

Global Innovation Index 2026 Special

Technology SPARK Report Series

Patenting in Deep Science Startups and Spinouts

WIPO

Technology SPARK Report Series
Global Innovation Index 2026 Special

Patenting in Deep Science Startups and Spinouts

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

This work is licensed under Creative Commons Attribution 4.0 International. To view a copy of this license, please visit https://creativecommons.org/licenses/by/4.0

The user is allowed to reproduce, distribute, adapt, translate and publicly perform this publication, including for commercial purposes, without explicit permission, provided that the content is accompanied by an acknowledgement that WIPO is the source and that it is clearly indicated if changes were made to the original content.

Suggested citation: World Intellectual Property Organization (WIPO) (2026). *SPARK: Patenting in Deep Science Startups and Spinouts*. Geneva: WIPO. DOI: https://doi.org/10.34667/tind.60368

Adaptation/translation/derivatives should not carry any official emblem or logo, unless they have been approved and validated by WIPO. Please contact us via the WIPO website to obtain permission.

For any derivative work, please include the following disclaimer: "The Secretariat of WIPO assumes no liability or responsibility with regard to the transformation or translation of the original content."

When content published by WIPO, such as images, graphics, trademarks or logos, is attributed to a third party, the user of such content is solely responsible for clearing the rights with the right holder(s).

Any dispute arising under this license that cannot be settled amicably shall be referred to arbitration in accordance with Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL) then in force. The parties shall be bound by any arbitration award rendered as a result of such arbitration as the final adjudication of such a dispute.

The designations employed and the presentation of material throughout this publication do not imply the expression of any opinion whatsoever on the part of WIPO concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This publication is not intended to reflect the views of the Member States or the WIPO Secretariat.

The mention of specific companies or products of manufacturers does not imply that they are endorsed or recommended by WIPO in preference to others of a similar nature that are not mentioned.

Cover: Getty Images; Unsplash.
WIPO Publication No. 1089.4EN/26

© WIPO, 2026
First published 2026

World Intellectual Property Organization
34, chemin des Colombettes
P.O. Box 18
CH-1211 Geneva 20
Switzerland

ISBN: 978-92-805-3969-1 (print)
ISBN: 978-92-805-3968-4 (online)

Contents

Acknowledgments 6

Executive summary 7

Introduction 11

Global patenting trends in deep science startups and spinouts 13
Patent adoption among deep science startups 13
Geographic and national patterns 15
Patents across income groups 20
Patents across sectors 24
Patents across technologies 32

Patenting strategies across the startup life cycle 39
Patent filing timing 39
Patent assignment 45
Joint patent filings 55
PCT international filing routes 65
Growth stage 68

Conclusions and key takeaways 71
Ongoing structural shifts 71
Key takeaways 72

Appendix 73
Patent search and matching strategies 73
Data coverage and limitations 73
Sampling methodology 73

Acknowledgments

This WIPO Technology SPARK (Short Pieces of Analysis, Research and Knowledge) Report was prepared under the stewardship of Marco Alemán (Assistant Director General, IP and Innovation Ecosystems Sector) and was led by Christopher Harrison (Patent Analytics Manager, IP Analytics Section, IP for Innovators Department).

The report was prepared by a project team led by Christopher Harrison and Hong Kan (Patent Analytics Officer, IP Analytics Section).

We also acknowledge the support of the Global Innovation Index team, led at the time of the preparation of this report by Sacha Wunsch-Vincent, and extend our thanks to Lorenzo Chiavarini and Felix Ullmer (both from Dealroom.co), to Mosahid Khan and Kyle Bergquist (Statistics and Data Analytics Division), and to the WIPO editorial and design team led by Charlotte Beauchamp.

Our thanks also go to Allison Mages (Head, IP Commercialization Section) and Lorena Rivera Leon (Acting Head, Composite Indicator Research Section) for reviewing the report and providing valuable input, and acknowledge equally valuable external input from Gaétan de Rassenfosse (École polytechnique fédérale de Lausanne (EPFL)).

email: ip.analytics@wipo.int

Executive summary

Deep science startups are gaining momentum worldwide, both in number and in the volume of venture capital they attract. Unlike other startups, deep science startups are scientific and engineering breakthroughs and typically require extended R&D cycles, specialized infrastructure and rigorous multi-stage validation before commercialization.[1] They operate across a wide range of sectors, including Life Sciences, Semiconductors, Medical Devices and Digital Health, Food and Agritech, Robotics and Autonomous Systems, Space, Energy, Transportation, and Advanced Materials and Manufacturing. Spinouts are a subset of deep science startups: firms originating from research carried out at a university or research center.[2] According to the Dealroom–WIPO Deep Science Startup Tracker,[3] more than 30,000 deep science startups, including spinouts, have been set up worldwide since 2000. By the end of 2025, they were worth a total of USD 7.6 trillion.

For these startups, intellectual property is not optional but a core strategic asset. However, comprehensive evidence on how the patenting behavior of deep science startups varies across regions, income levels, industries and developmental stages has remained limited.

This WIPO Technology SPARK Report aims to fill that gap. By mapping all 24,490 VC-backed deep science startups founded between 2010 and 2025 in the Dealroom–WIPO Deep Science Startup Tracker against global patent databases, WIPO presents a global analysis of patenting activities among deep science startups.

Patents are one visible proxy for innovation activity, and not the complete picture of a startup's intangible assets. Trademarks, trade secrets, know-how, proprietary data and regulatory exclusivity are increasingly central to how deep science ventures capture and defend value – and are often more accessible to earlier-stage or resource-constrained startups than a full patent strategy, which can require significant upfront cost and legal infrastructure. This is particularly true as software and data-driven models become increasingly embedded in scientific commercialization. Patents are the focus here because they offer the most comprehensive, structured and internationally comparable data available for matching at global scale. Extending this methodology to trademarks and other IP forms is a priority for future WIPO research.

1 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

2 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

3 Dealroom–WIPO Deep Science Startup Tracker. Available at: https://www.wipo.int/en/web/global-innovation-index/2026/deep-science-innovation

Serving as a companion analysis to the *Global Innovation Index 2026 Special theme: Powering entrepreneurs at the frontier of science, turning pilots into pipelines*,[4] this report highlights the following key findings:

The global distribution of patents among deep science startups is highly unequal, with high-income countries accounting for about 76% of all international patent families (IPFs), while China and India alone generate over 99% of IPFs in the upper middle- and lower middle-income groups, respectively

Deep science startups are significantly more likely to hold patents than their non-deep peers: 50% compared to just 15% globally. This gap has continued to widen over the past decade. It may reflect the higher technical barriers and longer research and development (R&D) cycles in deep science sectors, where patents serve as critical assets for fundraising and defensive positioning. This does not imply that the remaining half of deep science startups lack valuable IP. Many rely instead on trade secrets, know-how or data assets that are not captured in patent databases, particularly in early stages or software-adjacent sub-sectors.

Deep science startups in the Republic of Korea (69%), Finland (67%) and Japan (65%) exhibit the highest patent adoption rates[5] globally. High-income economies such as France, Germany, Israel and the United States of America (US) cluster within the 45% to 55% range. In terms of total patent volume, no single economy dominates: China, Europe, Japan, the Republic of Korea and the United States all hold comparable shares of international patent families. Notably, Chinese enterprises have rapidly expanded their patent footprint in Asia through a massive volume of patent filings.

International patent filings are highly concentrated in a small number of countries. High-income countries contributed 76% of the global total of international patent families, compared with 24% for upper middle-income countries and only 0.4% for lower middle-income countries. Meanwhile, within the upper middle- and lower middle-income brackets, China and India account for over 99% of the international patent families in their respective income groups – though India's within-group dominance rests on a very small absolute base, in contrast to China's globally significant volume.

Patent adoption rates vary significantly by sector. The underlying technologies also differ in how broadly they are applied, falling into two groups: specialized technologies, whose patents are concentrated in a single application domain, and general-purpose patterns, whose patents are distributed more evenly across several sectors

Patent strategies differ across sectors. Life Sciences startups, as well as those in the Medical Devices and Digital Health sector, rely on highly focused, core-patent strategies, averaging just six international patent families per firm. Conversely, Semiconductors (averaging 14) and Transportation (averaging 12) startups hold substantially larger portfolios, possibly reflecting efforts to secure freedom-to-operate and hedge against litigation from industry giants. Driven by rapid-scale entities, Chinese deep science startups are building large patent portfolios in areas like Energy, Semiconductors, and Robotics and Autonomous Systems.

4 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

5 The patent adoption rate is the share of startups holding at least one published patent application

The technologies covered by deep science startups' patents fall into specialized and general-purpose categories. Specialized technologies, such as Biotechnology and Quantum Technology, are closely tied to specific industries. For example, 87% of Biotechnology applications are concentrated in Life Sciences, while 70% of Quantum Technology applications are concentrated in Semiconductors. In contrast, general-purpose technologies, such as Artificial Intelligence and Materials Science, are applied more broadly: their patents are distributed across multiple sectors including Life Sciences, Medical Devices and Digital Health, Robotics and Autonomous Systems, and Semiconductors.

Final products usually depend on combining several underlying technologies. For instance, as chips shrink to the nanoscale, up to 64% of international patent families held by semiconductor deep science startups are related to Quantum Technology. Similarly, the Space and Transportation sectors deeply integrate Artificial Intelligence, Materials Science and Autonomous Robotic Technology, suggesting a highly interwoven technological landscape.

Startups typically file their first patent in their first or second year of founding; 7% of their patents were filed before the startup was founded and later transferred to them

Whether in Life Sciences R&D or in rapidly iterating Robotics and Autonomous Systems, the most common timing for patent-holding deep science startups to file their first patent is in their founding year (16%) or in the year after founding (18%). This may suggest that business survival pressures could accelerate the timing of first patent filings, rather than waiting for a completed R&D cycle. For patent-holding startups, early patent filings may help demonstrate technology ownership to investors and secure the funding needed to cross the early-stage "valley of death" – the gap between research and successful commercial development.

Deep science startups often build on research carried out before the company existed. For 28% of patent-holding deep science startups, the earliest priority year of their first patent predates the founding of the company, compared with 19% for non-deep science startups. Globally, approximately 7% of the patents held by deep science startups were originally filed by research institutions or other companies prior to the startup's founding and subsequently transferred to them – a share that rises to 13% in high-income countries.[6]

Filing speeds and transfer mechanisms vary across countries. Israel has the highest share of patent-holding deep science startups filing patents in their founding year (31%). The Republic of Korea leads in pre-founding patent transfers from academia (51%), highlighting a strong university-driven incubation model. Conversely, and possibly due to a lack of funding and technology transfer channels, lower middle-income countries – led by India – see their first patent filing peak a full year later (in the second year after founding).

Patent-holding deep science startups frequently collaborate with external partners

Deep science startups are built on collaborative innovation. Globally, 17% of patent-holding deep science startups have filed at least one patent jointly with another organization, and 3% with a co-applicant located in another country – both shares significantly exceeding those of non-deep science startups. While 82% of co-filings by patent-holding non-deep science companies occur internally between parent companies and subsidiaries, over half of the

6 These figures capture transfers of ownership only. Patents licensed without a change in ownership do not appear in startups' portfolios, so the actual share of startups building on externally developed technology is likely to be higher

collaborations by patent-holding deep science startups involve external partners. Notably, 22% of these joint filings are co-filed with universities and research institutions.

In international collaborations, Life Sciences plays a dominant role, with the sector's startups occupying seven of the top ten spots for joint cross-border patent applications.

Switzerland appears to be positioning itself as a hub for cross-border collaborative innovation. With its well-recognized R&D environment, Switzerland is home to three of the top ten global patent-holding deep science startups in cross-border cooperation, holding the top two positions (ADC Therapeutics and CRISPR Therapeutics). This points to Switzerland's appeal to global technological assets.

Deep science startups rely heavily on the PCT system for international expansion

Globally, up to 84% of patent-holding deep science startups have used the Patent Cooperation Treaty (PCT) route at least once to seek international patent protection, far surpassing the 57% recorded by their non-deep science peers.

At the portfolio level, however, PCT applications account for only 31% of the patents held by deep science startups. This suggests that, given the higher costs of international patent protection, companies may selectively seek protection abroad for their most valuable assets. Over the past decade, the cumulative PCT share has declined from nearly 40% to 31%.[7]This does not necessarily signal weakening internationalization intent, but rather reflects a structural dilution effect: overall patenting has grown rapidly, driven in large part by a surge in domestic patenting in China. This has expanded the global patent base and diluted the PCT share, even as the share of PCT patents within high-income and upper middle-income economies has remained stable or increased.

7 The cumulative share is calculated across all patents filed up to and including each year, rather than patents filed in that year alone

Introduction

The rise of deep science entrepreneurship is reshaping global innovation and industry boundaries. In this report, deep science startups refer to ventures built on scientific and engineering breakthroughs in fields such as advanced materials, energy science, genomics, health technologies, quantum physics and synthetic biology.[1] Spinouts are a subset of these startups, comprising firms that originate from research carried out at a university or research center.[2] Unlike other startups, deep science ventures typically lengthy R&D cycles, multi-stage validation, prototyping and trials before generating revenue.[3] They are capital-intensive, relying on laboratories, specialized equipment, pilot plants and manufacturing scale-up,[4,5] as well as multidisciplinary teams combining scientific and engineering expertise with regulatory, manufacturing, quality and business capabilities. Consequently, intellectual property (IP) plays a far more critical and distinct strategic role in deep science compared to other technology sectors.

For deep science enterprises, IP performs three distinct functions.[6]

- First, it bridges the gap between invention and revenue. In many deep science sectors, the time lag between the initial invention and commercial revenue generation spans five to fifteen years. During this period, patents often represent the primary verifiable asset on the balance sheet. Startups must leverage this asset to demonstrate technology exclusivity to investors, signal credible ownership to partners and build a defensible legal foundation for licensing negotiations.
- Second, it defines the boundaries of collaboration. Deep science startups often scale through strategic integration; they license to incumbents, form joint ventures or are acquired for their value. In these multi-party collaborative structures, IP clauses define who owns what, who can use what and under what conditions – serving as the institutional foundation for establishing and sustaining complex partnerships.
- Third, it supports non-dilutive financing. IP-backed financing is emerging as an innovative tool, providing deep science startups with the non-dilutive capital required to sustain operations over lengthy development cycles.

1 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

2 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

3 Raff, S., F. Murray and M. Murmann (2024). Why you should tap innovation at deep-tech startups. *MIT Sloan Management Review*, 65(2), 61–66.

