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EU INNOVATION POLICY

HOW TO ESCAPE THE MIDDLE TECHNOLOGY TRAP

A Report by the European Policy Analysis Group

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ABSTRACT

The EU is losing the global innovation race. EU industry invests less than its peers in R&D, it lags way behind in software and artificial intelligence, and its pharmaceutical component is at risk. For over 20 years the same companies, mostly from the automotive sector, have dominated EU innovation activity. We call this the middle technology trap.

Existing EU programmes to foster innovation, including those under the heading of the European Innovation Council (EIC), are far from the gold standard – the US Advanced Research Projects Agency (ARPA) model. Their decision processes are still very political, they impose collaboration instead of accompanying them, they devote too much of their limited resources to venture capital investment rather than to supporting breakthrough innovation, and the few project managers are over-stretched.

We propose an ARPA-style model of governance and a budget-neutral shift of resources to support high-risk, high-return projects that are far from commercial application. Project selection and management should be improved by increasing the scientific and engineering excellence of the EIC Board and by delegating more to scientists. The current venture capital activities should be outsourced to a specialised fund.

ACKNOWLEDGEMENTS

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RECOMMENDED CITATION

Through its missions and governance, Horizon Europe does not meet the innovation challenge and anchors our industry in the mid-tech range. This report argues that current European efforts, while laudable, are insufficient, in both quantity and quality. Important reforms are required to enable Europe to compete in the value-creating space.

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EXECUTIVE SUMMARY

Encouraging innovation has long been a priority for European policymakers, with the implicit aim of reaching the technology frontier represented by the US. This goal has not been achieved. The Innovation Scoreboards regularly published by the European Commission have consistently found that the EU lags behind the US on many indicators. The most recent Scoreboard indicates that the transatlantic gap has widened.

This report argues that current European efforts, while laudable, are insufficient, in both quantity and quality. Important reforms are required to enable Europe to compete in the value-creating space.

The disappointing European performance might surprise the reader, given that government support for research and development (R&D) has grown gradually over the last two decades and is now at about the same level as in the US (around 0.7% of GDP). It is in the private sector where one finds a large quantitative difference between the US and EU. Business expenditure on R&D (BERD) in the EU, at 1.2% of GDP, represents about half that of the US (2.3% of GDP).

Moreover, European business R&D is concentrated in mid-tech sectors, like the automotive industry. These sectors compete by applying the latest technological advances to production, but they do not require the same R&D intensity or offer the same growth potential as high-tech industries that produce the newest technologies. The main reason for US private R&D being twice that of Europe is therefore the much higher weight of high-tech industries in the US.

European specialisation in mid-tech, the 'middle technology trap', has persisted for two decades. The largest EU companies in terms of R&D expenditures are almost invariably car producers, whereas in the US car producers, which were important 20 years ago, have been supplanted by software companies. The EU's comparative advantage in cars is worrisome, as despite its massive investment in R&D, the EU automotive industry now risks being leapfrogged by US producers and increasingly by Chinese ones. Foreign producers can build on their leadership in electric and autonomous-driving technologies.

Today, the transatlantic gap is particularly wide in software development, where US companies account for 75% of the global total, compared with 6% for the EU (less than China). A large portion of the growth in US corporate R&D spending over the last decade has come from software-related companies, underpinning US dominance in the latest advances in artificial intelligence (AI). The quasi-monopoly position of US high-tech sector also applies to next generation of upcoming software (most cutting edge LLMs are US) and hardware (see Nvidia for semi-conductors etc). And China is rapidly catching up in terms of high-tech R&D spending.

A shift in the direction of EU innovation towards high-tech industries thus appears highly desirable. Escaping the middle technology trap would foster growth and increase the geopolitical weight of the EU. But to achieve this, governance must match ambitions. Simply put, the EU does not have the institutions it takes to meet the 21st century innovation challenge.

Most (90%) of the public-sector support for R&D in the EU originates at the national level. The EU contributes through the Horizon Europe[1] programme, which earmarks about €11-12 billion per year to support broadly-defined innovation, research and development.

However, less than 5% of Horizon Europe supports breakthrough innovation, which has the potential to create new markets but is remote from commercial applications. Distinguishing between types of R&D is important (yet overlooked), as projects aimed at bringing known technologies closer to the market cannot be expected to deliver disruptive innovation.

The recent creation of the European Innovation Council (EIC) was a positive step towards redirecting R&D efforts, but it is hampered by several limitations. First, is too dependent on the European Commission. Second, it only marginally targets breakthrough research, which is still substantially underfunded.

The EIC seems more focused on remedying perceived capital market imperfections than on promoting innovation, as a substantial share of its spending supports the capital structure of small to medium-sized enterprises (SMEs) and, to a more limited extent, startups. Moreover, serious governance issues may undermine its mission of boosting breakthrough innovation: the EIC is mostly led by EU officials rather than top scientists; some eligibility criteria impose severe constraints, rendering the selection mechanisms highly bureaucratic; collaborations are mandated rather than accompanied; and the disbursement of funding is slow.

Institutional change is thus needed to boost the development of EU high-tech industries.
Specifically, we propose:

(i) giving leading scientists a more central role on the EIC Board and in selecting projects;

(ii) shifting decision-making power from the European Commission to a larger number of independent project managers; and

(iii) drawing resources from underperforming programmes of Horizon Europe and other parts of the EU innovation ecosystem to expand the size and scope of programmes actually devoted to breakthrough research, without changing the existing Multiannual Financial Framework.

Our budget-neutral, yet radical reform of the EIC could give the EU an innovation engine along the lines of the US ARPAs (advanced research project agencies). ARPAs have been widely credited with supporting advances in several breakthrough technologies and the development of the American biotechnology, software and hardware industries. A flourishing innovation ecosystem would create the right incentives, attract private investment and stimulate the growth of high-tech industries, helping the EU to escape its middle technology trap.

1 Horizon Europe is the name of the 9th Framework Programme for Research and Technological Development (2021-2027).

I.

INNOVATION SPENDING COMPARED:

DOES THE EU HAVE AN INNOVATION PROBLEM?

European leaders certainly think so. Expenditure on R&D of 3% of GDP has been an official goal of the EU since the launch the Lisbon Strategy in 2000. However, gross domestic expenditure on R&D in the EU is still roughly 2% of GDP, lower than in other major economies such as the US, Japan and China.

The reason why the EU lags behind other regions is *not* that governments (national and EU) spend less on R&D than its rivals. In 2020, government-funded R&D amounted to €110 billion in the EU (mostly by national governments[2]) and €150 billion in the US, accounting for a very similar percentage of GDP, around 0.7%.[3] In the other regions of the world, government R&D spending is somewhat lower at 0.5% of GDP.

The key reason for the overall transatlantic difference is the lower engagement in R&D by the business sector, whose spending amounts to only 1.2% of GDP in the EU, versus 2.3% of GDP in the US.

These oft-cited OECD figures, however, do not allow us to decompose them among the different sectors. To analyse in more detail the sectoral composition of R&D, we use data from the EU Industrial R&D Scoreboard, which are based on the accounts of the 2,500 largest companies in the world in terms of R&D spending.[4] A cross-check with the OECD data shows that these 2,500 companies account for 80 to 90% of the R&D spending in the regions we analyse, making our data representative of the actual total R&D spending.

2 National funding is very concentrated, with Germany alone accounting for over 40% and France for almost 20% of the EU (and national) total. It is sometimes argued that a selection of projects based on merit alone could favour the richer Member States. But this is not the case. *Appendix Figure 11* shows that across EU countries there is very little correlation between income per capita and EU research funding as a percentage of GDP.

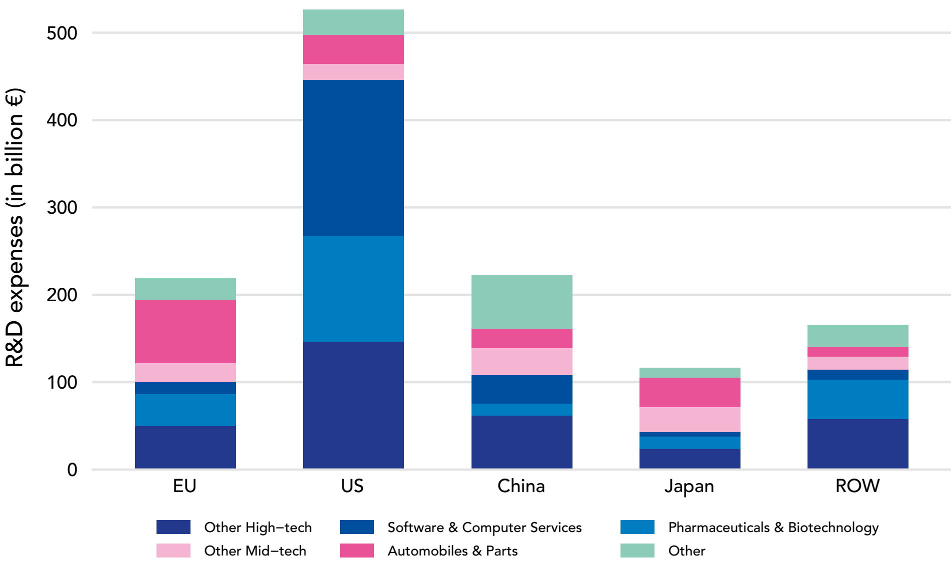
3 There are no substantial differences in government tax support for BERD either, since the EU spends 0.1% of GDP, while the US spends 0.12%. See the OECD data here.

4 The data are taken from the EU Industrial R&D Scoreboard: https://iri.jrc.ec.europa.eu/scoreboard/2022-eu-industrial-rd-investment-scoreboard. Representativeness should not be compromised, as global R&D is concentrated among the world's top R&D investors. Other sources provide scant data on R&D spending by industrial sectors. The OECD provides some, but the classification varies and some EU member countries are either absent or have missing data for key industries/years.

THE MIDDLE TECHNOLOGY TRAP

Figure 1 shows the sectoral composition of business R&D spending (BERD) in nominal terms for businesses headquartered in the four regions, plus a residual, the rest of the world (ROW). In the US, high-tech industries – mostly *software & computer services* and *pharmaceuticals & biotechnology* – account for 85% of BERD. In the EU, by contrast, mid-tech industries – especially *automobiles & parts* – account for roughly 50% of BERD, a much higher share for mid-tech industries than in the US.[5] The sectoral composition of corporate R&D spending by EU-headquartered firms is more similar to that of Japan and China than the US.

Figure 1.
BERD by technology level 2022 (Top 2,500 companies)



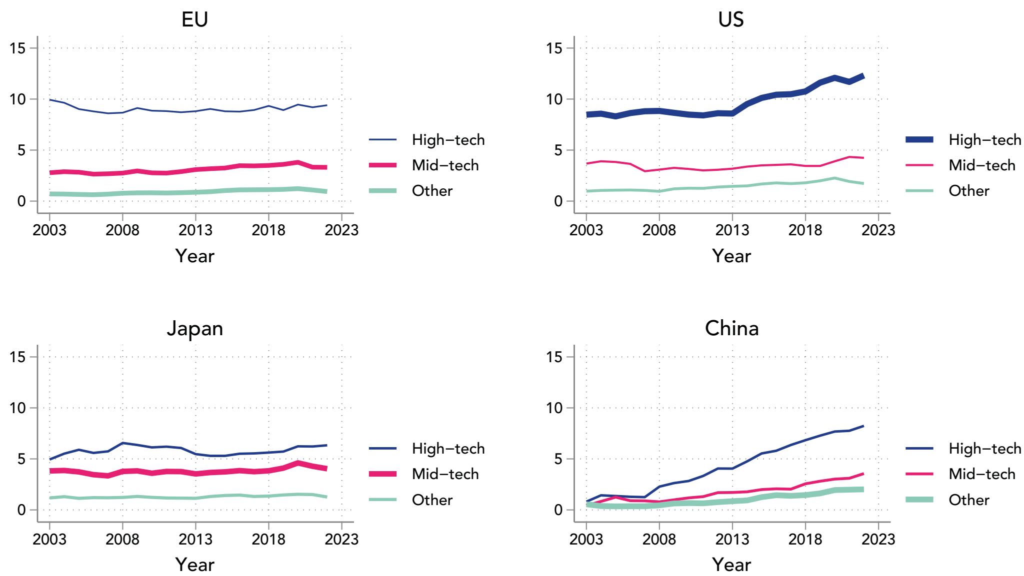
Source: Industrial R&D Investment Scoreboard (2023).

5 For the purpose of this exercise, we have used three broad categories – high- and mid-tech plus the remainder, 'other', mostly including services and utilities. Our classification is similar to that adopted by Eurostat and the OECD. ***High-tech*** includes aerospace & defence, alternative energy, electronic & electrical equipment, health care equipment & services, pharmaceuticals & biotechnology, software & computer services, and technology hardware & equipment. ***Mid-tech*** includes automobiles & parts, chemicals, financial services, fixed line telecommunications, industrial engineering, industrial metals & mining, industrial transportation, leisure goods, mobile telecommunications, and personal goods. ***Other*** includes banks, beverages, construction & materials, electricity, food & drug retailers, food producers, forestry & paper, gas, water & multiutilities, general industrials, general retailers, household goods & home construction, life insurance, media, mining, nonlife insurance, oil & gas producers, oil equipment, services & distribution, real estate investment & services, support services, tobacco, and travel & leisure.

