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Advanced Manufacturing Study. Preliminary findings on EU's Advanced Manufacturing industry in the global landscape

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Contents

Abstract

The Advanced Manufacturing (ADMAN) study, launched in 2023, aims to support EU policymakers, industrial stakeholders, and Member States in assessing the performance of the advanced manufacturing industry in Europe and shaping EU industrial strategy. Focused on advanced technologies applied to manufacturing processes, the ADMAN study builds on the recommendations of the Industrial Forum's Task Force on Advanced Manufacturing and aims at addressing existing data gaps by deploying a methodological approach that provides a comprehensive and comparative overview of the ADMAN industry. This report is one of the first outputs of the ADMAN study. It defines and discusses the metrics proposed to map the ADMAN industry at global level and some preliminary findings, with a special emphasis on the EU's position relative to global competitors.

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Key findings

The Advanced Manufacturing (ADMAN) study aims at informing EU policymakers, industry, academia, and other public and private stakeholders on the evolution of the advanced manufacturing industry in the Union, and how it is spread across European industrial ecosystems.

This report is one of the outputs of the ADMAN study. It provides a first in-depth insight into the ADMAN industry and the relative position of the EU firms. It presents an overview of the key advanced technologies applied to manufacturing processes, offering also a preliminary comparative analysis of the position of the EU with respect to foreign competitors.

The **key findings** of the presented analysis allows drawing some **main takeaways** for industry and policymakers, which are listed below.

State of Play in Europe

- The number of firms engaging in ADMAN activities (intended as core businesses and/or patent related to the industrial application of advanced technologies to manufacturing processes) in the EU rose remarkably since 2009, from 1,900 to 4,500 in 2023.
- The ADMAN landscape in the EU is concentrated in a few countries, with Germany, Spain, France, and Italy together hosting almost 60% of all EU firms engaging in ADMAN activities.
- EU funded projects have also been playing a significant role: firms involved in ADMAN-related the EU funded projects involve about 40% of all ADMAN firms.
- When looking at advanced manufacturing technology areas, '3D Printing' (39%) is the main technological area EU ADMAN firms engage in, followed by 'Power electronics' (10%) and 'Robotics' (9%).

Europe compared to the US and China

- The global ADMAN landscape is highly concentrated: 72% of all firms engaging in ADMAN activities (intended as core businesses and/or patent related to the industrial application of advanced technologies to manufacturing processes) are located in China (45%), the US (17%) or the EU (10%).
- China has been strengthening its global leading position over time, surpassing the US in 2014 in terms of number of ADMAN firms.
- In terms of number of ADMAN firms the EU has been growing faster than the US in latest years (growth rate of 130% versus 75%), reducing the gap.
- Chinese ADMAN firms tend to be more innovative, with 66% having filed at least one patent related to the industrial application of advanced technologies to manufacturing processes, compared to only 20% in the US and 31% in the EU.
- China has a larger percentage of ADMAN-related activities in the technology area of 'Semi-conductor and power electronics' (23%) compared to the EU (13%) and the US (13%).
- When looking at the Relative Comparative Advantage (RCA) as indicators of relative competitiveness in a given advanced manufacturing technology area, the EU has a stronger relative competitive advantage in 'Internet of Things' (IoT), 'Extended Reality' and 'Robotics' over China and the US. However, China is leading in 'Artificial Intelligence (AI)' and the US in 'Advanced Computing.'

Ownership Structure

- 18% of EU27 firms engaging in ADMAN-related activities are foreign owned (>50% control outside the EU). This figure is in line with the global average.

- Most foreign-owned EU ADMAN firms (40%) are controlled by US investors, while Chinese investors control about 7% of EU ADMAN firms.
- The EU leads in controlling foreign-owned ADMAN firms worldwide, as the ultimate owner of 34% of foreign-owned ADMAN firms is located in a European country.

Venture Capital

- EU ADMAN firms have significantly worse access to venture capital (VC) compared to the US and China.
- Half of the global VC investment to ADMAN firms since 2009 (31.6bn EUR) went to firms located in the US, while a still large portion of 34% funded Chinese firms. Only 5% went to EU Firms.
- Global VC investments have been highly concentrated in four advanced manufacturing technology areas, with 60% of investment flowing into 'Dynamic data', 'AI', '3D Printing', and 'Power electronics'.
- ADMAN firms engaging in activities related to 'Robotics' received half of the investment that went to ADMAN firms engaging in 'AI' activities.

Advanced manufacturing technology areas: zoom on '3D Printing', 'Dynamic Data', 'Artificial Intelligence (AI)', 'Robotics'

3D Printing

- '3D printing and additive manufacturing' is the largest advanced manufacturing technology area within the ADMAN industry. Nearly one every four activities belong to this technological domain.
- Over 2009-2023, there have been over 10,000 ADMAN-related patent applications (almost 40% of applications of the total ADMAN industry) in this technology area. Chinese firms have filled the large majority of them (60%), followed by the EU (11%) and the US (10%).
- Almost 12,000 firms worldwide engage in ADMAN activities related to this technological domain, with China hosting 44% of them, followed by the US (18%) and the EU (15%).
- Within the EU, Germany and Spain together host more than half of the EU ADMAN firms in technological domain, with 29.5% and 22.5% of ADMAN firms engaged in '3D Printing', respectively.

Dynamic Data

- 'Dynamic Data' is the third largest advanced manufacturing technology area in ADMAN industry, concentrating 15% of total ADMAN activities.
- Over 2009-2023, there have been over 3,000 ADMAN-related patent applications in this area, the large majority filed by Chinese players (84%). The US and EU had a participation of 2% each as share of ADMAN firms engaging with 'Dynamic Data' at global level.
- Almost 8,500 firms worldwide are actively engaged in ADMAN activities related to this technological domain, with half of them located in China, 14% in the US, and 8% in the EU.
- Within the EU, half of the ADMAN firms in this technological domain are concentrated in three Member States (MS): Germany (30%), France (12%), and Italy (10%).

Artificial Intelligence

- 'AI' is the fourth largest advanced manufacturing technology area in ADMAN industry, concentrating 10% of total ADMAN activities.

- Over 2009-2023, there have been over 2,500 ADMAN-related patent applications in the AI domain, the large majority filed by Chinese players (69%). The US hosts 7% of firms filing patents while the EU 4% of the global share.
- Almost 8 500 firms worldwide are actively engaged in ADMAN activities related to AI technologies: half of them are located in China, 15% in the US, and 10% in the EU.
- Within the EU, half of the ADMAN firms are concentrated in three MS: Germany (26%), Spain (13%), and Italy (12%).

Robotics

- Autonomous systems and robotics is the fifth largest technology area in ADMAN industry, concentrating 9% of total activities.
- Over 2009-2023, there have been over 1,600 ADMAN-related patent applications in this area: the majority filed by Chinese players (65%) while the US has 6% of players filing patents and the EU 5% of the global share.
- Almost 5,000 firms worldwide are actively engaged in ADMAN activities related to these technologies: 41% of them are located in China, 19% in the US, and 10% in the EU.
- Within the EU, half of the ADMAN firms are concentrated in three MS: Germany (25%), France (16%), and Italy (13%).

1 Introduction

Advanced manufacturing is a key enabler for European competitiveness. Being crucial also for the manufacturing of net-zero technology for the green transition, the industry has been identified as critical for the EU's economic security and industrial resilience.

The Industrial Forum's Task Force on Advanced Manufacturing, set up as part of the new industrial strategy for Europe, published a report outlining actions deemed to most effectively support the industry, namely *Advanced Manufacturing at the heart of a resilient, sustainable and competitive Europe*. In the report, the task force recommended establishing a methodology to quantify the industry.

Building on this previous work, in 2023 the European Commission launched the Advanced Manufacturing (ADMAN) study to support EU policymakers, industrial stakeholders, and Member States in assessing the performance of the advanced manufacturing (ADMAN) industry. The ADMAN study focuses on advanced technologies, which when integrated into manufacturing support resource efficiency, optimise manufacturing processes, enable the production of advanced technologies, and enable automation and smart manufacturing.

The main goals of the ADMAN study are to define the advanced manufacturing industry, produce a quantifiable overview, and facilitate the creation of metrics for the market segment. To do so, the ADMAN study addresses the existing gaps in traditional data sources. This aims, ultimately, at supporting the EU industrial strategy and EU policymaking.

This report is one of the outputs of the ADMAN study. Relying on the methodological approach proposed in a first study - the JRC report "Advanced Manufacturing in Europe and beyond: Defining, mapping and measuring the Advanced Manufacturing ecosystem with a DGTES-based methodology" (Calza et al., 2024) - , this report deploys the DGTES([1]) methodology to produce a first overview of the key advanced technologies applied to manufacturing processes and to explore the ADMAN industry worldwide.

After the identification of business actors that engage in manufacturing activities using advanced technologies, the focus is placed on identifying industry size, developments, and EU's position with respect to other international competitors, investments, and innovative capacity. This allows offering a comprehensive overview of the landscape of ADMAN industry globally as well as in Europe, providing a first in-depth insight into the relative position of the EU with respect to its main global competitors, such as China and the US.

The ADMAN study also entails the development of an interactive online tool, accessible by the public, allowing users to pull key messages relevant for their interest. The underlying data is built on the ADMAN study methodology (Calza et al., 2024), allowing for deep dives on areas of interest. In addition, a final report would summarize the main findings of all outputs of the ADMAN study.

([1]) The Digital Techno-Economic ecoSystem (DGTES) methodology developed by the EC JRC combines and harmonises multiple data sources into a network database of the digital ecosystem. The DGTES database provides a comprehensive overview of the critical elements of the digital ecosystem (i.e., players, activities, and interlinkages). DGTES is a policy-relevant analytical tool to analyse the digital transition, such as the players influencing a particular cluster of technologies, the entities leading the global race in digitalisation and the extent of the EU's involvement in comparison to other global regions.

2 Quantifying the Advanced Manufacturing industry

This section starts with a brief definition of advanced manufacturing (ADMAN) and of its technological perimeter. This is identified by 14 advanced manufacturing technology areas, corresponding to the families of advanced technologies applied to manufacturing. The section also introduces the main element of the analysis: firms that engage in ADMAN-related activities – that is, whose core businesses and/or patents are related to the industrial application of advanced technologies to manufacturing processes. The section then provides a first overview of the global ADMAN industry through a series of indicators addressing *who does what*, as outlined in the ADMAN methodological document (Calza et al., 2024).

Advanced Manufacturing and its technological scope in this work

In this study ADMAN corresponds to a production mode that arises from the convergence, integration and application of the latest and most cutting-edge advanced technologies to transform and enhance manufacturing production by driving innovation and leading to new and improved products, processes and business models (Calza et al., 2024).