4 Auerswald, P.E. and L.M. Branscomb (2003). Valleys of death and Darwinian seas: Financing the invention to innovation transition in the United States. *Journal of Technology Transfer*, 28(3–4), 227–239.

5 Howell, S.T., J. Rathje, J. Van Reenen and J. Wong (2023). Innovating to net zero: Can venture capital and startups play a meaningful role? Entrepreneurship and Innovation Policy and the Economy, 2, 107–145.

6 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

These three functions are most clearly documented through patents, which is why this report focuses on them. However, patents are not the only IP form performing these roles. Trade secrets protect proprietary processes and know-how that startups may deliberately choose not to disclose through patenting; regulatory data exclusivity offers de facto market protection in sectors like pharmaceuticals and agritech; and proprietary data sets and trained models are increasingly treated as core defensible assets in AI-enabled and data-driven ventures. As deep science increasingly intersects with software and data-centric business models, this broader IP toolkit is likely to grow in strategic importance alongside, and not instead of, patents.

Deep science entrepreneurship has reached a scale that can no longer be ignored. According to the Dealroom–WIPO Deep Science Startup Tracker, by the end of 2025, more than 30,000 deep science startups and spinouts had been founded globally since 2000 – representing a 9.5-fold increase compared to 2010, with a Compound Annual Growth Rate (CAGR) of 16.2%. These startups attracted USD 122 billion in venture capital in 2025 alone.[7]

As this ecosystem rapidly expands, policymakers, investors and academics are increasingly focused on understanding how deep science startups protect, manage and leverage their IP. To what extent do deep science startups actually hold patents? How does this behavior toward patents vary across regions, industries and growth stages? Does a country's income level influence a startup's patent strategy? To date, systematic, global empirical analyses leveraging such comprehensive and recent startup-level data sets remain limited.

This WIPO Technology SPARK (Short Pieces of Analysis, Research and Knowledge) Report aims to address this gap. By matching 24,490 startups founded between 2010 and 2025 in the Dealroom–WIPO Deep Science Startup Tracker with global patent databases, WIPO has delivered a global comparative analysis of patenting activities among deep science startups. The matched patent data set is sourced using the Patsnap patent database, covering patent family filing records across all major global patent offices worldwide.

The data and insights in this report both support and complement the *Global Innovation Index 2026 Special Section on Deep Science Entrepreneurship*,[8] which examines the scaling pathways and policy environments of deep science startups. While the GII special section discusses IP as one component of a broader commercialization ecosystem, this report builds on that foundation by providing a deep, dedicated analysis of the patent dimension. It reveals how patenting behavior varies by sector, growth stage and income level, thereby establishing an evidence base for tailored policy design.

This report is structured around two main themes, corresponding to its two analytical sections.

- First, the overall patent landscape of adoption rates and portfolio sizes among deep science startups is considered, analyzing them across four dimensions: regions and economies, income groups, sectors and technologies.
- Deeper analysis then goes beyond patent adoption rates to investigate how deep science startups leverage their patents at different stages of their life cycle. This includes patent filing timing, patent transfers, joint filings, PCT international filing strategies, how patent adoption evolves across growth stages.

7 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

8 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

Global patenting trends in deep science startups and spinouts

This section is dedicated to mapping out a comprehensive landscape of the global deep science patent ecosystem, based on an analysis of patents held by over 24,000 deep science startups and spinouts founded between 2010 and 2025. To this end, the analysis unfolds across four key dimensions: geography, income groups, sectors and underlying technologies. Through this perspective, we offer a useful guide for policymakers and investors to measure the strength of deep science innovation worldwide.

Patent adoption among deep science startups

The patent adoption gap between deep science and non-deep science startups continues to grow.

Patent adoption rates[1] among deep science startups have increased substantially. In 2016, only 24.0% of deep science startups globally held patents; by the end of 2025, this share reached 49.2% (versus 15.1% for non-deep science startups), and further rose to 49.7% as of March 2026 (versus 15.4% for non-deep science startups). This means that nearly half of all deep science startups worldwide now hold patents within their IP portfolios.

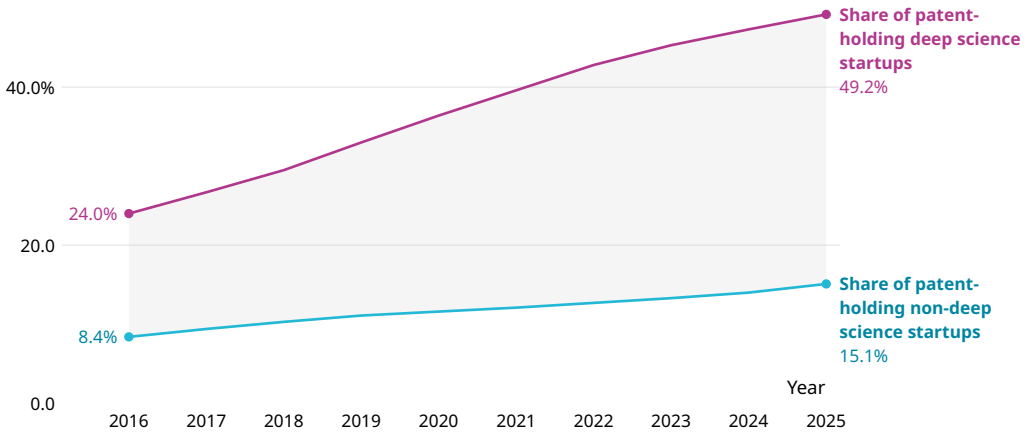
In contrast, the patent adoption rate for non-deep science startups rose from 8.4% in 2016 to 15.1% in 2025. However, their growth was much slower, and the overall share remained consistently low.

The patent adoption gap between these two types of startups has widened substantially, expanding from 15.6% in 2016 to 34.1% in 2025. Today, a deep science startup is 3.3 times more likely to hold patents than its non-deep science peers (Figure 1).

1 The patent adoption rate is the share of startups holding at least one published patent application

Share of patent-holding startups is rising for both startup types, but faster among deep science startups

Figure 1 Share of patent-holding startups over time: deep science vs. non-deep science startups, 2016–2025



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

This widening gap appears to be correlated with the unique nature and commercialization pathways of deep science startups:

- **Differences in the nature of technology.** Non-deep science startups, particularly in digital and software sectors, often operate in faster product cycles where business model innovation, rapid execution and network effects serve as primary competitive barriers, relying less on patent-based exclusion. These sectors typically rely on first-mover advantage – the benefit experienced by a firm as the consequence of its early entry into a new market – and network effects to build barriers to entry. Their IP strategies focus primarily on software copyrights, as well as designs and method patents; furthermore, in many jurisdictions, software code is not considered typical patentable subject matter. Conversely, deep science enterprises are deeply rooted in physical and life sciences such as synthetic biology, quantum physics and advanced materials. Their innovations are highly advanced with significant technical barriers, requiring utility patents for physical, chemical or biological inventions in order to protect their technology.
- **Pressure from capital markets.** For deep science startups facing multi-year R&D cycles and zero revenue, patents serve as a primary verifiable asset that can be measured and checked. To survive the long research phase and secure funding, these startups are incentivized to build their patent portfolios strategically to demonstrate both technical barriers and risk control to investors.[2]

2 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

Geographic and national patterns

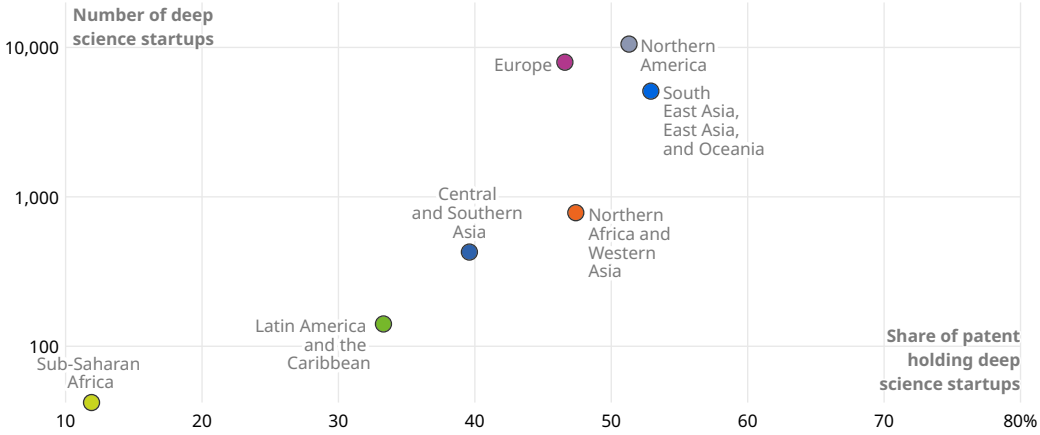
On the global map of deep science innovation, IP is not only a measure of technological strength but also a strategic asset that shapes a region's competitive edge. Led by Northern America, Europe, and East Asia, this section provides a deep analysis of the regional imbalances, national efficiency variations, dynamic evolution of international patent families (IPFs) and patent patterns at the firm level.

The global map: Northern America, Europe, and East Asia dominate

The distribution of deep science startups and their patent adoption rates exhibits high geographic concentration. Figure 2 illustrates the distribution of regions across two axes: startup volume and patent adoption rates.

Northern America, Europe, and East Asia dominate the landscape, leading in both deep science startup volume and IP intensity

Figure 2 Share and count of patent-holding deep science startups by region, 2010–2025



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Northern America exhibits a significant scale advantage, with over 10,000 deep science startups and a patent adoption rate of 51.3%.

Europe possesses the second-largest startup base (7,963) and maintains a steady patent adoption rate of 46.6%.

South East Asia, East Asia, and Oceania, while having a smaller number of deep science startups (5,100) than Northern America and Europe, lead globally with a patent adoption rate of 52.9%. This may reflect policy incentives and patent-focused growth strategies in the region, particularly in countries such as China, Japan and the Republic of Korea.

In contrast, other global regions remain in a catch-up phase. Latin America and the Caribbean, and Central and Southern Asia lag behind the three core hubs in the total number of startups (141 and 427, respectively), and their patent adoption rates are also lower (33.3% and 39.6%, respectively).

Sub-Saharan Africa faces a dual challenge: a limited number of deep science startups (42) and a patent adoption rate of approximately 12%. These figures partly reflect data coverage limitations but also underscore the reality that the region's deep science innovation ecosystem is in an early stage of development.[3] The low patent adoption rate in Africa may be partially linked to direct cost barriers; for example, in Uganda, the lack of public subsidies means early-stage inventors must bear the relatively high costs of IP protection entirely on their own.[4] Conversely, South Africa, supported by a more mature IP infrastructure and commercialization ecosystem, exhibits a relatively higher patent adoption rate of 16.7%, illustrating the influence of the institutional environment on patenting behavior.

National profiles: scale giants and patent intensity leaders

When we look beyond regional averages to specific countries (Figure 3), the global deep science patent ecosystem exhibits a dual-track pattern: high-volume economies led by the United States and China on one track, and high-intensity economies led by the Republic of Korea, Japan and Finland on the other.

High-volume economies. The United States has the largest number of deep science startups (9,665) with a patent adoption rate of around 51.4%. China has 3,112 deep science startups and maintains a patent adoption rate of 47.7%.

High-intensity economies. The rightmost area of Figure 3 (representing high patent adoption rate) is occupied by a few countries. Although they have fewer startups than United States and China, their patent adoption rates are notably higher. The Republic of Korea and Japan show patent adoption rates of 69.4% and 65.8%, respectively, while Finland leads Europe with a rate of 67%.

In economies such as Brazil, India and the Republic of Türkiye, deep science startups have grown rapidly since 2020.[5] However, because these companies are relatively young (on average), this shorter operating history may partly explain their lower patent adoption rates.

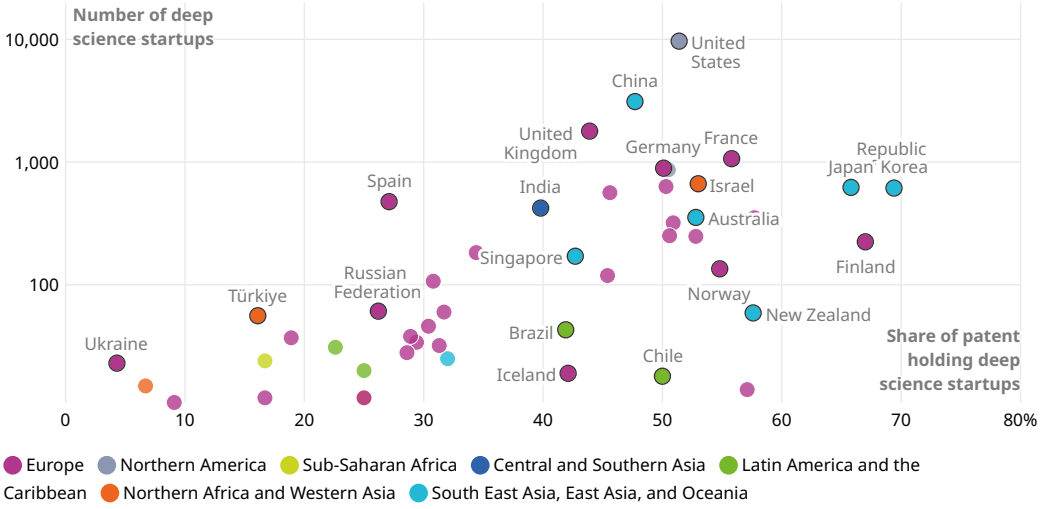
3 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

4 Saxena, K. (2026). From research to scale: Evidence on deep-tech startup development in developing economies. Background study prepared for the Global Innovation Index 2026. Geneva: WIPO.

