Memo to the commissioner responsible for research and innovation

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Various indicators show the European Union continuing and even increasing to lag behind the United States and China on research and innovation, mostly for R&D carried out by companies. You must use the main instrument at your disposal – the Framework Programme for research – to push for improvements in the EU position, while bearing in mind that most EU public R&D spending comes from the budgets of member states.

In reforming the EU research programme and its components you should be guided be an assessment of the effects of any EU research spending in terms of redressing the EU's current R&D performance deficits, learning from what has worked best in the past, while not being shy to pilot new instruments, including an EU mission-oriented advanced research projects agency. You should show more clearly how EU countries are benefitting from EU research support, while remaining internationally open.

Implement effects-based Framework Programme reform

Develop a truly directed, mission-oriented perspective

Foster partnerships based on excellence

State of affairs

EU spending on research and development hovers at around 2 percent of GDP, while the US spends increasingly more

The recent performance of the European Union's research and innovation system compared to the United States and China mostly delivers an alarming wake-up call. EU spending on research and development hovers at around 2 percent of GDP, while the US spends increasingly more, meaning the gap is widening rather than shrinking (the US share was 3.5 percent/GDP in 2022). Meanwhile China has overtaken the EU on this indicator, with a 2.4 percent share in 2022. Within the EU, there has been very slow convergence: the bottom five EU countries in 2022 spent only 31 percent of the EU average GDP share, though this was up from 28 percent in 2015.

Public funding of R&D in the EU is provided mostly at national level. While this memo focuses on EU publicly funded R&D as your main instrument, it is important to note that the EU research spending deficit compared to the US is not down to public funding. Rather, the business sector is responsible for the persistent and growing EU R&D deficit relative to the US. Government-financed R&D was 0.66 percent of GDP in the EU in 2022 and 0.6 percent in the US, but the shares of GDP for business-financed R&D were 1.22 percent and 2.4 percent respectively[1]. This business R&D deficit has been long-standing (in 2015 the respective EU and US numbers were 1.12 percent and 1.76 percent), but the EU has not been able to reduce it.

In terms of high-quality science as measured by top-cited publications, however, the EU-US gap is shrinking. But China has taken the lead, with a 25 percent share of the world's top 1 percent most-cited publications in 2022, compared to 22 percent for the US and 19 percent for the EU. If the United Kingdom and Switzerland are included, 'Europe' with a 26 percent share has increased its lead over the US and still, though marginally, outdoes China.

The EU's lag in patent performance over the US has reduced somewhat over time. The EU share of patent applications filed under the Patent Cooperation Treaty was 19 percent compared to 22 percent for the US. But again, China is fast rising, with a 26

1 For China, the shares of GDP in 2022 were 0.46 percent for government-financed R&D, and 1.9 percent for business-financed R&D.

percent share compared to 14 percent in 2015 (when the EU27 and US shares were 24 percent and 28 percent respectively).

The EU still leads the US in AI-related scientific publications, but has been overtaken by China

In AI, a major battleground general-purpose technology, the EU still leads the US in AI-related scientific publications, but has been overtaken by China. On AI-related patents, however, the EU is a dwarf. The AI patent race is between the US and China, with China winning.

Finally, the position of EU firms in the ranking of the 2500 largest R&D spending companies worldwide illustrates the EU's lagging business R&D performance. In 2022, EU companies held only 15 percent of these slots, less than half the US number. As US firms on average are highly R&D intensive, the lead of the US over the EU is even bigger in terms of scale of R&D spending. Meanwhile, China's share of the top 2500 firms was the same as the EU27 in 2017, but almost double the EU27 share in 2022.

The continued and increasing dominance of the US over the EU and the catching-up of China is very much driven by sectoral composition. The most strongly growing sector in innovation terms is information and communication technologies (defined broadly as electronics, hardware and software, and ICT services). Alphabet, Meta, Microsoft and Apple – all US companies of course – were the world's top four R&D spenders in 2022, followed by China's Huawei in fifth place. EU firms are virtually absent from the top ICT R&D spenders. Health is the second most important sector in the innovation landscape, but the EU firms in this sector are on average only mildly less R&D-intensive than their US counterparts.

