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Sovereignty Built on Strength and Significance

Proposals for the EU to lead again in breakthrough innovation

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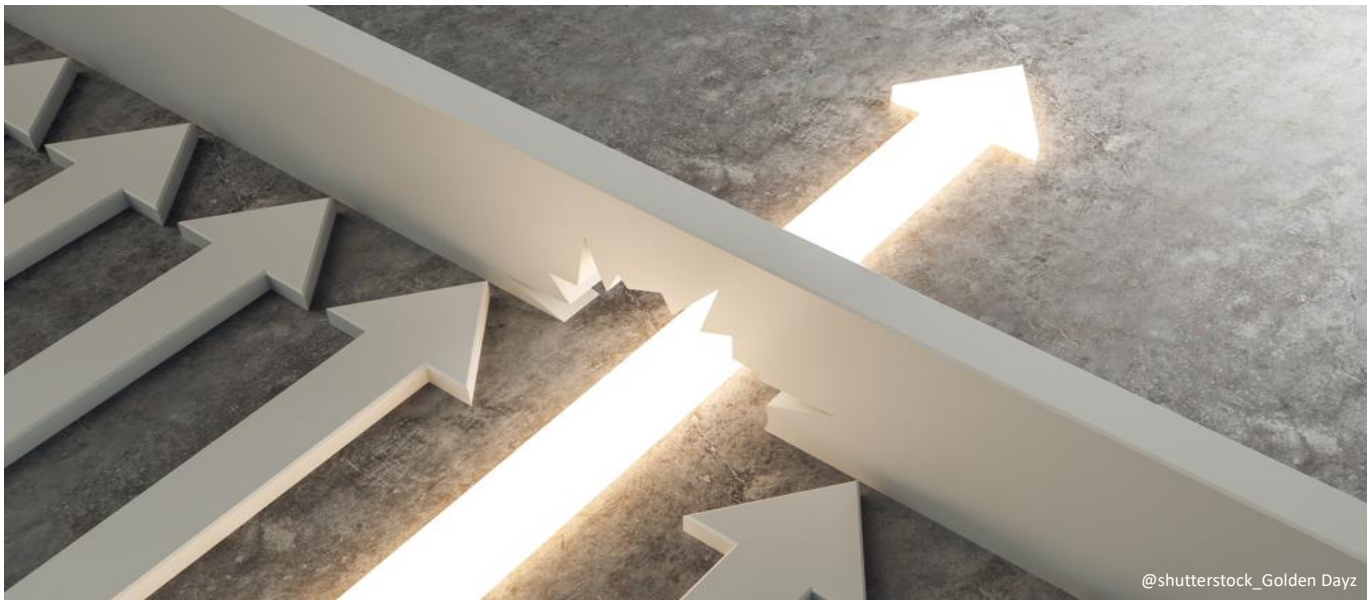


Europe has been able to grow over the last 30 years via a model largely based on incremental innovation, a strong industry, and exports. However, this situation is challenged today as the world is getting more geopolitical: regional blocs dominated by the United States and China are increasingly developing regional growth models, where breakthrough innovation plays an increasing role to seek dominance. At this game, the EU is late: the traditionally strong European sectors in terms of innovation like the automotive or pharmaceutical industries, are at risk of disruption by external technologies. Besides, the EU has not developed a very powerful high-tech industry in key sectors like software to compensate. To get out of this trap, **the EU must among other things take more risks by focusing more on producing breakthrough - if possible disruptive – innovations**. The EU is legitimate to pursue that objective when it is related to European public goods like European security and defense, economic security, public health, or environmental protection, whose related private R&D expenditures are suboptimal and should be compensated by a public involvement, with positive spill-overs to industries.
Hence, after precisely defining the different categories of breakthrough innovations and better characterizing the situation in the EU, the following study focuses on two breakthrough innovation systems that have showcased results to infer European solutions: the American ARPAs, and the Chinese "Zhongguo System". It results from the analysis that, **for the EU to give itself the capacity to lead again in breakthrough innovation, it should**:

- **Dedicate a fixed share of 0,02% of EU's annual GDP to an independent European dual-use goods breakthrough innovation agency (EDUGBIA);** boost public procurements to the European defense industries in order to allow them to incubate EDUGBIA exponential technologies; coordinate the 27 to finance these innovations via a highly confidential and secure European marketplace.
- **For other European public goods, test a "Innovation Champion's League" system targeting young high-tech SMEs,** support these SMEs with a multiple tier "Industry 5.0" program, perpetuate and widen the system if it works; integrate the Joint European Disruptive Initiative as official European independent agency for non-defense "moonshot" innovations.
- **Gather a team of charismatic figures dedicated to travel in European schools**, and produce more European cultural audiovisual programs, in order to inspire more students to follow STEM studies and become entrepreneurs.

Successive experimentations and iterations based on these proposals shall help us define which breakthrough innovation model best suits European needs and aspirations, to remain strong and significant. It is nevertheless urgent to start experimenting as soon as possible.

Preamble

Europe is facing a time of historical upheaval, a time of internal and external threats to peace and freedom, with great opportunities as well as risks from new technologies, and a time beset by the consequences of climate change and its impact on prosperity and justice. Today's Europe is the result of its eventful history, its experiences and the lessons it has learned from its scientific and cultural achievements, from its civilisational accomplishments, as well as from war, suffering and crisis. The legacy of the past has also given us a promise for the future: human dignity and freedom are inviolable. Today – in the face of major upheavals that will decide the fate and future of Europe – the question once again arises as to what solutions Europe can find to the troubles of the present and the challenges of the future. Can it preserve peace and freedom, defend its sovereignty and security, and increase prosperity and justice?

With this series of articles, the cep Network would like to draw attention to pressing issues and developments which go beyond day-to-day politics and regulation and will be of crucial importance for the EU in the run-up to a significant and game-changing European election. We aim to ask the key questions, shed light on their strategic context and provide some political answers.

Table of Contents

List of illustrations

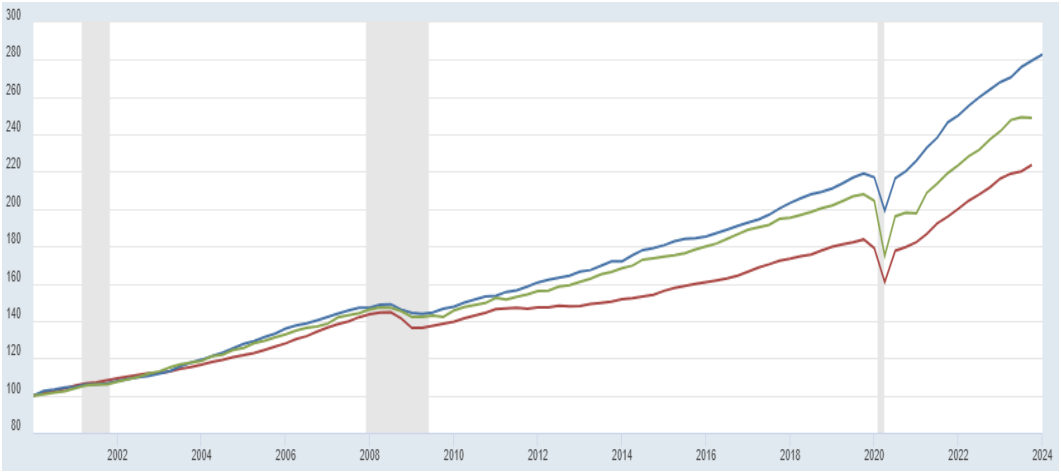
List of tables

1 Introduction

The European Union has been a great engine for growth over the last decades, especially before the Great Financial Crisis (see Figure 1). By implementing stringent competition policies[1], by promoting free trade and commercial surpluses as path to prosperity[2], it allowed a particularly vivid European industry to grow, especially since the 2000s to the end of the 2010s[3].