5 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

The Republic of Korea, Finland and Japan lead global patent adoption among deep science startups

Figure 3 Share and count of patent-holding deep science startups by economy and region, 2010–2025



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

The evolution of international patent families: the global landscape and China's catch-up curve

While patent ownership is a fundamental step, we introduce the concept of international patent families (IPFs) to evaluate how deep science startups protect and expand their business globally. An IPF represents a patent filed in at least two different jurisdictions, serving as a widely recognized proxy for foreign-oriented innovation.[6]

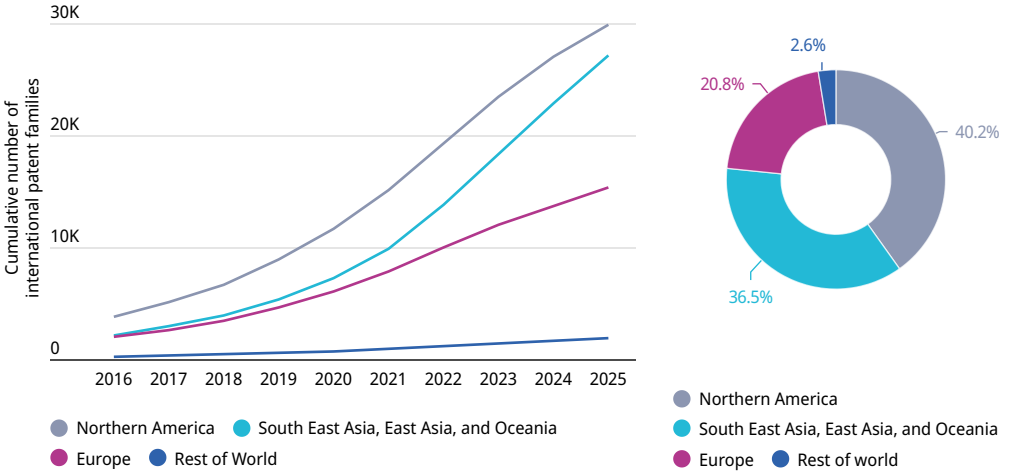
The cumulative IPF share (as of May 2026) shows a high concentration in two primary regions (Figure 4): Northern America accounts for 40.2% of the global total, closely followed by South East Asia, East Asia, and Oceania at 36.5%. Despite its large startup base, Europe accounts for only 20.8% of the global total. The rest of the world combined holds only 2.6%, reflecting more localized patent protection strategies or limited international market expansion in these regions.

6 Dechezleprêtre, A., Y. Ménière and M. Mohnen (2017). International patent families: From application strategies to statistical indicators. *Scientometrics*, 111, 793–828. DOI: https://doi.org/10.1007/s11192-017-2311-4.

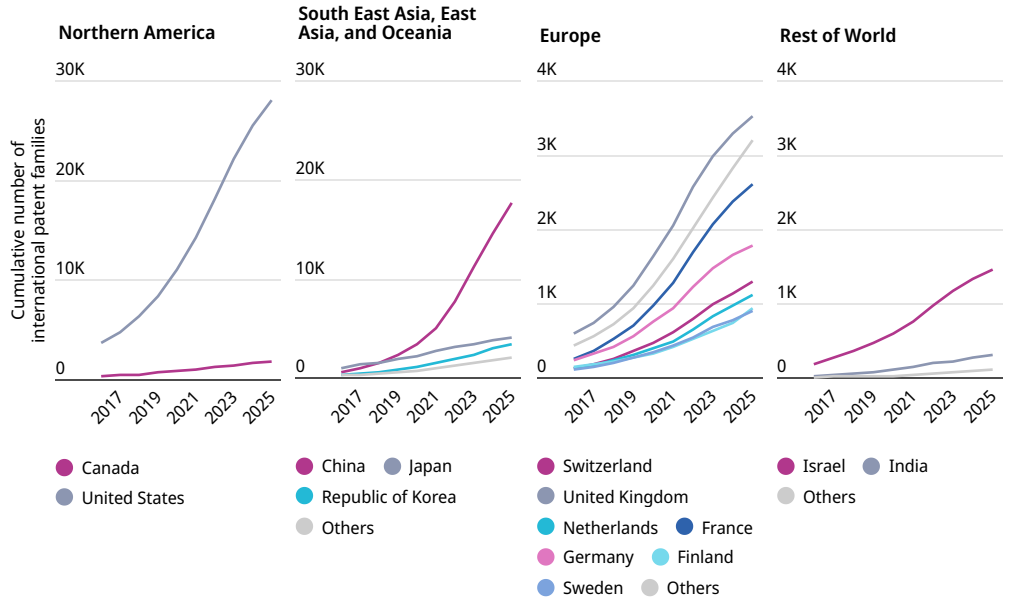
Northern America holds the largest share of international patent families, as East Asia's IPF growth accelerates

Figure 4 Geographic growth trends of international patent families (IPF) held by deep science startups

Regional growth trends and share distribution of cumulative international patent families held by deep science startups



Country-level growth trends of cumulative international patent families held by deep science startups



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

The dynamic growth curves of cumulative IPFs from 2016 to 2025 reveal distinct narratives across different countries:

- The curve for Northern American is heavily driven by the United States, where cumulative IPFs grew from 3,588 in 2016 to approximately 28,000 by the end of 2025 (a nearly eightfold increase).
- China exhibits a steep catch-up curve. Its cumulative IPFs increased from 571 in 2016 to approximately 17,600 by the end of 2025 – a more than 30-fold expansion. This upward trend largely underpins the overall growth of the South East Asia, East Asia, and Oceania region.
- Europe's growth curve is notably flatter than those of China and the United States. Within Europe, the United Kingdom and France lead in IPF accumulation, followed closely by Germany, Switzerland, the Kingdom of the Netherlands, Sweden and Finland.
- Israel dominates the "Rest of the World" cohort, accounting for the vast majority of its IPFs. Conversely, while India has seen a rapid rise in deep science entrepreneurship in recent years, its performance in IPFs is still in its early stages, having not yet achieved significant scale.

A micro-level perspective: Chinese deep science startups build technological defensive barriers through high-density patent filings

The list of top global deep science startups by number of simple patent families (Table 1) exhibits a high concentration of Chinese enterprises. Of the top ten positions, aside from seventh-ranked CTRL-labs (a US neural interface startup subsequently acquired by Meta)[7], the remaining nine companies are all based in China.

However, the picture becomes more geographically diverse when startups are ranked by the number of international patent families (IPFs). Chinese companies account for five of the top ten – Changxin Memory Technologies, United Imaging Healthcare, UBTECH Robotics, Hithium, and SVOLT Energy – while four are based in the United States (CTRL-labs, Magic Leap, Verily, Zoox) and one in Japan (JOLED).

Semiconductor-related startups account for four of the top ten companies ranked by the number of simple patent families: Changxin Memory Technologies, Biren Technology, ESWIN Computing and Origin Quantum. Among them, Changxin Memory Technologies ranks first with 8,311 simple patent families, of which 3,395 are international patent families (IPFs), reflecting a potentially high barrier to entry and global litigation risks inherent in the Semiconductors sector.

The data also reveal different patenting strategies among these deep science startups. For instance, companies like Leapmotor (2,180 simple patent families, 31 IPFs) and SVOLT Energy (3,684 simple patent families, 402 IPFs) possess a vast volume of domestic patents but a relatively small number of international patent families, suggesting a primary focus on establishing defensive positions within China – the world's largest market for new energy vehicles. Conversely, CTRL-labs and Changxin Memory Technologies pursue an active international strategy, filing extensive foreign-oriented patents, possibly to reduce potential litigation risks during global market expansion.

7 CTRL-labs. Accessed at: https://dsvw8jmuo45j8.cloudfront.net/

Chinese startups occupy nine of the top ten deep science startups by patent holdings

Table 1 Top deep science startups across regions based on total simple and international patent families

	Startups	Number of simple patent families	Number of international patent families	Sector	Country	Region
1	ChangXin Memory Technologies	8,311	3,395	Semiconductors	China	South East Asia, East Asia, and Oceania
2	United Imaging Healthcare	5,463	909	Medical Devices and Digital Health	China	South East Asia, East Asia, and Oceania
3	SVOLT Energy	3,684	402	Transportation	China	South East Asia, East Asia, and Oceania
4	UBTECH Robotics	3,273	641	Robotics	China	South East Asia, East Asia, and Oceania
5	Leapmotor	2,180	31	Transportation	China	South East Asia, East Asia, and Oceania
6	Hithium	1,986	607	Energy	China	South East Asia, East Asia, and Oceania
7	CTRL-Labs	1,776	1,564	Robotics	United States	Northern America
8	Biren Technology	1,600	65	Semiconductors	China	South East Asia, East Asia, and Oceania
9	ESWIN Computing	1,509	134	Semiconductors	China	South East Asia, East Asia, and Oceania
10	Origin Quantum	1,502	65	Semiconductors	China	South East Asia, East Asia, and Oceania

Additional 55 rows not shown.

Note: Extended lists featuring top deep science startups across a wider range of regions and economies are available in the online version of this report.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Patents across income groups

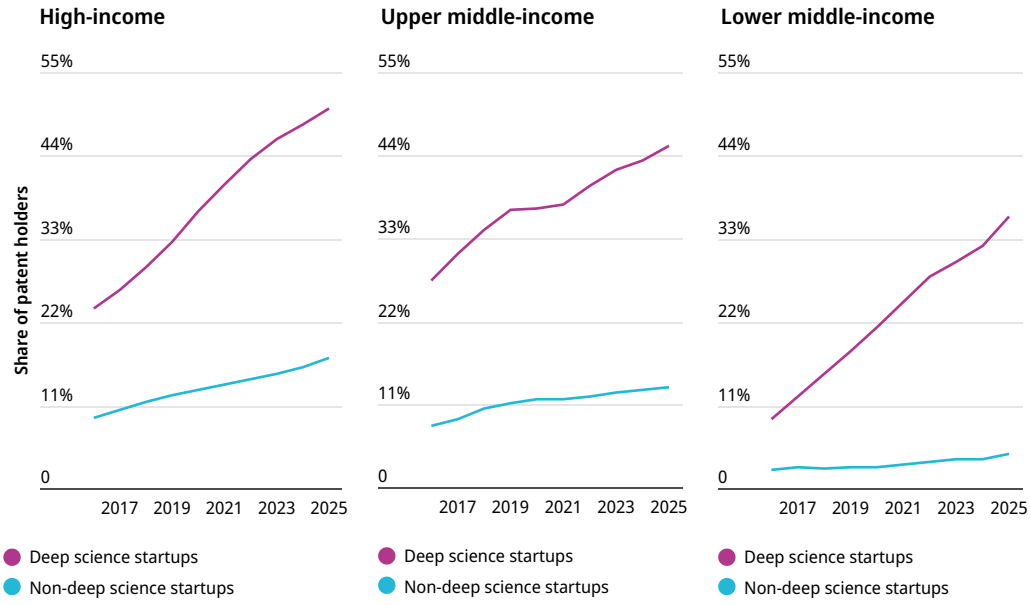
For deep science startups characterized by long R&D cycles and highly capital-intensive operations, the wealth of a country or economy can influence the funding availability of its domestic innovation ecosystem. It can also constrain a startup's capability to go global and file expensive international patents. This section shifts focus to the dimension of income groups, analyzing the trajectory of patent adoption rates across different economies and the global distribution patterns of international patent assets.

Patent adoption rates: rising across all income groups, alongside a decline down the income scale

Figure 5 illustrates the evolution of patent adoption rates for deep science and non-deep science startups across different income groups from 2016 to 2025. Across all levels of economic development, the patent adoption rates of deep science startups consistently exceed those of their non-deep science peers. In high-income economies, the patent adoption rate for deep science startups reached 50.2% in 2025 (compared to only 17.3% for non-deep science). In upper middle-income economies, this share stood at 45.3% (compared to only 13.2% for non-deep science). Even in lower middle-income economies, the adoption rate for deep science startups rose from 9.1% in 2016 to 35.9% in 2025, whereas the rate for non-deep science startups in the same group was only 4.6%.

Patent-holding rates fall as income levels decline, yet deep science startups consistently outpaced non-deep science peers across all income groups

Figure 5 Share of patent-holding startups among deep science and non-deep science startups by income group



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with p = 0.5), the margin of error is approximately ±1.08% for High-income group, ±2.28% for Upper middle-income group, and ±2.87% for Lower middle-income group. Data for low-income economies are not displayed due to the limited number of observations.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Despite this upward trend, patent adoption rates declines as the income level of their headquarters' economy decreases, dropping from 50.2% in the high-income group to 35.9% in the lower middle-income group. In lower middle-income economies, 64.1% of deep science startups do not hold any patents.

However, this gap in patent adoption rates across income groups should not be simply attributed to lower-income economies not valuing IP. In fact, IP adoption is not merely a matter of willingness to protect; rather, it is fundamentally constrained by the objective capability of the innovation ecosystem.

As *GII 2026* points out, structural barriers, such as capability gaps between research and industrial application, may contribute to lower IP activity in lower-income economies between scientific research and industrial application, rather than a lack of awareness of patents value among startups. Specifically, structural barriers – such as unclear licensing terms, weak technology transfer office (TTO) capabilities and short-term funding incentives – are more common in lower-income regions.[8] This could contribute, to some extent, to the observed gap in patent adoption rates between startups in high-income and lower-income countries.

This suggests that closing the global deep science IP gap may depend less on promoting the value of patent protection, and more on addressing structural constraints – such as filing costs, international filing capacity and technology transfer infrastructure – that shape whether startups in lower-income economies are able to convert research into protected IP.[9]

Distribution of international patent families (IPFs): 75.6% of global IPFs concentrated in high-income economies, while China and India dominate their respective middle-income groups

An analysis of cumulative IPFs as of May 2026 reveals a highly uneven global distribution of deep science patent assets (Figure 6).

High-income economies hold cumulative 58,181 IPFs, representing 75.6% of the global total. Upper middle-income economies hold 18,456 IPFs, representing 24.0% of the global share. Meanwhile, lower middle-income economies hold only 328 IPFs, representing just 0.4 of the global total. This could indicate that when expanding globally and filing foreign-oriented patents, enterprises in high-income economies maintain a significant lead, supported by established international legal networks and substantial financial resources.

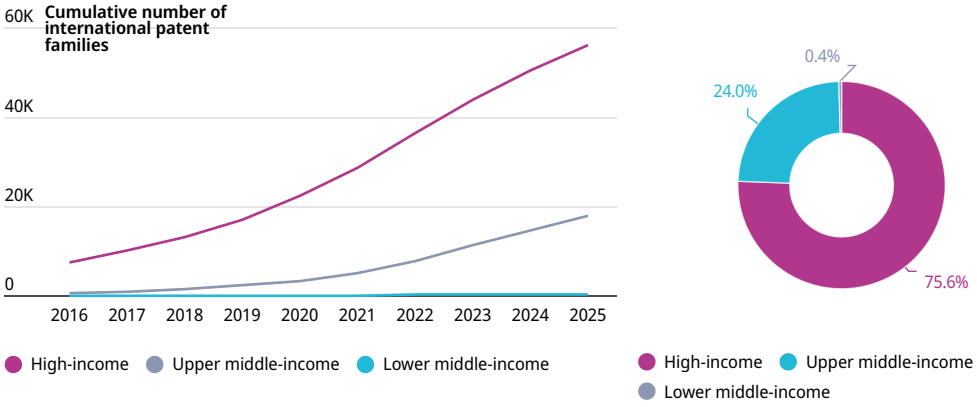
8 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

9 Saxena, K. (2026). From research to scale: Evidence on deep-tech startup development in developing economies. Background study prepared for the Global Innovation Index 2026. Geneva: WIPO.

