-investment platforms, dedicated to market-oriented R&D in Europe.

**iii) Maintain a balanced intellectual property rights (IPR) framework to foster innovation-driven competitiveness:**

Maintain a balanced intellectual property framework able to support EU innovation, especially in sectors with high R&D intensity and where R&D is inherently market-oriented. Given the peculiar characteristics of EU innovation ecosystem and critical role of licensing revenues in financing European innovation , the EU should preserve IP protection, while promoting industry-based solutions to encourage involvement, upstream and downstream, of EU innovative SMEs in order to further stimulate incremental improvements and differentiation in the innovation ecosystem.

**iv) Enhance the productivity yield of R&D through stronger innovation–deployment alignment**

To increase the effectiveness and productivity impact of R&D investment, the EU should ensure that R&D support is tied to downstream adoption incentives, including demand-pull levers like tax credits. Moreover, it should foster cohesive innovation ecosystems, by promoting partnership among large market actors (upstream and downstream), start-ups, public research institutions, universities, and financing entities.

Finally, it is important to acknowledge that, although this paper does not directly engage with **the implementation of the Single Market**, the effective integration and consolidation of a unified EU Single Market - comprising 440 million consumers and 23 million companies – emerges as a fundamental structural condition for enabling all core drivers of innovation-based competitiveness.

The Single Market is pivotal for multiple dimensions of competitiveness, e.g., enhancing frontier innovation capacity, also through EU-level coordination of public R&D spending; allowing the scaling-up of young, innovative companies and large industries capable of competing globally; mobilising greater volumes of private finance; fostering broader technology adoption across sectors; stimulating intangible investment to unlock productivity potential of ICT investments; and strengthening domestic demand and overall investment.

Accordingly, the answers to the cross-cutting policy questions, as well as the recommendation in the next section, are premised on the progressive implementation of the Single Market reform agendas proposed in Letta and Draghi policy paper, which are fundamental for building a sustained innovation-driven competitiveness in the EU.

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