Not surprisingly, high-tech industries are much more R&D-intensive than mid-tech industries, as shown in *Figure 2*. Therefore, the larger share of high-tech industries in the US contributes to explaining why BERD is so much higher than in other economies. What is more, evidence suggests that public-sector support is more likely to crowd out business R&D in low R&D-intensity industries (e.g. Marino et al., 2016; Szücs, 2020), which might explain the low business-sector multiplier in the EU relative to the US.[6,7]

Figure 2 shows that US and EU R&D intensity within high- and mid-tech industries was similar until 2013. This implies that up to that point most of the difference in aggregate BERD was driven by differences in the sectoral *composition*. After 2013, however, the R&D intensity of US high-tech industries (and of others) began an upward trend. In China, the R&D intensity increased even more: starting from close to zero, it has now reached the EU level.[8]

Figure 2.
R&D intensity by technology level (% of sales)



Note: Sector lines weighted by share of total net sales. Sector R&D Intensity is the ratio of R&D expenditures within a sector to the total net sales.

Source: Industrial R&D Investment Scoreboard.

6 One reason might be that R&D-intensive industries need resources far exceeding the typical amounts of a grant.

7 In the EU, €1 of public-sector spending is associated with €2 spent by the private sector. In the US, the private-sector multiplier is equal to 3.

8 This is not due to a reallocation across sectors within high-tech industries. More broadly, we observe very similar trends if we focus on the main sectors separately.

We decompose the difference in R&D intensity between the US and EU and find that in 2022, 60% of it was due to differences in composition – the R&D-intensive high-tech industry is larger in the US – and the remaining 40% to a generally higher R&D intensity in the US across all industries.[9] Before 2013, the composition effect explained more than 90% of the disparity in average R&D intensity between the US and EU.

Clearly, specialising in mid-tech industries limits growth opportunities. While there are examples of successful high-tech industries in the EU (see *Box I* for aerospace and defence), the status quo is problematic because mid-tech industries have only limited potential for sustained growth. We document that sales and profits tend to grow faster in high-tech industries, as *Appendix Figure 14* and *Figure 15* show, respectively.

BOX I
The EU aerospace & defence industry

This industry represents one of the few sectors where EU companies spend almost as much on R&D as those in the US (€8.7 billion versus €9.4 billion). The main difference is the size of the market, as can be seen from net sales of €260 billion for the US and €140 billion for the EU: defence spending is much higher in the US and most of this spending naturally benefits US companies.

The near equality in R&D efforts (in terms of capital expenditure, the figures would be similar) suggests that EU industry should be competitive in the open market. That is, EU firms should be able to satisfy a large share of the increases in defence expenditure that are required immediately to support Ukraine and also those in the medium and longer term, as Member States ramp up defence expenditure.

The European Defence Industrial Strategy can therefore count on a strong industrial base. The problem here pertains much more to market fragmentation within the EU and the limited role of joint procurement.

The recently-created European Defence Fund should at least partially address these long-standing problems. But its main focus will be technologies close to commercial application, which carries the risk that it might substitute, rather than complement, existing industrial R&D.

At least some of its budget could be devoted to bold transformative projects, like the Defense Advanced Research Projects Agency (DARPA) in the US.

9 Specifically, we apply a decomposition of the R&D intensity (RDI) gap between US and EU using a standard shift-share formula:

$$RDI_{US} - RDI_{EU} = \sum_i RDI_{EU,i}(S_{US,i} - S_{EU,i}) + \sum_i S_{US,i}(RDI_{US,i} - RDI_{EU,i}) \quad (1)$$

Where *i* indexes high-, mid-tech and other industries, and *S* denotes the respective shares in both regions.

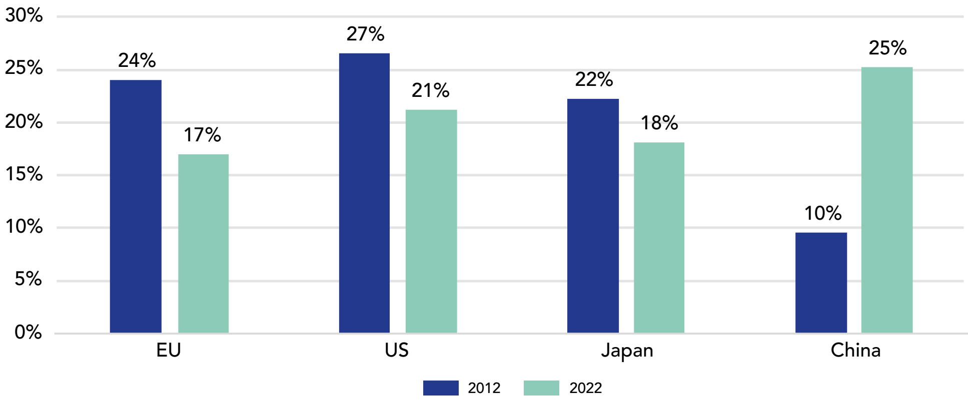
PATENTS AS A MEASURE OF INNOVATION OUTPUT

R&D spending is an important indicator of public- and private-sector innovation *efforts*. Another key measure of innovation *output* is patent activity. Although what matters is the most important (usually often-cited) patents, the sheer quantity of patents and its composition tell us an interesting story.

In 2022, around 270,000 Patent Cooperation Treaty (PCT) applications were filed with the World Intellectual Property Organization (WIPO) from all over the globe. Four regions, the EU, US, Japan and China, dominate patent activity with a combined total of 220,000 filings. *Figure 3* shows the shares of all patents filed in the various regions under the PCT.[10]

This figure shows that in the same year, the EU accounted for 17% of all applications, down from 24% in 2012. A similar decline is observed for the US, which accounted for 27% in 2012 and 21% in 2022.

Figure 3.
International patents applications (PCT) (% of global applications)



Source: WIPO.

China's share, by contrast, soared from 10% in 2012 to 25% in 2022. Still, a number of sources suggest that this increase is the result of domestic subsidies exceeding the cost of filing a patent (see *Box II*). For this reason, the figures for China need to be taken with caution. Since it is not possible to disentangle the real from subsidy-induced Chinese patent activity, we concentrate on data for the EU, US and Japan.

10 If the patent is accepted in the 'international phase', applicants can (but do not have to) simultaneously seek patent protection for their invention in 'national phases' in a large number of countries, so that it de facto becomes an 'international' patent. Further information can be found at https://www.wipo.int/portal/en/index.html. See also the statistical database of the WIPO: https://www3.wipo.int/ipstats/pmh-search/pct.

BOX II

Subsidies for patents and trademarks in China

China appears to lead in many patent statistics, at least in terms of the sheer number of patents granted. Yet, the Chinese numbers are most probably inflated by government subsidies.

A recent report (USPTO, 2021) discusses a number of measures introduced by the Chinese government since 2008, including patent subsidies, government mandates, bad-faith trademark applications and defensive countermeasures, which together have contributed to inflating the number of patent filings in the region. In particular, the report provides examples of subsidies that exceed the cost of registering a trademark, therefore leading Chinese economic actors to pursue a trademark application even without any intention to use it commercially.

Along similar lines, Beebe and Fromer (2020) present empirical evidence that in 2017, almost 70% of the patents registered at the USPTO originating from China included fraudulent specimens, and that a substantial fraction of these ended up being published.

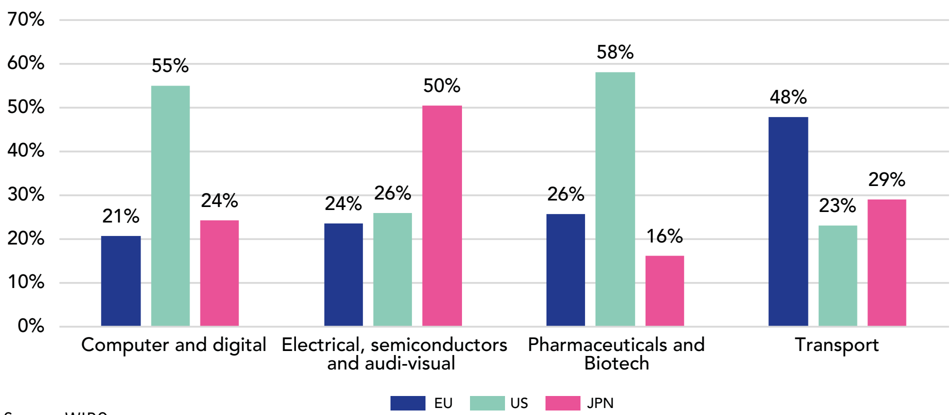
Thus, non-market factors can explain why, despite the inflation of Chinese patents over the period of analysis, few Chinese inventors file for patent protection overseas. They also explain the low commercialisation rate of patented Chinese inventions.

All this does not imply that China is making little progress in science and technology, but that one has to look more closely at the quality than the quantity of output.

Thus, in terms of aggregate innovation output and with the previous caveat that we look at patent quantity rather than quality, the EU does not appear to have a significant innovation problem. All the same, a closer look at the specific technologies being patented reveals a different picture.

Figure 4 shows that each region tends to specialise in a different technological field. We consider four broad technological domains: ICT (computer and digital); electronics (electric, semiconductor and audio-visual); pharmaceutical and biotech; and transport-related technologies, which together accounted for roughly 20% of global applications in 2022.

Figure 4.
PCT applications by technology class (% of applications in all regions, 2022)



Source: WIPO.

The US accounts for more than half of the patents filed across these regions in two sectors: ICT, and pharmaceuticals and biotech. Japan leads in electronics. Thus, the EU lags behind other major economies in patenting in these key high-tech fields.

Instead, the EU dominates in patents filed for mobility technologies, accounting for almost 50% of the total. Thus, the evidence on patents echoes the evidence of the previous section about the specialisation of EU R&D activity.

Furthermore, the specialisation of the EU in mobility-related technology has increased over time. EU patent filings in the other three industries considered have stagnated over the last 10 years. By contrast, US patent filings in ICT and pharma have continued to grow strongly over this period (see *Appendix Figure 12*).

The EU seems stuck in a middle technology trap not only in terms of innovation efforts, but also in terms of innovation output, as measured by patent counts.

PATH DEPENDENCY

How can one interpret such a large difference (in level and trend) in industry composition of R&D efforts and patents between the EU and US?

Prospective profit margins are usually a key driver of R&D investment. One possible explanation for the strong R&D effort by automotive producers in Europe could be that their profit margin is high, thus justifying the strategic orientation of EU producers. But this does not seem to be the case. *Appendix Figure 16* shows that in all regions, mid-tech industries tended to deliver lower profit margins than high-tech ones. On average, between 2020 and 2022, the profit margin was 5.5 percentage points lower in the EU than in the US.[11] However, the transatlantic difference in profit margins was even larger for high-tech industries (6 percentage points) than for mid-tech ones (less than 2 percentage points).

The incentive to transition between sectors should not be measured by the transatlantic gap, but by the difference in profitability within each region. This incentive was much lower in Europe, where the profit margin of high-tech industries was only about 3 percentage points higher than mid-tech ones, whereas in the US the difference between high-tech and mid-tech industries was about 7 percentage points.

It is possible that the higher profit margins of high-tech firms at least partially reflect the near-monopoly position of US software giants in their respective markets. But this does not alter the fact that the availability of higher profit margins for US firms presented a strong incentive to invest in these industries. R&D-intensive industries can be considered natural oligopolies, in which a few market leaders emerge, sustained by the dynamics of large market shares fuelling R&D, which in turn sustain large market shares in a virtuous cycle leading to dominant positions.[12] In these industries, sales and R&D expenditures follow a similar pattern (Sutton, 2007).

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11 If one removes the software industry, the difference goes to around 4 percentage points. Thus, it is not exclusively the software industry that drives the higher profitability.

12 We wish to thank Michele Polo for pointing this out.

The evolution of profits in our data reflects these patterns of natural oligopoly formation. In 2003 (the first year for which data are available), profits for US high-tech firms were already 3 times larger than for their mid-tech counterparts. By 2022, US high-tech firms made 6 times more profits. By contrast, in 2003 the profits of EU high-tech firms amounted to only a quarter of mid-tech ones and by 2022, this ratio had only marginally increased. Looking at sales likewise reveals stark differences.

Table 1 shows the top-3 R&D spenders and their industries over time as a further illustration of the diverging development of industries. It gives the top-3 companies in terms of R&D spending and their respective industries over a recent 20-year period in the US, EU and Japan.[13] In the US, Microsoft is the only company appearing more than once among the top-3 R&D spenders. Meanwhile, in the EU and Japan, Volkswagen (VW), Mercedes and Toyota remain in the top-3 over the 20 years, while Panasonic, Bosch and Honda appear at least twice.

Interestingly, in the US two of the three top R&D spenders in 2003 were also in the automotive industry, but this changed over time. The software industry became increasingly important over the years; by 2022, all top-3 spenders produced software. In the EU and Japan, the auto industry tended to dominate throughout the 20-year period. These patterns are consistent with the literature on path dependence in innovation and industrial specialisation (e.g. Acemoglu, 2023; Aghion et al., 2021; Aghion et al., 2016).[14,15]

Table 1.
Top-3 R&D spenders and their industries compared over time

	2003	2012	2022
US	Ford (auto) Pfizer (pharma) GM (auto)	Microsoft (software) Intel (hardware) Merck (pharma)	Alphabet (software) Meta (software) Microsoft (software)
EU	Mercedes-Benz (auto) Siemens (electronics) VW (auto)	VW (auto) Mercedes-Benz (auto) Bosch (auto)	VW (auto) Mercedes-Benz (auto) Bosch (auto)
JPN	Toyota (auto) Panasonic (electronics) Sony (electronics)	Toyota (auto) Honda (auto) Panasonic (electronics)	Toyota (auto) Honda (auto) NTT (telecom)

Source: Industrial R&D Investment Scoreboard (2004, 2013 and 2023).