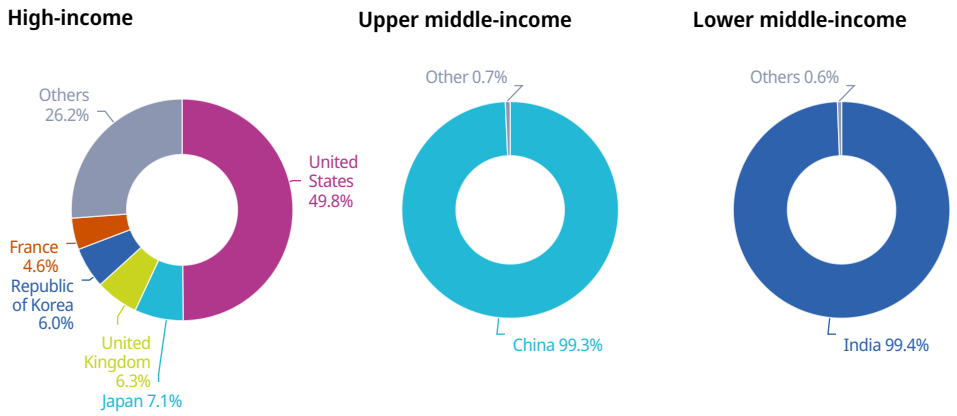
High-income economies hold 76% of international patent families filed by deep science startups, led by the United States, while China and India dominate their respective income groups

Figure 6 Income group-level growth trends and share distribution of international patent families held by deep science startups

Growth trends and share distribution of cumulative international patent families held by deep science startups by income group



Country-level share distribution of cumulative international patent families held by deep science startups by income group



Note: Data for low-income economies are not displayed due to the limited number of observations.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

A closer analysis of the country-level shares within each income group reveals a high level of concentration. Within the high-income group, while the United States maintains a commanding lead (49.8%), the remaining share is distributed among several active countries, including Japan (7.1%), the United Kingdom (6.3%), the Republic of Korea (6.0%) and France (4.6%). This pattern reflects relatively diverse sources of innovation and competitive dynamics within the high-income group.

In the upper middle-income category, China holds 99.3% of the IPFs, while all other upper middle-income economies combined represent only 0.7%. Similarly, in the lower middle-income group, India accounts for 99.4% of the IPFs, while all other lower middle-income economies combined represent just 0.6%. This data could indicate that within the upper middle and lower middle-income groups, the global IP performance of deep science startups is essentially equivalent to the performance of China and India, respectively. This extreme concentration may also be highly correlated with the distribution of venture capital (VC), as China and India host the vast majority of VC-backed startup activity within their respective income groups.[10] In contrast, deep science startups in other middle-income economies may rely more heavily on non-VC public funding and university frameworks, both of which fall outside the scope of this data set.

Patents across sectors

Not all sectors within deep science share the same landscape. From Life Sciences and Semiconductors to Space, Robotics and Autonomous Systems, different industries show very different patterns in how they protect and build up IP. These variations appear correlated with differences in their technology features, university roots and business competition rules. By analyzing patent data from deep science startups in each sector, this section examines the patenting habits across different sectors.

Sectoral analysis: variations in startup volume, patent adoption rates and international patent assets

Figure 7 illustrates the distribution of deep science startups founded between 2010 and 2025 across sectors, analyzing three dimensions: startup volume (vertical axis), patent adoption rate (horizontal axis) and cumulative IPFs (represented by bubble size).

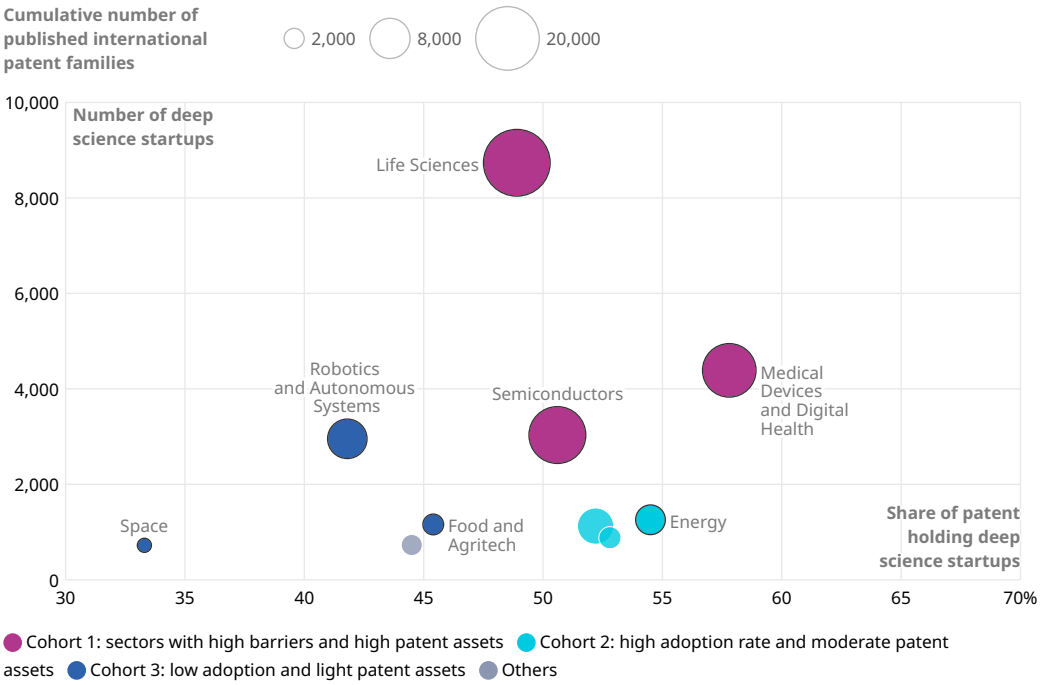
The data could indicate that deep science startups show not only sectoral differences in patent adoption rates but also in the total number of international patent families. We can group these sectors into three cohorts with distinct IP characteristics:

- Cohort 1: sectors with high patent adoption rate and high patent assets (Life Sciences, Medical Devices and Digital Health, Semiconductors).
- Cohort 2: sectors with high patent adoption rate and moderate patent assets (Advanced Materials and Manufacturing, Energy, Transportation).
- Cohort 3: sectors with low patent adoption and light patent assets (Food and Agritech, Robotics and Autonomous Systems, Space).

10 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

Life Sciences drives startup volume, Medical Devices and Digital Health leads in patent adoption, while Life Sciences and Semiconductors lead in cumulative international patent families

Figure 7 Deep science startup volume, patent adoption rate and cumulative international patent families of startups founded 2010–2025, by sector



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Sectors in Cohort 1 have the largest bubble sizes (each exceeding 10,000 IPFs) and lead in either startup volume or patent adoption rates. Life Sciences has the largest deep science startup (8,736 companies) and the most IPFs (22,007), while maintaining a high patent adoption rate of 48.9%. Semiconductors, despite having a startup volume (3,033) about one-third the size of Life Sciences, ranks second in cumulative IPFs with 15,917 and has a patent adoption rate of 50.6%. This could indicate that Semiconductors is a highly patent-dense industry, with the highest average number of international patent families per firm (an average portfolio size of 13.8 IPFs, Figure 8). Medical Devices and Digital Health exhibit the highest patent adoption rate at 57.8%, with a startup volume of 4,388 and a total of 14,090 IPFs.

Sectors in Cohort 2 have a high adoption rate and moderate patent assets. Energy has 1,258 deep science startups with a high patent adoption rate of 54.5% (second only to Medical Devices and Digital Health), and it has accumulated only 4,171 IPFs. Transportation has 1,126 deep science startups, a patent adoption rate of 52.2% and 6,335 IPFs. Advanced Materials and Manufacturing has a smaller deep science startup base of 882 companies, but maintains a patent adoption rate of 52.8% and has 2,226 published IPFs. The three sectors in Cohort 2 are capital- and physical-asset-intensive. Whether manufacturing new battery cells, researching high-strength lightweight alloys or developing electric chassis, R&D requires significant investment in laboratories and production lines, making it difficult to iterate quickly and

cheaply. Consequently, startups in these sectors exhibit a strong strategic reliance on patent protection (with adoption rates all above 52%). However, in the global technology landscape, because the startup base in these sectors is relatively small (between 800 and 1,200 deep science startups), their IPFs remains moderate.

Sectors in Cohort 3 show low adoption and light patent assets. Robotics and Autonomous Systems has a deep science startup volume of 2,954 and a patent adoption rate of 41.8%, with 7,550 IPFs. This sector depends more on software, control systems and hardware integration. Given the rapid iteration of digital technologies and the time required for substantive patent examination, startups in this sector may place greater emphasis on rapid product updates and lead-time advantages, alongside formal patent protection.[11] Space has the smallest deep science startup base (723), the lowest patent adoption rate (33.0%) and the smallest number of IPFs (766). The relatively low observed patent adoption rate in the space sector may partly reflect national security and confidentiality considerations surrounding defense-related or dual-use technologies.[12] It may also be associated with the sector's historically state-led structure and continued reliance on public funding and government procurement, although private investment and commercialization are increasing.[13] Food and Agritech has 1,160 deep science startups, a patent adoption rate of 45.4% and 1,917 IPFs. While agritech involves biological and chemical R&D (such as new fertilizers and crop gene modification), many projects focus on smart agriculture (such as hardware-software integration for agricultural drones and IoT). The adoption and deployment of agricultural technologies are shaped by local production and enabling conditions including soil, climate, connectivity, infrastructure, skills and institutional capacity.[14] These context-specific requirements may partly explain why some startups place less emphasis on broad cross-jurisdictional patent protection, leading to a lower volume of international patent families.

These sectoral differences appear correlated with two underlying factors: the depth of academic background, and sector-specific competition and survival rules.

The depth of academic background profoundly shapes patent adoption rates. In Energy (54.5% patent adoption rate) and Life Sciences (48.9% patent adoption rate), over 40% of startups originate from academic research.[15] These universities and research institutions tend to file patent applications for their technologies during the laboratory phase. Conversely, in Space (33.0% patent adoption rate) and Robotics (41.8% patent adoption rate), most founders come from backgrounds in industry.[16] The relatively low patent adoption rates may mechanisms, including rapid commercialization, system integration, and trade secrets.[17]

11 Diana Kearns-Manolatos, Deborah Golden, Brenna Sniderman, Timothy Murphy (2024), Ownership unbound: Reinventing intellectual property in the open innovation age, Deloitte Center for Integrated Research. Available at: https://www.deloitte.com/us/en/insights/topics/innovation/rethinking-intellectual-property-in-age-of-open-innovation.html

12 USPTO (2025). Privatizing the space economy: A perspective on U.S. government and private sector participation based on patents. Available at: https://www.uspto.gov/sites/default/files/documents/oce-ip-and-space.pdf

13 EPO (2021). Cosmonautics: The development of space-related technologies in terms of patent activity. Available at: https://link.epo.org/web/patent_insight_report-cosmonautics_en.pdf

14 World Bank (2019). Future of Food: Harnessing Digital Technologies to Improve Food System Outcomes. Available at: https://documents1.worldbank.org/curated/en/941601554962010560/pdf/Future-of-Food-Harnessing-Digital-Technologies-to-Improve-Food-System-Outcomes.pdf

15 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

16 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

17 WIPO (2021). Enterprising Ideas: A Guide to Intellectual Property for Startups. Available at: https://www.wipo.int/publications/en/details.jsp?id=4545

Sector-specific competitive dynamics and commercialization pathways shape the scale of international patent portfolios. In the Life Sciences, Medical Devices and Digital Health sectors, pharmaceutical R&D suffers from a natural weakness: high R&D costs but very easy replication. Coupled with strict clinical trials and regulatory approval processes that mandate public disclosure, companies cannot protect themselves by keeping their technology secret. They therefore often seek patent protection at an early stage to support commercialization and attract investment. In Semiconductors, which involve highly complex physics, materials and circuit designs, startups are easily caught in a massive net of existing patents. To reduce the risk of being blocked by incumbent patent holders, startups may actively build patent portfolios bargaining tools to strengthen their positions in cross-licensing negotiations, gain access to external technologies on more favorable terms, and obtain defensive leverage in patent disputes.[18] In Space, technologies are closely linked to national security. For example, in the United States, patent applications involving critical military or space technologies may be subject to secrecy orders that withhold their publication and grant while the orders remain in force.[19,20] The sector has also historically relied heavily on public funding and government departments procurement, although private investment and commercialization are increasing.[21,22] These characteristics may shape startups' choices between patenting and secrecy.

Average patent portfolio size: differing patenting patterns across sectors and economies

In addition to evaluating patent adoption rate and total volume of patents, another relevant indicator is the average number of international patent families held per startup. This reflects the average international patent portfolio size of individual companies within the sector, with Semiconductors and Transportation leading the way.

Deep science startups in the Semiconductors sector hold an average of 13.8 IPFs, ranking first globally. This is consistent with the high technical complexity in the Semiconductors sector, where a single product may be covered by multiple of complementary patents. Chip design and manufacturing involve highly complex and cumulative technologies, and a single semiconductor product may incorporate multiple patentable elements and complementary technologies.[23]

Transportation follows closely with an average of 12.4 IPFs. This may be associated with intensive patenting activity in autonomous driving and power batteries in recent years.