In terms of technological scope, here ADMAN is primarily identified with the specific **industrial application of certain families of advanced IT-based production technologies**, which typically include industrial Internet of Things (IoT), big data analytics, artificial intelligence (AI), additive manufacturing, advanced robotics, among others ([2]). Thus, in this study, ADMAN technologies have a marked **applied nature and industrial purpose**. The application of these advanced digital technologies in manufacturing gives rise to **ADMAN production systems**, which in their most advanced forms enable the real-time integration of production systems and leads to the emergence of smart production methods often defined as "smart factory".

In the so-defined ADMAN industry, the main players are **firms** that engage with **activities** related to advanced manufacturing technologies. Following the DGTES methodology, these activities refer to the generation and/or deployment of ADMAN technologies in operations and **core business** (business activities) and/or to **patents** related to manufacturing technologies (innovation activities).

In practice, we apply a methodological approach based on DGTES (described in the first ADMAN study by Calza et al. 2024) to build the ADMAN database from a series of datasets ([3]) and use a text-search algorithm to identify about 44,100 firms worldwide that between 2009 and 2023 have been engaging with activities related to ADMAN ([4]). This means that (independently on their economic sector of operation) these firms perform a core business associated to advanced manufacturing

([2]) The considered technology areas are: 3D printing, Additive Manufacturing; 5G and beyond, Autonomous Networks, Communications, Telecommunications and connectivity; Advanced Computing, High Performance Computing (HPC); Artificial Intelligence (AI); Autonomous Systems, Robotics, Advanced Machine Tools; Blockchain, Distributed Ledger Technologies (DLT); Cybersecurity, Safety & Security, Digital Identity; Big Data, Dynamic Data; Electronics, Semiconductors, Power Electronics; Extended Reality, Virtual Reality, Augmented reality, Metaverses; Infrastructure, Cloud Computing, Digital Platform, IaaS, SaaS, PaaS, on-line platforms, Social Networks, Internet; Internet of Things (IoT), AIDC (Automatic Identification and Data Capture); Quantum Technologies; Verticals (including Biotechnologies and Advanced Materials). Abbreviations of the full names of the technology areas are used In text and figures.

([3]) The datasets providing the study's evidential foundation include ORBIS by Moody's (ex-Bureau van Dijk), Crunchbase, Dealroom, Ventoresource by Dow Jones, EPO Patstat, CORDIS Framework Programmes project repository.

([4]) See Annex in Calza et. al (2024) for the list of keywords used to detect relevant activities and identify related firms.

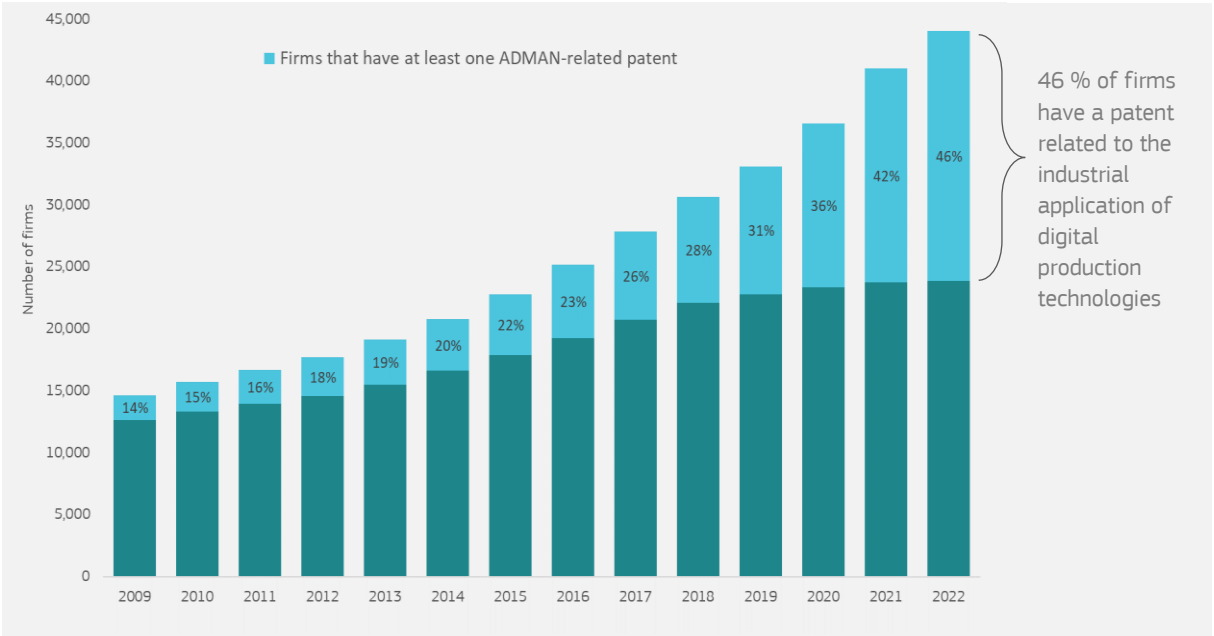
or/and have filed in a (priority) patent ([5]) that is related to advanced manufacturing – that is, a patent related to the industrial application of certain families of advanced IT-based production technologies. These firms, their core business and their relevant patents constitute the domain of advanced manufacturing.

There has been a sharp increase in the number of firms with ADMAN patents compared to those ADMAN firms with no ADMAN-relevant patents.

- The number of ADMAN firms have grown consistently over the period 2009-2022 (avg. annual growth about 9%) (**Figure 1**).
- Particularly, the number of firms that have filed at least for one ADMAN-related patent grew 10 times faster than those that have no innovation activities.
- Thus, the share of firms in ADMAN with at least one (ADMAN-related) patent in 2022 is 46% (**Figure 1**)

Almost half of the identified ADMAN firms (46%) have at least one patent related to the application of advanced technologies to manufacturing. The share of firms with at least one relevant patent has been constantly growing since 2009, with an increase from 14% in 2009 to 46% in 2022 (**Figure 1**). This is due to the marked rise in the number of patents related to advance manufacturing, which has not been matched by an equally marked increase in the number of firms with a core business related to advanced manufacturing.

Figure 1. Firms in the advanced manufacturing domain over time (2009-2022)



Note: The figure shows the cumulative number of firms in each year of the considered period. The light-shaded areas represents the number of firms with at least one (ADMAN-related) patent and labels display their share with respect to ADMAN firms.

Source: JRC DGTES database.

([5]) Priority patents filed in in any national patent office (not only triadic patents).

3D printing, including additive manufacturing, is the leading advanced technology area in the EU-ADMAN industry

- With almost 32% of EU-activities, the technology area of '3D Printing and additive manufacturing' leads in terms of number of activities (**Figure 2)**.
- In the global ADMAN industry, the top three technology areas are '3D Printing' (with 24.8% a leading position as in the EU-ADMAN ecosystem), 'Power Electronics' (18.3% globally while 8.3% in the EU), and 'Dynamic Data' (15.1%) (**Figure 2**).
- The ADMAN firms engaged in '3D Printing'-related activities cover altogether a wide range of technological applications and solutions including, but not limited to, layer-by-layer product creation instead of traditional subtractive manufacturing.
- When considering the ADMAN activities performed by EU firms, their contribution to each advanced manufacturing digital area falls within a range of 5%-15% and is rather diverse, going from 15% of 'IoT' to 15% of 'Power Electronics'
- The DGTES methodology allows associating each activity – core business or/and patent related to advanced manufacturing - with one or more areas of advanced technologies ([6]) with industrial applications. Almost 30% of activities are associated to the area of '3D Printing', followed by 'Power electronics" with 21% and 'Dynamic data' with 11% (**Figure 3**). Each of the areas of 'AI' and 'Robotics' are associated to almost 10% of activities in advanced manufacturing.

The technology area of '3D Printing' leads per the number of activities, with a strong participation in innovation. The group covers technologies related to layer-by-layer product creation instead of traditional subtractive manufacturing, applied, for instance, to rapid prototyping using different methods based on the material, such as fused deposition modelling (FDM), stereolithography (SLA), and selective laser sintering (SLS) for plastics.

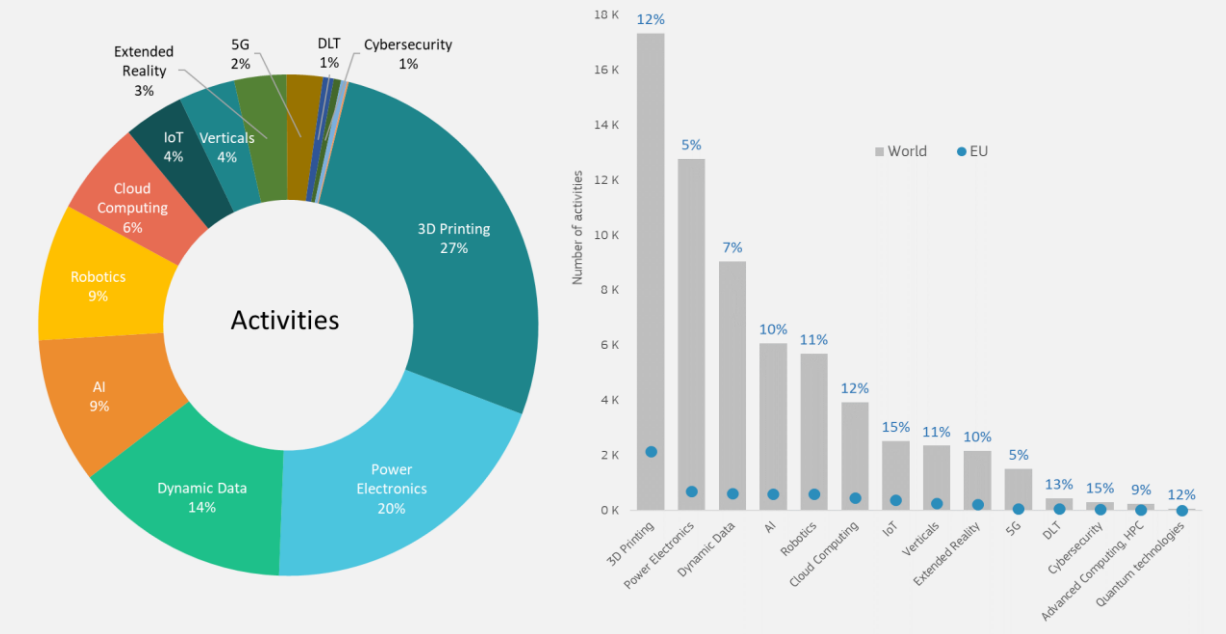
Over 12 thousand firms worldwide are engaged in these technologies: 47% are located in China, 17% in the US, and 15% in the EU.