13 We do not include China because some companies there have changed their reference industry over the years.

14 Typically, in these models increasing returns to scale resulted in past advances in a given sector technology facilitating further advances in the same sector.

15 These patterns are also consistent with evidence of declining business dynamism around the world (e.g. Akcigit, 2024; Biondi et al., 2023; Decker et al., 2020), but analysing that aspect goes beyond the purpose of this study.

The initial advantage of the US in high-tech was magnified over time, whereas EU (and Japanese) industries remained in their specialisation pattern. Breaking this path dependency might justify public-sector intervention to provide the seeds for an alternative model of specialisation.

Appendix Figure 17 shows how global R&D shares in the automotive and software sectors have evolved over the years. US companies have always dominated in software and accounted for about three-quarters of worldwide BERD in that category in 2022, while the EU is almost absent. The EU has long had a strong position in automobiles. Unsurprisingly, Japan, its biggest competitor in the sector so far, is also a major R&D spender in this area. Thus, the EU has much less of a stronghold in the automotive industry than the US has in software.

Recent developments furthermore show that the large weight of the automotive sector exposes it to vulnerabilities, such as the risk of being leapfrogged by vehicles from the US and China. This illustrates the broader danger for the EU of being locked in a middle technology trap, where the current policy programmes are focused on incremental improvements of mature technologies, rather than on industries with greater potential for radical innovation. The purpose of EU innovation policy should be to provide the initial impetus for the growth of new sectors and to support the key role of *new firms* in developing EU high-tech industries.

BOX III
Does the EU have an investment problem?

Over the last decade there have been several EU initiatives to encourage (private) investment, the low level of which is perceived to be a key obstacle to growth. For example, increasing investment is the purpose of the InvestEU programme and its predecessor, the Juncker Plan. However, the total capital expenditure (capex) of the top-2,500 companies in the Scoreboard is similar in the EU and US, as shown in *Appendix Figure 13*. Actually, the overall investment-to-GDP ratio is at 23%, slightly higher in the EU than in the US (21%).

Once again, what is different is the composition of investment, with the share of high-tech industries being much greater in the US than in Europe. Importantly, in 2022 the US software sector spent €104 billion on capex, mostly on the computing power essential for the AI revolution, while EU companies spent only €1 billion. Such a 1-to-100 ratio will make it very difficult for EU companies to catch up, or even to carve out significant niches in the market for generative AI, which requires huge computing power to train large foundational models.

Aghion et al. (2024) propose a number of policies to support the development of AI in France and Europe. But the scale of US companies' spending is so large that even generous government support is unlikely to provide EU companies with the required computing power.

II.

CAN THE EUROPEAN INNOVATION COUNCIL HELP EUROPE ESCAPE THE MID-TECH TRAP?

The flagship EU programme for research and innovation is Horizon Europe, with a budget of about €11 billion per annum. Later, in Section 3, we discuss in detail the composition of Horizon Europe.

In this section, we focus on the part of Horizon Europe that is explicitly devoted to breakthrough innovation: the European Innovation Council (EIC), which has a budget of only about €1.4 billion per annum.[16]

THE ARPA MODEL

The creation of the EIC was officially inspired by the US Advanced Research Projects Agency – or 'ARPA model' of innovation. There are several ARPA-style programmes in the US, each associated with a respective government agency. Examples include the Defense Advanced Research Projects Agency (DARPA) associated with the Department of Defense, ARPA-E with the Department of Energy and ARPA-H with the Department of Health.[17] Below we refer to ARPAs as the set of agencies conforming to the ARPA model.

A key characteristic of ARPAs is their mission-oriented approach to innovation.[18] The EIC devotes roughly half of its budget to predefined thematic calls, or 'missions'. Some of the literature suggests that mission-oriented R&D funding can be an effective tool to crowd in private R&D (Pallante et al., 2021). On the other hand, predefined thematic calls might prevent promising projects in other fields from being financed; relatedly, they might also reflect the preferences of the European Commission rather than the best technological prospects.

Similar to ARPAs, the details of EIC calls are set by *programme managers* in line with the overarching objectives of the European Commission. Programme managers refine the broad goals set in the work programme and include them in thematic portfolios.

Still, despite efforts to emulate the salient features of the ARPA model, the EU approach falls short in several respects.

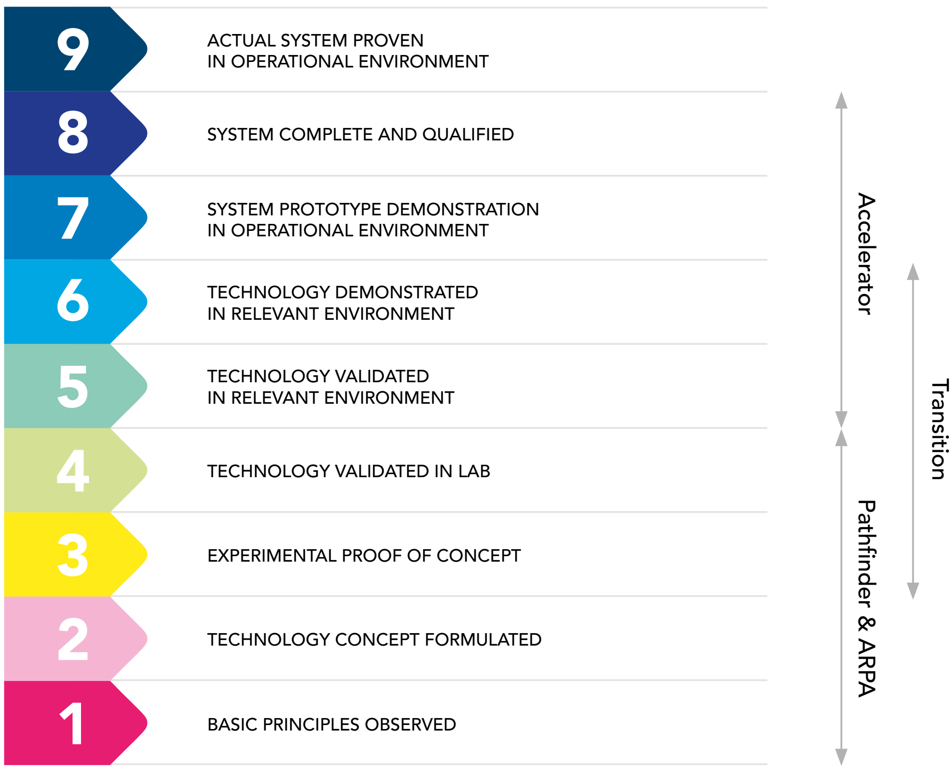
16 While referred to as the 'Council', in reality no such council exists. The EIC underwent a pilot phase between 2018 and 2020, and became fully operational only in 2021. See https://eic.ec.europa.eu/about-european-innovation-council_en.

17 There are other ARPAs, such as ARPA-I, related to the Department of Transportation, and IARPA, an arm of the Office of the Director of National Intelligence.

18 Mission-oriented policies refer to a set of public-sector interventions aimed not only at promoting innovation but also at directing technical change towards the achievement of well-defined technological or societal goals (Mazzucato, 2018).

One key aspect, the type of projects financed by the EIC, can best be explained using a technology readiness level (TRL) indicator, described in *Figure 5*. ARPAs typically focus on developing 'proof-of-concept' (Azoulay et al., 2019) or projects up to TRLs 3-4 at most. Once projects reach a sufficient maturity, usually taken to be the demonstration stage (TRL 5 or above), they 'graduate' and leave ARPAs with the expectation that private capital will flow and scale them up. Instead, the EIC focuses on projects with TRLs above 5.[19]

Figure 5.
Technology Readiness Levels (TRL)



Sources: authors' representation based on official sources.

19 Public support for projects whose TRL is below 5 can also be found at the national Level. For instance, in both France and Germany there exist several programmes/agencies aimed at supporting innovations that are still far from commercial applications, i.e. low TRL projects (examples include in France the CEA, CNES and France 2030, in Germany the recently created Federal Agency for Disruptive Innovation, Sprin-D). As our focus is on the efforts at the EU level, we did not investigate how these national efforts could be better coordinated among themselves and with the EU level.

Azoulay et al. (2019) position ARPA-funded projects on the initial flat part of the innovation *S-curve*, relating research effort and technical progress (Foster, 1986).[20] On the initial part of the curve, a high degree of effort results in very limited performance gains, and delayed payoffs limit incentives to pursue the project. This is where public-sector support is most needed, because it addresses a clear market failure (see *Box IV*).

By comparison, projects with higher TRLs correspond to the final, flat part of the S-curve and so are closer to their maturity. Uncertainty about the commercial viability of the product or process involved is considerably lower. In this part of the curve, subsidies can only be justified to address capital market imperfections.

BOX IV
Prerequisites for an effective industrial policy

1. Identification of the market failure so as to design the proper policy;
2. Use of independent high-level experts to select projects and recipients of public-sector funds;
3. Attention to the supply side (talent and infrastructure) and not just to the demand side (will there be the talented people who are going to make this happen?);
4. Adoption of a competitively neutral policy;
5. A humble approach of not prejudging the solution, but instead setting objectives (as illustrated by the Covid-19 vaccines: the vaccines could be based on several approaches, including the innovative but relatively untested mRNA technology);
6. Ex-post evaluation and dissemination of policy effectiveness, and the inclusion of a 'sunset clause' in the programme, forcing its closure in the event of a negative assessment;
7. Involvement of the private sector in risk taking, so as to avoid white elephants;
8. A process that is as expedient and hassle-free as possible.

For more detail, see chapter 13 of Tirole (2017).

20 The metric of technological progress depends on the technology considered, such as kilowatt-hour of electricity generated, or computational speed.

GOVERNANCE OF EU INNOVATION POLICY (EIC)

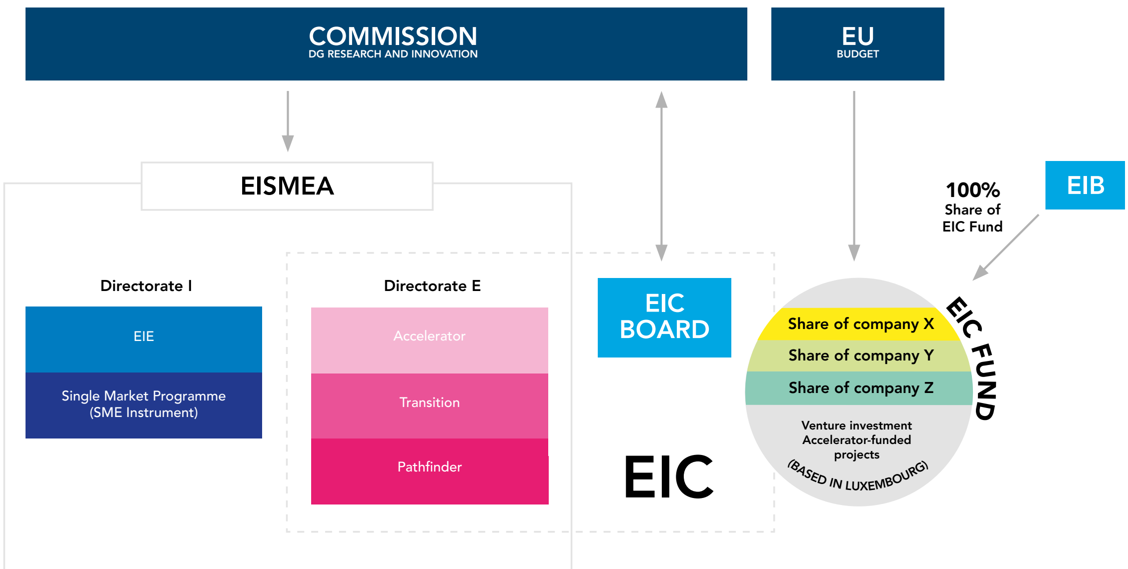
The EIC is not a self-standing body. The EIC's core bodies are managed by an EU agency – the European Innovation Council and SMEs Executive Agency (EISMEA). This agency 'implements' and manages other EU programmes aimed at SME support. Thus, the management of the EIC programme has been given to an existing body whose task is to support SMEs (it used to be called the Executive Agency for Small and Medium-sized Enterprises, EASME). The fact that the EIC was simply added to the tasks of an agency for the promotion of SMEs already shows that, behind the creation of the EIC, the mission of encouraging innovation is at best competing with that of supporting SMEs.

The EIC Board and its president advise the European Commission on the broad strategy of the EIC, its work programme – a document specifying the various funding opportunities – and more specifically on the thematic portfolios and profiles of EIC programme managers, both key elements of the EIC as discussed below.

The EIC Board and its president are appointed by the European Commission and have an *advisory* role, thus leaving to the European Commission the bulk of the decision power. This compromises the independence of the EIC and sets it apart from the European Research Council (ERC), an EU-funded programme devoted to basic research that has acquired considerable prestige over the years.[21]

The governance structure of the EIC is summarised in *Figure 6*.

Figure 6.
Governance of the EIC



21 The ERC is discussed in more detail in Section 3.

EIC Board members are not required to be leading scientists, and many have a business background. This echoes the EIC inclination towards bringing projects to market rather than developing new technologies.