In contrast, while Life Sciences has the largest total patent volume, its average IPF count per firm is only 5.6. One possible explanation is that patenting in Life Sciences is often organized around a specific molecular structure or a core technology platform, so that a smaller number of filings can cover a company's principal asset. This pattern stands in contrast to the more

18 Bronwyn H. Hall and Rosemarie Ham Ziedonis (2001), The patent paradox revisited: An empirical study of patenting in the U.S. semiconductor industry, 1979–1995, RAND Journal of Economics, Vol. 32, No. 1, pp. 101–128. Available at: https://eml.berkeley.edu/~bhhall/papers/HallZiedonis%20RJE01.pdf

19 United States Code (1952, as amended). 35 U.S.C. § 181: Secrecy of certain inventions and withholding of patent. Available at: https://www.law.cornell.edu/uscode/text/35/181

20 USPTO (2022). Manual of Patent Examining Procedure, Section 120: Secrecy Orders [R-07.2022]. Available at: https://www.uspto.gov/web/offices/pac/mpep/s120.html

21 USPTO (2025). Privatizing the space economy: A perspective on U.S. government and private sector participation based on patents. Available at: https://www.uspto.gov/sites/default/files/documents/oce-ip-and-space.pdf

22 https://link.epo.org/web/patent_insight_report-cosmonautics_en.pdf

23 Bronwyn H. Hall and Rosemarie Ham Ziedonis (2001), The patent paradox revisited: An empirical study of patenting in the U.S. semiconductor industry, 1979–1995, RAND Journal of Economics, Vol. 32, No. 1, pp. 101–128. Available at: https://eml.berkeley.edu/~bhhall/papers/HallZiedonis%20RJE01.pdf

cumulative, multi-patent filing behavior seen in Semiconductors and Transportation, where products are highly complex systems typically covered by denser sets of patents (Figure 8).

In the country breakdown shown in Figure 8, China ranks first globally in six out of ten sectors for the average number of IPFs held by its deep science startups.

In the Energy sector, Chinese deep science startups hold an average of 82.7 IPFs, showing a substantial lead over second-place Japan (9.6) and third-place Australia (8.8). This high average appears to be influenced by outliers such as Hithium, which holds 607 IPFs. However, even if Hithium is excluded, the average for the remaining Chinese energy startups is still 16.5, which remains the highest in the world.

In Semiconductors (38.6), Transportation (32.1), Robotics and Autonomous Systems (24.6) and Medical Devices and Digital Health (22.1), Chinese startups also record substantially larger average IPF portfolios than their counterparts in Japan, the Republic of Korea and the United States.

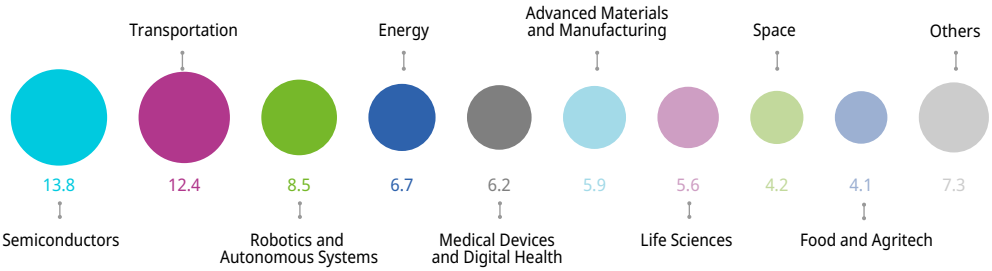
Despite China's lead in several sectors, Europe, Japan and the United States record the largest average portfolios in several specific fields:

- In the Space sector, United States deep science startups rank first globally with an average of 4.9 IPFs, followed closely by China (4.3) and Germany (3.9). Japan (2.6) and France (2.4) also place in the top five.
- In the Food and Agritech sector, Japan leads significantly with an average of 12.8 IPFs per startup. The United States ranks second with an average of 5.2, followed by Canada (4.5), France (4.2) and Australia (3.0).
- In the Advanced Materials and Manufacturing sector, Japanese startups rank first with an average of 12.3 IPFs, followed closely by Finland with 10.3. China (7.7), the United States (7.0) and Sweden (6.9) also show solid performance.

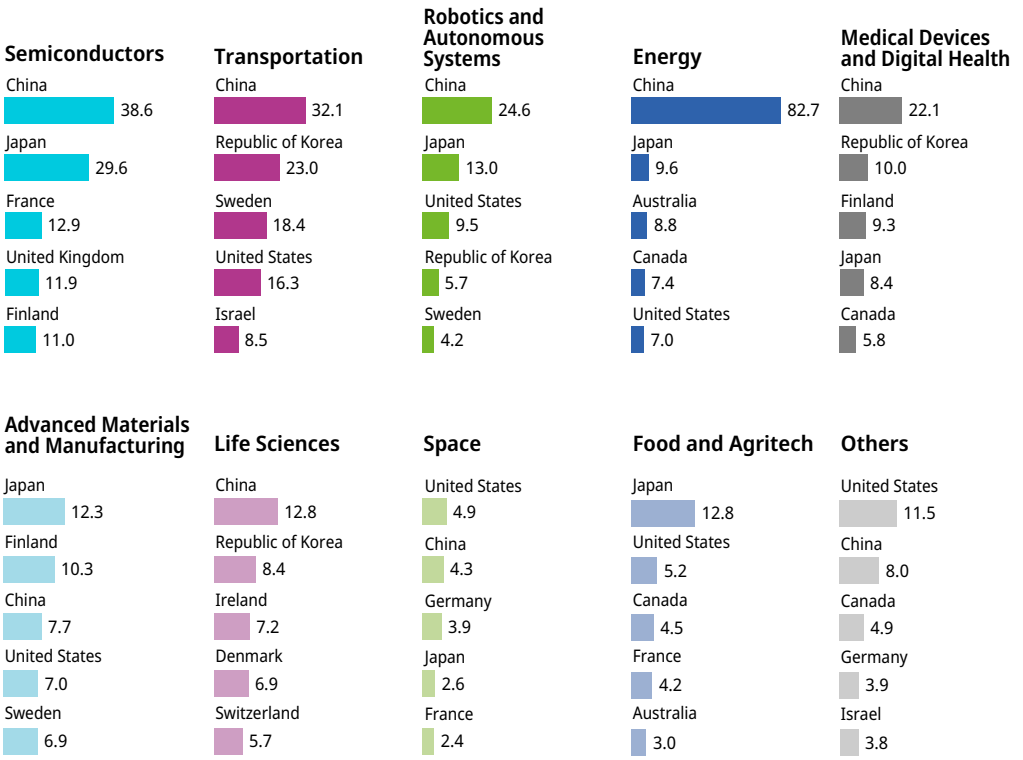
Average international patent portfolio size varies by sector, with Semiconductors and Transportation leading, while China ranks first in six of ten sectors

Figure 8 Sectoral and country-level distribution of average portfolio size by international patent families of deep science startups

Average portfolio size by international patent families of deep science startups by sector



Country ranking of average portfolio size by international patent families of deep science startups by sector



Note: Countries with fewer than nine deep science startups in a given sector are excluded.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Having examined the average patent portfolio sizes across different countries, we now transition from country-level trends to firm-level analysis. The following section highlights the leading deep science startups driving international patent families within each of these sectors.

A sectoral micro-level perspective: strong representation of US and Chinese startups

By analyzing the top five deep science startups in each sector (Figure 9), we can identify the leading patent applicants across different domains. The threshold for being considered a leading patent holder varies across sectors:

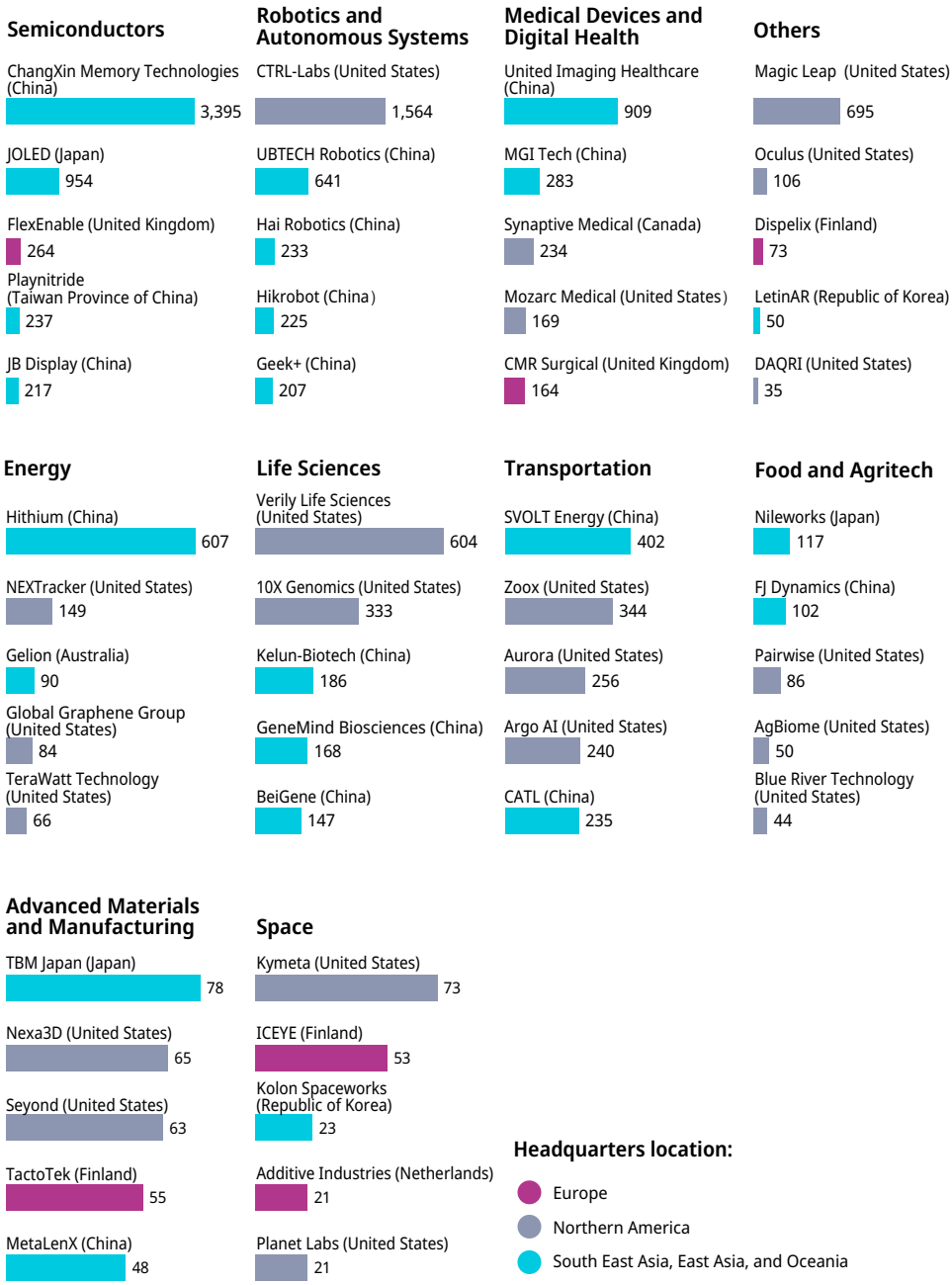
In high-complexity, patent-dense industries, leading firms hold hundreds or thousands of IPFs to secure their market positions. For instance, in Semiconductors, the top-ranked firm, ChangXin Memory Technologies, holds 3,395 IPFs (within a wider patent portfolio of 8,311 simple patent families). In Robotics and Autonomous Systems, CTRL-labs holds 1,564 IPFs (out of 1,776 simple patent families).

In sectors relying more on system integration, unique company methods, or targeting smaller markets, companies can become patent leaders with comparatively modest international patent portfolios. For example, in the Space sector, the top-ranked US satellite communication firm Kymeta holds only 73 IPFs (and 81 simple patent families). In Advanced Materials and Manufacturing, Japan's TBM (a startup that makes eco-friendly alternatives to paper and plastic from limestone,[24] ranked first, holds only 78 IPFs (and 198 simple patent families).

24 See TBM website. Available at: https://tb-m.com/cn/business/

China, Japan and the United States lead deep science startup patent rankings across sectors, with startups from Australia, Finland, the Netherlands and the United Kingdom also emerging as notable patent holders in specific sectors

Figure 9 Top deep science startups ranked by international patent families by sector



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

In Robotics and Autonomous Systems, Life Sciences, and Transportation, the top five spots are highly concentrated among US and Chinese enterprises:

- In the Robotics and Autonomous Systems sector, while US neural interface pioneer CTRL-labs leads with 1,564 IPFs (and 1,776 simple patent families), the remaining positions are held entirely by Chinese firms, including UBTECH Robotics (641 IPFs, 3,273 simple patent families), Hai Robotics (233 IPFs, 503 simple patent families), Hikrobot (225 IPFs, 1,356 simple patent families) and Geek+ (207 IPFs, 801 simple patent families).
- In the Life Sciences sector, the top five spots are split between US and Chinese firms. US-based Verily Life Sciences (604 IPFs, 1,202 simple patent families) and 10X Genomics (333 IPFs, 1,146 simple patent families) hold the top two positions, while China's Kelun-Biotech (186 IPFs, 355 simple patent families), GeneMind Biosciences (168 IPFs, 272 simple patent families) and BeiGene (147 IPFs, 153 simple patent families) occupy the remaining three spots.
- In the Transportation sector, the top five positions are held exclusively by US and Chinese enterprises. Chinese firms are focused primarily on battery manufacturing, such as SVOLT Energy (402 IPFs, 3,684 simple patent families) and CATL (235 IPFs, 627 simple patent families). US companies focus on autonomous driving development, including Zoox (344 IPFs, 1,121 simple patent families), Aurora (256 IPFs, 1,092 simple patent families) and Argo AI (240 IPFs, 339 simple patent families).

Beyond the United States and China, deep science startups from several other countries have placed in the global top five within specific niches:

- Japanese startup Nileworks (117 IPFs, 144 simple patent families) ranks first in Food and Agritech, and TBM ranks first in Advanced Materials and Manufacturing.
- Finland features startups in the global top five across three fields: ICEYE (53 IPFs, 54 simple patent families), a commercial synthetic aperture radar satellite tech firm, ranks second in Space; TactoTek (55 IPFs, 58 simple patent families) a pioneer in integrating electronics into molded plastic parts, ranks fourth in Advanced Materials and Manufacturing; and Dispelix (73 IPFs, 75 simple patent families), an augmented reality (AR) diffractive waveguide tech company, ranks third in the Others category.
- The United Kingdom hosts top-five startups in two domains: flexible organic electronics developer FlexEnable (264 IPFs, 287 simple patent families) ranks third in Semiconductors, and CMR Surgical (164 IPFs, 218 simple patent families), which develops surgical robotic systems, ranks fifth in Medical Devices and Digital Health.
- The Republic of Korea also claims top-five startups in two categories: LetinAR (50 IPFs, 218 simple patent families), an optical module supplier for AR smart glasses, ranks fourth in the Others category, and Kolon Spaceworks (23 IPFs, 41 simple patent families), a composite materials company supplying aerospace and defense industries, ranks third in Space.