([6]) In the DGTES methodology, these families of technologies are defined as 'digital areas' (Calza et al., 2024). See Annex in Calza et al. (2024) for a detailed definition and a comprehensive description of the application of each of these groups of advanced technologies in advanced manufacturing.

Figure 2. Activities by advanced manufacturing technologies area (2009-2023)

a) Composition of activities in advanced manufacturing

b) Number of activities in advanced manufacturing



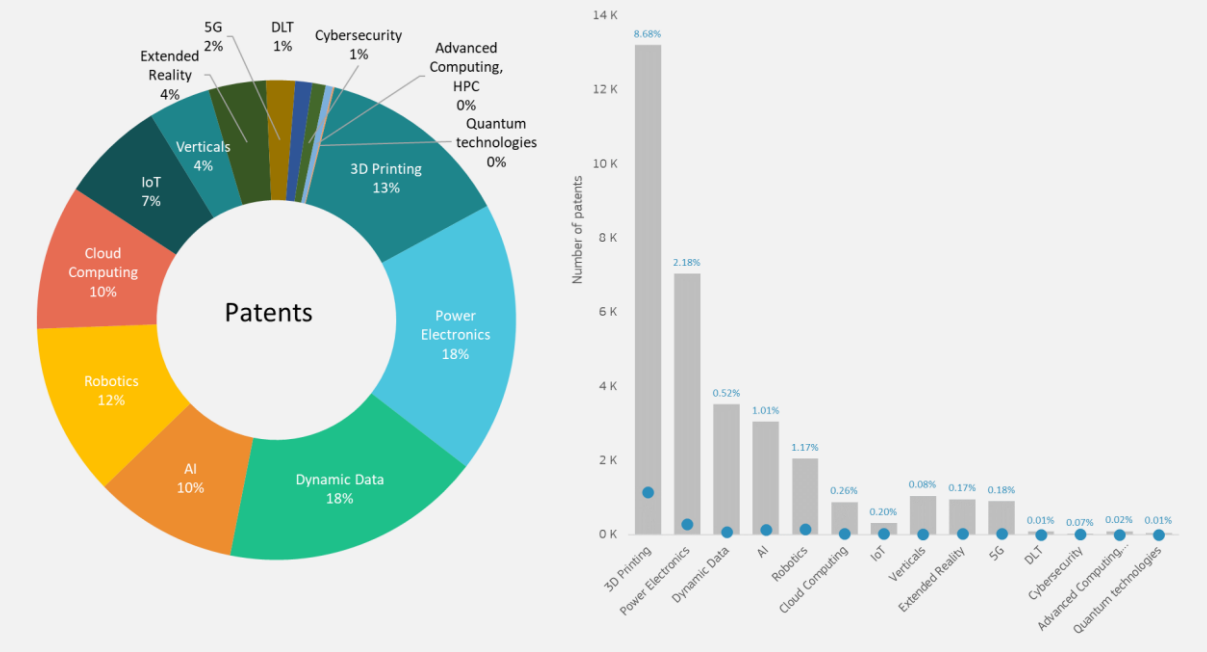
Note: In Panel b, labels (in light blue) on the upper part of the bars report the share of EU activities (as number of EU activities over total world activities) by technology area.

Source: JRC DGTES database.

Figure 3. Patents by advanced manufacturing technologies area (2009-2023)

a) Composition of patents in advanced manufacturing

b) Number of patents in advanced manufacturing



Note: In Panel b, labels (in light blue) on the upper part of the bars report the share of EU ADMAN patents (as number of EU ADMAN patents over total world ADMAN patents) by technology area.

Source: JRC DGTES database.

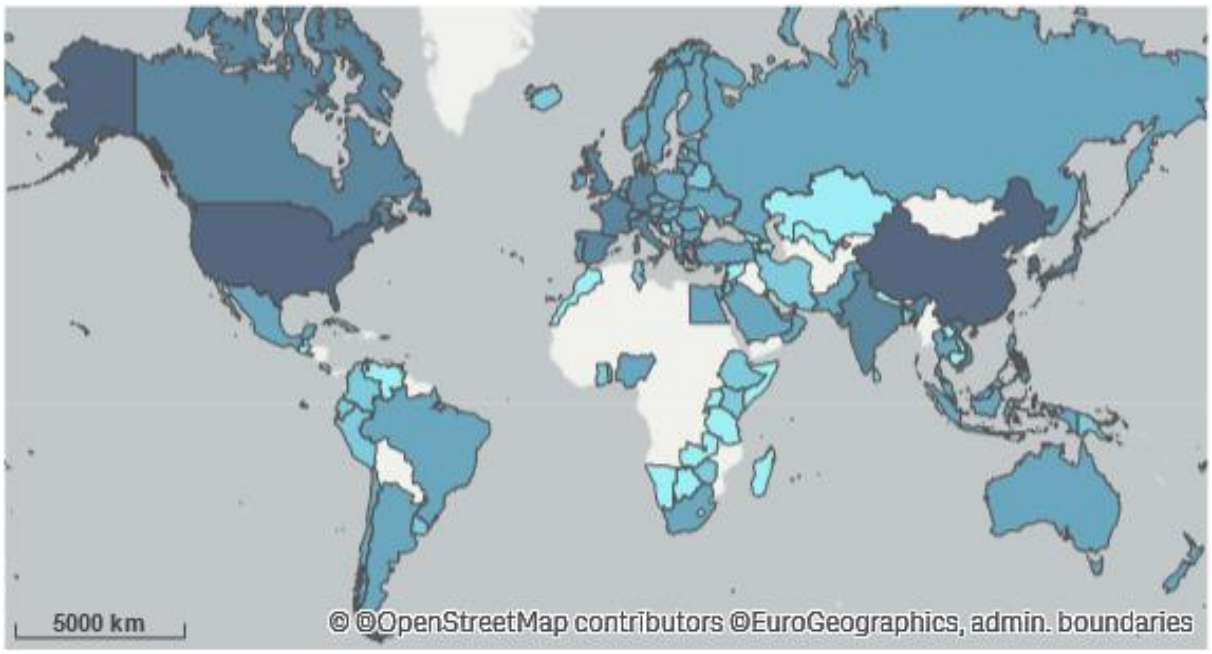
3 Uncovering the EU position in Advanced Manufacturing industry

This section offers a preliminary analysis of the relative position of the EU in the ADMAN industry compared to main global competitors: China and the US. In doing so, it presents the results of a mapping exercise of the global geographical distribution of firms engaging in ADMAN activities (that is, whose core businesses and/or patents are related to the industrial application of advanced technologies to manufacturing processes). Besides providing a global overview of the ADMAN industry, this section also discusses its main features, such as the prevalence of some advanced manufacturing technology areas and the relative position of the EU with respect to its main competitors in each of these.

The global landscape in advanced manufacturing is highly concentrated.

- About 44,100 firms worldwide engage in ADMAN activities, 45% of them have at least one patent related to the industrial application of advanced technologies to manufacturing processes.
- About 72% of these firms engaging in ADMAN activities are located in China, the US or the EU (**Figure 4**).
- China is leading in terms of number of firms engaging in ADMAN activities, hosting about 45% of firms (**Figure 5**)
- On the widespread of innovation activities, China has 65.7% of firms with at least one ADMAN-relevant patent filing, which is consistent with domestic policies that incentivize patent applications.
- The EU improved its relative position in the innovation landscape over time. The number of firms with at least one ADMAN-related patent increased by a factor of 4.4 from 2009 to 2023 (**Figure 6**).

Figure 4. Firms in the advanced manufacturing domain by country (2009-2023)

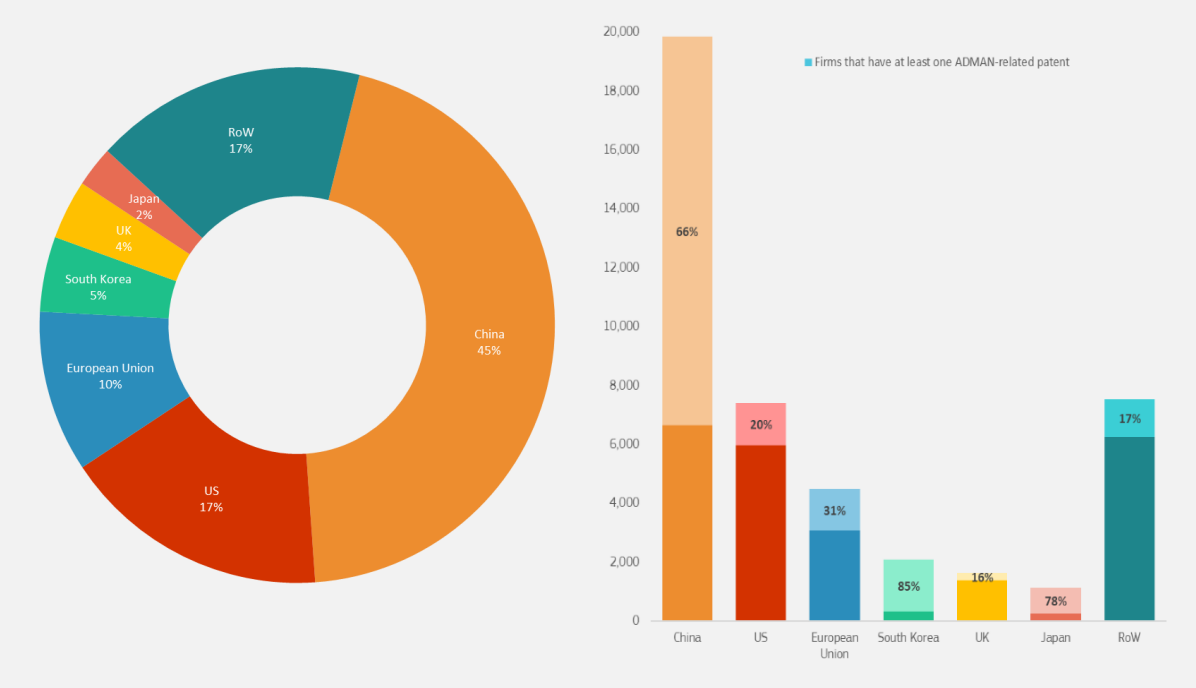


Note: The colours are proportional to the number of players.
Source: JRC DGTES database, ADMAN online tool.