Only 4 of its 21 members are professors and fewer than half have a degree in science or engineering. Business 'insiders' might be better positioned to identify key global challenges and technology needs, but they appear unfit to specify the details of the work programme and identify the right people to manage scientific projects. Of the 10 EIC Board members with a PhD, only 7 have a profile in the Web of Science, with an average of close to 2,700 citations and an h-index equal to 18. One can compare these numbers with the average citations and h-index of the ERC Scientific Council, respectively 18,000 and 58. The EIC Board thus has fewer scientists, and they are less prominent than those of the ERC.

More details on the comparison between the governance of EIC and ERC can be found in *Appendix Table 2*.

BUDGET

The EIC oversees three key funding schemes: *Pathfinder, Transition* and *Accelerator* (see *Figure 6* above). Only the first two of these programmes finance the types of low-TRL projects that are typical of the ARPA model and make use of highly-skilled programme managers. This implies that at best €470 million of the EIC budget is managed similarly to ARPAs. Given that the EIC should ideally cover all fields, this seems very small if compared with the combined annual budget of US ARPAs, which exceeds $7 billion.[22]

The other half of the EIC budget is allocated to the Accelerator programme, which finances projects close to commercialisation, i.e. projects with TRLs above 5. Therefore, the support from the Accelerator programme for the scaling of almost-mature technologies is unlikely to generate breakthrough innovation. Its purpose is more to remedy a perceived capital market imperfection. The question is then whether this use of EIC funds is the best way to address firms' limited access to capital and loans, if any.

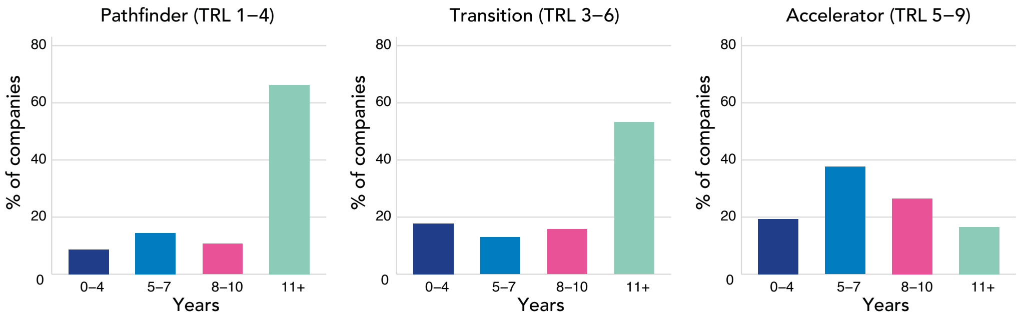
22 Considering only three ARPA-style agencies in 2024, DARPA has an annual budget of more than $4 billion, ARPA-E $0.650 billion, and ARPA-H $2.5 billion.

WHO RECEIVES SUPPORT FROM EIC PROGRAMMES?

In light of the technological path dependency afflicting the EU innovation ecosystem, new firms have a key role to play in boosting the development of high-tech industries. While the Accelerator programme's official aim is to support startups, i.e. firms no older than 4 years, much of the funding is directed towards projects by mature mid-tech companies.

First, the median age of Accelerator beneficiaries is 7 years, as revealed by a sample of EU-funded projects matched with the dataset of Crunchbase, a widely used database. Less than 20% of Accelerator beneficiaries are startups (*Figure 7*).[23] *Appendix Figure 18* shows that only 20% have revenue below €1 million but the vast majority have fewer than 50 employees.[24] This suggests that the EIC mostly targets mature SMEs.

Figure 7.
Age of Horizon Europe companies by programme



Sources: authors' calculations based on CORDIS and Crunchbase.

Our evidence is consistent with the EIC's declared allocation of 70% of its budget to scale up *SMEs*. This is not the typical task of ARPAs. Available sources suggest that DARPA spends less than 2.5% of its budget ($100 million per year) on SBIR and STTR, the two US programmes devoted to SME support.[25] Other ARPAs can participate in these programmes, but they are unlikely to spend more than DARPA.[26]

23 Pathfinder and Transition participants have a higher median age of 12-14 years, but that does not constitute an issue since their missions are not to create new companies.

24 Because Crunchbase is a database of companies, we have data only for the private companies that participate in the projects, but not for research institutions. Revenue and employment figures are estimates and need to be interpreted with caution. Age, however, is highly accurate.

25 Each federal agency with an extramural R&D budget of $1 billion or more is required to allocate a portion of its R&D funding to conduct a multi-phase R&D grant programme for small businesses. The total EIC budget is not far from the $1.7 billion spent by the whole US Department of Defense in 2019 in favour of SMEs.

26 In FY2019, US agencies awarded $3.3 billion in SBIR funding. The Department of Defense and the Department of Health and Human Services accounted for more than three-fourths of SBIR funding in FY2019.

It is an open question whether an innovation model so focused on SMEs will be successful.[27] But it seems clear that the EIC aims more at remedying capital market imperfections than encouraging breakthrough innovation. This is also reflected in the key performance indicators set by the EIC Board, which are mostly related to *investment* performance, rather than innovation.[28]

The second, broader issue is that the EIC seems to be underfinancing the sectors that could help the EU escape the middle technology trap. Specifically, Crunchbase lists the industries associated with companies whose projects are financed by the EU.[29] The detailed results are presented in *Appendix Figure 19*, which shows the number of financed projects by industry. The overall result is that the industries usually classified as high-tech, such as software and AI, appear relatively infrequently in the data. Biotech appears more often than software-related industries, but lies far behind the general categories of 'science and engineering' and 'healthcare', which are not necessarily high-tech although they have some advanced technological content.

ROLE OF PROGRAMME MANAGERS

The key role of ARPA project managers is to identify projects with high potential for breakthrough innovation. To accomplish this task in a broad set of scientific fields, ARPAs rely on *hundreds* of highly-qualified programme managers (or directors), who manage a portfolio with a limited number of projects and enjoy a high degree of discretion in project selection and management. These programme managers have an entrepreneurial mindset/background and a strong incentive to decide whether to put more means on functioning projects or stopping/abandoning them despite sunk costs.

Meanwhile, the EIC has only 9 programme managers, each managing projects worth around €200 million annually.[30] What is more constraining than the financial amount each EIC programme manager has to oversee is the sheer number of projects and the wide range each manager has to cover. The small number of programme managers severely limits the diversity of available expertise.

27 For instance, Akcigit and Kerr (2018) estimate and simulate a structural model in which small firms are more likely to innovate. Yet, Akcigit et al. (2022) find that in a world of imperfect information, higher productivity firms have a comparative advantage at innovation and should be subsidised more than small firms. Santoleri et al. (2022) exploits a regression discontinuity design to provide evidence that R&D grants to small and young firms with relatively mature technology boost patenting and investment in intangibles; they do not find a significant impact of grants on early-stage projects. By contrast, Howell (2017) finds that early-stage grants are the only ones that are effective in spurring innovation. Bronzini and Ianchini (2014) do find a positive impact of R&D grants to small firms on innovation, although these did not result in crowding in additional private investment.

28 See the annex of the EIC impact report 2023.

29 See the documentation from Crunchbase here.

30 Programme managers manage only Pathfinder and Transition projects, whose annual 2022-2023 budget was €0.47 billion. Roughly 40% of this budget (Challenges calls) is managed by the 9 programme managers.

Moreover, less than half of the €470 million devoted to breakthrough innovation is managed by ARPA-style programme managers. The majority of EIC funding (roughly 55%) is awarded through open calls with no predefined thematic priorities ('EIC Open') and without the involvement of programme managers.[31] By contrast, ARPAs publicise funding opportunities primarily by soliciting proposals tied to programme-specific areas of research and development, set and managed by programme managers, with unsolicited proposals being allowed but generally discouraged.[32]

ELIGIBILITY REQUIREMENTS

Unlike ARPAs, but similar to other Horizon Europe funding schemes, two of the three EIC programmes require projects to be collaborative, meaning that applicants must form consortia of independent legal entities, with at least one established in a Member State, and at least two others in different Member States or Associated Countries.[33]

Almost all Pathfinder projects are run jointly by companies and research institutions. In Transition, 13% of projects are run solely by companies, and 6% solely by research institutions alone. Accelerator exclusively finances single companies and does not require collaboration. The average size of consortia is six members in Pathfinder and three in Transition. Accelerator does not have collaborative requirements. These statistics must be seen in conjunction with the average size of the grants disbursed: €3.2 million for Pathfinder, €2.3 million for Transition, and €2.3 million for Accelerator. This implies that each consortia member in the first two programmes receive on average just €0.5-0.75 million in grants. It is unlikely that these very small sums can generate breakthrough innovations.

The success rate of EIC projects is quite low. The average success rate for all of Horizon Europe is 16%, but for the EIC it is less than 10% (with some variation across subprogrammes).[34] It would be a mistake, though, to conclude that, for a given budget, a low success rate jeopardizes innovation. The application success rate may reflect the cost of writing proposals (a low cost inducing more applications). Another determinant of the success rate is the quality of screening. As Adda and Ottaviani (2023) show, the number of applications for a grant call increase with the imprecision of the grading; in a nutshell, the more random the allocation of grants, the more weak projects have a chance of being selected, and the more applications are received, increasing the rejection rate. So, it may be the case that a high rejection rate is a symptom of an insufficient quality of screening rather than of a size of grants that exceeds the optimum one given the fixed budget for the programme. Thus, a low application cost or an accurate screening, while desirable, may well decrease the success rate.

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31 It is not clear how projects under open calls are managed. In all likelihood, this role is covered by EISMEA officials with the help of external experts.

32 Recent evidence from Howell et al. (2021), based on the US, suggests that projects selected through open calls involve younger and smaller firms, and that they are successful according to different metrics of innovation activity. However, these firms are less likely to win further funding competitions.

33 This applies to Pathfinder Open, but not necessarily to Pathfinder Challenges. Collaboration applies only to part of Transition and it does not apply to Accelerator, which are targeted at individual legal entities (startups).

34 The data are available here.

Furthermore, increasing the acceptance rate given a fixed budget would lead to sprinkling European money, with limited ability for Horizon Europe to have a real impact on the best projects. So, just increasing the acceptance rate for a fixed budget is unlikely to be a good idea.

The selection mechanism might be improved by being articulated in two phases. The first phase could be a streamlined version of the current screening process under the supervision of experts who would have the power to 'desk reject' proposals that are anyway unlikely to be approved. One reason for the success of the ERC is that its selection panels involve top scientists. But these individuals should not devote their attention to unpromising applications; instead, their valuable time should be used to select the best projects. It might thus be useful to associate several specialised scientific boards with the EIC, composed of top scientists and engineers. Their task would then be to make the final decision among the best applications that have survived the first screening process. In this way, they would not spend their time on projects whose rejection is a no-brainer, but rather on comparing marginal projects, i.e. projects for which the decision is complex.

FUNDING DELAYS

EIC funding of successful proposals is expected to take place in 8 months. In ARPAs, it can be as little as 3 months. This may be due to several factors. For instance, EIC officials evaluate proposals following complex guidelines requiring special briefings. Awardees are subject to a Commission-wide grant agreement contract (241 pages long) and additional provisions specific to the EIC programmes.[35] By contrast, proposals to ARPAs are required to follow the 'Heilmeier Catechism', a concise list of questions speeding up the evaluation process, without compromising clarity and informativeness.

A related issue is that ARPAs have the authority (typically delegated by their respective governmental agency) to enter into, and flexibly administer, contracts and grant agreements. By contrast, EIC funding has to follow standardised EU procedures that tend to be highly bureaucratic.[36] There has been progress in the speed of decisions and disbursement, but unless procedures and contracts are radically reformed, little further progress seems feasible.

35 Different EIC stakeholders have complained about intellectual property issues with the current model.

36 Most notably, ARPAs use 'Other Transactions', contracts designed to avoid burdensome regulations, complicated accounting rules, and extractive intellectual property terms that characterise federal contracts.

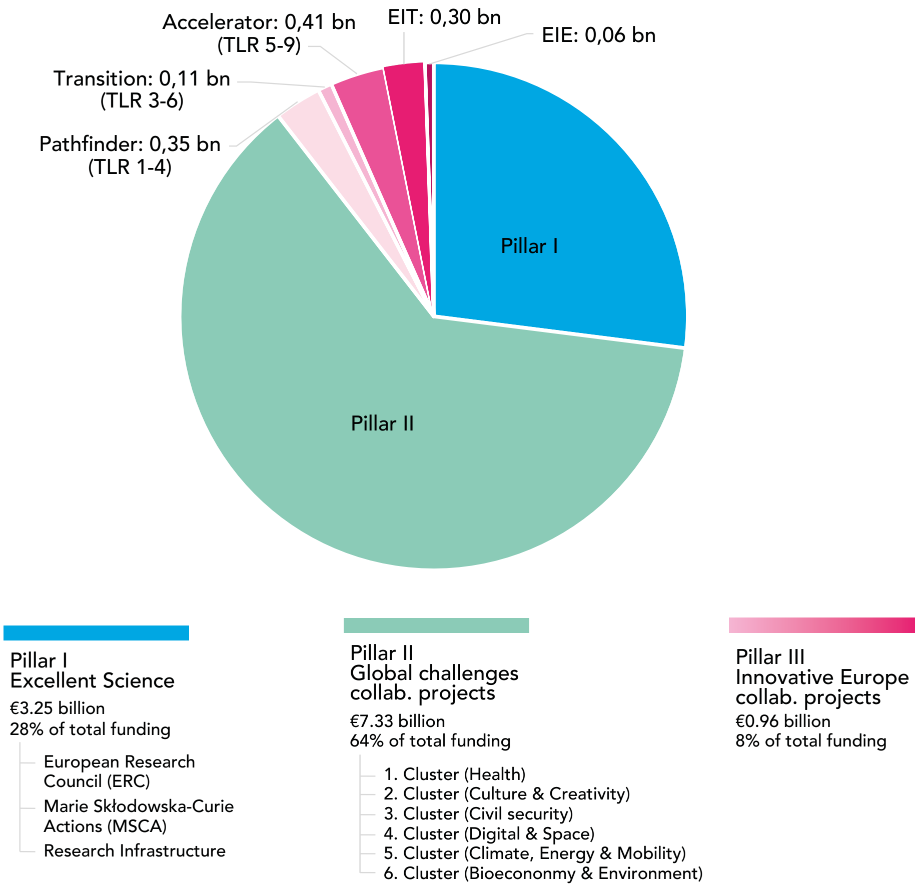
III.