Patents across technologies

While sectors represent the commercial application markets for deep science startups, technologies represent their underlying scientific classifications. In the actual innovation ecosystem, a single sector often requires cross-disciplinary support from multiple technologies, while an underlying technology can extend into several different application industries.

By analyzing the international patent growth trends of underlying technologies (Figure 10) and the bidirectional flow between technologies and sectors (Figure 11), this section provides a review of patenting activities across ten deep science technology domains and their connections to end-application sectors.

Patent growth trends of underlying technologies: Biotechnology, Medical Technology, and Quantum Technology lead

In terms of cumulative volume of international patent families as of May 2026 (Figure 10), Biotechnology (19,233 IPFs), Medical Technology (15,691 IPFs) and Quantum Technology (14,261 IPFs) constitute the leading technology groups of patent applications.

Artificial Intelligence (AI) ranks fourth in cumulative patent volume with 7,334 IPFs. It is important to note that the scope of the Dealroom–WIPO Deep Science Startup Tracker only covers sectors with tangible or physical-world applications. Consequently, under the specific methodology of the Dealroom–WIPO Deep Science Startup Tracker, digital-first innovations that primarily operate within software environments – such as certain generative AI and large language model (LLM) developers, blockchain infrastructure, novel cybersecurity protocols, and other foundational software – are excluded.[25] Therefore, the AI-related patents captured in this report's retrieval are primarily AI technologies applied to the physical world, such as AI for robotic intelligence or AI-driven drug discovery.

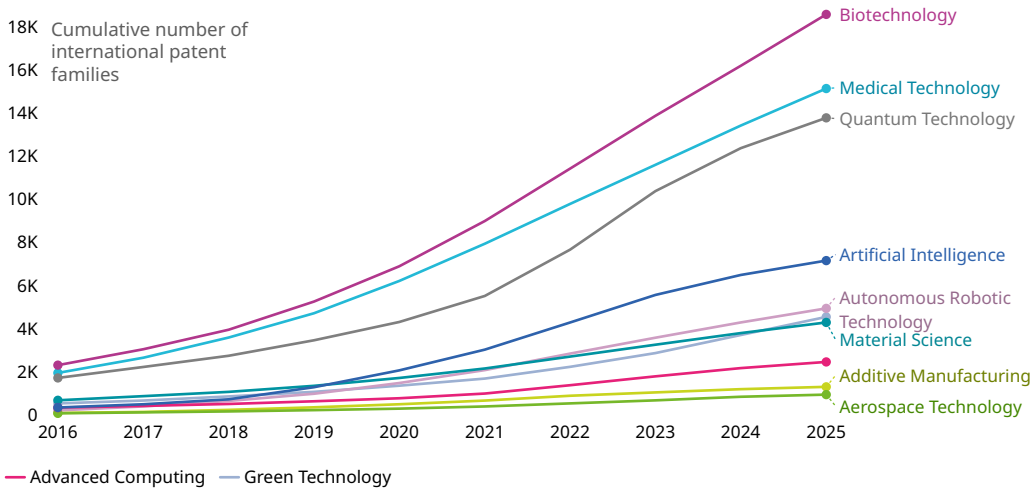
Autonomous Robotics Technology (5,163 IPFs), Green Technology (4,765 IPFs), Materials Science (4,404 IPFs) and Advanced Computing (2,514 IPFs) are moderate in scale.

Meanwhile, Additive Manufacturing (1,315 IPFs) and Aerospace Technology (958 IPFs) have the smallest cumulative volume of IPFs.

25 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

Biotechnology, Medical Technology and Quantum Technology lead deep science patent filings

Figure 10 Cumulative number of international patent families filed by deep science startups founded 2010–2025, by technology



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Connecting technologies and sectors: specialized and general-purpose technologies in deep science

Figure 11 illustrates the mapping relationships between deep science technology domains (top) and application sectors (bottom).

This mapping reveals two distinct patterns of deep science innovation: specialized and general-purpose.

Specialized technologies: Biotechnology, Medical Technology, Green Technology and Quantum Technology are highly specialized. Their patents primarily flow into a single corresponding business sector:

- Biotechnology: 87% of its IPFs flow into the Life Sciences sector, with only 6% going to Medical Devices and Digital Health and 5% to Food and Agritech.
- Medical Technology: 64% of its IPFs flow into Medical Devices and Digital Health, and 23% into Life Sciences.
- Green Technology: 55% of its IPFs flow into the Energy sector, and 29% into Transportation (primarily electric vehicles).
- Quantum Technology: 70% of its IPFs overlap with Semiconductors, highlighting the close relationship between quantum hardware and advanced semiconductor manufacturing. Many quantum devices rely on semiconductor-related nanofabrication techniques, particularly in areas such as silicon-spin qubits and quantum dots.

General-purpose technologies: In contrast, AI and Materials Science act as general-purpose technologies, spreading across multiple different application industries:

- Artificial Intelligence: AI patent flow is highly decentralized, with no single industry holding a dominant share. Specifically, 21% flows into Medical Devices and Digital Health, 19% into Robotics and Autonomous Systems and 19% into Semiconductors. This could indicate that AI, as a general-purpose technology, is actively powering every application area of deep science.
- Materials Science: Its patent flow is similarly diverse. 31% is utilized in Semiconductors, 16% in Advanced Materials and Manufacturing and 15% in Energy (such as battery materials).

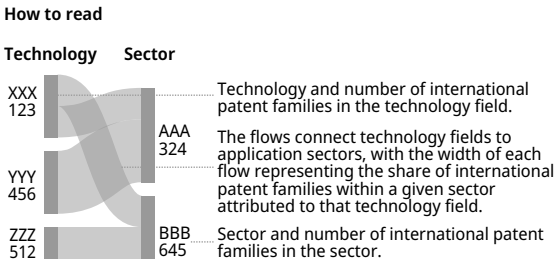
From an application perspective, deep science sectors do not rely on a single technology. Instead, they are built on a mix of different core technologies that work together. Observing the technical composition of patents from the sector side reveals some notable industry features:

- Space is made up of more than aerospace technology. Although the Space sector is small, its patent makeup is highly advanced. While 43% of its patents are in aerospace technology and 24% are in Quantum Technology (such as quantum communications and quantum satellites), 8% are in Additive Manufacturing (3D-printed parts).
- Transportation shows highly balanced diversity. No single technology dominates this sector. Its patents are evenly split among Green Technology (23%), AI (22%) and Autonomous Robotics (22%), representing electric batteries, self-driving algorithms and smart vehicle control systems.
- In Semiconductors, 64% of the IPFs are also classified under Quantum Technology, indicating a strong technological overlap between the two fields. This reflects the growing importance of quantum-related phenomena, materials and devices as semiconductor technologies advance at the nanoscale. The result suggests that innovation in semiconductors increasingly extends beyond conventional circuit design to areas involving nanoscale physics, advanced materials and quantum-enabled technologies. In addition, 11% of semiconductor IPFs overlap with Advanced Computing and 9% with AI, highlighting the increasingly multidisciplinary nature of semiconductor innovation.

Deep science startup patents reveal tight technology-sector linkages

Figure 11 Technology-sector flows of international patent families among deep science startups

How do technologies and sectors connect and flow overall?



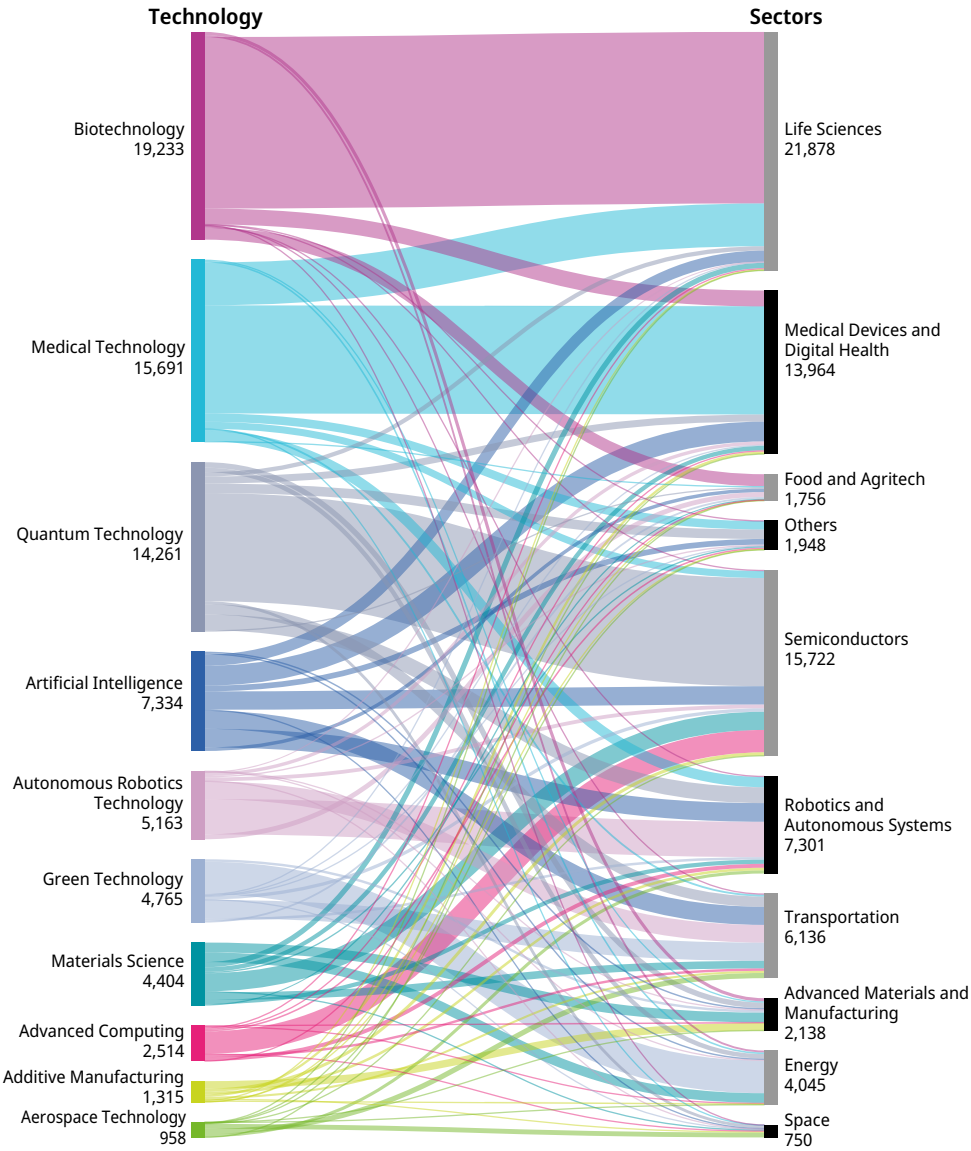
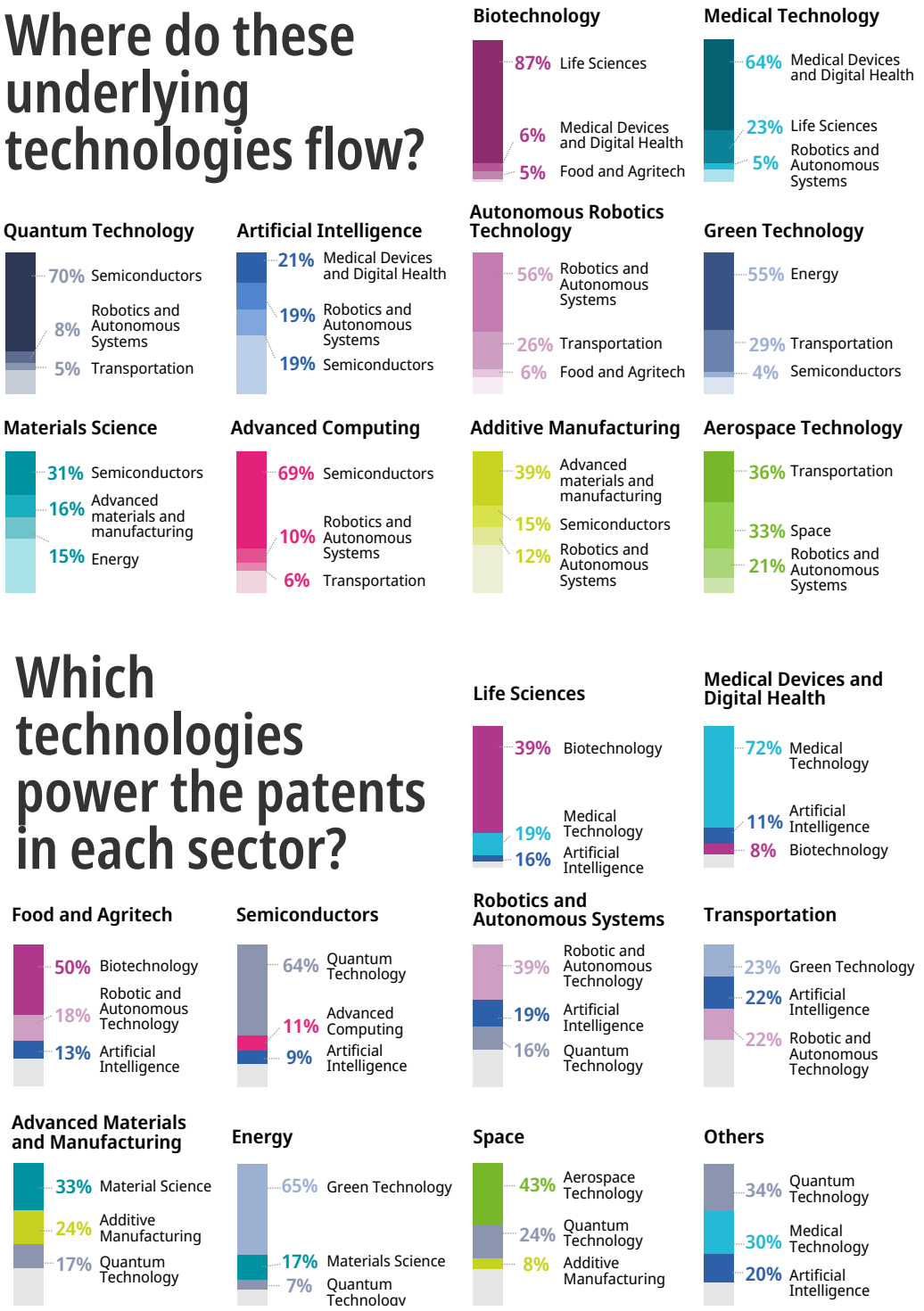


Figure 11 Technology-sector flows of international patent families among deep science startups (cont.)