Nevertheless, the situation has changed: the growth of industrial demand is flat if not negative since that period[4], as the world is getting increasingly geopolitical and world exchange growth stalls[5]. This is among other things to be linked to a change of attitude from the US regarding free trade: for instance, tariffs are being reimposed in the US to prevent the flooding of American markets by highly subsidized Chinese breakthrough innovations like very cost-efficient electric vehicles[6]. On China's side, it is officially part of the economic strategy to seek self-reliance in terms of manufacturing supply chains, leading the country to replace foreign suppliers and foreign producers with local ones[7]. Everywhere one looks, the world is preparing for a "friendshoring" era[8], where allies and regional blocs tend to make their growth models more local when possible. In this context, and to face the increase in production costs induced by deglobalization, breakthrough innovation development plays a key role in the middle and long-term. Considering for instance that China will prevent from transferring its critical technologies to the rest of the world by any means[9], it shall be up to regional blocs to develop and strengthen their own innovation systems to keep up.

Figure 1: GDP over time for the United States, the United Kingdom and the European Union since 2000 (base 100 in 2000)



Source: Saint Louis' FRED, BEA, Eurostat, GDP. Office for National Statistics. Colors: (1) blue = United States, (2) green = United Kingdom, (3) red = European Union.

1 EUI, the Rise of European Competition Policy, 1950-1991: A Cross-Disciplinary Survey of a Contested Policy Sphere, 2010.
2 "The EU is highly open to trade, which makes it particularly vulnerable to trade disruptions." Gita Gopinath, IMF, Europe in a Fragmented World, 30.11.2023.
3 Eurostat, Long-term developments in industrial production – results from short-term statistics, 05.2021.
4 Central Bureau of Statistics, Manufacturing output down by 6 percent in March, 08.05.2024.
5 World Bank, Global trade has nearly flatlined. Populism is taking a toll on growth, 22.02.2024.
6 The White House, FACT SHEET: President Biden Takes Action to Protect American Workers and Businesses from China's Unfair Trade Practices, 14.05.2024.
7 Bruegel, What is behind China's Dual Circulation Strategy? 07.09.2021.
8 World Economic Forum, What's the difference between "friendshoring" and other global trade buzzwords? 17.02.2023.
9 KPMG, China's tighter grip on technology export restrictions, 02.01.2024.

How can the EU succeed to ensure long-term growth prospects in that context? To answer this difficult question, we shall first better define what breakthrough innovation means (Section 2), before characterizing the European situation in terms of breakthrough innovation (Section 3). Once problems are identified, inspiration for solutions is sought on the US' side with American ARPAs (Section 4) and on China's side with the "Zhongguo System" (Section 5). Finally, recommendations to allow the EU to lead again in breakthrough innovation are formulated (Section 6) and a conclusion is drawn (Section 7).

2 Defining breakthrough innovation

2.1 The different categories of breakthrough innovation

Breakthrough innovation describes an innovation that brings major advancement in one field, and usually open paths for other advancements, be it technological or commercial[10]. This advancement can be a product, a service, or a process. Breakthrough innovations can either be radical (high-tech) or non-radical (low-tech). Sometimes, they have the potential to disrupt markets by – at least partially – ousting incumbents whose productive and competitive structures end up out of date, or even to create new markets. Nevertheless, sometimes, they do not.

Table 1: Examples of groundbreaking innovation depending on their radical and disruptive features

	Radical breakthrough innovations	Non-radical breakthrough innovations
Disruptive breakthrough innovations	Personal computers, Reusable space rockets, App Store.	Containerization in shipping, MP3 players, Streaming video services.
Non-disruptive breakthrough innovations	Magnetic resonance imaging (MRI), Lithium-ion batteries, 3D-printing.	Online banking, HD televisions, Noise-cancelling headphones.

Source: own conception.

Where does disruption erupt? There is no definite rule allowing to predict the place of appearance of new disruptive innovations: it can come from well-established large innovative companies like Apple's Appstore included in the iPhone that created a market for digital apps[11], from long-established outsiders like the streaming platform of Netflix[12], it can come from bold newcomers like OpenAI's ChatGPT[13]. Finally, it can come from publicly supported research programs, like the Arpanet[14], financed by the American Defense Advanced Research Programs Agency (DARPA), which ended up giving birth to the

[10] ScienceDirect, Breakthrough innovations and where to find them, 01.2022.
[11] Innospective, The Smartphone Revolution: Why the App Store Was More Important than the iPhone, 21.06.2018.
[12] Harvard Business Review, Netflix's Bold Disruptive Innovation, 20.09.2011.
[13] Harvard Business Review, ChatGPT and How AI Disrupts Industries, 12.12.2022.
[14] Inria, ARPANET is now 50 years old, 22.10.2019.

Internet. Hence, disruptive innovation emerges in very different contexts and, sometimes, from the combination of various innovations that had not been combined before, like when lithium-ion batteries were associated with performing electric motors to produce attractive electric vehicles. For innovations to disrupt established markets and create new ones, they also have to display a certain level of cost-efficiency and performance to be appealing to the mainstream producers and consumers on these markets. When these technologies take time to reach the adequate cost-performance profile but reach it in an exponential way – be it regarding their cost-efficiency or performance, or both –, they are called "exponential technologies"[15]. Furthermore, their appeal to the market is also exponential as time passes by, and they can give way to "exponential returns" on investment at this occasion. This is how non-disruptive radical innovations become disruptive radical innovations. For instance, 3D-printers might soon reach a suitable combination such that they will be in position to disrupt and create markets.

Hence, in the following subsection, disruptive breakthrough innovations – and especially radical disruptive breakthrough innovations – are given more focus as they are the ones showing the potential to sustain large productivity increases for a given economy as well as long-term growth.

2.2 Chasing disruptive breakthrough innovations to generate productivity increases and long-term growth prospects

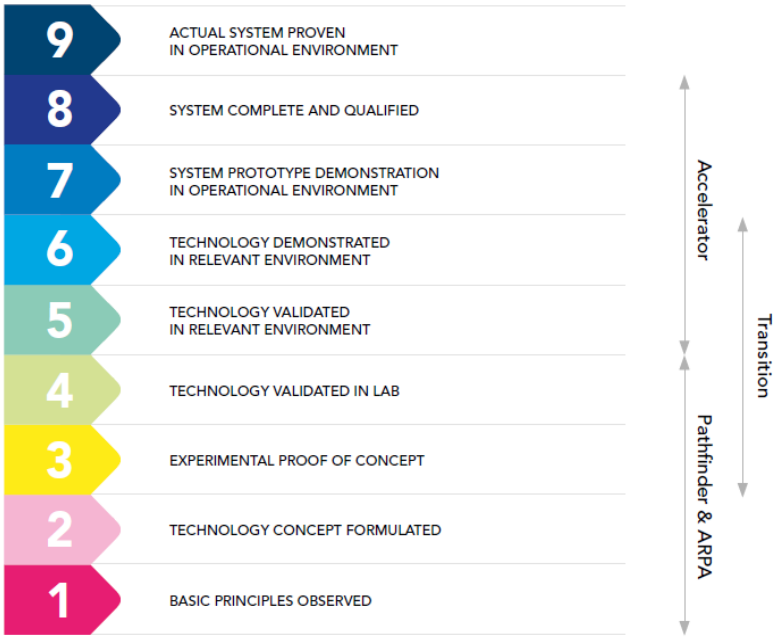
Disruptive breakthrough innovations have more chance to emerge from the periphery than from the core of a market[16]. It does not mean that established incumbents will not be able to produce disruptive breakthrough innovations, only they are less likely to do so than smaller marginal outsiders, whose organizational features – flexibility and agility among other things – are more compatible for disruption[17]. Other characteristics favor these structures: usually, the persons taking part to these start-ups are more likely to think differently from the "entrenched elite" working at large incumbent companies[18]. They also have less to lose – if not nothing – by undertaking high-risk high-reward projects[19]. Thomas Kuhn said that scientific revolutions happen "one grave at a time"[20]: this also holds for commercial and technological revolutions, which happen when newcomers or very innovative incumbents are able to oust other incumbents from the low-end mainstream segment of their market(s)[21]. Hence, it is probable that one economy will be able to boost its disruption potential and long-term growth by encouraging entrepreneurship from talented individuals in key sectors. Given the technology-intensive nature of our developed economies, these key sectors usually involve a high degree of technicity and will thus mostly require "scientist-entrepreneurs" to produce disruptive breakthrough innovations.