ANATOMY OF HORIZON EUROPE

Increasing the EU's budget for innovation would be highly desirable but might be difficult for political reasons; therefore, our aim is to propose *budget-neutral* reforms. To that end, this section identifies which parts of Horizon Europe could be repurposed to finance breakthrough innovation.

Figure 8 presents the structure of Horizon Europe, which is organised around three 'pillars'. The figure provides the breakdown of the average 2021-2022 R&D grants paid by the EU through its various research and innovation programmes.[37]

Figure 8.
Horizon Europe by its pillar components and relative subprogrammes



Source: CORDIS.

37 The main source of data is the Community Research and Development Information Service (CORDIS), the European Commission's primary public repository on all EU-supported R&D activities. It should be noticed that the sums allocated from one year to another can vary to some extent. Also, they do not include venture capital investment, which is discussed further below.

PILLAR I

The first pillar funds basic and applied research; it includes the well-known ERC. Due to data availability, the ERC is the most widely studied among EU funding programmes (e.g. Nagar et al., 2023; Ghirelli et al., 2023). The first pillar has a yearly budget of roughly €3 billion and accounts for the vast majority of basic research, around 30% of Horizon Europe.

The ERC accounts for about two thirds of the budget of Pillar I. It is characterised by its own government structure, which differs from other Horizon Europe programmes. Specifically, the ERC Scientific Council is composed of independent and internationally reputed scholars. Its president is appointed by the European Commission, which selects one among three names proposed by an independent commission, the Scientific Council having a veto right on these names. Unlike for other Horizon Europe programmes, the ERC work programme is set by the Scientific Council itself, without interference from European Commission officials.[38]

Likewise, the scientific panels of the ERC are made up of renowned scientists, who pick the laureates without any intervention from the European Commission (other than checking the conformity of applications and grant awards with the general rules). The award process establishes shortlists on which much of the skilled attention focuses, as it should.

It is therefore no surprise that, like its US counterparts the National Science Foundation (NSF) and the National Institutes of Health (NIH), the ERC functions with integrity and funds disruptive science. For example, Ugur Sahin, the BioNTech founder, received in 2018 a grant from the ERC to explore the mRNA technique in order to develop mRNA vaccines for various types of cancer. The scientist behind the AstraZeneca vaccine had also received an ERC grant.[39]

However, the ERC has a much smaller budget (about €2 billion) than its transatlantic counterparts. In 2023, the NSF had a budget of $9.5 billion, with $7.6 billion dedicated to research. The same year, the NIH had a budget of around $47 billion. It should be noticed that these sums do not include the budget of ARPA-H ($2.5 billion).

38 Anecdotal evidence of past conflicts between the Scientific Council of the ERC and the Commission suggests that the independence and academic excellence of the ERC cannot be taken for granted and must be safeguarded. More generally, there has been a political backlash against the independence of central banks, competition authorities and the judiciary, despite the fact that these institutions have served the general interest very well whenever competent and impartial leaderships were selected.

39 For more on the need for fundamental research and on European attitudes towards it, see 'The Future of European Science' by the former head of the ERC, Prof. Jean-Pierre Bourguignon.

PILLAR II

The second pillar is the largest in terms of budget – over €7 billion annually or 64% of the Horizon Europe budget. The official title of Pillar II is 'Global Challenges and European Industrial Competitiveness'. It thus has a thematic focus. This pillar has two salient features.

The first is that it adopts a top-down approach by eliciting applications on specific topics decided by the European Commission.[40] It is organised around six main thematic clusters. These are: Cluster 1, Health; Cluster 2, Culture, Creativity and Inclusive Society; Cluster 3, Civil Security for Society; Cluster 4, Digital, Industry and Space; Cluster 5, Climate, Energy and Mobility; and Cluster 6, Food, Bioeconomy, Natural Resources, Agriculture and Environment. These themes reflect the judgement of the Commission of what constitute the main global challenges.

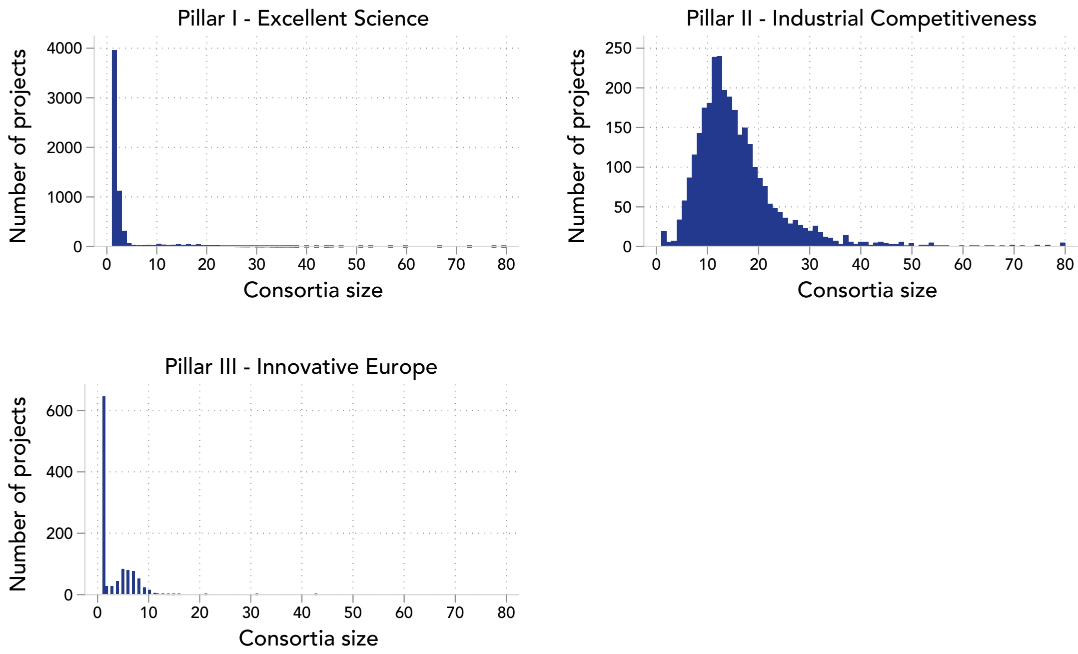
The second feature is that it funds *collaborative* projects by imposing consortia requirements, designed to strengthen EU country representativeness – a formal blending of EU cohesion policy and innovation policy. *Figure 9* shows the distribution of projects by number of consortium members in each pillar. Pillar II features many projects with a very large number of participants. It is an open question whether the cross-country collaboration has a positive net impact.[41] The impact is probably case-specific. One thing is certain: top-down collaboration requirements do not work. Teams collaborate on a proposal to grab their share of money and the announced collaboration is rarely operational. Bottom-up collaborations are a different ballgame. So, our recommendation is of course not to rule out collaborations, but rather to not make them mandatory. In this way, only value-creating collaborations will emerge: if the teams deliver more through an alliance, they will form the latter so as to increase their chances of success.[42]

40 Conclave Europe (2023) argues that 'R&D initiatives must be based on bottom-up projects, while top-down support should focus on a reduced number of strategic areas with enough continuity'.

41 On the one hand, this might be desirable given that there is literature suggesting that collaboration – research consortia in particular – generates positive outcomes, especially if involving basic research (e.g. Branstetter and Sakakibara, 2002). However, imposing collaboration across multiple entities in different countries might hamper innovation outcomes. This possibility is supported by a large body of literature studying the negative impact of coordination and communication frictions (e.g. Backer and Murphy, 1992), with some contributions arguing that small teams are better at developing radical innovation (e.g. Wu et al., 2019).

42 In this we agree with Conclave Europe (2023) that 'Europe must eliminate the geo-return rule, which ties contract allocations to national contributions, prioritizing competitiveness and smart investment over political motives'. This rule used to plague the funding of fundamental research prior to the creation of the ERC, and also constrains some important agencies such as the European Space Agency.

Figure 9.
Number of consortium members by pillar



Source: authors' calculations based on CORDIS.

Appendix Figure 20 shows total and per-project funding by thematic cluster, distinguishing between basic and applied research, and product development. Pillar II tends to fund basic and applied research more than the upscaling of mature technologies. It is thus not clear what distinguishes Pillar II funding from the EIC, other than the collaborative aspect.

However, development projects receive on average more funding in the largest climate and digital clusters. The average grant per project is around €6 million. Bearing in mind that the number of consortium members can easily be around 10-20, like for the EIC, one is left to wonder how impactful such fragmented funding can be.

PILLAR III

The objective of the third pillar is funding the development of ground-breaking technologies. It is composed of the EIC (the largest programme discussed in the previous section), the European Institute of Innovation & Technology (EIT) and the European Innovation Ecosystem (EIE). We argue that the EIT and the EIE do not have a clear mission and it is hard to understand what they do. Given that they absorb substantial resources, we review them below. We also describe the EIC Fund, the venture capital arm of the EIC.

European Institute of Innovation & Technology

The EIT, headquartered in Budapest, was created in 2008 and its mission has changed over time. At present it aims at encouraging the formation of 'networks'. Its mission is to connect education, research and business, not to finance innovation.

Yet, its declared budget is about €300 million per year, close to the budget of Pathfinder. Official data from the European Commission show that it financed eight projects, on average around €50 million, more than ten times the average grant from the EIC. The eight projects correspond to eight Knowledge and Innovation Communities (KICs) – whose categories are largely similar but somewhat more granular than the thematic clusters of Pillar II.

The EIT governing board selects the KICs and evaluates them every 3 years with the support of external experts.[43] The KICs typically receive financing for between 7 and 15 years, which implies that tens of million in grants are paid each year to the same entity, which in turn independently decides how to allocate the grant to the beneficiaries of its activities.[44] *Appendix Figure 21* shows the cumulative amount in grants paid to the KICs, some reaching over €700 million over their term.

KICs are supposed to create 'meeting hubs' around Europe for workshops, networking and incubator activities, but it is not clear how they operate or allocate the funding. Each KIC has its own governance and operational approach, implying reduced accountability and fragmentation of these funds. Moreover, it is not clear how the grants paid by the EIT differ from those awarded by the EIC or those in Pillar II, whether the eligibility requirements and contractual forms used by KICs differ from the rest of Horizon Europe, or how the EIT differs from other training-focused programmes such as Erasmus+.[45]

Finally, and more broadly, it is not clear why the EIT should be better placed than scientists and businesses to identify potential partners and synergies. For these reasons, it is natural to question the EU value added of the EIT and ask whether its budget could be more efficiently allocated elsewhere.

43 See *Appendix Table 2* for a comparison of the EIT's governance with that of the EIC and ERC.

44 Financing data are available here. Some additional info is here.

45 This has been recently argued also by Denmark's representatives. See this article here, this one here and another here.

European Innovation Ecosystem

The smallest component of Pillar III is the EIE, a funding programme aimed at 'creating more connected and efficient innovation ecosystems' across the EU. The overall budget for the period from 2021 to 2027 is relatively small – roughly €60 million per year. Given that Pathfinder provides individual grants of up to €4 million, this implies that the funds of EIE would enable it to finance at least 15 potential breakthrough projects.

A key goal of the EIE is to overcome spatial issues of specialisation and integration in global value chains in less developed regions. However, it is not clear how the programme would achieve such a goal or how the funding it provides to SMEs differs from other existing programmes, which in this case also casts doubt on whether the programme serves any specific purpose.

EIC Accelerator and EIC Fund

The EIC Accelerator has the largest declared budget of the EIC, accounting for half to three-quarters of the total EIC budget depending on the year. It is implemented through an agency, the EISMEA. which collects and evaluates proposals by startups and SMEs through public calls, split roughly equally between 'EIC Open' and 'EIC Challenges'.

Following selection, and conditional on the rubberstamping of the decision by the European Commission, EISMEA can disburse a grant (up to €2.5 million). But while the Pathfinder and Transition programmes offer support exclusively through grants, selected Accelerator companies can receive much more financing (up to €15 million) in the form of equity.

Indeed, more than half the budget allocated to Accelerator takes the form of equity investment, around €400 million depending on the year.[46] The equity investment is delegated to the EIC Fund, the venture arm of the EIC. It is a capital fund subject to private law, with the European Commission as the unique investor and shareholder.[47] This implies that all risk, profits and losses are borne by Member States.

The EIC Fund decides on financing operations and does the monitoring, milestone disbursements, reporting and exit.[48] The external Fund Manager, AlterDomus Management Company S.A., is responsible for making investment decisions following the selection process designed by EISMEA and due diligence by the EIB.[49]

46 See Annex I here.

47 Official EU sources state: 'In the future it is envisaged that the European Investment Bank (EIB) will take over this role under a mandate agreement'.