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026)

In summary, this section has drawn a detailed big picture of deep science startups' patent assets across four global areas: geography, income groups, sectors and technologies. We see that while deep science startups naturally rely heavily on patents, these assets are not spread evenly across different regions, income levels and industries.

However, just knowing what these startups own and where they own it is not enough. Patents are not just static numbers on a balance sheet. They are active tools used by deep science startups to protect themselves and compete in a fast-moving corporate world.

On their challenging growth paths, how do deep science startups actively and flexibly use patents as strategic tools? When do they apply for their first patent? How do they handle shared patent ownership with universities or other institutions? How do they use international pathways like the PCT to expand overseas? As startups progress through successive funding rounds and scale their operations, how do their patent portfolios change over time? How do these strategies correlate with commercial exit outcomes, such as initial public offerings (IPOs), acquisitions or business dissolutions?

To answer these questions about how they use patents, the following section of this report will shift focus to the dynamic life cycle of deep science startups, taking a closer look at their real-world IP strategies as they grow.

Patenting strategies across the startup life cycle

If the static patent holdings presented previously represent an asset snapshot of deep science enterprises, this section shifts the focus to how their patent activities evolve over time. It explores how these startups actively and flexibly leverage patents as a strategic tool throughout their highly complex journeys to commercialization.

For deep science startups, patents are far more than legal documents filed away; they are dynamic business assets that drive value across every stage of growth. From their origins in the laboratory to their ultimate entry into capital markets, enterprises face fundamentally different survival challenges at each stage, driving a corresponding functional shift in their IP strategies.

Following the growth trajectory of startups, this section provides an in-depth analysis across five core strategic dimensions: the timing of first patent filings, patent transfers (technology flows), joint patent filings (collaborative innovation), PCT international filing strategies, evolution across growth stages.

The analysis presented throughout this section is based on the 12,409 patent-holding deep science startups, together with their combined portfolio of over 220,000 patents. This analysis illustrates how deep science enterprises convert technological capital into commercial capital, revealing an IP-backed pathway for deep science value creation.

Patent filing timing

The timing of a first patent filing must weigh considerations that pull in opposite directions. Filing early secures priority and establishes documented ownership of the underlying technology – often a precondition for raising proof-of-concept or seed capital, for negotiating with industrial partners, and for publishing or presenting results without destroying novelty. Filing later allows the invention to mature: claims can be drafted around a technically validated embodiment, the relevant markets and jurisdictions can be identified, and scarce capital can be conserved until international protection becomes affordable.

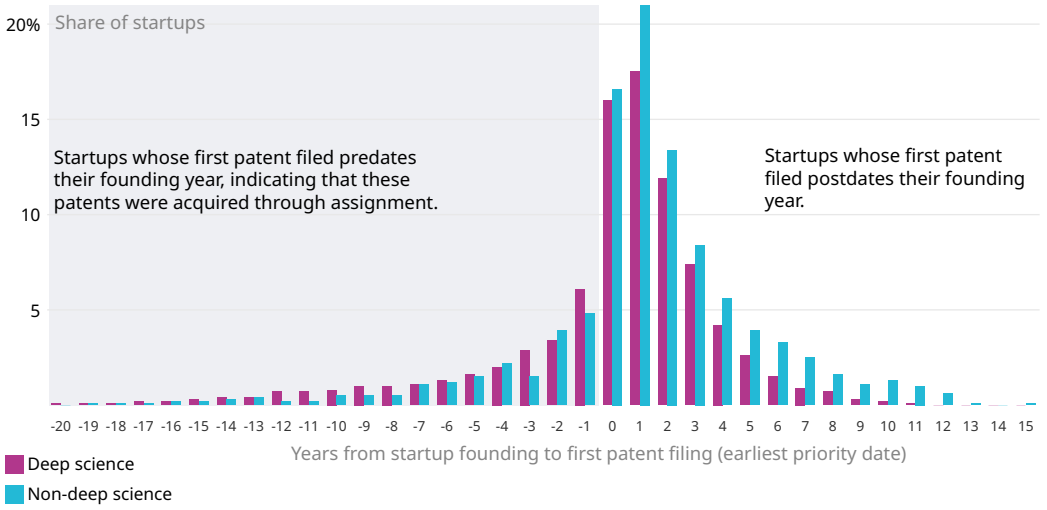
By analyzing the time lag between the first patent filing (based on the earliest priority year) and the startup's founding year, this section reveals the dynamic patenting behavior of deep science startups in the early stages of their life cycle.

Overall trend: shared peak filing years and different patent sources

Figure 12 illustrates the share of startups filing their first patent in each year relative to their founding year, for deep science and non-deep science startups established between 2010 and 2025.

Both deep and non-deep science startups peak in first patent filing one year post-founding, but deep science startups more frequently enter with pre-existing IP

Figure 12 Patent filing timing relative to startup founding: deep vs. non-deep science startups



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

The data indicates the peak for first patent filings occurs in the first year after incorporation, accounting for 17.5% of deep science startups and 21.0% of non-deep science startups. However, looking at a broader timeline reveals a clear divergence in patent origin strategies. Unlike non-deep science startups, which typically establish the company before filing, deep science startups appear to be characterized by a "technology-first, company-later" pattern, building upon foundational patent assets (existing patent assets filed or transferred prior to founding).

In the post-founding stage, the share of non-deep science startups filing their first patent remains consistently higher than that of their deep science peers. This could indicate that non-deep science enterprises tend to initiate patent filings or acquisitions as their business operations progress after incorporation.

In contrast, prior to official incorporation, the share of deep science startups with first patent filings (27.9%) is significantly higher than that of their non-deep science peers (19.4%). This reveals the heavy reliance of deep science startups on research done before they were founded.

Globally, approximately 7.1% of patents held by deep science startups have earliest priority dates that predate their company's founding. Among these, transfers from existing corporate entities account for the largest share (63.9%), while 20.7% originate from academic institutions and 18.3% from individual inventors.[1] This implies that these patents were not

1 Shares sum to slightly more than 100% because a single patent may be associated with more than one category of original owner.

independently developed and filed by the deep science startups after founding; rather, they existed within other entities prior to incorporation and were subsequently transferred to the startup through patent assignment. This pattern of launching with pre-existing technology constitutes a fundamental difference between deep science entrepreneurship and non-deep science startups.

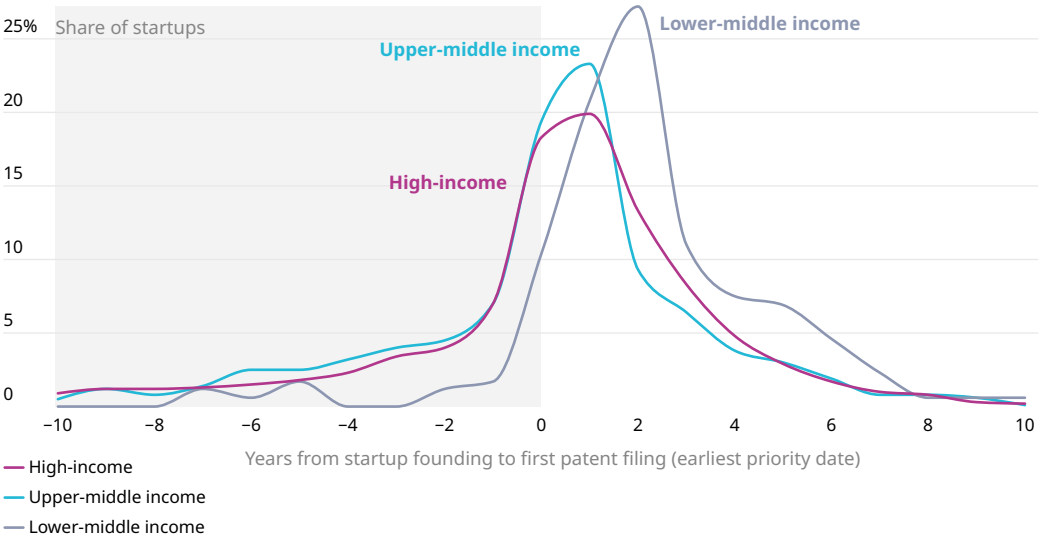
It should be noted, however, that assignment records capture only changes in ownership and do not cover licensing arrangements, under which institutional technology may be commercialized while title is retained by the originating organization.

Income-group differences: startups in high-income nations lead in acquiring patents filed prior to founding, while lower middle-income peers lag by one year in initial filings

When introducing the dimension of income groups, the curves for first patent filings show differences across different economies (Figure 13).

Deep science startups in lower middle-income countries peak in patent filing a year later than their high-income and upper middle-income counterparts

Figure 13 Distribution of deep science startups by years elapsed between founding and first patent filing (earliest priority date), by income group



Note: Data for low-income economies are not displayed due to the limited number of observations.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

For deep science startups in lower middle-income countries, the peak for first patent filings occurs in the second year after founding, a full year later than in high-income and upper middle-income countries.

This difference appears to be influenced by country-specific factors. As previously mentioned in this report, the data for the upper middle-income group are heavily driven by China, while the lower middle-income group's data closely reflects characteristics of the system in India.

Therefore, this structural lag in lower middle-income countries is largely due to the deferred patent filing patterns among Indian deep science startups.

In the high-income group, the upward lift of the curve in the negative time range (prior to founding) is most noticeable. In high-income countries, for 13.0% of deep science startups, the earliest priority year of their first patent predates the company's founding year. In contrast, this share is only 2.6% in upper-middle-income and 2.3% in lower-middle-income countries. This wide gap could indicate that developed countries have a highly mature IP transfer system where patents are first filed by other companies or research institutions and later transferred to startups. In developing and middle-income countries, pre-incorporation transfer appears to be less common.

Additionally, the filing curve for high-income economies is the flattest and most widely distributed. This may reflect a more diversified deep science ecosystem, where startups have greater latitude to align filing with their own actual technology readiness level and specific business milestones. In contrast, first filings in lower middle-income economies show high concentration, with almost all patent filings heavily compressed between the year of founding and two years post-founding. The concentration of first filings in upper middle-income economies sits in the middle.

Geographic comparison: Israel exhibits the fastest patent filing pace, India shows a delay and, in the Republic of Korea, over half of deep science startups' first patents predate founding, reflecting transfers from academia or other firms

Figure 14 focuses the analysis on specific countries and regions, revealing clear differences between their innovation ecosystems.

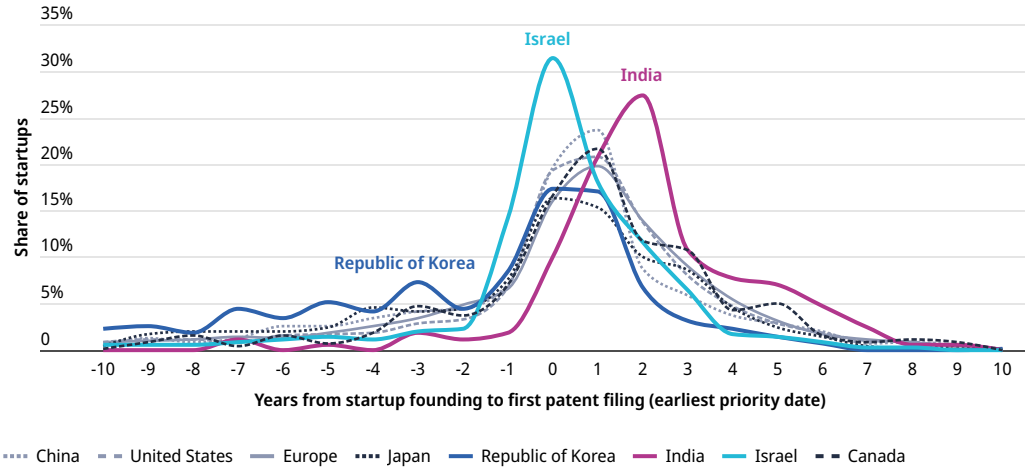
Israel has the fastest patent filing pace. Its first filing peak occurs in the founding year itself and is the highest peak (31%) among all the countries analyzed. This appears to correlate with Israel's high level of IP awareness and its highly mature, fast-moving venture capital ecosystem.

In contrast, India's filing curve shows a clear lag. Its peak occurs in the second year after founding – one to two years later than in China, Europe, Japan and the United States – with the entire curve shifting to the right. Among the major economies analyzed individually, India also has the lowest share of startups whose first patent's earliest priority year predated their founding year, at only 7.1%.

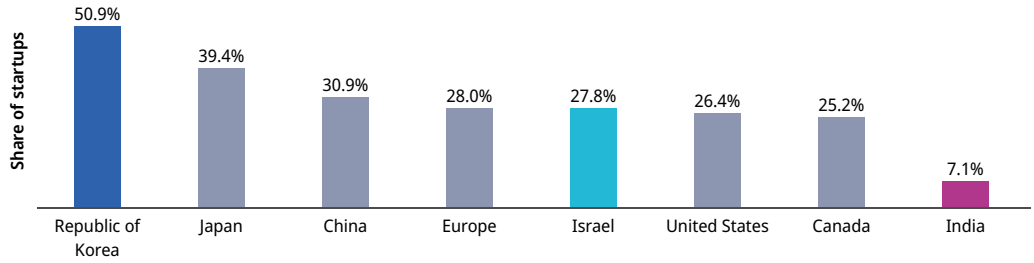
Israel leads in speed with patent filings peaking at founding year; the Republic of Korea leads in pre-founding IP transfer, with over half of its deep science startups' first patents predating founding

Figure 14 Patent filing timing and pre-founding IP acquisition among deep science startups, by country/region

Distribution of deep science startups by years elapsed between founding and first patent filing (earliest priority year)



Share of deep science startups whose first patent predates their founding year (by earliest priority year)



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

For 50.9% of deep science startups in the Republic of Korea, the earliest priority year of their first patent predates their founding year. This share is far higher than in any other country. Among these pre-founding patents transferred to Korean startups, 51.8% originate from companies, 43.7% from academic institutions, and 9.2% from individual inventors.[2] Although corporate transfers remain the largest source, consistent with the global pattern noted above, the share attributable to academic institutions in the Republic of Korea is more than double the global average (20.7% from academic institutions). This, combined with the subsequent analysis of the top patent-transferring research institutions (Table 4), suggests that the

2 Shares sum to slightly more than 100% because a single patent may be associated with more than one category of original owner.