Figure 5. Firms in the advanced manufacturing domain by main geographical area (2009-2023)

a) Composition of firms in advanced manufacturing by geographical area

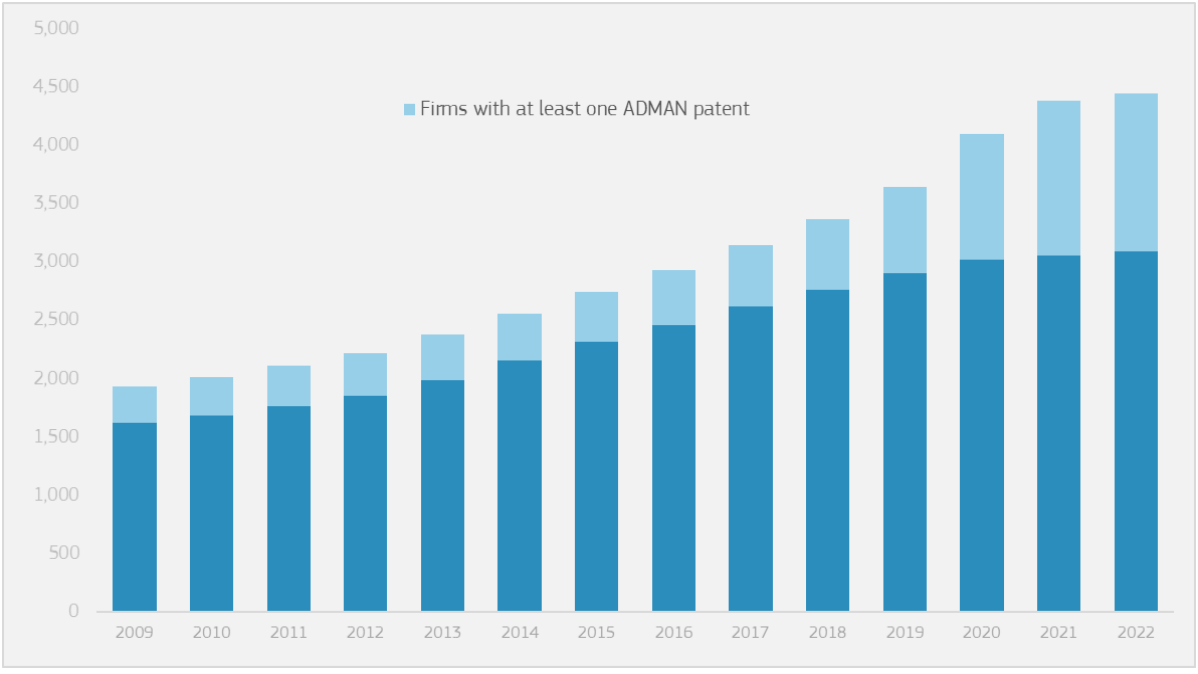
b) Number of firms in advanced manufacturing by geographical area



Note: In Panel b, the light-shaded areas represents the number of firms with at least one (ADMAN-related) patent and labels display their share with respect to ADMAN firms.

Source: JRC DGTES database.

Figure 6. EU Firms in the advanced manufacturing domain over time (2009-2023)



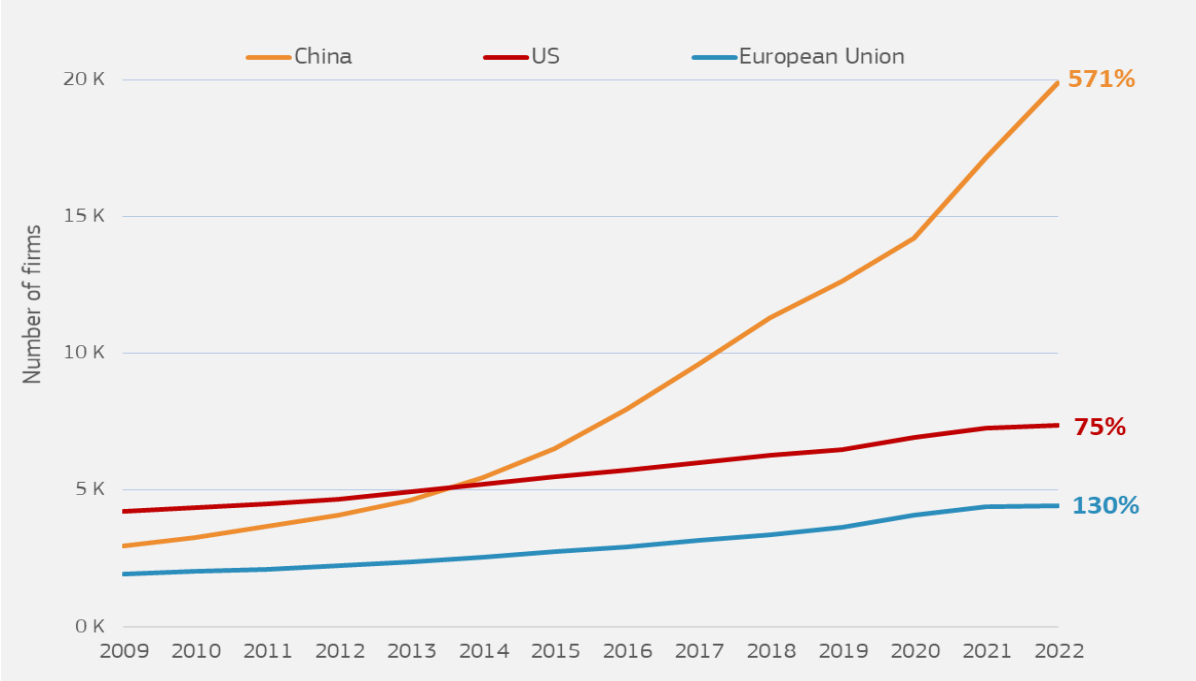
Note: The figure shows the cumulative number of firms in each year of the considered period. The light shaded area represents the number of EU firms with at least one (ADMAN-related) patent.

Source: JRC DGTES database.

China has been strengthening its global leading position in the ADMAN industry over time, but the EU is keeping the pace with respect to the US

- The number of Chinese firms that engage in ADMAN-related activities has sharply grown since 2009 (growth rate % above 500% between 2009-2022), overtaking the US in 2014 has global leader (**Figure 7**).
- In terms of number of ADMAN firms the EU has been grown faster than the US (130% versus 75%), reducing this distance in latest years.

Figure 7. Firms in the advanced manufacturing domain in China, the EU and the EU over time (2009-2022)



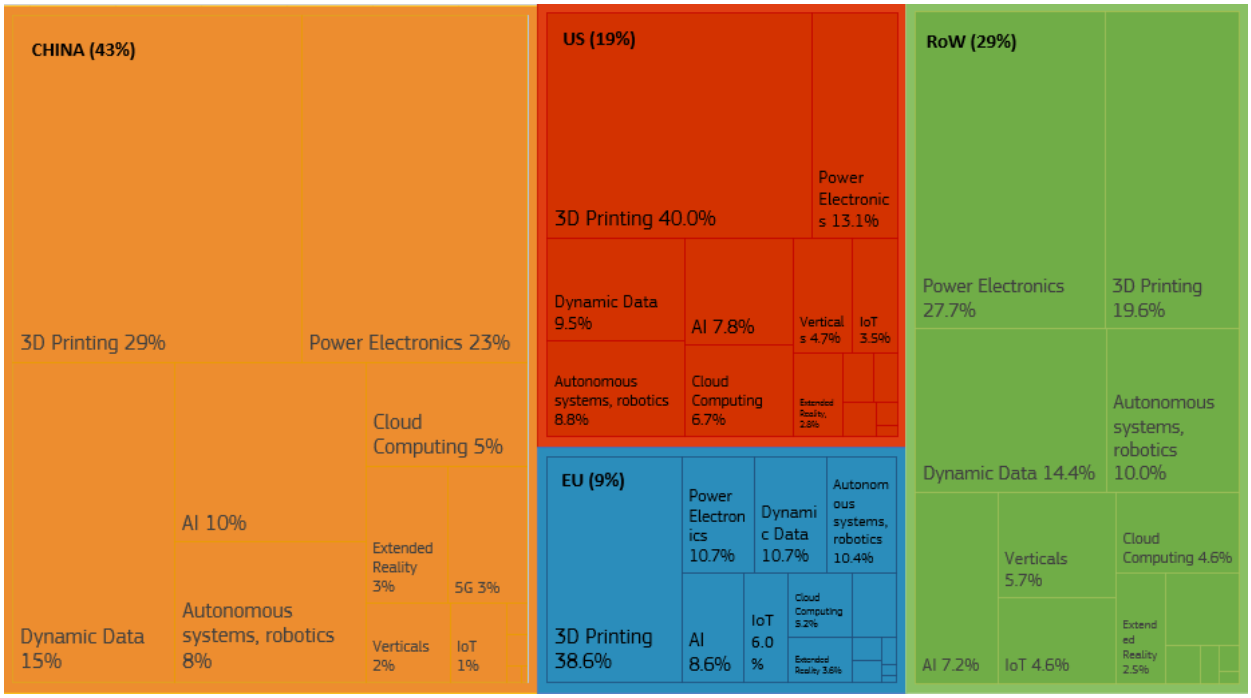
Note: The figure shows the cumulative number of firms in each year of the considered period.
Source: JRC DGTES database.

China, the EU and the US display a rather similar technological composition of ADMAN activities, but with some relevant differences

- '3D printing' is the main advanced manufacturing technologies area in China, the US and the EU (**Figure 8**)
- The technology area of semiconductors and power electronics ('Power electronics') is more relevant in the ADMAN ecosystem in China than in the US and the EU. With 23% of Chinese activities, it doubles the weight of the area in the US or EU ecosystems where it represents 13% and 11%, respectively.
- The EU displays a relatively larger share of activities in 'IoT' (6%) compared to the US (3%) and China (1%)
- The technological composition of the ADMAN industry varies a lot between patents and core businesses: while '3D Printing' dominates in patents, especially in the US and EU, core businesses display a rather diverse technological composition across China, the US and the EU, with the share technology area of 'Power electronics' being relatively high in China (**Figure 9**).