48 The EIC Fund Board is vested with the broadest powers of the EIC Fund. The Board oversees the investment strategy and makes the final decision on any single operation. The EIC Fund Manager is an external authority that manages the EIC Fund. It makes all the investment and divestment decisions on the selected companies. With the support of the EIB, it manages the EIC portfolio of invested companies.

49 The EIC Fund Manager receives a commission fee of up to a 10%. Once the EIC Fund has approved the investment, the EIB, in its role of an investment adviser, guides the work of the lawyers for each specific transaction. This leads to an investment agreement, which is signed by the EIC Fund and the company.

Despite the EIC's focus on funding 'unicorns', 55 of the top-100 startups in the world are from the US, while only 8 are EU companies.[50] Moreover, in a sample of 5,859 companies that received Horizon Europe funding, from Crunchbase, we find that less than 10% of funding rounds involved additional investors; for EIC-funded projects, it was less than 5%.[51] Some of these are private funds. This evidence suggests that EU-backed venture capital investment mobilises little private investment, possibly due to adverse selection. That is consistent with the literature, which casts doubt on the effectiveness of public-sector venture capital in boosting innovation.[52] In a nutshell, it is not obvious that a statist body, such as the Executive Agency for Small and Medium-sized Enterprises within the Research and Technical Development framework, can emulate the best private equity funds.

These concerns are supported by data from the EU Innovation Scoreboard (Grassano et al., 2022), which show that: (i) EU-based corporations provide about 22% of global corporate venture capital, but EU-based startups receive only 9% of the global total; and (ii) over 80% of venture capital investment by EU-based companies targets US-based companies (*Appendix Figure 22*). This seems an indication of a lack of investment opportunities, casting doubt on the claim that developing its venture capital market would solve the EU's innovation problem.

Finally, and more broadly, it is unclear whether an EU venture capital market can be as developed as it is in the US.[53] Reasons include differences in fiscal regimes, corporate and labour laws, which in the EU are often inappropriate for the world of startups and innovation.[54] Cultural differences can also play a role. In the EU, universities – at which researchers, by lack of incentives or because of ideological reasons – are loath to participate in applied innovation. In the US, the general mindset emphasises advice, handholding, monitoring and relatively early termination – values that are not necessarily shared in the EU. And entrepreneurship is very rarely taught in the EU at the undergraduate level. Another often-mentioned hindrance is the absence of a single home market in a number of European tech markets (defence, AI, energy, healthcare…), complicating the emergence of sufficient scale technology champions.

50 See the EIC Impact Report 2022. The full list from Crunchbase can be found here.

51 According to Crunchbase, 30% of EU-funded companies never benefited from additional investors. However, we cannot observe whether the remaining 70% got funding from private sources, or whether the investments followed or arrived before the EU contribution.

52 For instance, Breschi et al. (2021) find that government-backed venture capital underperforms its private counterpart, and that mixed public-private investment fails to attract additional private investment in later funding rounds. For these reasons, it might be better to use Accelerator funding solely for R&D grants, which are generally seen as an efficient policy instrument to boost innovation (Teichgraeber and Van Reenen, 2022).

53 See Coatanlem (2024).

54 Risky strategies mean a high probability of failure and a need to keep moving on, making slow and expensive layoff processes particularly cumbersome (see Bartelsman et al., 2016). The corporate law literature points to substantial differences between the flexible US legislative system – largely deferring contractual choices to private parties – and the EU, where regulatory rigidities might prevent the development of an efficient venture capital market (see Enriques et al., 2024).

Innovation Fund

The Innovation Fund is an EU fund for climate policy, independent from Horizon Europe, which invests in innovative Green-tech projects with the goal of reducing European emissions. It is entirely financed by the Emissions Trading System (EU ETS) and hence its overall funding depends on the carbon price. Given a carbon price of €75/tCO2, it might amount to annual funding of about €4 billion. We do not want to take a stance on this financing modus.[55] The amount number of ETS certificates allocated to the Innovation Fund represented a political compromise. The result of higher ETS prices has however been that a substantial amount of funding will be available to foster research on green energy solutions. It is thus important that this fund be effectively used.

The Innovation Fund is managed by the European Commission through delegation to the European Climate, Infrastructure and Environment Executive Agency (CINEA), led by four heads of department, who are responsible for more than seven other programmes, including Cluster 5 of Pillar II in Horizon Europe.

The Innovation Fund is actually not about innovation, but rather finances large-scale demonstration projects (with TRLs above 5). A large portion of these projects is related to hydrogen, which exposes the fund to the risk involved in a scarcely diversified portfolio.

The fund mostly awards grants through calls for proposals, and in some part through competitive bidding (auctions). Specifically, projects need to be *sufficiently mature* in terms of planning, business model and financial and legal structure, which sets the Innovation Fund apart from the kind of breakthrough innovation the EU needs.

55 One might argue that, for a given climate objective, the higher the ETS carbon price, and therefore the stronger the European abatement ambition, the less need there is for green innovation support, all the more that a high carbon price already allows green innovators to monetize their technologies. While a high carbon price and high funding of green R&D are excellent news given the perilous climate situation, it is by no means clear that the financing mode as such is desirable. For certain it exposes green R&D funding to a populist backlash leading to a weak ETS price.

IV.

A BUDGET-NEUTRAL POLICY PROPOSAL TO BOOST EUROPEAN DEEP-TECH

This section formulates a concrete policy proposal to boost the EU's capability for breakthrough innovation.

Reallocation towards disruptive innovation

Panel (a) of *Figure 10* depicts the status quo by illustrating the declared 2024 budget of key components of the EU ecosystem for innovation.

Our proposal is articulated in five steps:

1. Reform the governance of the EIC, hiring more independent and highly qualified programme managers and giving them greater discretion over project selection and management. Streamline management practices and simplify the application process. Design a procedure that allows prominent and busy scientists to cast the decisive vote on the best proposals.

2. Scale down progressively the European Institute of Innovation & Technology (EIT) and the European Innovation Ecosystem (EIE). The current projects (KICs) of the EIT are anyway expected to become financially independent in 7 to 15 years. Over time, this could free up to €0.51 billion per annum.

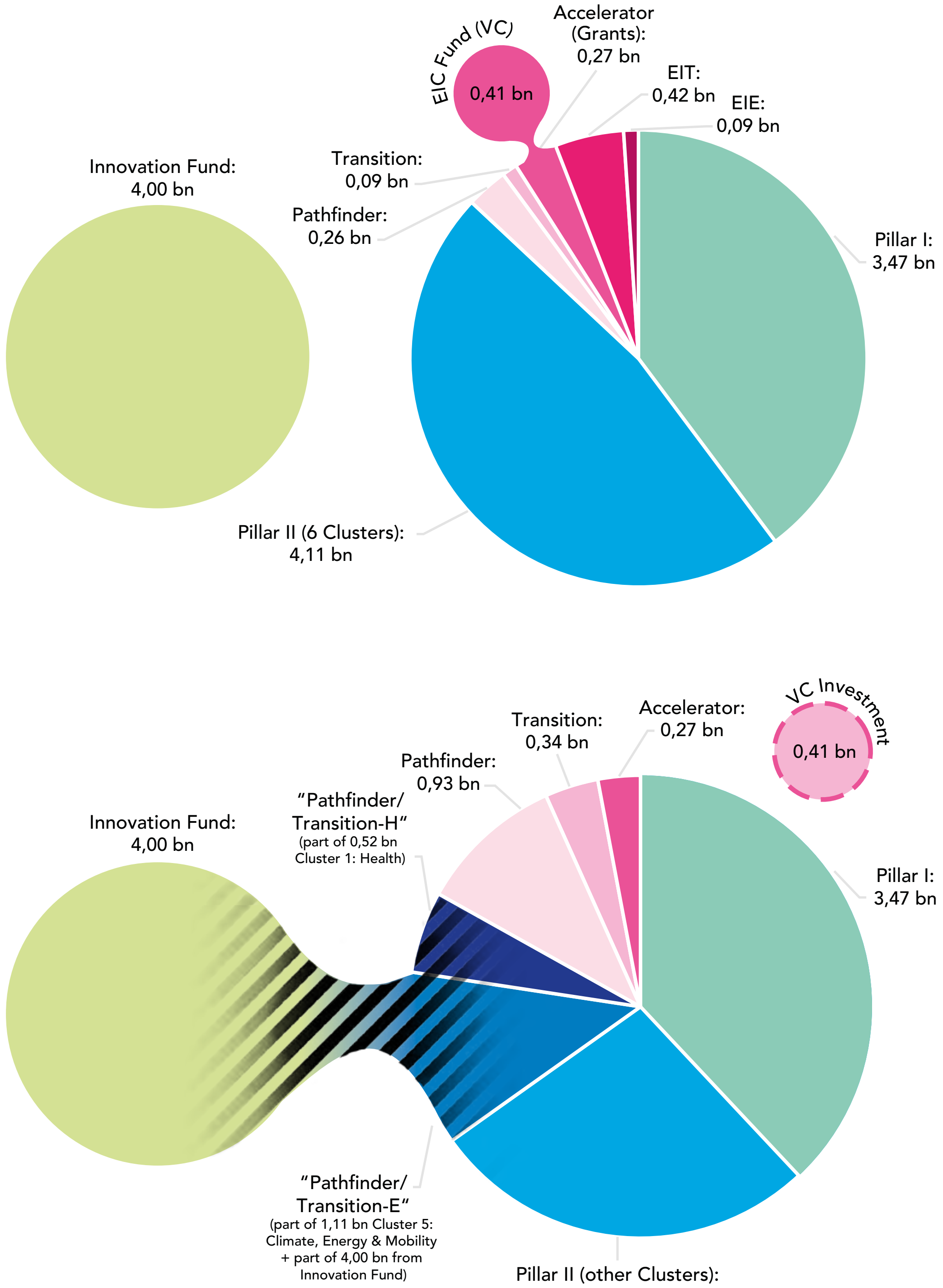
3. Replace the financing of equity stakes by the Accelerator budget with other sources whose mission is investment, rather than innovation. For example, the EIC could be merged with the European Investment Fund (EIF, which does not rely on EU budgetary resources) or the proposed Sovereignty Fund. This would free up €0.41 billion per annum.

4. Use the resulting €0.92 billion for grants to increase the budget for ARPA-style programmes, through Pathfinder and Transition.

5. Pool a share of resources from Pillar II clusters, as well as part of the Innovation Fund, to finance Pathfinder-type programmes (or create two thematic agencies on energy and health, with the same reformed ARPA-style governance of the EIC).

Panel (b) of *Figure 10* depicts Horizon Europe after the reform. The dark colouring of the new EIC represents an ARPA-style governance, which extends to two new agencies through the dark bands. These are Pathfinder/Transition-E and Pathfinder/Transition-H.

Figure 10.
Before and after our policy proposal (in € billion)



Source: authors' representation.

Pathfinder/Transition-E would focus on energy, climate and transportation matters, and pool resources from Cluster 5 of Pillar II and the Innovation Fund. The Innovation Fund has a much larger budget than the EIC, so devoting only a small portion, say 10-20%, of its budget to breakthrough innovation would free up resources equivalent to what is currently available to the EIC.

Pathfinder/Transition-H would deal with health issues, and pool resources from Cluster 1 of Pillar II.[56] Resources from the original, 'general' Pathfinder and Transition programmes could also be used to finance the new agencies.

More broadly, we argue that through the EIC, the ARPA-style governance model could be extended to other components of the EU innovation landscape. A natural candidate is the European Defence Fund, which represents a long-overdue effort to foster cooperation in defence-related R&D. Currently, the fund devotes only 4-8% of its budget to disruptive innovation.

The amounts on the table for promoting disruptive innovation are very small in the EU. It is therefore important to find a solution for bringing more money to this end. Yet, il is also interesting to note that we could get "more bang for the buck". Our proposed reform is therefore EU budget-neutral (except for the minor cost of hiring programme managers).

About €400 million would be needed to finance the equity stakes that currently use up to 60% of the EIC Accelerator programme. Buying equity stakes in startups represents a financial operation that does not need to be funded by budgetary resources. Alternative funding could potentially come from an EU sovereign fund, or the existing European Investment Fund – part of the European Investment Bank group – whose remit could be enlarged to take over the equity stakes from the Accelerator programme in its portfolio.

56 As shown in *Appendix Figure 18*, most of the funding of Pillar II already goes to basic and applied research.

V.

SUMMARY AND CONCLUSIONS

The first part of the paper documents the reasons for the transatlantic differences in business R&D. We argue that a key reason is that European industry is skewed towards mid-tech sectors, with a middle level of R&D-intensity. This specialisation in mid-tech has persisted for decades, even increasing over the recent past, whereas the weight of different sectors has profoundly changed in the US. Possibly due to path dependency, the EU is thus failing to catch up in high-tech industries and with the AI and biotech revolutions. Moving away from the status quo requires public-sector intervention to encourage research in new technologies and to promote the development of EU high-tech industries.

The second part of the paper examines the main body set up by the EU to boost breakthrough innovation: the European Innovation Council (EIC). We argue that in order for the EIC to be more effective and compete with its benchmark models on the other side of the Atlantic, it needs, first of all, substantial restructuring of its governance. Specifically, the EIC needs less political decision-making, more highly qualified scientists and engineers on the EIC Board, and more programme managers who are experts in the fields of projects they manage. Programme managers should also be given more decision-making power. Top scientists and engineers could become involved in a redesigned, two-stage evaluation process.