One sector dominated by EU firms is automotive. The strong concentration in this medium-tech sector contributes to the EU's significantly lower overall corporate R&D intensity (referred to as the "*EU mid-tech trap*"; Fuest *et al*, 2024). But even in the automotive sector, EU firms are increasingly challenged by the new wave of interconnected, autonomous and electric cars from China and the US. In 2022, China's BYD recorded the highest year-on-year R&D growth rate in this sector (80 percent).

Table 1: Sectoral R&D intensity, 2022

	Share of region in sector total R&D (%)			Region's R&D to sales ratio			Region's share of top 10% R&D-spending firms per sector*		
	ICT	Health	Cars	ICT	Health	Cars	ICT	Health	Cars
China	18	6	13	7.7	7.6	5.2	18	3	12
US	55	52	19	12.3	13.1	5.1	49	53	18
EU	9	17	42	7.2	11.6	5.5	7	19	41

Source: Bruegel based on 2023 EU Industrial R&D Investment Scoreboard. Note: * refers to top 10% firms per sector from the 2023 EU Industrial R&D Investment Scoreboard.

Correlated with the EU's persistently lagging business innovation performance are the differences between the EU and the US (and China) in the incumbency of their leading R&D spending firms. This is most striking in ICT: the sector top five are well-established but all still relatively young stars (Alphabet, Meta, Microsoft, Apple and Huawei), while stellar growers like Nvidia, established in 1993, was already ranked 26 in 2022. The EU firms with the highest R&D spend in ICT are incumbents SAP followed by Nokia and Ericsson. Relatively young star ASML (established in 1984) ranks 36. In cars, all EU leading firms are incumbents, while Tesla is the US's highest R&D spender in this sector and BYD is China's second largest R&D spender. The same issue of vintages prevails in the health sector. Of the 31 US health firms in the top 10 percent of R&D spenders, 11 are new (including Gilead, Amgen, Novavax and, more recently, Moderna). In contrast the EU has only one new health firm, BioNTech, among its largest R&D spending companies.

Challenges

Failure to redress the EU's growing business corporate R&D deficit

The EU's increasingly lagging performance in R&D spending is not explained by public funding levels or even science, but by its business sector R&D. While Europe has pockets of great science, it typically succeeds less in turning them into innovative corporate successes. Compared to the US, and more recently China – which

hosts most of the new corporate R&D leaders, especially in digital and innovative digital/AI using sectors – the EU corporate R&D system generates both fewer new leading innovators and fewer dynamic incumbent leaders. This has been a long-diagnosed challenge for the EU, which policy does not seem able to address. The EU's business innovation shortfall has become even more critical in the fast-changing and highly competitive global AI-powered innovation environment.

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A less open global innovation environment

The global innovation scene is increasingly characterised by a race between the US and China for technology sovereignty and dominance, protected by domestic fences. This challenges the EU's traditionally open-to-the-world approach to R&D, with the EU struggling to adopt a strategy of "*as open as possible, as closed as necessary*" (European Commission, 2021).

Addressing innovation gaps with a limited instrument: the EU's Framework Programme budget

While the challenges for EU's innovation system are sizeable, structural and urgent, your powers to address them are modest. Your main tool is the portion of the EU budget that goes to research, its Framework Programme (FP). While public funding is not responsible for the EU lagging behind the US on innovation, it could nevertheless help to address its business innovation gaps – but only if flanked by policies that improve framework conditions for private investment in research and innovation. Unfortunately, the latter are outside your remit. And the budget instrument with which you can work, albeit sizable (€100 billion in the current seven-year budget), represents only a small share of the total public budget for R&D spent by EU countries. The power of EU research spending should thus be seen in terms of what extra value added it can bring alongside member-state spending to alleviate the innovation gap, and policies to improve framework conditions.