- Considering relative competitiveness (measured as the RCA), the EU ADMAN domain turns out to be competitive in some key emerging advanced technologies such as 'IoT', but lagging behind in others such as 'Advanced computing' (**Figure 10**)

Figure 8. Activities by advanced manufacturing technologies area in China, the US and the EU (2009-2023)

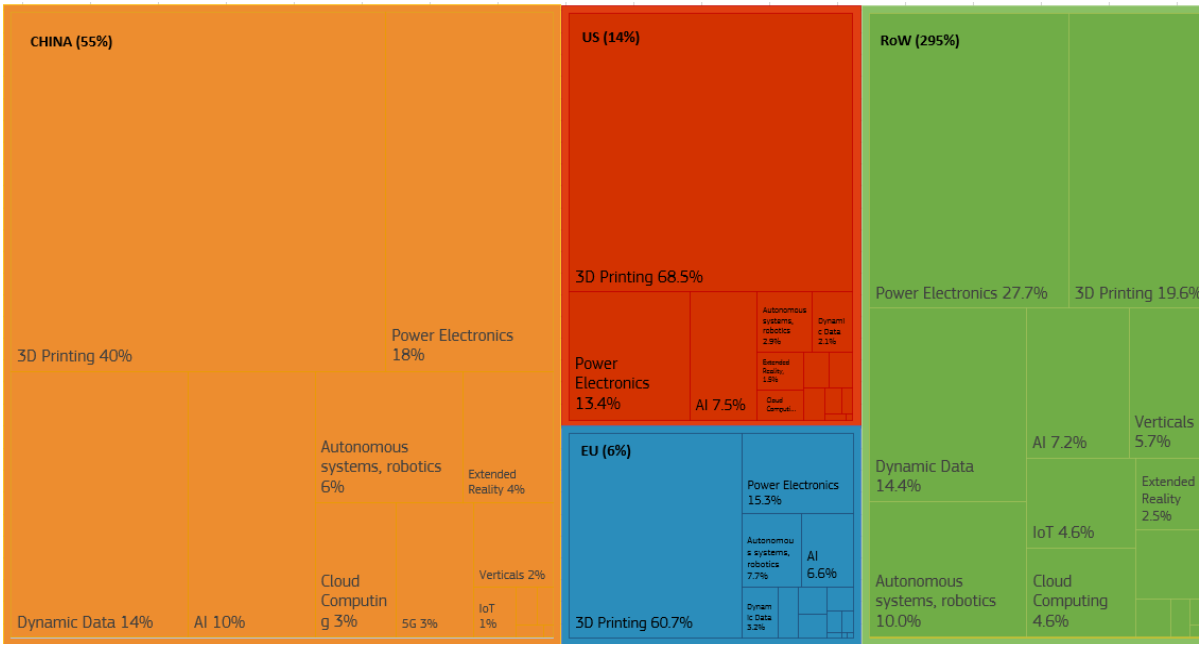


Note: An activity that is associated with more than one technology area counts as *1/n* (where *n=total number of technology areas associated to that activity*) in a given technology area. Activities shared across more than on geographical area (i.e. collaborations on a patent) are counted in a similar way. RoW: rest of the world.
Source: JRC DGTES database.

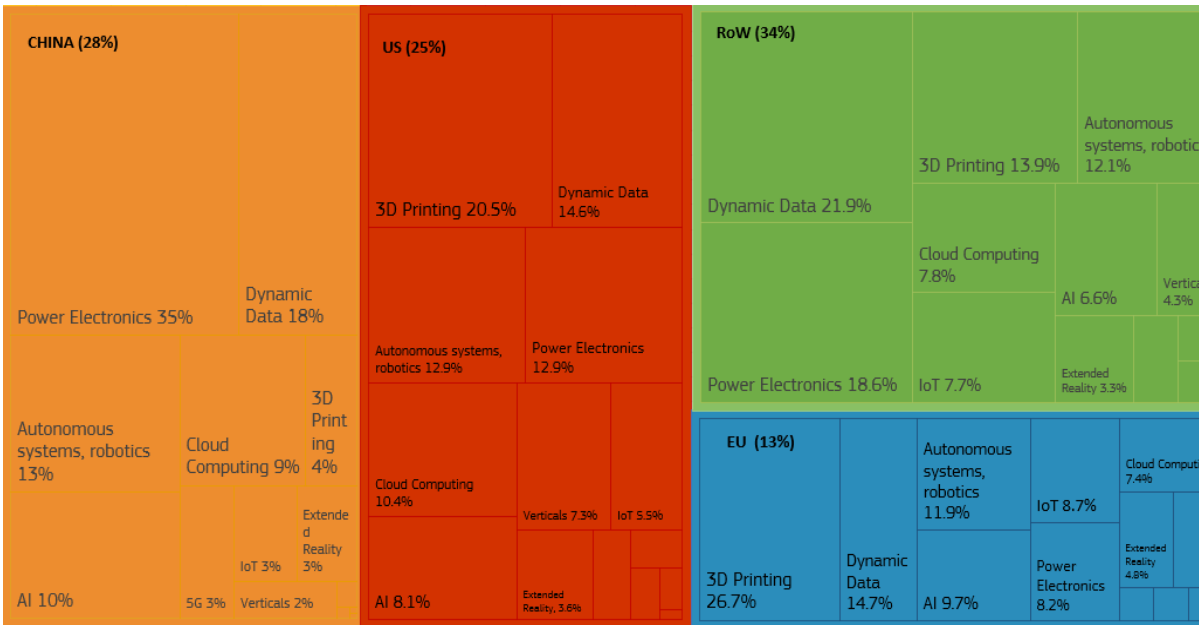
ADMAN patents are clearly dominated by China (55%) and characterized by a marked relevance of '3D Printing' (40%). However, the prevalence of '3D printing' in patents is even stronger in the US and in the EU, which report 69% an d 60% of patents in this technological group, respectively (**Figure 9, Panel a**). The technological composition of ADMAN businesses is more different across the considered geographical areas (**Figure 9, Panel b**): while '3D Printing' remains the main technology area in the EU (27%) and the US (20%), 35% of Chinese ADMAN businesses are related to 'Power Electronics'. European ADMAN businesses are also characterized by a larger share of 'IoT' (9%) compared to their global competitors.

Figure 9. Patents and core businesses by advanced manufacturing technologies area in China, the US and the EU (2009-2023)

a) Composition of patents by technology area



b) Composition of core businesses by technology area



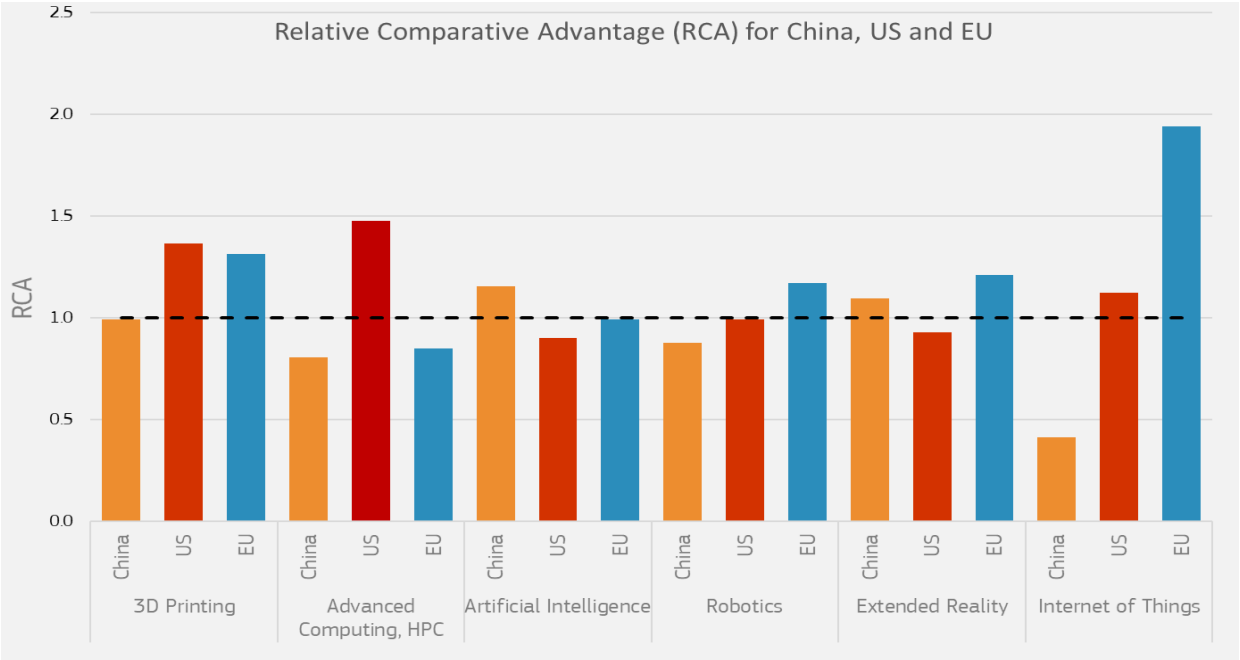
Note: See note to Figure 8.
Source: JRC DGTES database.

The share of a given technology area within a certain geographical area (as displayed in **Figure 8**) can serve as a first proxy for the degree of technological competitiveness of that geographical area. However, to get a better idea of the relative global positioning of each of these world regions (China, the US and the EU) in each technological domain applied to ADMAN, the relative comparative

advantage (RCA) can be used ([7]). The RCA measures the relative engagement of a certain geographical area in a given technology area in comparison with the world average: it is calculated by comparing the geographical area's share of activities in a specific technology area against the global average in that same digital area (Samoili et al., 2020). A value of RCA above 1 means that the geographical has a higher-than-world average proportion of activities in that digital area, therefore revealing a relative advantage in that advanced manufacturing technology area.

Comparing the RCA of China, the US and the US in selected technology area reveals that the EU ADMAN industry is relatively more competitive in some key but rather *niche* advanced technologies, since their relative weight in the global ADMAN industry is still rather small, such as 'IoT' (3% of all ADMAN activities worldwide) and 'Extended reality' (4%). The EU is also scoring higher than its competitors (and higher than the world average) in terms of RCA in 'Robotics', but it is lagging behind China in 'AI' and behind the US in 'Advanced computing' and '3D Printing' (**Figure 10**).

Figure 10. Relative Comparative Advantage (RCA) of China, the US and the EU in selected advanced manufacturing technologies area (2009-2023)



Note: An activity that is associated with more than one technology area counts as *1/n* (where *n=total number of technology areas associated to that activity*) in a given technology area. Activities shared across more than on geographical area (i.e. collaborations on a patent) are counted in a similar way. The dotted line corresponds to the world average (RCA=1).
Source: JRC DGTES database.