To foster disruptive breakthrough innovation in that context, it is important to consider the financing system that shall help high-quality research – on which patents are usually based[22] – become a breakthrough, and then a disruption. The different sources of funding needed usually are the following:

15 Creative HQ, What is exponential technology?
16 Stanford Business, To Discover Breakthrough Ideas, Look to the Outsider, 05.03.2024.
17 Ibid.
18 Ibid.
19 Ibid.
20 Ibid.
21 Harvard Business Review, What is Disruptive Innovation? 12.2015.
22 80% of research papers in the top 0.01% of high-quality research measured by three-year citation counts are references in patents, 60% for the top 0.1%, and 40% for the top 1%. ASPI, Critical Technology Tracker, 2023, p.13

bootstrapping (funding stemming from the innovator, or the innovation company)[23], venture-capital (funding stemming from funds specialized in high-risk high-reward projects)[24], scaling-capital and debt (funding stemming either from funds or banks dedicated to help the company scale on one or several markets)[25]. Considering technology readiness levels (see Figure 2 below), these three categories of funding capital correspond to Pathfinder & ARPA (levels 1 to 4 on the technology readiness ladder) for bootstrapping and venture capital, while scaling capital correspond to Accelerator (levels 5 to 9). Transition capital helps bridge companies that need transform their prototypes into scalable products.[26] This funding can either be private, public, or both. Economic science argues that the public sector shall intervene in that case when there is a market failure in terms of R&D expenditure, because of a lack of perceived commercial potential, or because of chronically depressed private investments. At the EU levels, these market failures are visible considering European public goods (European security and defense, economic security, public health, environmental protection, European infrastructures, etc.), which suffers from chronic R&D underinvestment due to their public nature.[27]

Figure 2: Technology Readiness Levels (TRL)



Source: EU Innovation Policy: How to Escape the Middle Technology Trap (Gros-Tirole Report), 10.04.2024.

How is the European Union doing in terms of breakthrough innovations and potentially disruptive breakthrough innovations regarding its public goods compared to the United States and to China?

[23] Corporate Finance Institute, What is Bootstrapping?

[24] Cambridge Dictionary, Definition of venture capital.

[25] Using the vocable of venture capital investment, scaling capital correspond to Series B and C fundraising, dedicated to scale the product at a national, then international level. Gilion, Funding stages of startups: Seed, Series A, Series B & Series C, 22.01.2024.

[26] In this context, Pathfinder, Transition and Accelerator correspond to the terminology used by the European Innovation Council, an institution dedicated to boost breakthrough innovation development in the EU since its inception in 2020 within the Horizon Europe program. European Commission, European Innovation Council, About.

[27] Journal of Policy Modeling, Good value for public money? The case of R&D policy, 2019.

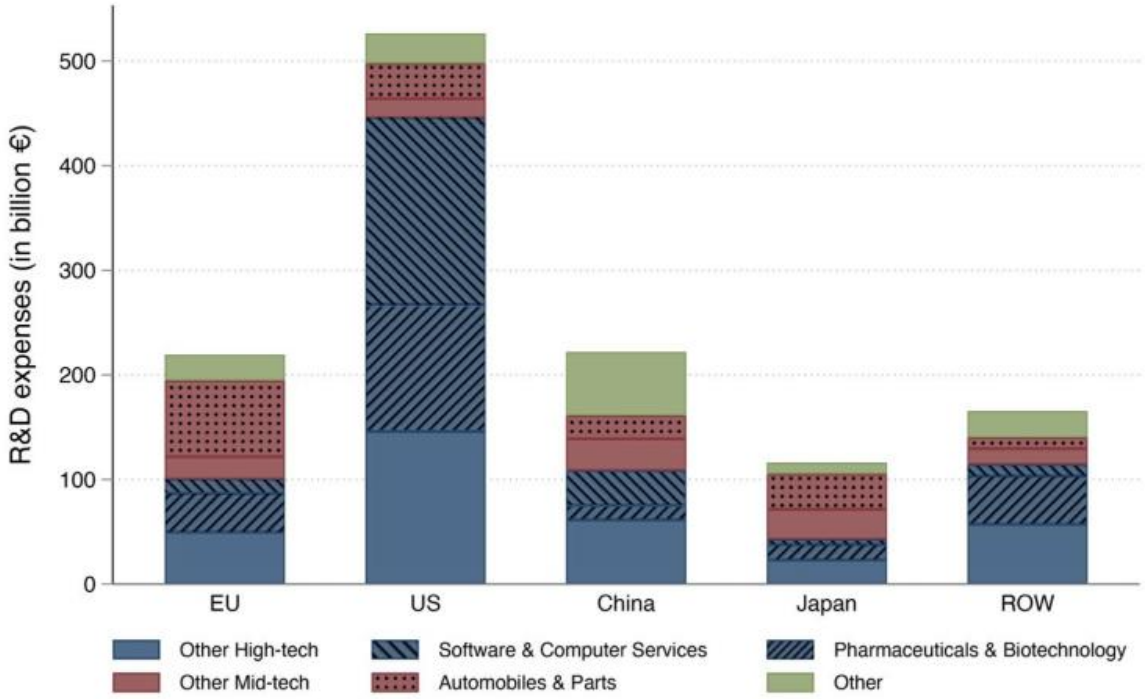
3 The European Union is behind in terms of public-good-related breakthrough innovation, jeopardizing its long-term prosperity

3.1 Reduced R&D investments, lacking disruption potential, and incumbent strength

The European Union has an R&D expenditure level issue: is it far from its objective of 3% of GDP of R&D expenditures per year introduced by the strategy of Lisbon in 2000 (2,11 in 2022)[28], even if some sensible national disparities are visible.[29] It is among other things linked to the size of companies: the total market capitalization of American companies in the top 2,500 companies at the world scale is 150% higher than the total market capitalization of European companies in this same top 2,500.[30] Furthermore, among these companies, the return on investments in 30% greater in the US compared to the EU, the level and growth of revenues is about 50% greater as well, as much as investments which is 60% greater in the US. Finally, R&D expenditures are 80% higher in the US than in the EU for these big companies.[31]

Besides this size effect, R&D spendings have a composition issue in the EU: as pointed out in the recent Gros-Tirole report, most private R&D investments in the EU are made in the automotive sector, which is categorized as mid-tech (see Figure 3).[32]

Figure 3: Business R&D spending by technology level, top 2,500 companies



Source: Industrial R&D Investment Scoreboard (2023), Gros-Tirole report.

[28] INSEE, Research & Development effort in the European Union, 17.05.2024.
[29] Sweden, Belgium, Austria and Germany are all above 3% in 2022, while the Netherlands and France are below 2,5% of their national GDP. Ibid.
[30] McKinsey, Accelerating Europe: Competitiveness for a new era, 16.01.2024.
[31] McKinsey, Accelerating Europe: Competitiveness for a new era, 16.01.2024.
[32] CEPR, Reforming innovation policy to help the EU escape the middle-technology trap, 19.04.2024.

In the digital sector for instance, which is categorized as high-tech, European R&D investments in 2019 only amounted to 8% of worldwide private digital R&D investments, vs. 11% in China and 77% in the United States.[33] This belatedness in the digital domain is also illustrated by the quantity of world-class patents in advanced digital technologies, which only reached about 10 000 for the EU in 2024, vs. 50 000 for the US, and 30 000 for China (see Figure 4). Besides, the EU invests significantly less than the United States in intangibles like software and databases, intellectual property, and economic competencies.[34]

Figure 4: Number of world-class patents in advanced digital technologies

Source: Association of the Bavarian Economy, Financial Times.