The next FP will start during your mandate. Discussion have started already, mostly about the size of the budget, with stakeholders demanding a massive expansion. Less discussed is how to use the next budget to address the EU's major challenge: narrowing the business innovation gap.

Lack of intra-EU cohesion

In light of evidence indicating weak or no convergence in R&D performance across member states, the question is how to reconcile broader participation in the FP with excellence-based selection (which remains crucial if the FP is to improve innovation performance). There is also no consensus between EU countries on whether and how to support R&D through EU-level instruments, or through coordination of national instruments.

Recommendations

Implement regulation in an innovation-friendly way

Most of the focus of your term will be on the size and content of the next Framework Programme budget

Most of the focus of your term will be on the size and content of the next FP budget. Rather than being guided by the usual stakeholder consultations, which typically lead to path-dependent calls for more money for an at best marginally changed FP, you should seek agreement based on evidence of the FP's effects. The main weaknesses that the next FP must address are Europe's weak science-industry connectivity and the lack of new players able to grow to sufficient scale for world innovation leadership and/or to challenge incumbents. The key performance indicator you should use is therefore the contribution of the portfolio of FP instruments to nurture the next scientific and technology ideas that will boost business innovation.

Taking an effects-based approach requires *ex-ante* and *ex-post* micro and macro assessments of the long- and short-run impacts of the FP portfolio and its instruments. This requires a permanent in-house monitoring and evaluation capacity, which should open source its data and methodologies so that external expertise can validate and complement internal analysis. In its evaluation of the previous FP, published in January 2024, your services used macro-econometric exercises to come up with a 1:5 multiplier for the direct and indirect economic effects from each FP euro spent. This is a generous assessment, which could do with more independent robustness analysis. Also needed is more hard evidence on the direct and indirect benefits of the instruments in the FP portfolio.

Programmes that fail to show unique value, and that do not pass the test of *ex-post* evaluation of their effectiveness and proportionality, should be subject to the sunset clause, creating budgetary space for new programmes.

Empower the FP instrument: innovation effectiveness

The EU's entrepreneurs face obstacles in bringing their ideas to commercial fruition, particularly in finding risk finance

The EU's entrepreneurs, particularly first-time and radical innovators, aspiring to be the new world leaders and/or to challenge incumbent leaders, face obstacles in bringing their ideas to commercial fruition, particularly in finding risk finance. Public funding support could help to address this barrier.

The FP's Open Innovation pillar and its new instrument, the European Innovation Council (EIC), are a small (less than 10 percent of the total FP budget), step forward towards addressing this issue. As various support schemes already exist both in member states and at EU level (for example, the European Investment Fund), the question is what unique value the EIC can bring to the public funding landscape. Unfortunately, it is too early for hard evidence of its success. But you can justify the value added of the EIC over other instruments by referring to its potential to be an EU-level quality label. Being an EIC grantee could and should become valuable certification to secure other funding.

For this, it is critical that you install an EIC governance model like the European Research Council (ERC)

Based on an autonomous council composed of recognised technology leaders, who can design the programme and select the evaluators. The potential for EIC value added is more obvious for high-risk proposals in their early stages of financing, when certification is much more critical; it is less clear for later accelerator phases of financing. You should therefore prioritise the early-stage pathfinder EIC instrument over its accelerator instrument. Like the ERC, the EIC should be based fully on bottom-up proposals from entrepreneurs, and not confined to specific top-down selected areas or other requirements such as collaboration.

The Open Science pillar, currently about 30 percent of the FP budget, is perhaps the pillar that might be least on your radar, given

the EU's overall performance on scientific excellence. The ERC, relying on bottom-up proposals selected based on excellence only and with an autonomous and independent scientific council, has become a success story, as shown by EU's position at the world scientific frontier.