Moreover, a large part of the EIC's budget goes to high-TRL activities and therefore does not support breakthrough research, but rather the upscaling of technologies by SMEs. In principle, the EIC was meant to support startups (i.e. no older than 4 years), but few of them are beneficiaries. This applies in particular to the equity investments by the Accelerator programme, which tend to support mature enterprises instead of breakthrough innovation.

The third part of the paper illustrates the plethora of funding instruments in Horizon Europe, the flagship EU programme for R&D, and two formally independent initiatives, the European Innovation Fund and the European Defence Fund. We argue that there are a number of funding sources nominally devoted to innovation, but *de facto* most of this funding is earmarked for projects that are close to being commercially viable. These resources, including those currently allocated to the European Institute of Innovation & Technology and European Innovation Ecosystem, could have a greater impact on innovation if they were transferred to the (reformed) EIC, or at least reassigned to the task of supporting ground-breaking innovation and managed accordingly.

Finally, the last part of the paper formulates our policy proposal for a budget-neutral but radical restructuring of the EU ecosystem for innovation. If successful, the reform would enable the EU to escape its middle technology trap by supporting innovation, thus creating the basis for private investment in new sectors with higher growth potential. The aim is not to channel more resources into specific areas, but rather to create more space for innovation and economic dynamism across the board.

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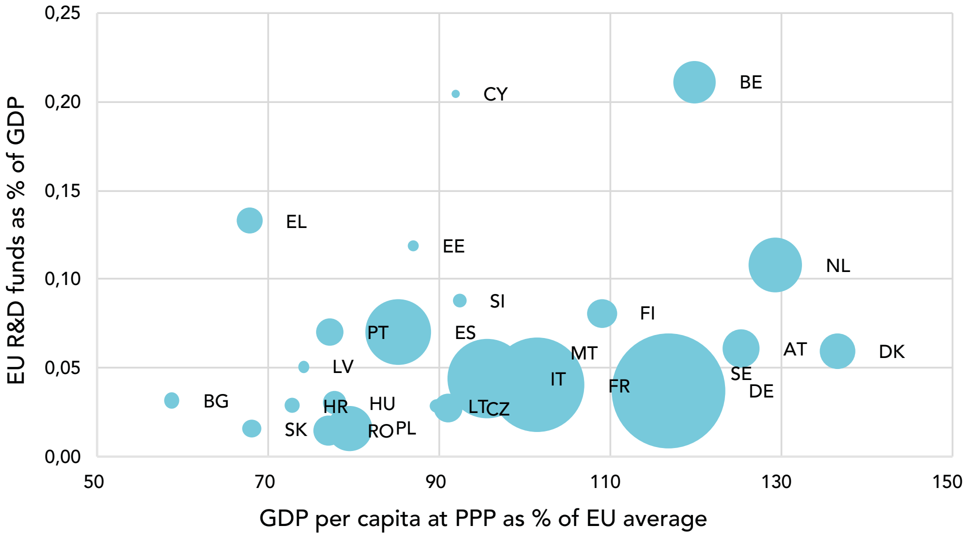
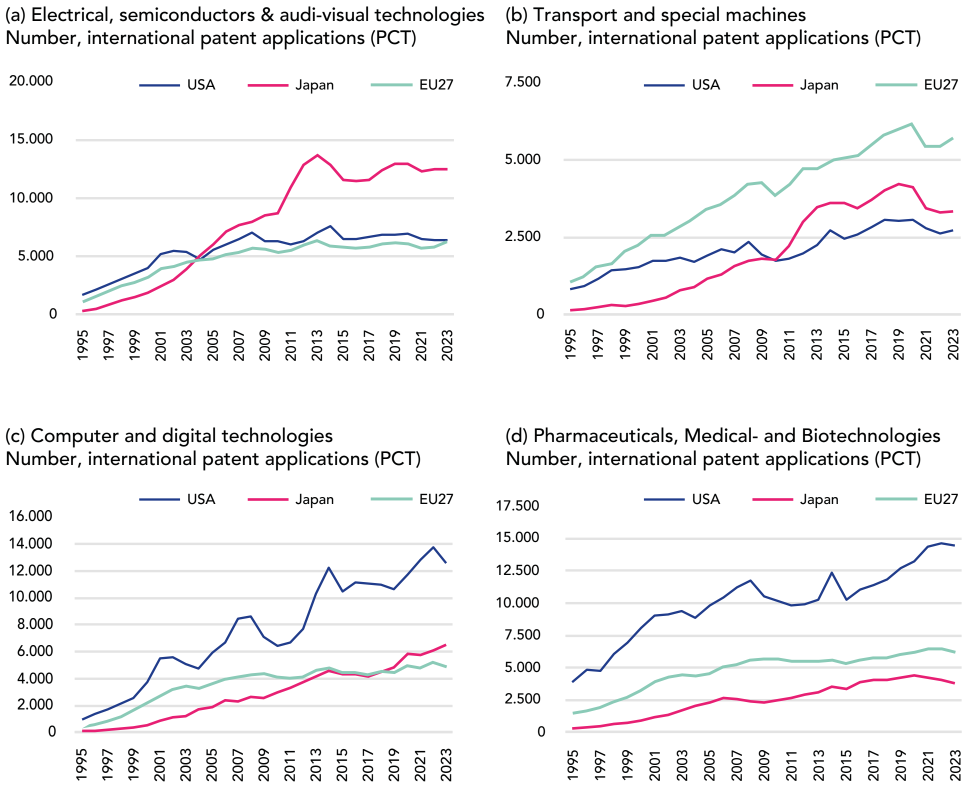
APPENDIX

Figure 11.
EU R&D funding and per-capita GDP



Source: authors' calculations based on Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R%26D_expenditure&oldid=627002.

Figure 12.

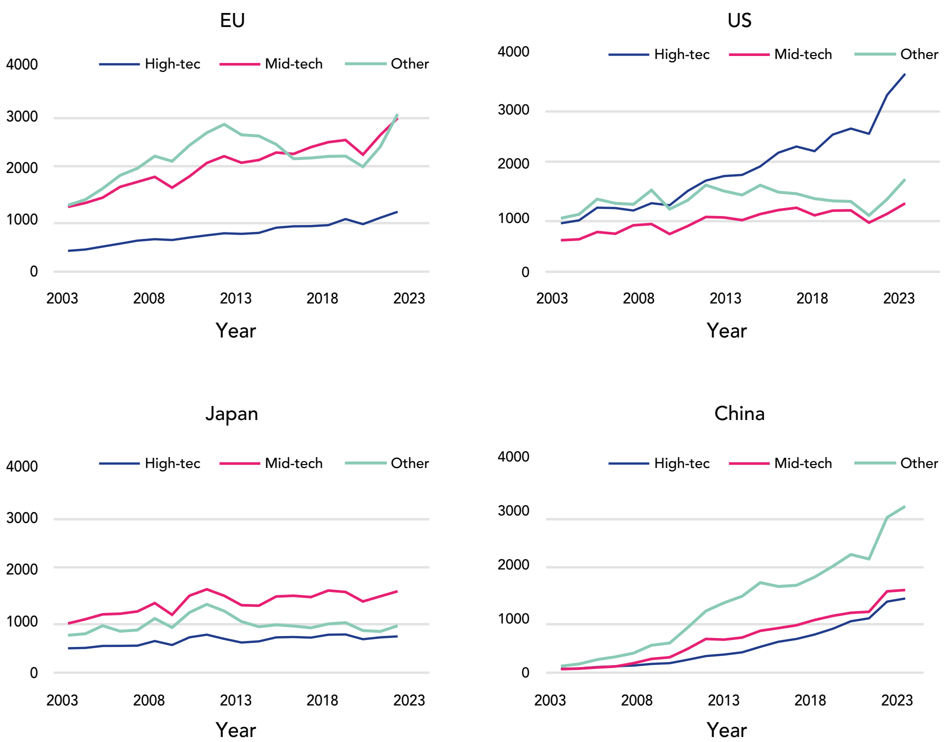


Source: WIPO.

Figure 13.
Capital expenditure by technology level 2022 (Top 2,500 companies)

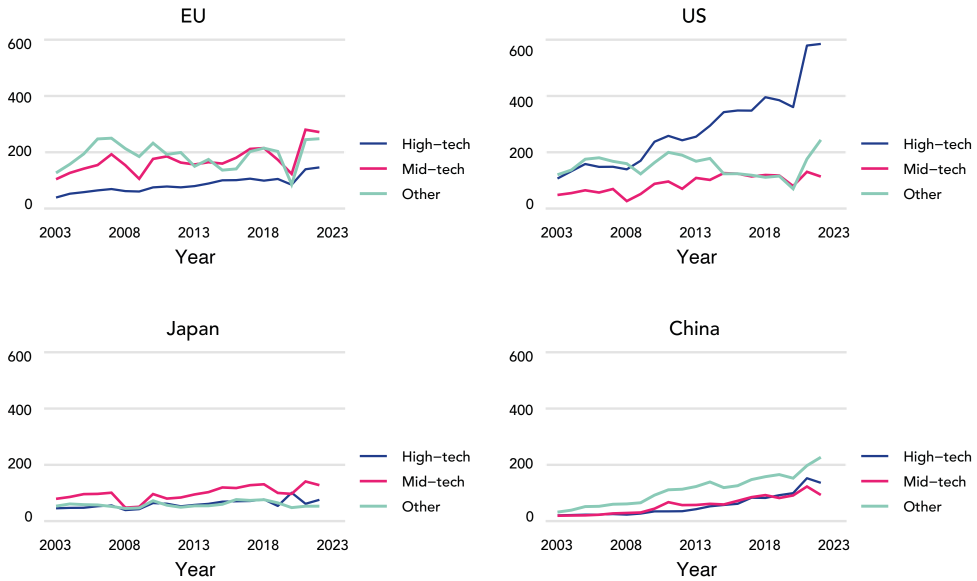
Source: Industrial R&D Investment Scoreboard.

Figure 14.
Net sales by technology level (billion €)



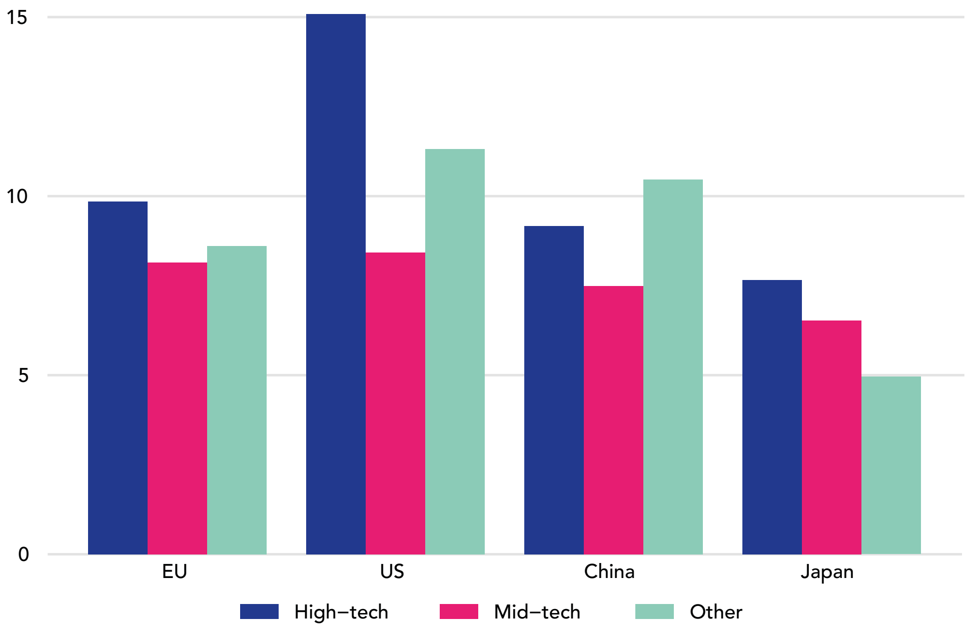
Source: Industrial R&D Investment Scoreboard.

Figure 15.
Profit margins by technology level (billion €)



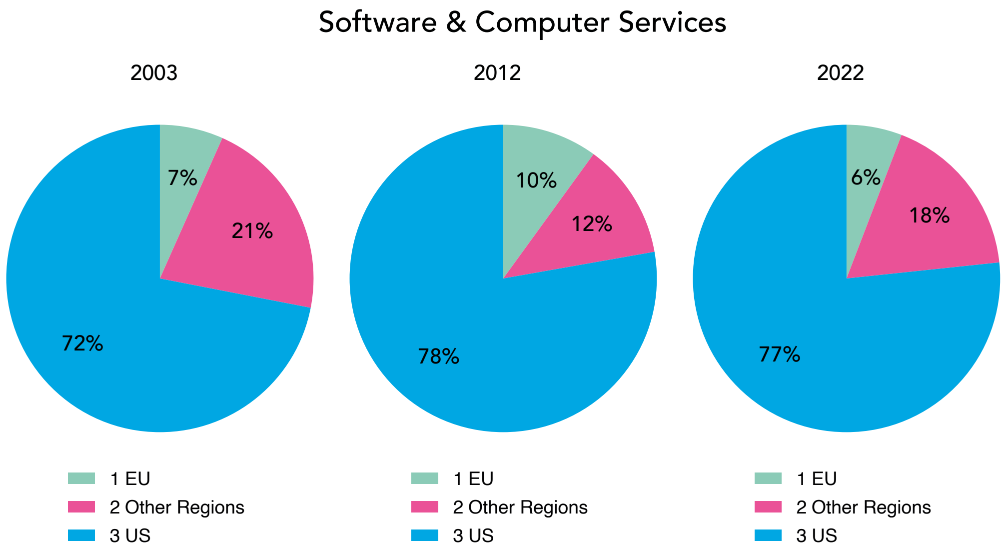
Source: Industrial R&D Investment Scoreboard.