As a result, the share of Western Europe companies among companies in the top 1% of economic profit globally – which also are the greatest R&D spenders in the private sector – has been collapsing over the last three decades (from 32 to 16%, from 1997 to 2016) and shall continue to do so.[35] Besides, the number of unicorns – used here as proxy for potentially disruptive breakthrough innovations in the private sector[36] – is much less important in Europe than it is in the United States (about 600 vs. 150 in 2022).[37]

Last but not least, the top R&D spenders in the United States have dramatically changed over the last twenty years, while they have remained the same in the European Union over the same period, illustrating the – too large? – strength of incumbents as well as the too weak capacity of new companies to challenge the existing business order in the EU with their own innovations.

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33 McKinsey, Reviving innovation in Europe, 16.10.2019.

34 Ibid.

35 McKinsey, Reviving innovation in Europe, 16.10.2019.

36 Indeed, unicorns in Europe have been valued as able to generate above 1 bn EUR of profits over their lifetime because of the usually disruptive potential their product convey, such that expected returns are very high. Faster Capital, Unicorn Disruption: How Innovative Startups Are Shaping Industries, 02.04.2024.

37 Silicon Republic, Europe is slowly catching up to the US in the unicorns race, 06.07.2023.

Table 2: Top three R&D spenders and their industries compared over time

	2003	2012	2022
US	Ford (auto)	Microsoft (software)	Alphabet (software)
	Pfizer (pharma)	Intel (hardware)	Meta (software)
	GM (auto)	Merck (pharma)	Microsoft (software)
EU	Mercedes-Benz (auto)	VW (auto)	VW (auto)
	Siemens (electronics)	Mercedes-Benz (auto)	Mercedes-Benz (auto)
	VW (auto)	Bosch (auto)	Bosch (auto)

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

Hence, given this situation, the European economy is in danger. If American and Chinese breakthrough innovations display some disruptive potential in established sectors, large shares of European private R&D investments will prove irrelevant. The most jeopardized sectors are the automotive industries, the aerospace sector and pharmaceuticals.[38] Besides, The EU may also be outpaced in terms of technological advancement in new strategic areas like AI and quantum computing, without any possibility to come back.[39] For instance, in 2023, the European Union's private sector invested for instance 1.7 billion USD in generative AI, vs. 23 billion USD in the United States.[40]

3.2 The root causes of the European underperformance

Many factors are at play to explain that situation. When considering the "supply chain" of breakthrough innovations, one must first notice the "STEM crisis" that is occurring in the European Union: not enough students are willing to undertake hard-science studies such that there is a strong shortage of talents at the EU level. In 2021, there were 20% less STEM graduates per inhabitants than in the United States, and even 45% less that in South Korea.[41] This phenomenon is even more accentuated by the American Brain Drain which further depletes the stock of human capital on the old Continent.[42] It does not succeed in attracting other talents to compensate, providing the US with a massive advantage in terms of breakthrough innovation giving the increasing marginal returns of collaborative research between very strongly talented researchers.[43]

Furthermore, the financing capacities of the European Union in terms of venture-capital and scaling-capital is dramatically lower than in the United States.[44] Overall, the investment rates in the EU are also lower than in the United States.[45] Mario Draghi recently said that the European Union needed 500 more billion euros of investments per year.[46] A large share of this increased financial capacity could

[38] McKinsey, Accelerating Europe: Competitiveness for a new era, 16.01.2024.
[39] Euronews, Europe has lost the AI race. It can't ignore the quantum computing one, 23.11.2023.
[40] McKinsey, Accelerating Europe: Competitiveness for a new era, 16.01.2024.
[41] Ibid.
[42] NBER, Global Talent Flows, 2016.
[43] When matching selectivity increases, inventive productivity increases as well. Considering global talent flows, the highly selective emigration of talented researchers to the US does raise inventive productivity in research across the Atlantic. Matching externalities and inventive productivity.
[44] Sifted, The data: European vs. US VCs, 03.05.2021.
[45] IPPR, Now is the time to confront UK's investment-phobia, 20.06.2023.
[46] Politico, EU must find "enormous amount" of money to face global challenges, Draghi says, 24.02.2024.

improve R&D expenditures. Unfortunately, Europeans are unlikely to find these annual 500 bn EUR given the high-rate environment and strong fiscal constraints, while the persistent fragmentation of the single market in many sectors – including capital markets – keep on reducing even more the profitability of European investments and, hence, the available funding for productive investments.[47]

Finally, beside money, market size, and talents, a fourth factor can explain the European underperformance: the absence of convincing institutions connecting money and talents to pursue high-risk high-reward breakthrough innovation projects. Usually, following the classical ordoliberal playbook, innovative companies are the ones looking for funds to climb up the ladder of technological readiness, from basic research to scaled-up innovation. On this journey, they might get public or private funding, from various establishments. They follow their own agenda as decentralized economies are used to create wealth. Nevertheless, it has been recognized that specific circumstances necessitated transformative policies[48] – i.e. ad-hoc transparent industrial policies – to face external competition, especially from the United States and China. It is nonetheless straightforward that regarding certain public goods, especially European security and defense, operating in a transparent environment is not optimal and could even jeopardize the success of related industrial policies. Discrete and discretionary industrial policies targeting breakthrough innovations are more adapted to the preservation of this public good. In this context, the public sector eminently has a role to play, both because it regards public goods, but also because the need for confidentiality is very high.

Considering that no satisfying breakthrough-innovation institution exists at the EU level, we focus in the next sections on European economic rivals, i.e. the United States and China, to identify the reasons of their success in outpacing the EU in breakthrough innovation. Understanding how the US and China achieve better results in terms of potentially disruptive breakthrough innovations shall guide us to identify what is needed at the EU level.

4 Seeking inspiration: the American ARPAs

4.1 Nature and impact of ARPAs

Since the end of the 2010s, the world has understood that a lot of the directions taken by technological progress over the last 60 years had been driven by an American entity called “Defense Advanced Research Projects Agency” or DARPA.[49] This led many countries, including in Europe, to duplicate this concept for their own needs. The EU also has incorporated mission-driven programs in its 2021-2027 Horizon Europe innovation policy, but without aiming at mimicking the DARPA’s success features.

What is the DARPA? This entity created in 1957 after the Sputnik launch was born with the following slogan as guideline: “no surprise”.[50] Hence, to prevent the US from being surprised, the DARPA has been investing in very disruptive ideas from that day on, in a very entrepreneurial spirit. Overall, in the long-run, the US government invested on average about 0.015% in DARPA programs, for an expected return exceeding 10% of the US GDP annually, only for the US – i.e. an unbelievable but true overall return on investment of more than 66000%.[51] When considering the impact of DARPA-related

47 ECIPE, European strategic autonomy – What role for Europe’s fragmented single market? 10.2022.
48 cepInput, United We Transform, Divided We Fall!, 14.11.2023.
49 DARPA, About DARPA.
50 DARPA, Innovation at DARPA.
51 Harvard Kennedy School, DARPA: the Differentiator, Section 4.3, p. 8.

innovations on other economies (like the Internet or the GPS), many more trillions of dollars of annual GDP can easily be added.

To illustrate it differently, according to Mazzucato[52], about 80% of iPhone components were the result of early-stage DARPA programs. In a different domain, Boston Dynamics was missioned to design a humanoid robot to perform strength tasks in the contest of a DARPA program and is now well positioned to lead in humanoid and life-like robotics.[53]

Given these successes, since the 2000s, the American government has widened its use of such programs by creating an ARPA for energy (ARPA-E), for intelligence (IARPA), and for health (ARPA-H).[54]

4.2 ARPAs' objectives and philosophy

All these institutions have in common to pursue American-public-good-related objectives.[55] This dimension is key to the success of ARPA programs. For instance, national security is typically a public good that suffers from an associated collective action problem that leads to chronic underinvestment and fewer innovations if the state does not step in. Besides, by being mission-driven, they adopt an approach that completes the traditional ordoliberal approach: when innovation discovery financial efficiency is favored by classical ordoliberal theory, mission-driven systems favor innovation discovery speed. Said otherwise, by pursuing national security objectives to avoid any technological "surprise", without any preconceptions on the method to achieve them, ARPAs are allowed to be fully discrete, discretionary, agile and adaptative to live up to their challenges as fast as possible.