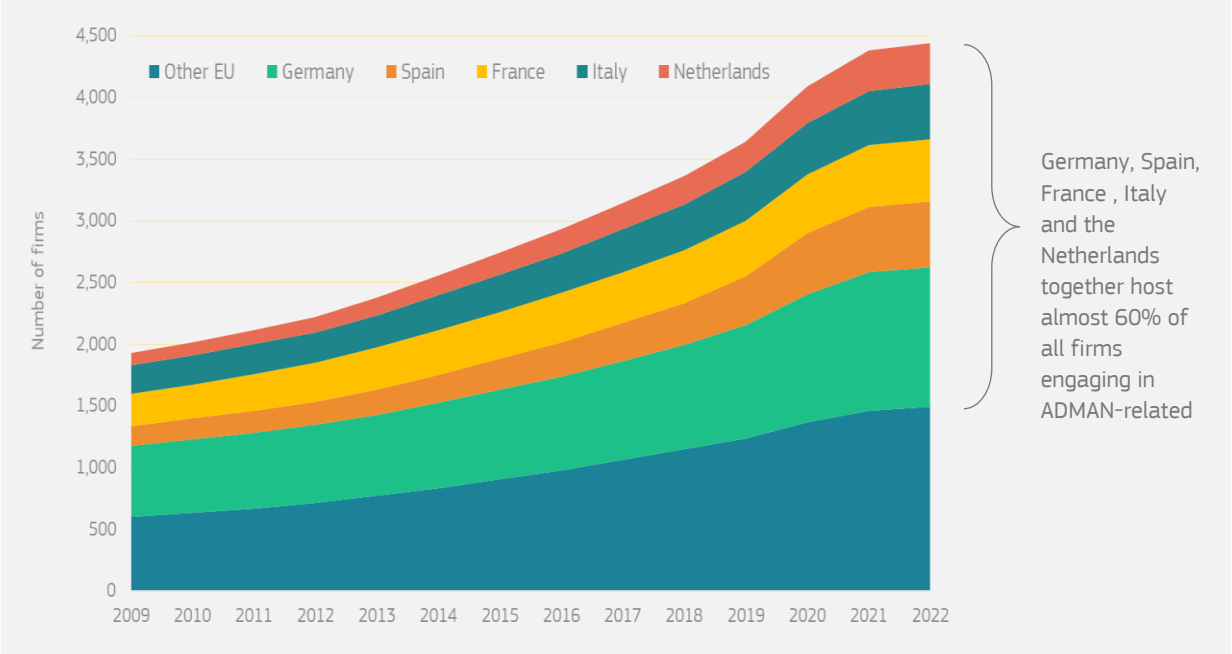
<u>Within the EU the ADMAN industry is concentrated in a few Member States</u>

- Within in the EU27, a few Member States (MS) host the majority of firms engaging in ADMAN-related activities: Germany, Spain, France and Italy together host almost 60% of all firms engaging in ADMAN-related activities in the EU27 (**Figure 11**).

([7]) See Calza et al. (2022) for more information about how to calculate and interpret this indicator.

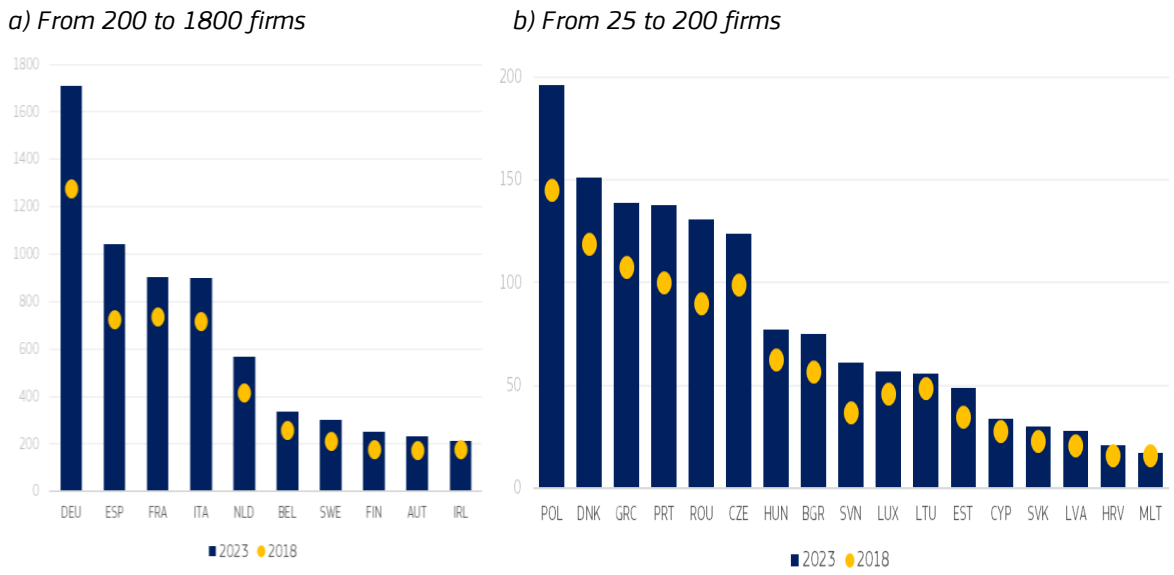
- The concentration around a few MS has been a feature of the European ADMAN industry since 2009.
- About 4,500 firms in the EU27 engage in ADMAN activities, corresponding to about 10% of all ADMAN firms worldwide. However, when including EU funded projects (FP7, H2020, HE), the number of ADMAN firms doubles. Thus, EU funded projects play a significant role in supporting the European ADMAN business ecosystem. The share of firms engaging in ADMAN-related EU funded projects is, overall, consistent across MS, around 40% of firms within each country.
- The number of ADMAN firms in all MS increased over time with disparities across countries. On average, MS increased by 30% the number of ADMAN firms between 2018 and 2023. Slovenia had the highest growth rate, increasing the number of firms by 65%, while Malta remained stable. Even though Germany exhibited a growth rate right above the average, it represented the highest increase in number of ADMAN firms in the EU, with over 400 firms joining the ADMAN industry since 2018 (**Figure 12**).
- The technological distribution of firms is, in broad terms, homogeneous across MS: one third of firms engage in '3D Printing', another third of firms engage in one of the other large digital areas ('Robotics', 'AI' and 'Dynamic Data'), and the remaining share engage in other advanced manufacturing technology areas (**Figure 13**).

Figure 11. Firms in the advanced manufacturing domain in selected EU27 MS over time (2009-2022)



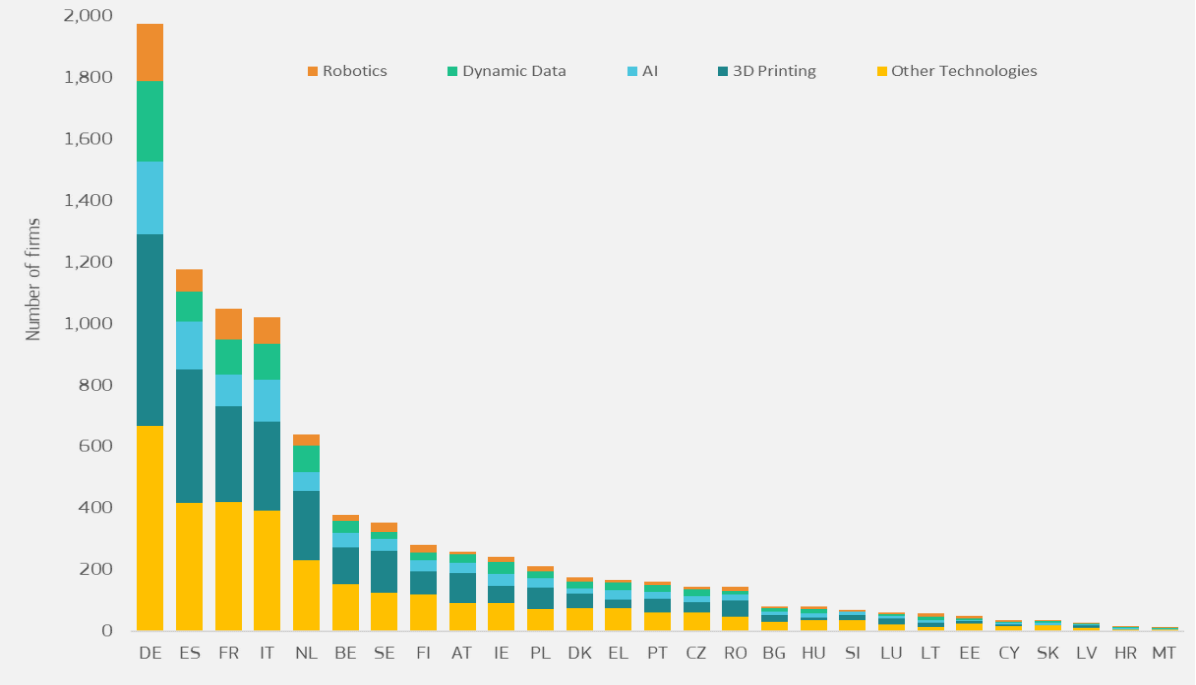
Source: JRC DGTES database.

Figure 12. Firms in the advanced manufacturing domain by EU27 MS, 2018 vs 2023



Note: Note that the vertical axis in Panel a and b display a different scale.
Source: JRC DGTES database.

Figure 13. Firms in the advanced manufacturing domain in the EU27 MS (2009-2023)



Source: JRC DGTES database.

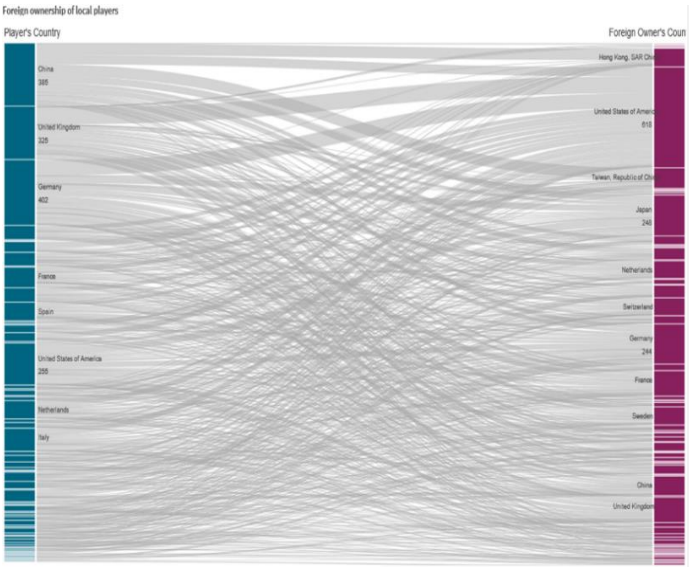
3 Foreign ownership in the Advanced Manufacturing industry

US companies control one out of three foreign-owned ADMAN firms in the EU

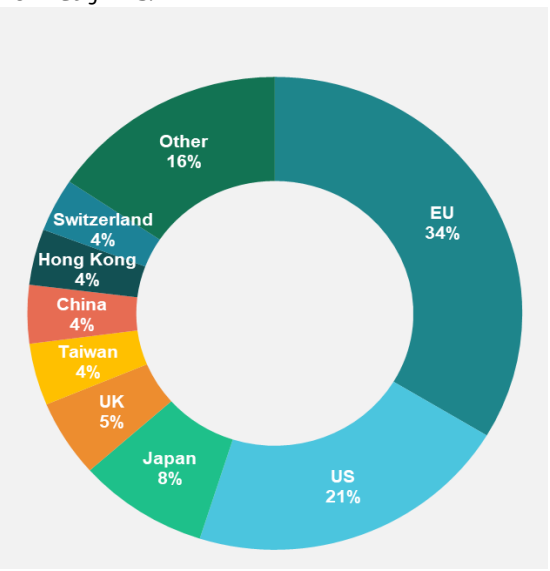
- Out of all the ADMAN firms, 35% have known ownership (i.e. 15,504 firms). From this sample, 2,905 firms worldwide are foreign owned (19%).
- The coverage of ownership in EU-ADMAN ecosystem is of 95%. That is, it is possible to track ownership of almost the entire ADMAN ecosystem in the EU.
- 18% of EU27 firms engaging in ADMAN-related activities are foreign owned (>50% control outside the EU). This figure is in line with the global average.
- EU investors control one third of foreign-owned ADMAN firms, but they represent a small number over total ADMAN firms.
- The EU leads in controlling foreign-owned ADMAN firms worldwide, as the ultimate owner of 34% of foreign-owned ADMAN firms is located in a European country (**Figure 14**).
- Most foreign-owned ADMAN firms (40%) in the EU are controlled by US investors, while the second country by share of controlled EU ADMAN firms is the UK (13%). China is the fifth country by number of controlled EU ADMAN firms (7%) (**Figure 15**).