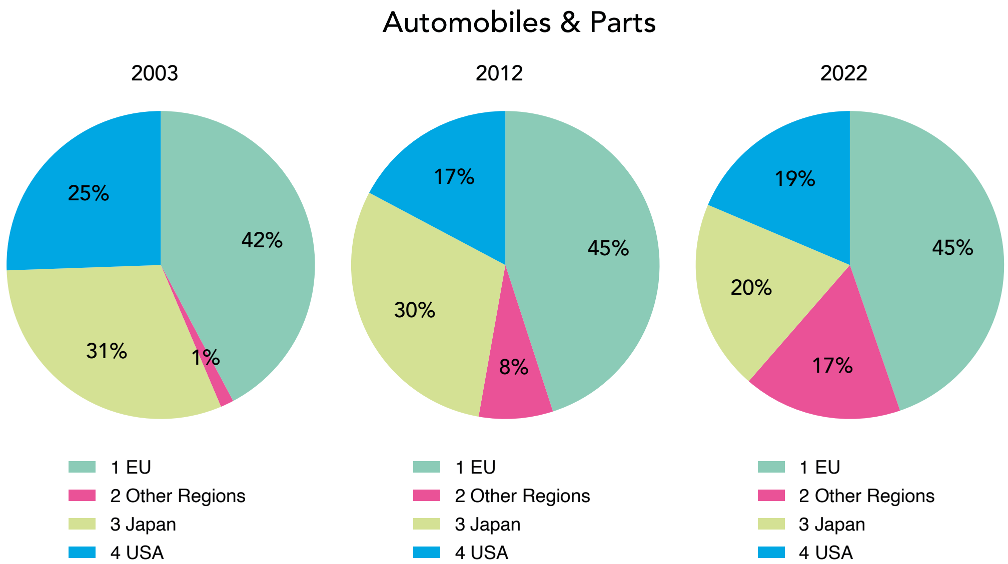
Figure 16.
Profits margins by technology level (% of sales, 2020–2022)



Note: sector profit margin is the ratio of profits to sales. Average for the years 2020-2022.
Source: Industrial R&D Investment Scoreboard.

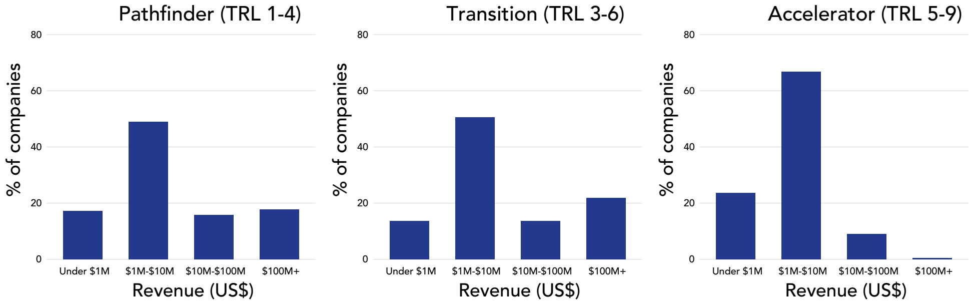
Figure 17.
Country share of total international BERD



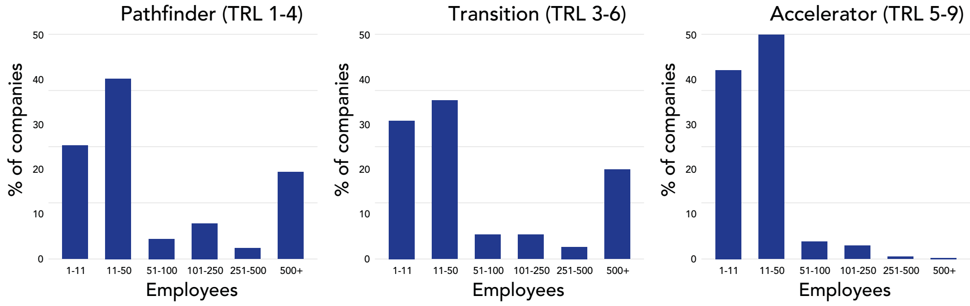


Note: BERD based on sample of global 500 largest companies.
Source: Industrial R&D Investment Scoreboard (2004, 2013, 2022).

Figure 18.
Revenue of Horizon Europe companies by programme

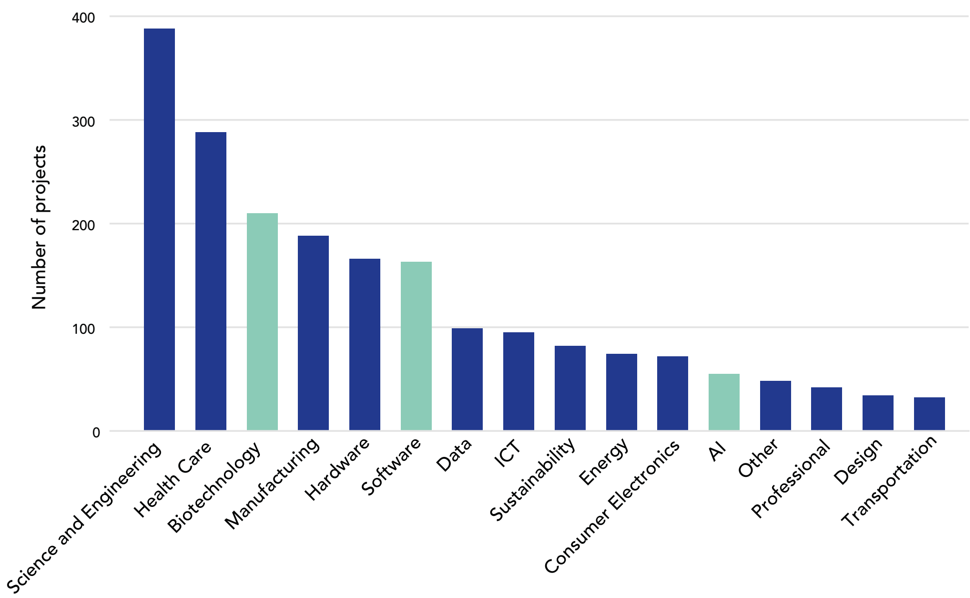


Employees of Horizon Europe companies by programme



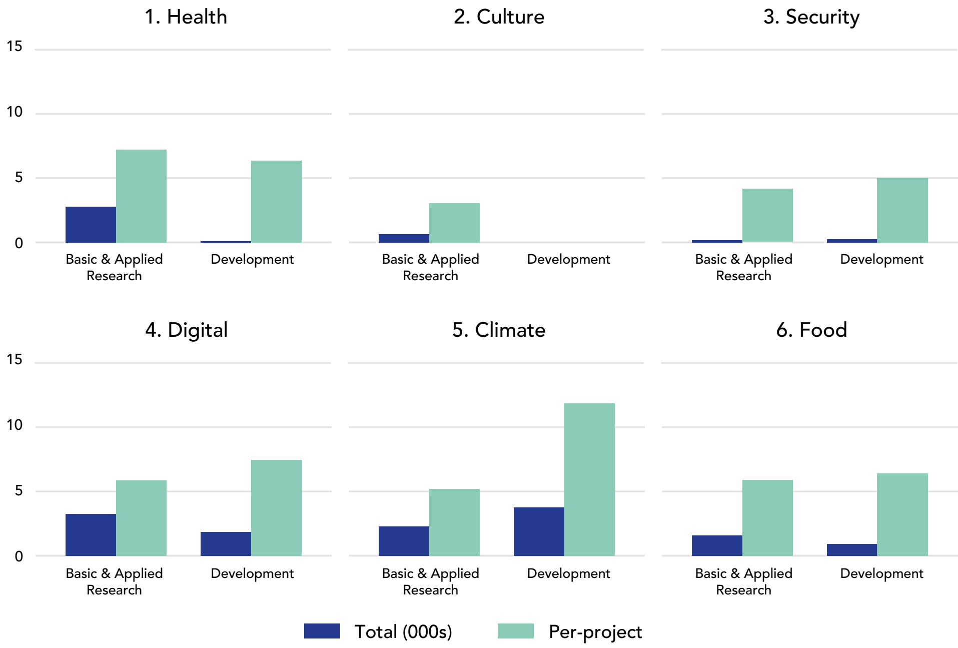
Source: Crunchbase.

Figure 19.



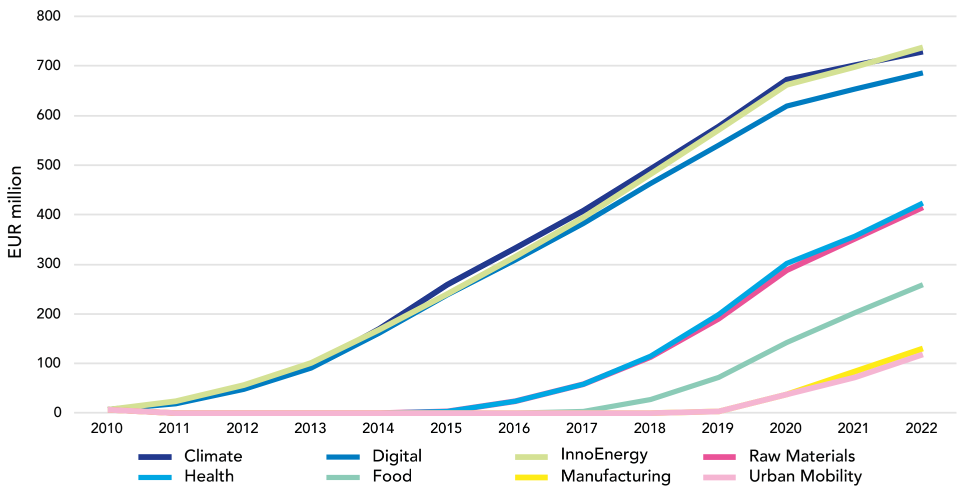
Source: Crunchbase.

Figure 20.
EU funding by activity type (million €)



Source: authors' calculations based on CORDIS.

Figure 21.
Cumulative Funding of EIT-KCIs



Source: own calculations based on https://eit.europa.eu/global-challenges/about-our-communities.

Figure 22.
Corporate venture capital investment by headquarter region of the Scoreboard parent company

Source: Grassano et al. (2022), page 30.

Governance of European research/innovation bodies

The table below provides a synoptic overview of the governance characteristics of key EU bodies tasked with promoting research and innovation. These bodies have very different governance structures.

The main message that emerges from this table is that the governance of the ERC is much more independent from the Commission than the EIC or the EIT. Moreover, the academic qualifications of the scientific members of the respective boards vary enormously.

Table 2.
Overview of main governance elements of EU Research/Innovation bodies

	European Research Council	European Innovation Council	European Institute Of Innovation And Technology
President's qualifications	Senior and internationally respected scientist	A high-profile public figure linked to the world of innovation	Governing Board shall elect its Chairperson from among its members
Appointment of the president	Appointed by the Commission, which selects one among three names proposed by the Scientific Council[57]	Appointed by the Commission	Appointed by the Commission
Board members' appointment	The Scientific Council is appointed by the Commission under the recommendation of an Independent Identification Committee	Appointed by the Commission	Appointed by the Commission
Qualifications required	Independent scientists, engineers and scholars of the highest repute	Entrepreneurs, corporate leaders, investors, public administration experts and researchers, including academic experts on innovation	Proven experience in the fields of higher education, research, innovation or business
Scientific/ technical qualifications of the Board/ Scientific Council	All 22 members are professors and in the Web of Science, with an average h-index of 58 and average citations of over 18,000.	5 out of 21 members are professors, 11 have a PhD, of whom 7 are in the Web of Science with an average h-index of 18 and average citations of 2,000.	2 out of 14 members are professors, 8 have a PhD, of whom 5 are in the Web of Science with an average h-index of 25 and average citations of 8,000.
Term	4 years, renewable once	2 years, renewable twice	4 years, extendable by the Commission once by 2 years on a proposal of the Governing Board
Independence	Independent of extraneous interests	Not required	Not required
Tasks/ competences	(a) overall strategy for the ERC (b) the work programme for the implementation of the ERC's activities (c) the methods and procedures for peer review and proposal evaluation	Advise the Commission Upon request address ecommendations to the Commission	Provide strategic guidance and select, evaluate, and support the Knowledge and Innovation Communities
Work programme	Established by the ERC Scientific Council	Commission decision, following the advice of the EIC Board	Strategic Innovation Agenda set by EU regulation for the 7-year period

Note: The legal framework of EIT has been modified since its creation in 2008, in particular in 2021. See https://eur-lex.europa.eu/EN/legal-content/summary/european-institute-of-innovation-and-technology-eit.html

Sources. Own evaluation on the basis of Publications Office (europa.eu) for the EIC and ERC; for the EIT, see https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2021:189:FULL

57 The Chair is appointed by the European Commission to a position as Special Advisor to the Commission, after submission of the dossiers of the three finalists in the selection made by an independent committee to the Scientific Council, which can only issue a veto.