This specific method is linked to ARPAs' successes for another reason: seeking transcendental "moonshot" objectives, be it related to national security or other public goods like public health, climate or environmental preservation, is oftentimes a great source of inspiration, enthusiasm, and motivation for participants to ARPA programs. This also helps create solidarity and hard-work ethic within project teams to ease their pursue of difficult objectives.

4.3 ARPAs' project selection

Which technologies do ARPAs target? ARPAs only intervene in certain circumstances, i.e. when a specific national-security-related objective can be reached via a promise of breakthrough innovation that the market refuses to finance given its unfavorable risk-reward profile. Since ARPAs only finance high-risk high-reward projects, their success rate is low. Breakthrough innovation financing success is indeed very uncertain. And, even if peer-reviewing help reduce uncertainty[56], as a former responsible of the DARPA would phrase it, "if we reach more than 20% of success, it means we did not take enough risks".[57] To prevent any "pick-the-winner" effect that shall create disincentives for companies

52 Mariana Mazzucato, The Entrepeneurial State,
53 DARPA, Début of Atlas Robot.
54 NBER, Funding Breakthrough Research: Promises and Challenges of the "ARPA Model", 06.2018.
55 Recently, ARPA-H dedicated to finance "moonshot" projects related to health was introduced. This new agency does not pursue national security objectives.
56 Even if peer-reviewing has its importance to select programs and projects in ARPA contexts, their biases on novelty – as a group of peers will tend to agree upon what they know and disagree on what they don't know – typically undermines the likelihood of supporting deep breakthrough innovations when relying on this selection method. Therefore, nothing ultimately replaces the discretionary power of the program manager of selecting programs and projects.
57 NBER, Funding Breakthrough Research: Promises and Challenges of the "ARPA Model", 06.2018.

participating to ARPA programs, it is usual that several companies/projects are financed by the same program to sustain competition – ARPA programs are neutral in terms of competition.

Figure 5: the three characteristics an ARPA program must display to be financed

Source: NBER, funding breakthrough research: promises and challenges of the "Arpa Model", 06.2018.

Besides, ARPAs typically intervene at the bottom of the technology readiness ladder: they aim at bridging basic research and proof-of-concept (levels 1 to ¾, see Figure 2). More precisely, they focus on projects that are prone to offer the greatest expected return on investment, whatever the risk level is.[58] Once the promise of breakthrough has been realized, the proof-of-concept is usually incubated either by the public sector (via, for instance, public procurements from the Department of Defense for defense breakthrough innovations) or the private sector if the company involved in the breakthrough does not need strong public support to commercialize its innovation. Generally, since the proofs-of-concept necessitated ARPA programs to come to life, they usually belong to the category of exponential technologies, which means they need long incubation to reach an appealing cost-performance profile for the market.[59] Most of the time, the public sector continues to play a role in this incubation.[60]

[58] NBER, Funding Breakthrough Research: Promises and Challenges of the "ARPA Model", 06.2018.
[59] Ibid.
[60] Ibid.

4.4 ARPAs' organisation

How do ARPAs operate? When considering the original DARPA, it currently has about 100 program officers, managing up to 250 programs.[61] A program duration is typically short: from 3 to 5 years, with flexible contracting allowed.[62] Program managers[63] are key to the success of DARPA: they usually are selected outside the administration for their recognized scientific expertise in a certain field and are given much leeway to organize their programs as they want. First, they have a great role in defining the national-security-related specific objective that her/his program will pursue. Furthermore, their added value usually resides in their capacity to connect circles and people that would not have worked with each other otherwise. They can come from universities, public laboratories, venture-capital funds or other types of institutions. Building-up the project team is a key component of a project's success. In this context, program managers have a great discretionary power, and are also supposed to actively manage the program along its duration, by either cancelling projects or extending their funding if they are promising, or by reshaping teams. Nevertheless, teams themselves are also frequently associated to capital, task, milestone-setting and technology decisions throughout the project. Program managers is accountable to the director of the ARPA and can also be checked by a college of program manager alumni. Hence, the program manager is overall the key person to bring harmony and success to ARPA programs. Finally, this bottom-up structure brings much flexibility to the organization that is in fact everchanging.

4.5 ARPAs' financing

Regarding program and project funding of ARPA programs, let's take again the example of the DARPA. Its enacted budget for 2024 was 4.122 bn USD and is expected to reach 4.369 bn USD in 2025 – i.e. far less than 1% of total military expenditures in the US.[64] Hence, if we assume that the average annual DARPA budget between 2000 and 2025 was 4 bn USD, and that about 250 programs were financed, and that programs last on average 4 years, each program benefited from about 64 bn USD. If 10 projects are financed by one program, it would benefit from more than 6 bn USD on average to achieve its foreseen breakthrough, which is very comfortable for a high-risk high-reward endeavor.

In comparison, at the EU level, the European Defense Agency and European Defense Fund only offer up to 435 000 EUR of support to help companies develop breakthrough innovations.[65]

61 DARPA, About DARPA.
62 NBER, Funding Breakthrough Research: Promises and Challenges of the "ARPA Model", 06.2018.
63 Ibid.
64 Ibid.
65 Intervention from André Loesekrug-Pietri at the Paris Strategy and Defense Forum, 13-14.03.2024.

5 Seeking inspiration: the Chinese "Zhongguo System"

5.1 The surprising success of Chinese breakthrough innovation systems

5.1.1 A massive advantage of China in terms of research impact for critical technologies

Even if it sounds rather odd to seek inspiration on the Chinese side regarding breakthrough innovations, one must nonetheless admit that China has indeed reached the technological frontier in many domains and could overcome the US in terms of breakthrough innovations very soon. For instance, regarding a panel of 44 critical technologies for tomorrow, an Australian think-tank – the Australian Strategic Policy Institute -- measured last year that 37 out of them were dominated in terms of research impact by Chinese authors.[66] The higher the research impact factor, the likelier the research will produce high-quality patents and breakthrough innovations.[67] And overall, China produces 5 times more high-impact research as its closest competitor, the United States.[68] China benefits from high research impact monopoly in nanoscale materials and manufacturing, advanced radiofrequency communications, hydrogen and ammonia as power use, electric batteries, synthetic biology or photonic sensors.[69] It benefits from medium research impact monopoly in smart materials, advanced explosives and energetic materials, distributed ledgers, photovoltaics, lasers, hypersonic planes and collaborative drones.[70] Furthermore, China dominates in terms of doctoral degrees awarded.[71]

If China succeeds in transforming this research into truly disruptive breakthrough innovations, it might represent a great challenge for the West, that will have to catch up if possible. Otherwise, it will be tempted to adopt Chinese technology, with the loss of sovereignty it implies. This catch-up shall furthermore be much more difficult than the Chinese catch-up of the last decades as the Chinese do not practice critical technology transfers – at all.[72]

5.1.2 An innovation output that already exceeds the US' one in absolute terms

This situation is even more likely as China is overcoming the US in terms of innovation output: innovation and advanced-industry capabilities increased in to reach 139% of American capabilities in absolute terms by 2020, vs. 78% in 2010.[73] Four years have passed, and these capabilities have even more improved, as characterized by the massive increase in robotization China experienced over the last years, among other things.[74] Therefore, China is developing a capacity to manufacture breakthrough innovations at a pace that Humanity has never experienced before.

66 ASPI, Critical Technology Tracker, 2023, p. 5.
67 Ibid., p. 13.
68 Ibid., p. 5.
69 ASPI, Critical Technology Tracker, 2023, p. 8.
70 Ibid., p. 8.
71 ITIF, Wake Up, America: China is Overtaking the United States in Innovation Output, 11.2022, p. 5.
72 KPMG, China's tighter grip on technology export restrictions, 02.01.2024.
73 ITIF, Wake Up, America: China is Overtaking the United States in Innovation Output, 11.2022, p. 1.
74 Financial Times, Chinese robot maker says protectionism will not stop its march, 04.04.2024.