Figure 14. Foreign ownership of ADMAN firms worldwide (2009-2023)

a) Firms located in the geography on the left owned by the geography on the right



b) Who owns foreign ADMAN firms worldwide? Owner geographies as a share of total foreign-owned firms.

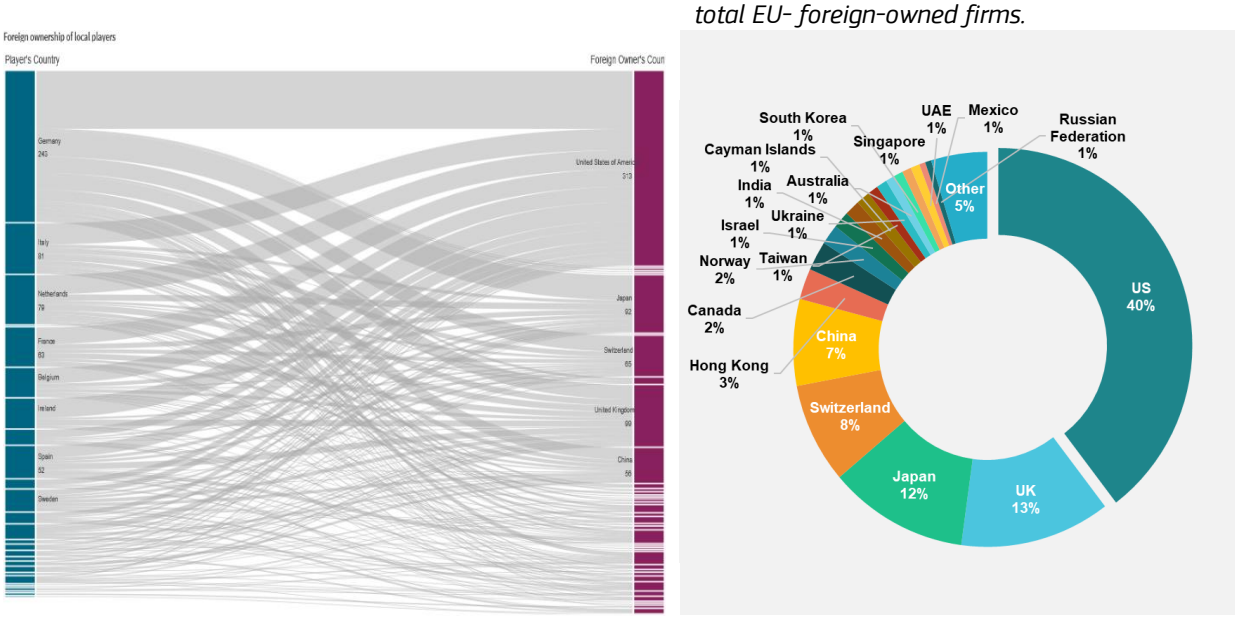


Source: JRC DGTES database.

Figure 15. Foreign ownership of ADMAN firms in the EU27 (2009-2023)

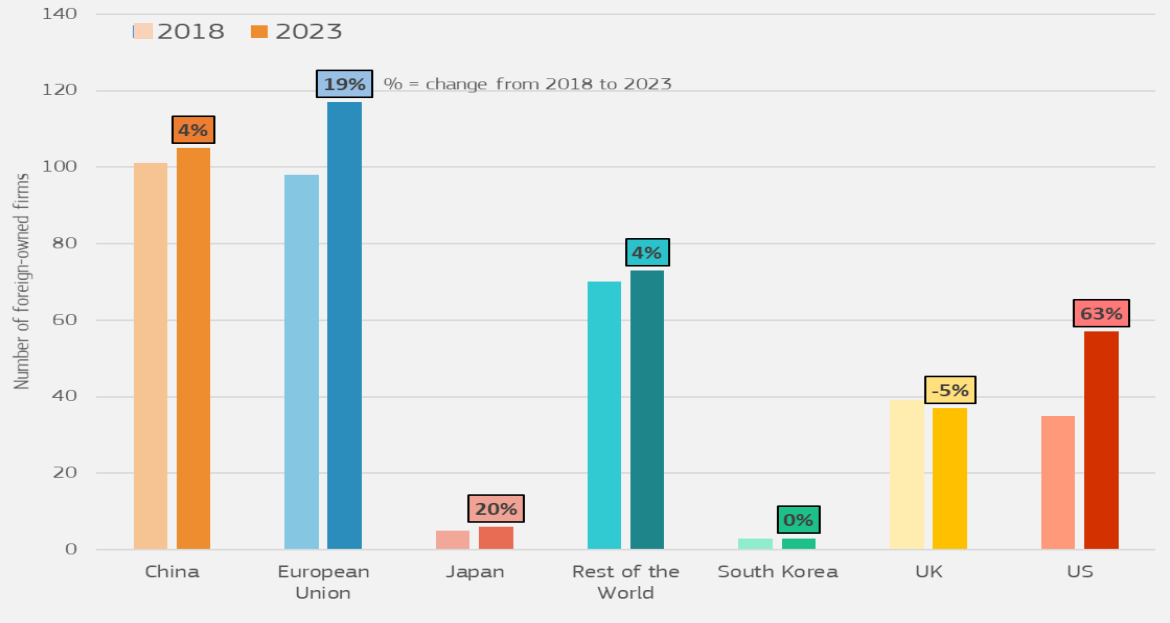
a) Firms located in the EU by Member State on the left owned by the geography on the right

b) Who owns foreign EU-ADMAN firms worldwide? Owner geographies as a share of total EU- foreign-owned firms.



Source: JRC DGTES database.

Figure 16. Foreign owned ADMAN firms worldwide by geographical area, 2018 vs 2023



Note: The figures refers to ADMAN firms for which ownership data are available. The light shaded bars represent the number of foreign owned ADMAN firms in 2018, the darker shaded bars the number in 2023. Labels report the change (%) in the number of foreign owned ADMAN firms between 2018 and 2023.

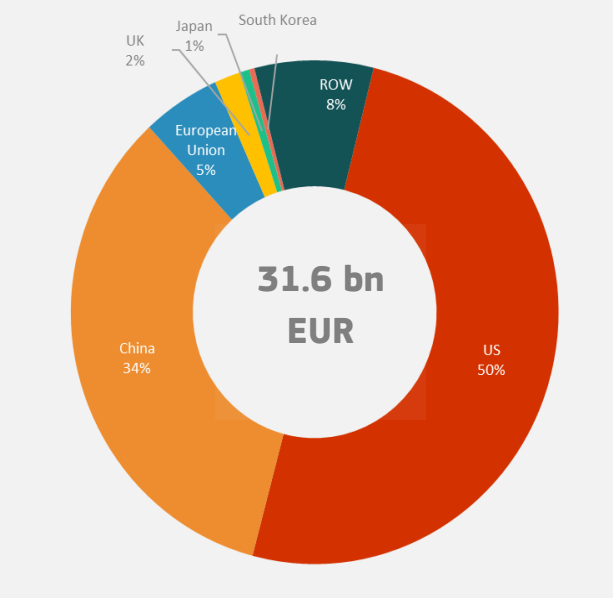
Source: JRC DGTES database.

4 Assessing the venture capital and private equity landscape

EU ADMAN firms had and keep on having a limited access to global venture capital funding

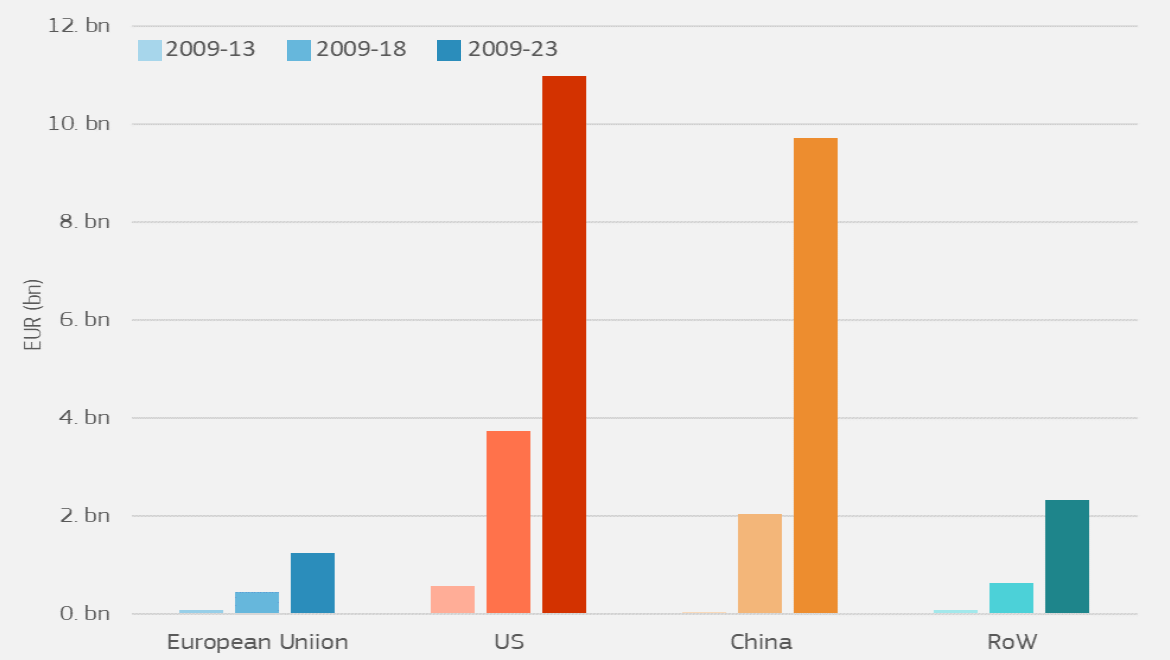
- Over 2009-2023, firms engaged in advanced manufacturing received EUR 31.6 bn funded through venture capital (VC). Half of this investment went to US firms, while a large portion of 34% funded Chinese firms and 5% firms located in the EU (**Figure 17**).
- Over 2009-2023, VC investments have been rising globally, although at a different speed across geographical areas: while in the EU and the US VC investments have increased by 3 times between 2009-18 and 2009-23, in China they increased by almost 5 times over the same time period (**Figure 18**).
- Global VC investments have been highly concentrated in four technology areas. Over 2009-2023, 'Dynamic data', 'AI', '3D Printing', and 'Power electronics' accounted for 60% of total investments. Venture capitalists in advanced manufacturing doubled funding in 'AI' compared to 'Robotics' (**Figure 19**).
- However, in the EU, the leading technology areas by amount of VC received over 2009-2023 is '3D Printing', followed by 'Power Electronics', and 'Internet of Things' that received higher investment than "Robotics".
- EU-firms engaged in '3D Printing' and 'Internet of Things' activities almost doubled their cumulative VC investments post-COVID-19 pandemic, between 2020 and 2023. Other areas such as 'Robotics', and 'AI' grew notably that period, multiplying by over three times their cumulative investments. Instead, the growth of venture capital investments in 'Power Electronics' remained relatively stable (**Figure 20**).