Particular attention should be paid to the Marie Skłodowska Curie Actions (MSCA), currently mostly dedicated to doctoral training. Researcher mobility is a critical pathway for knowledge networks, collaboration and connectivity. Yet, only a small part of the current MSCA budget, itself already relatively small, is spent on individual fellowships for mobility. Sending more EU researchers from academia to industry across borders will help bridge the EU's gap between science and the commercialisation of innovative ideas. It would help address the skills shortfalls that are identified by start-ups as a constraint in scaling up, and by companies as a major constraint in adopting new digital technologies. More targeting of MSCA mobility fellowships to specific missions would help improve the knowledge spillovers in key areas, such as AI. Enabling researchers to move from lagging countries to excellent research destinations, and to subsequently return or connect, will help in intra-EU convergence. In addition, mobility fellowships to and from non-EU countries are important to deliver on the EU's commitment to international openness. Any expansion of the MSCA programme should of course always be tied to evaluation of its intended impact.

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Empower the FP instrument: mission-directed

Global challenges such as climate change may demand more EU-level support and directedness. Tackling global challenges is what the biggest part of the current FP, Pillar II, is about. Pillar II should seek to stimulate intra-EU collaboration between science and industry in strategic technology areas (health, digital/AI, clean tech, quantum) and address the EU's weakness in connecting these dots at EU scale. Pillar II should be about bottom-up proposals for cross-border collaboration, selected on the basis of excellence and their impact in terms of tackling challenges. Specific calls, which are often only suitable for incumbents, should be avoided.

Still underdeveloped in FP is a truly directed, mission-oriented

perspective. Funding calls directed to new strategic fields, including hydrogen, AI, quantum computing and semiconductors, have been on the rise, but are too ad hoc. The new 'Missions' initiative in the current FP lacks a well-designed governance structure (Tagliapietra and Veugelers, 2023). The EU still lacks a mission-oriented advanced research projects agency (ARPA) supporting high risk/high gain projects using a goals-oriented, top-down approach (Pinkus *et al*, 2024). You should therefore consider creating an EU ARPA in the form of an independent agency with a mandate to fund precisely defined missions related to EU policy priorities. An ARPA-style approach requires sufficient funding – part of which could originate in the reallocation of existing budgets – to allow it to make multiple bets as part of a portfolio approach. (Sufficient does not mean enormous; for example, the budget of the US Defense Advanced Research Projects Agency is about $4 billion). Equally important is to design it properly, most notably, granting it autonomy and organisational flexibility, to recruit and accommodate the venture capital entrepreneur type of policy officers. Calls must have clear quantifiable goals and trackable metrics, so that policy officers can be given elevated levels of autonomy, together with clear accountability.

The EU still lacks a mission-oriented advanced research projects agency supporting high risk/high gain projects

Improve cohesion

The cohesion objective cannot be merged with the critical excellence objective of the FP. This dichotomy can only be solved by using multiple focused instruments. The Widening Participation and Spreading Excellence actions, introduced in the current FP, are targeted at supporting member states and regions in improving their capacities to adopt and adapt to new technologies. Focusing this instrument on widening will allow the other parts of the FP to remain focused on excellence. You only need to monitor whether the Widening Participation and Spreading Excellence actions complement other EU and national-level instruments to effectively unleash the innovation capacity of lagging countries and regions.

To shift the 'what's in it for me?' mentality of member states in the direction of a positive-sum, subsidiarity-consistent instrument, you should use your monitoring and evaluation capacity to document the direct and indirect gains for each EU country from

FP instruments, and how this depends on complementary national policies.

Stay open to the world

Science and innovation thrive on the international flow of ideas and cooperation. Even in a world of global retrenchment, it is important for the EU to remain open, certainly on science. It is important that the EU remains connected to the other global centres of science excellence. Past and current framework programmes have not been very successful in establishing links with the best science countries. Selection on the basis of excellence should become the priority for agreements with third countries, with the US and China being among the highest priorities, even if they are becoming less open, along with the UK and Switzerland.

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