5.1.3 Between innovation input and output, the "Zhongguo System"

But what are the bridges between innovation input and output in China? How does its breakthrough innovation system work? China is characterized by a unique approach to breakthrough innovation that combines strong patriotism – the domestic market is targeted[75], Chinese researchers have a duty to contribute to the national economy[76], foreign supplier and producer eviction is sought[77] –, sustained international connection – Chinese researchers typically go study and research outside China, and first of all in the US, at the beginning of their career[78] -, and massive subsidies in promising new fields.

In this context, central and local public authorities, universities, companies, venture capital funds, financial markets, and even households financially contribute to the "Zhongguo System"[79], i.e. the China System, according to which the entire society is working towards achieving the objectives enunciated by the government. These objectives have been among other things stated for instance in the "Made in China 2025" strategy[80], according to which China must become a technological leader in information technology (AI, IoT, etc.), robotics, renewables and alternative propulsion, planes, navy, energy generation, new materials, health and medicine, agriculture, and rail. The "Dual Circulation" strategy was launched in parallel and aimed at making China self-sufficient in key sectors by replacing foreign suppliers with local actors.[81] Therefore, China does not only have mission-driven institutions subsidizing breakthrough innovations, it also has a mission-driven society supporting it. And it seems to show some results given the edge China has gained in terms of related critical technologies within 10 years, as stated above. More recently, the Chinese government introduced the Plan for the Strategy to Expand Domestic Demand 2022-2035.[82]

5.2 The "Little Giant" program as declination of the Zhongguo System for SMEs

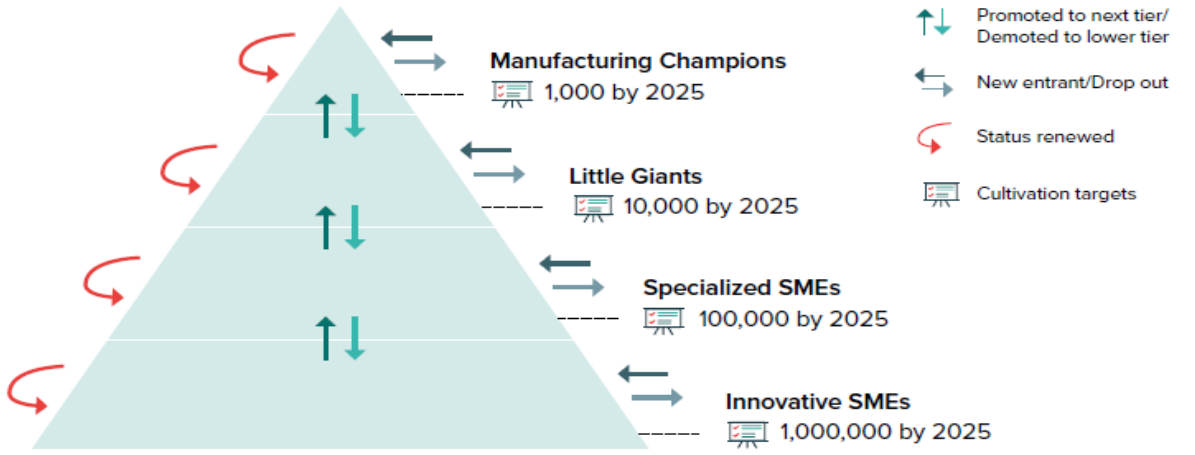
5.2.1 Maximizing high-tech SMEs' effort with a sport league system

To help achieve these objectives, the Chinese government also launched in 2018 a program to give access to improved funding and production conditions and costs to certain high-tech SMEs that could give an edge to China in key sectors or replace foreign suppliers.[83] This program is known as "Little Giant" program and work as a sport league system: certified high-tech SMEs get access to preferential funding and production conditions, and depending on their success and importance, they go up or down in the league system, improving or depreciating their funding and production access at the same occasion (see Figure 6). This league-shifting possibility is supposed to generate positive incentives, either to maintain oneself in a category, or to win the right to move upward. The innovation output is supposed to be maximized by following these principles. Research fully corroborates this assumption

75 CEPR, Assessing China's efforts to increase self-reliance, 04.01.2024.
76 Reuters, China's Xi calls for nurturing of patriotic scientists, 28.09.2021.
77 Bruegel, What is behind China's Dual Circulation Strategy? 07.09.2021.
78 NBER, The Contribution of Chinese Diaspora Researchers to Global Science and China's Catching Up in Scientific Research, 05.2020.
79 TED, What the World Can Lean From China's Innovation Playbook, 2023.
80 MERICS, Made in China 2025, 12.08.2016.
81 Bruegel, What is behind China's Dual Circulation Strategy?, 07.09.2021.
82 CSET, Outline of the Plan for the Strategy to Expand Domestic Demand (2022-2035), 14.12.2022.
83 MERICS, The Accelerator State: Small Firms Join the Fray of China's Techno-Industrial Drive, 29.04.2024.

for sport leagues[84], but there is no feedback regarding the validity of this assumption in the business domain. Indeed, high-tech SMEs are probably less interest in being promoted or relegated to funding and production categories than in achieving the breakthrough they pursue. This open experiment shall render its conclusions in a few years.

Figure 6: The "Little Giant" program designed as a sport league system to reproduce its incentives



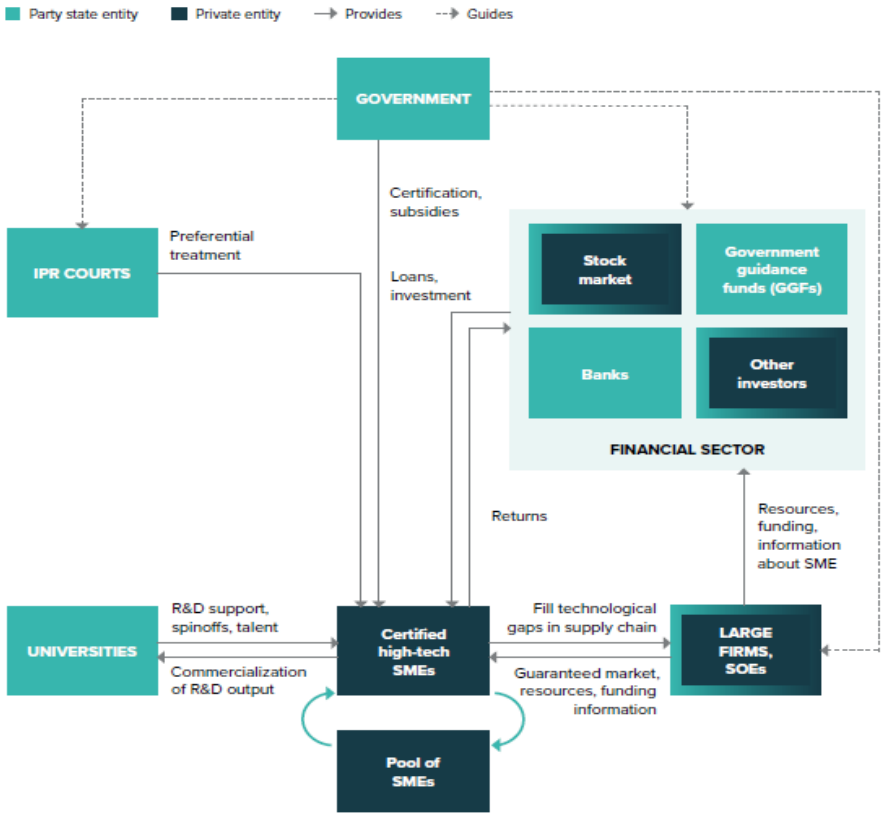
Source: MIIT, MERICS.[85]

Regarding funding, their provenance very well illustrates the Zhongguo system: central and local governments, universities, large companies, financial markets, venture capital funds, households via their savings, banks all contribute to the success of these certified high-tech SMEs (see Figure 7).

[84] League openness – i.e. promotion and relegation – tends to enhance effort incentives but diminishes incentives to share income. The Comparative Economics of Sport, Promotion and Relegation in Sporting Contests, 2010.
Sport leagues that practice promotion and relegation have higher aggregate spending on player talent than closed leagues. Profits are lower, but welfare is increased. Journal of Economics and Finance, A model of promotion and relegation in league sports, 20.01.2010.