Figure 17. Geographical composition of venture capital by destination in ADMAN industry (2009-2023)



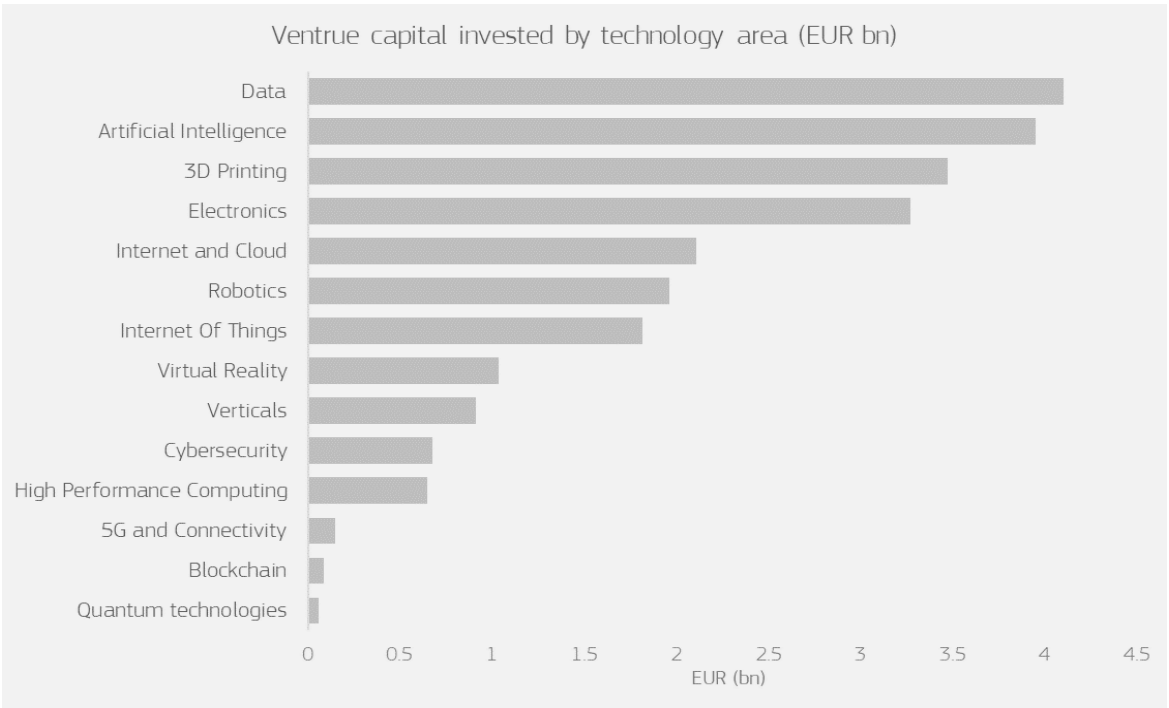
Note: Venture capital (VC) investment includes both early and late VC rounds. Data is sourced from Crunchbase and cover the firms receiving funding during 2009-2023.
Source: JRC DGTES database.

Figure 18. Venture capital investments by destination (EUR bn, 2009-2023)



Note: Venture capital (VC) investment includes both early and late VC rounds. Data is sourced from Crunchbase and cover the firms receiving funding during 2009-2023. The light shaded bars represent the VC investments in 2009-13 and 2009-18, the darker shaded bars in 2009-23.
Source: JRC DGTES database.

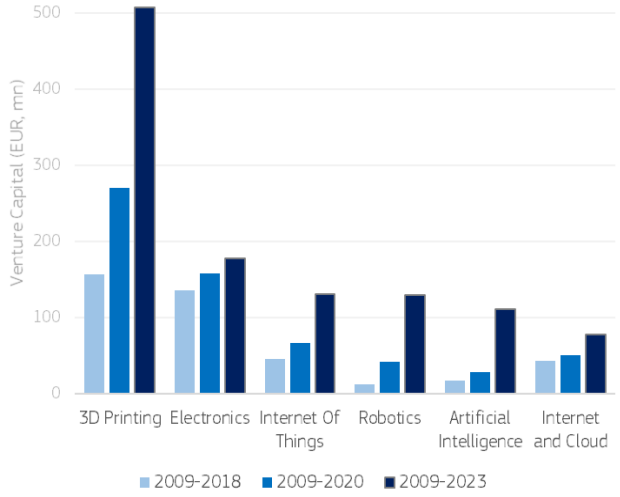
Figure 19. Venture capital global investments by technology area (EUR bn, 2009-2023)



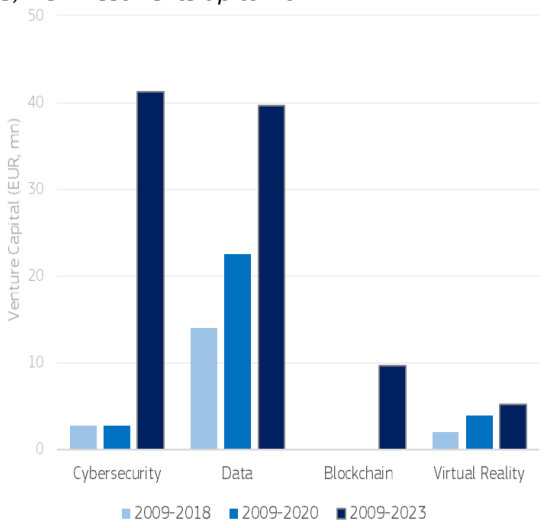
Note: Venture capital (VC) investment includes both early and late VC rounds. Data is sourced from Crunchbase and cover the firms receiving funding during 2009-2023. By definition, a firm can have activities in multiple technology areas. The investment figures are weighted by the engagement of each firm in each technology area based on keywords frequency.
Source: JRC DGTES database.

Figure 20. Venture capital investments in the EU by technology area (EUR mn, 2009-2023)

a) VC investments up to 500 EUR mn



b) VC investments up to 40 EUR mn



Note: Note that the vertical axis in Panel a and b display a different scale. Venture capital (VC) investment includes both early and late VC rounds. Data is sourced from Crunchbase and cover the firms receiving funding during 2009-2023. By definition, a firm can have activities in multiple technology areas. The investment figures are weighted by the engagement of each firm in each technology area based on keywords frequency. The light shaded bars represent the VC investments in 2009-13 and 2009-18, the darker shaded bars in 2009-23.

Source: JRC DGTES database.

Conclusions

The Advanced Manufacturing (ADMAN) industry is characterized by the integration of cutting-edge technologies into manufacturing processes. It is not only pivotal for the EU's industrial competitiveness; it also plays a crucial role in the twin transition and economic security.

The ADMAN study focuses on advanced manufacturing technologies that can facilitate resource efficiency, favour the optimisation of manufacturing processes, enable the production of advanced technologies, as well as the implementation of automation and of smart production modes. The ADMAN study builds on the recommendations of the Industrial Forum's Task Force on Advanced Manufacturing and proposes ways to address existing data gaps by deploying a methodological approach that provides a comprehensive and comparative overview of the ADMAN industry.

This report is one of the outputs of the ADMAN study. It explores the ADMAN industry globally and in Europe, offering a first overview of the landscape of ADMAN industry in Europe and with a special attention to the comparison with main global competitors such as China and the US. This report defines and discusses some preliminary metrics to map the ADMAN industry at global and EU level.

The global ADMAN industry is highly concentrated, with 72% of firms located in China, the US, or the EU. In terms of innovation, 46% of ADMAN firms have filed at least one patent related to advanced manufacturing technologies, signalling a strong innovative drive within the industry. While China has been strengthening its leading position in terms of ADMAN firms, the EU has been growing at a faster pace than the US in recent years. This is in line with the rise in the number of EU firms engaging in ADMAN activities, growing from 1,900 in 2009 to 4,500 in 2023, with a notable concentration in Germany, Spain, France, and Italy. Key factors in the EU's ADMAN industry are also the EU-funded projects, which engage around 40% of ADMAN firms in the EU and demonstrating the EU's commitment to supporting this industry. When looking at the technological scope of the ADMAN industry, '3D Printing' and 'Dynamic Data' are among the largest technological areas. However, European firms show a stronger relative comparative advantage in more *niche* technological domains, such as 'IoT' and 'Extended Reality'.

Foreign ownership of EU27 ADMAN firms stands at 18%, aligning with the global average. Most foreign-owned EU ADMAN firms are controlled by US companies. This underscores the ties in technological advancements and the potential for collaborations that characterize the relationship across these jurisdictions. Venture capital (VC) investments in the EU's ADMAN sector, however, lag behind those in the US and China, with only 5% of global VC funds flowing into EU firms. This indicates a critical area where the EU can improve to enhance the growth and innovation potential of its ADMAN industry.

The ADMAN study also entails the development of an interactive online tool, accessible by the public, allowing users to pull key messages relevant for their interest and deep dives on areas of interest. Finally, a last report would summarize all main findings of the outputs of the ADMAN study.

The outcomes of the ADMAN study aims at supporting EU policymakers, industrial stakeholders and MS in assessing the performance of the ADMAN industry and by providing a robust foundation for policy formulation and strategic planning. The EU's industrial strategy should continue to prioritize advanced manufacturing, leveraging the insights from this study to foster innovation, attract investment and strengthen the EU's relative position in the global ADMAN industry. In this regard, addressing the VC gap is essential to empower ADMAN firms and sustain the industry's growth trajectory. The EU's ADMAN industry needs to maintain momentum and to defend its position in the global ADMAN industry, continuing to foster an environment conducive to the twin – green and digital – transition.

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