[85] MERICS, The Accelerator State: Small Firms Join the Fray of China's Techno-Industrial Drive, 29.04.2024.

Figure 7: funding schemes for certified high-tech SMEs benefitting from the "Little Giant" program



Source: MIIT, MERICS.

5.2.2 Limits of the Little Giant program

Nevertheless, this public-private system is not exempt of shortcomings. For instance, the role of local governments in high-tech SME selection overponderates the importance of personal relations between local officials and companies receiving the title.[86] Therefore, it is not rare to observe selected companies that are typically out of the scope of the program, because they are too old, too large or not profitable.[87] Furthermore, the Little Giant program mostly target sectors that are in the scope of the Made In China 2025 and Dual Circulation strategies, which could lead to capital overallocation in these sectors at the expense of other ones. Besides, China still has a lot to do to improve its intellectual property system: the power of the Communist Party is far too strong and companies may have legitimate fears to see their innovations stolen with the assent of the judicial bbody. In 2023, it only ranked 50th in terms of intellectual property protection.[88] As long as the judicial system is not independent – at least in the domain of intellectual property protection -, Chinese innovators will suffer from strong disincentives to produce breakthrough innovations.

[86] Ibid. p. 2.
[87] Ibid., p. 8.
[88] Property Right Alliance, International Property Rights Index 2023, 2024.

5.3 The probable impact of a lack of individual freedom on breakthrough innovation intensity in China

Finally, individuals without freedom have a hard time challenging authority, be it economic, scientific or political.[89] Hence, it is less likely to observe the emergence of absolutely radical groundbreaking innovations in China compared to the US. Indeed, it was recently shown that after the introduction in 2018 of a US program limiting the scientific cooperation between Chinese and other US-based researchers, called the "China Initiative", the quality of the research of Chinese researchers decreased while the one of other US-based researchers remained unchanged.[90] Hence, being raised in a free country seems to give more abilities to challenge authority and produce radically authority-challenging breakthrough innovations.

Nevertheless, China might most of all continue to do what it does best: copying foreign breakthrough exponential technologies and making disruptive by improving their performance and decreasing their costs via an intensive use of labor[91]. With its unequalled manufacturing and funding system[92], China has all the power to massively produce innovations that will disrupt markets elsewhere, like eletric vehicles over the last years, although the country had never significantly exported cars before.

5.4 Defense: the Zhongguo system can potentially give a decisive edge to China

However, if the Chinese Zhongguo System leads to a too massive capital missalocation as one would imagine as possible in a communist system, and if the demographic decline of the country starts to limit the country's capacity to innovate, a financial crisis might put an end to this dynamic. This situation might eventually not be better for the West: if the Chinese government feels threatened by a depleted economic growth, it will certainly not try to democratize the regime first. Like in Russia, a simple new objective would be to wage war. Recently, the Chinese government renovated its Science and Techonology Military Committee to make it structurally closer to the American DARPA, with the objective of developing more defense-related breakthrough innovations.[93] No details have been disclosed on its functioning. Furthermore, when considering the 37 critical technologies China is leading in terms of research impact, the combination of certains of them – a usual recipe for breakthrough and disruptive innovations – could according to the ASPI give China the power (1) to outsmart all Western intelligence services, letting them go "into the dark", (2) to gain a decisive edge in AI-related warfare capacities, (3) to develop a new generation of collaborative killer drones.[94]

More than ever, defense-related breakthrough innovation institutions seem to play a great role in the future of technological leadership and Europe cannot ignore these threats.

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89 Journal of Technology Transfer, Freedom and innovation: a country and state level analysis, 25.04.2016.
90 College de France, Does Chinese Research Hinge on US Coauthors? Evidence from the China Initiative, 23.04.2023.
91 In Chinese technology companies, developers are used to work along the "996" rules: they must work from 9 am to 9 pm 6 days a week. Financial Times, China's ageing tech workers hit by 'curse of 35', 23.04.2024.
92 Tech In Asia, Why Chinese companies copy, 27.05.2015.
93 Science, China to create its own DARPA, 11.03.2016.
94 ASPI, Critical Technology Tracker, 2023, p. 18-19.

6 Recommendations for the EU to lead again in breakthrough innovation

Before anything else, one must first emphasize that eventually, nothing replaces a wide pool of high-level talents working in teams, benefitting from adequate funding and production conditions and costs, from adequate market potential, and dedicated to work very hard on producing breakthrough innovations. The modalities of these efforts can differ and previous cepInputs introduced their own vision of these modalities.[95] In complementarity to these visions, the cepInput proposes to introduce the following measures to help the EU lead again in breakthrough innovation. These measures are inspired by American and Chinese systems, but also aimed at being adapted to a European context and to existing European institutions, to correspond to EU values, and thus, to maximize their strength and significance. Ulterior discussions will allow to refine them.

(1) Dedicate a fixed share of 0,02% of EU's GDP to an independent European dual-use goods breakthrough innovation agency (EDUGBIA)

On January 24th, the European Commission released a white paper describing solutions to promote dual-use goods R&D in the EU.[96] The third solution provided introduced the idea of a "new instrument" dedicated to support dual-use good R&D. Assuming that this new instrument becomes after European negotiations a DARPA-like institution, showcasing the same level as the DARPA of independency, agility, discretion, adaptability, and rapidity in the development of breakthrough innovations, this agency should be endowed with a fixed share of EU's GDP. Indeed, as introduced above, only an annual budget equivalent to 0.015% of the US' GDP allowed DARPA to give birth to more than 10% of the current US annual GDP.[97]

Of course, this return on investment is measured more than 60 years after the creation of the DARPA. However, it is not irrational to assume that the EU will still exist in 60 years, as it already did for the past 60 ones too. If it succeeds in establishing an EDUGBIA as described above, more dual-use breakthrough innovations in compliance with EU values will be generated, with the hope of observing crowding-in effects from the private investors as we observe in the US[98], and of course with the hope of seeing many commercial applications for a wide public in the EU and elsewhere to generate exponential returns on investment.

Considering EU's 2023 GDP (approximatively 16.6 bn EUR[99]), the EDUGBIA should be endowed with about 3,3 bn EUR this year. Given the long-term impact of its breakthrough innovation projects, the EDUGBIA should receive a European funding commitment for 3 successive multi-annual financial frameworks (21 years). This institution must not be subject to political disputes, at least not in the short-term. Nevertheless, its effectiveness shall be econometrically evaluated on a three-five-year basis to help cancel or extend programs and projects.

To bring consistency in the defense-related institutional setup, this agency could also be a "subunit" of the European Defense Agency, while benefiting from a great political independence.

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95 See for instance, cepInput, Anticipating AI Instead of Preventing It, 2024.

96 European Commission, On options for enhancing support for research and development involving technologies with dual-use potential, 24.01.2024, P. 16 "option 3".

97 Harvard Kennedy School, DARPA: the Differentiator, Section 4.3, p. 8.

98 Research Policy, Does public R&D funding crowd-in private R&D investment? Evidence from military R&D expenditures for US states, 10.2023.

99 FRED, Gross Domestic Product for European Union.

Also, this EDUGBIA supposes to agree on European security objectives, that shall give a baseline to the EDUGBIA program managers and director, which will come from academia and industries, to design programs and select projects. Of course, these programs will have to target specific European security objectives while tackling a very promising research area the market is reluctant to consider given its high-risk profile. Given the current security situation in the EU, it is probable that a new European defense strategy will be negotiated after the appointment of the next European Commission. Emmanuel Macron mentioned in his second Sorbonne Speech the elaboration of a "strategic concept" related to European defense policies on April 25th.[100] This strategic concept should include some elements allowing to identify key European security objectives, that shall be revised at the appointment of every new Commission.

(2) Give the European defense industries more means to incubate EDUGBIA breakthrough innovations; coordinate the 27 via a highly confidential and secure European marketplace

The proofs-of-concept produced by the EDUGBIA will not be sufficient to produce potentially disruptive breakthrough innovations with exponential returns. They will need an adequate incubation period fed by public procurements to the defense sector to fully display their disruptive strength and commercial potential.

In this context, it makes sense to introduce a "European preference for dual-use-good-related innovations" in public procurements to the defense sector. This preference shall not be defined by a fixed share of innovation-related public procurements to the defense sector in each EU country, but rather by a coordinated effort of national defense sectors and governments to provide for venture and scaling capital to EDUGBIA-related startups. This coordinated effort could occur on an ad-hoc "digital marketplace" between EDUGBIA startups, defense industries and governments, where full transparency prevails in terms of sources of funding. Nevertheless, this transparency should only involve a minimal number of actors and should be subject to the highest level of confidentiality and cybersecurity, because of the European security objectives it aims at protecting.

It must also be made sure that defense industries and governments will provide sufficient funding for these EDUGBIA startups via increased defense expenditures, especially in the context of reaching NATO's 2% of GDP objective.

Eventually, this joint incubation effort shall help the European defense to consolidate via the birth of new European defense giants while incumbents shall also find incentives to merge between countries.

(3) For other European public goods, (a) test an "Innovation Champion's League" system targeting young high-tech SMEs, support these SMEs with a multiple tier "Industry 5.0" program, perpetuate and widen the system if it works; (b) integrate the Joint European Disruptive Initiative as official European independent agency for non-defense "moonshot" breakthrough innovations

The Gros-Tirole report of April 10th proposed a reform of the European Innovation Council (EIC)[101], which consists in reshaping the Pathfinder instrument – the only one really dedicated to breakthrough innovation at the EIC – to give more means to fund projects related to health and energy - while breakthrough innovation related to the Chips Act, space, critical raw materials, semiconductors and

[100] Elysee, Discours sur l'Europe, 25.04.2024.
[101] European Polcy Analysis Group, EU Innovation Policy: How to Escape the Middle Technology Trap, 04.2024, p. 36.

quantum technologies remain marginally supported. This proposal is a progress but, as Jean Tirole admits himself[102], this will not be sufficient to provide an adequate level of breakthrough innovation related to European public goods, and thus protect the EU against headwinds coming from the US or China.

In this context, we propose to test a multiple-tier funding/production breakthrough innovation system for young high-tech SMEs. This multiple-tier "Champion's League" system or "Innovation Champion's league" system shall provide incentives for European SMEs to innovate as much as possible to get the best funding and production conditions they can. The possibility of promotion and relegation are both meant to encourage high-tech SMEs to provide their best effort in the innovation process via external constraints.

The selection and integration to a funding/production access category will be made under a fully transparent and meritocratic procedure that will be audited by the European Parliament. The guiding principle will be that the more the innovation tends to be potentially disruptive, the more the company will access improved funding and production conditions. Said otherwise, these companies shall benefit from an exceptional regime – with less regulatory requirements among other things.

Its effectiveness shall be econometrically evaluated on a three-five-year basis. Nevertheless, it must be kept in mind that risks shall be taken in that context. Without risk, there won't be any breakthrough innovations in the EU. Keeping this in mind, if it is assessed to be a successful system, it shall be perpetuated and widened at the European level.

For starters, this system shall be supported on a voluntary basis by companies, financial markets, venture capital funds, households, universities, and governments. In particular, various industries could have the opportunity to join an "Industry 5.0" program dedicated to develop best practices for large-groups-SMEs production cooperation. Nevertheless, the coordination effort between all these economic agents shall be taken care of by the European Innovation Council that shall harmonize this new program with its existing Pathfinders.

Finally, this "Innovation Champion's league" system shall be rooted at the regional level to even opportunities for high-tech entrepreneurs between them. This regional system could be the first level of the league system, while the last one shall only count high-tech SMEs that have the potential to become European Giants, a new European economic elite.

Besides the system which would not purely be mission-driven as its guiding principles would only rely on the notions of European public goods, the Joint European Disruptive Initiative[103], dedicated to implement an ARPA-like organization for non-defense projects, could be integrated into European institutions and given a public budget to pursue moonshot missions.

(4) Give more substance to the concept of European economic security by identifying sectors targeted by "strategic indispensability" approach and the ones targeted by a "European leadership" approach

European economic security, defined as the ability of Europeans to resist the weaponization and the supply chain disruptions related to foreign economic dependencies, shall be better defined. More

[102] Ifo Institut, EU Innovation Policy: How to Escape the Middle Technology Trap? (Press Conference), 10.04.2024.
[103] Joint European Disruptive Initiative, About.

precisely, one shall differentiate between sectors where the EU can fully lead the way in terms of breakthrough innovation given its current lead (quantum cryptography, cleantechs, aerospace, biotechnologies, hydrogen, certain semiconductors, etc.) and the ones where it shall only try to preserve a strategic indispensability given its belatedness (AI, lenses and lasers, lithium-ion batteries, cloud computing, etc.).

Nevertheless, Europeans must also develop a system to identify potential breakthrough innovations that have the capacity to disrupt markets abroad, making the EU shift from a strategic indispensability approach to a technological leadership approach in the given sector.

Therefore, the EU is not condemned to strategic indispensability in certain sectors. For instance, if it invents tomorrow a rare-earth-free battery for electric vehicles and is able to display an appealing cost-performance profile for the mainstream market, tables shall turn. This is not arrogance to suppose the EU is able to produce such outstanding disruptive breakthrough innovations.

(5) Gather a team of charismatic figures dedicated to travel in European schools, and produce more European cultural audiovisual programs, to inspire students to follow STEM studies and to become entrepreneurs

Europeans study less hard sciences (science, technology, engineering and mathematics, STEMs) than Americans, which are even less into STEMs than the Chinese. Yet, students' preferences are not innate: they are built, and culturally embedded. STEM studies have not received the consideration they deserve in the EU.

This is why the European Union shall start promoting STEM studies among European students to trigger new vocations. It shall rely on a European public good narrative, for this is what the EU needs to face American and Chinese headwinds in the long-term.

As argued by the French economist Xavier Jaravel, empowering students and creating desirability to follow STEM studies and to become entrepreneurs is not very costly.[104] Yet, this could be a game-changer for many students who do not feel they are capable nor willing to go into that direction. Potential innovators are everywhere.[105] As argued above, the most radical ones are at the margins of innovation systems, i.e. in places where people are not supposed to innovate. By reaching out to these populations and empowering them, the European Union will give itself much more potential to generate breakthrough innovations in the middle and long-term.

Furthermore, the use of Arte as European audiovisual platform[106] could lead to the conception of original European cultural TV-shows and movies dedicated to inspiring students to follow STEM studies and protect European public goods. There is no European dream without European audiovisual industry.

[104] Institut Avant-Garde, Dialogue avec Xavier Jaravel – Pour une vision systémique de l'innovation, 01.11.2023.
[105] Ibid.
[106] Elysee, Discours sur l'Europe, 25.04.2024.

7 Conclusion

The European Union is indeed at a make-or-break moment in terms of breakthrough innovations. With an ageing population, a labor force that works much less than in the United States and in China, a flight of talents abroad, a lack of vocation for STEM studies, a fragmented single market, very stringent regulations in certain areas, a high level of public and private debt preventing from massively investing in R&D, one could think the EU has nothing left. That it is doomed to economic insignificance.

Yet, the EU has historically been a powerhouse for breakthrough innovation, and one shall not forget what made its strength: freedom, curiosity, enthusiasm, and willingness to take risks. By inspiring young Europeans to commit to breakthrough innovation for the common good, by giving them the means to pursue their dreams and making them compete for it, the EU has a chance to preserve all the dimensions of its sovereignty. Better now than tomorrow.

Finally, American and Chinese breakthrough innovation systems may not be completely compatible with European institutions and culture, but, given the lack of convincing European breakthrough innovation systems, it is worth experimenting some features of their models to prevent the EU from being completely left behind economically speaking. Successive experimentations and iterations shall help us define which breakthrough innovation model best suits our needs and aspirations, to remain strong and significant. Hence, when it comes to breakthrough innovation, there should not be any “too little, too late” anymore, but rather a “now or never”.

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