Republic of Korea's deep science ecosystem relies more heavily than most other economies on established research institutions or universities to build the IP foundation, even though corporate transfers still account for the largest share.

In comparison, the curves for China, Europe, Japan and the United States are highly similar, with their peaks all concentrated between the founding year and the first year after founding. These four largest global innovation regions/countries are highly aligned in the timing of their first filings, establishing the mainstream pace for patent applications among deep science startups worldwide.

Across different sectors, the timing of first patent filings shows a nearly identical trend. Whether in sectors with long R&D cycles like Life Sciences and Semiconductors, or those with rapid iteration like Robotics and Autonomous Systems or Transportation, first patent filings across all deep science sectors peak around the founding year, with the peak percentage remaining stable between 20% and 25%.

The differences across sectors are much smaller than the differences observed across countries or income levels. This could indicate that the timing of a deep science startup's first patent filing is not determined by the technology itself but is governed by fundamental business creation principles and the macro-innovation environment. One possible interpretation is that initial filing timing is shaped less by the characteristics of the technology itself than by a common set of business and legal considerations: the need to document ownership ahead of incorporation and the expectations of early-stage investors. Because these considerations apply broadly across technology fields, they may account for the relative uniformity of initial filing pacing across sectors. However, because institutional maturity and financing landscapes vary globally, these macro-environmental differences ultimately lead to variations in initial filing timelines across different countries and income groups.

Early filing is not, however, unambiguously advantageous. In long-cycle sectors such as biotechnology and pharmaceuticals, premature patent filing can reduce rather than create commercial value where international protection, freedom-to-operate analysis, market validation and regulatory strategy are not developed in parallel.[3] A priority filing starts the clock on the 12-month Paris Convention and 30-month PCT deadlines, which may oblige a company to commit to costly national-phase decisions before it knows which markets, indications or product configurations will matter; and claims drafted around an immature embodiment may later prove narrow or difficult to enforce once the product is defined. Seen in this light, the concentration of first filings around the founding year is better read as evidence of a prevailing norm – driven by ownership and financing requirements – than as evidence of an optimal strategy.

3 Pereira, L.V. and J.A. Lopes Filho (2026). Brazil's deep tech promise: From scientific creation to scalable ventures. In Global Innovation Index 2026. São Paulo and Geneva: gen-t, Banco Fator and World Intellectual Property Organization. Available at: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2026-gii-2026-contributors-cni-brazil.pdf

Patent assignment

Within the life cycle of deep science startups, patent assignment serves as a key indicator to observe technology flows, asset restructuring and startup exit pathways.

The analysis of patent assignment in this section aims to reflect the substantive flow of technology assets across different entities. To ensure precision, the data cleaning and analysis adhere to the following definitions:

- **Included transaction types.** Covers assignments from inventors to companies, transfers from academic institutions to enterprises, and commercial buying and selling between unrelated companies.
- **Excluded transaction types.** Excludes affiliated transfers within the same corporate group (intra-group transfers) and simple registration changes due to corporate name changes that do not involve transfer of ownership.
- **Partial transfer out.** If a patent originally held exclusively by a startup (or co-owned with others) undergoes a registration change that introduces a new co-owner, thereby diluting the startup's ownership, this change is recorded as a partial transfer out transaction for the startup.
- **Partial acquisition.** If a startup is added as a co-owner to an existing patent held by other entities, this change is recorded as a partial acquisition transaction for the startup.

Overall transfer patterns: deep science startups exhibit stronger in-house R&D and a higher propensity for outbound technology transfer

Figure 15 compares the macro-level data on patent assignment activities between deep science and non-deep science startups.

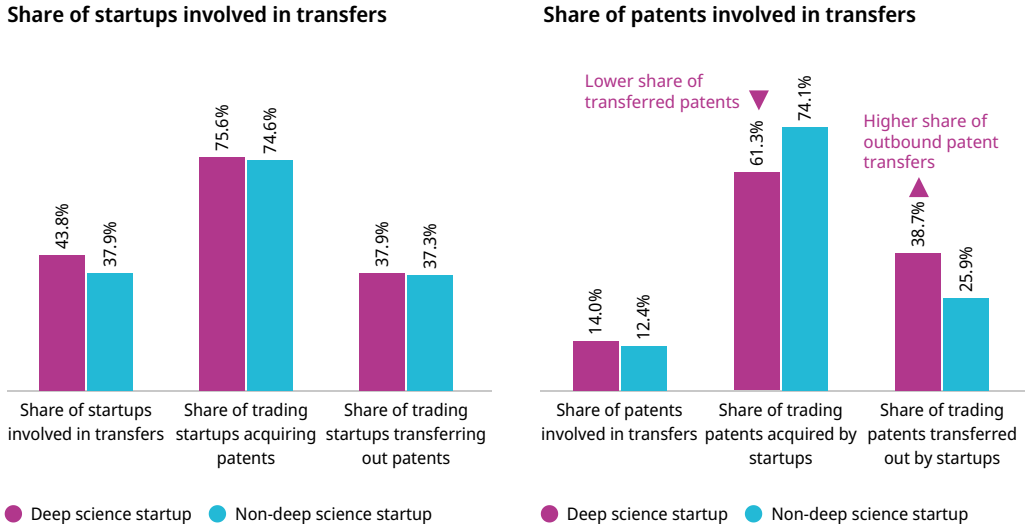
The participation rates of both types of startups in patent assignments are very close. Globally, 43.8% of deep science startups have participated in patent assignments, slightly higher than the 37.9% recorded by their non-deep science peers. Among these active startups with transaction records, the behavior patterns are also nearly identical: approximately 75% have acquired patents, while 37% to 38% have transferred patents out.

However, a deeper analysis of the transaction structure (right panel) reveals a significant difference in their underlying strategies.

Based on patent assignment data, deep science startups show lower reliance on external patent acquisitions. Among all traded patents, acquisitions make up 74.1% for non-deep science startups, but only 61.3% for deep science startups. On the other hand, deep science startups show a higher share of outbound patent transfer (38.7%) compared with non-deep science peers (25.9%). This suggests that deep science startups may act as both technology consumers and technology contributors.

Deep and non-deep science startups acquire patents at comparable rates, but deep science startups show significantly lower reliance on external purchases

Figure 15 Patent transfers: deep science vs. non-deep science startups



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%.

Source: WIPO, based on Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

It should be noted, however, that assignment records do not capture all forms of technology transfer, since licensing arrangements – under which ownership remains with the original institution – are not reflected in assignment statistics. For instance, CERN (the European Organization for Nuclear Research) has adopted a non-exclusive licensing model, commercializing technology through a 2% royalty on revenue rather than equity, while retaining ownership of the underlying technology;[4] Georgia Tech, meanwhile, has designed an express license process calibrated to the operational pace of startups, requiring no up-front cash payment and instead involving the university's participation through equity, thereby aligning the university's returns with the venture's success rather than with early-stage cost recovery.[5] These examples indicate that a substantial share of academia-to-industry technology transfer may occur through licensing rather than assignment, and is therefore not captured in the patent transfer statistics presented above.

4 Kretzschmar, L. and H. Dols (2026). Venture-based technology transfer at large research organisations: The case of CERN Venture Connect. In Global Innovation Index 2026. Geneva: European Organization for Nuclear Research (CERN) and WIPO. Available at: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2026-gii-2026-contributors-cern.pdf

5 Sivakumar, R. and A. Cabrera (2026). Disrupting the disruptors: Rebooting academia's commercialization playbook. In Global Innovation Index 2026. Atlanta and Geneva: Georgia Institute of Technology and WIPO. Available at: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2026-gii-2026-contributors-disrupting-the-disruptors.pdf

Tracing patent origins: deep science startups as the key link between academic research and industrial application

Deep science startups play a core role in the ecosystem as a crucial link between academic research and industrial application. This role is supported by data on the origins of transferred patents (Figure 16).

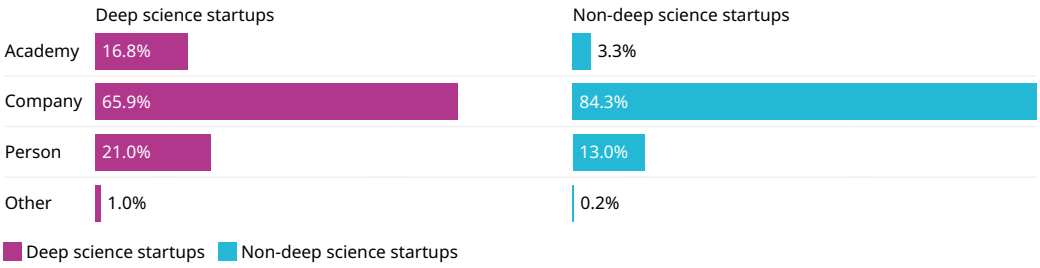
For non-deep science startups, 84.3% of their acquired patents are transferred from other companies, while only 3.3% come from academia (universities and research institutes). Their technology flow is primarily characterized by acquisitions from commercial firms.

In contrast, 16.8% of the patents acquired by deep science startups come from academia – a rate that is more than five times higher than that of non-deep science startups.

This could indicate that deep science startups serve as a primary bridge for translating early-stage, laboratory-proven technologies into viable commercial applications.

Deep science startups source a notably higher share of patents from academia

Figure 16 Distribution of assignor and assignee entity types in startup patent transfers: deep science vs. non-deep science startups



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%. Percentages represent the proportion of patents involving each entity type. Sums exceed 100% due to co-assignments (patents with multiple distinct entity types as assignees).

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Insights into patent acquisitions: corporate spinouts, restructuring and technological expansion

M&A and corporate restructuring drive patent acquisitions among top deep science startups

Table 2 Top 10 deep science startups by number of patents acquired and their primary original assignees

	Deep science startup	Number of patents acquired	Sector	HQ location	Primary original assignee
1	Aurora	820	Transportation	United States	**UATC** (477), **Uber Technologies** (196), **Ours Tech** (31)
2	CTRL-Labs	592	Robotics and Autonomous Systems	United States	**Meta Platforms** (539), **Oculus VR** (15), **Gary Sharp Innovations** (10)
3	JOLED	452	Semiconductors	Japan	**Panasonic** (216), **Sony** (208)
4	WM Motor	301	Transportation	China	**Chongqing Jiabenjia Tech** (5), **Foshan Zhihai Xingkong Tech** (5), **Ningbo Feierge Electromechanical Tech** (5), **Zhangjiagang Jiuding Machinery** (5)
5	Mozarc Medical	197	Medical Devices and Digital Health	United States	**Medtronic** (128), **Covidien** (46)
6	Verily	156	Life Sciences	United States	**Google** (61), **Twenty Twenty Therapeutics** (49)
7	White Box (Shanghai) Microelectronics Technology	152	Semiconductors	China	**Southeast University** (150)
8	Global Graphene Group	151	Energy	United States	**Nanotek Instruments** (88), **Zhamu Aruna** (54), **Jang Bor Z** (54)
9	FlexEnable	132	Semiconductors	United Kingdom	**Plastic Logic** (64), **Merck Patent** (51)
10	Wuhan Minsheng New Technology	110	Semiconductors	China	**Wuhan University** (105)

Note: The number in parentheses following each original assignee's name indicates the number of patents acquired by the deep science startup from that original assignee.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

From the acquisition side (Table 2), patent transfers to deep science startups are typically driven by corporate restructuring, parent company divestitures, or the outright acquisition of a giant's specialized business divisions. Key examples include:

Mergers and acquisitions:

- US-based autonomous driving startup Aurora ranks first with 820 acquired patents. This is primarily due to its acquisition of UATC LLC (Uber's autonomous driving division, Uber ATG). Through this acquisition, Aurora rapidly expanded its technology and team, accelerating its commercialization path.[6]

Corporate spinouts and divestitures:

- Verily (acquired 156 patents) was originally established as a life sciences subsidiary incubated by Google's parent company Alphabet, taking over Google's early life sciences and digital health technologies.[7]
- UK-based FlexEnable (acquired 132 patents) was strategically spun off from Plastic Logic (a Cambridge University spinout)[8] to become an independent entity. It inherited Plastic Logic's entire technology base, full patent portfolio and Cambridge-based team, with a mandate to independently deliver expertise and products in flexible electronics.[9] In 2019, FlexEnable further acquired flexible display material patents from Germany's Merck. Through this transaction, FlexEnable established a comprehensive "materials + manufacturing process" solution, successfully transitioning its business model toward the licensing of full-spectrum technology solutions.[10]

Joint ventures and corporate restructuring:

- Japanese startup JOLED (acquired 452 patents) was an organic light emitting diodes (OLED) joint venture established by the Japanese state-backed Innovation Network Corporation of Japan (INCJ), Japan Display Inc. (JDI), Sony and Panasonic. Sony and Panasonic injected their respective OLED display panel R&D functions into the company, which was jointly operated under a governance framework established by all parties.[11] Due to difficulties in achieving stable mass production and intense market competition, JOLED filed for bankruptcy protection and ceased manufacturing in March 2023, with its display technology R&D business taken over by JDI.[12] In June 2025, for financing and IP monetization purposes, JDI officially transferred these core OLED patents, which originally belonged to JOLED, to the newly established Magnolia Blue Inc. through its subsidiary (Table 3).[13]
- Mozarc Medical (acquired 197 patents) is an independent kidney health technology company established in 2023, jointly funded by global medical technology leader Medtronic

6 Aurora (2020). Aurora is acquiring Uber's Self-Driving Unit, Advanced Technologies Group, accelerating development of the Aurora Driver. Available at: https://ir.aurora.tech/news-events/press-releases/detail/22/aurora-is-acquiring-ubers-self-driving-unit-advanced-technologies-group-accelerating-development-of-the-aurora-driver

7 EconoTimes (2025). Alphabet plans Verily spinoff as Google prepares separation from Life Sciences Unit. Available at: https://www.econotimes.com/Alphabet-Plans-Verily-Spinoff-as-Google-Prepares-Separation-from-Life-Sciences-Unit-1722231

8 University of Cambridge (2009). Plastic Logic: from innovation to impact. Available at: https://www.cam.ac.uk/research/news/plastic-logic-from-innovation-to-impact

9 Ink World (2015). FlexEnable split off from Plastic Logic - Created from company's technology assets in Cambridge, UK. Available at: https://www.inkworldmagazine.com/breaking-news/flexenable-split-off-from-plastic-logic/

10 Hay Think (2024). FlexEnable announces acquisition of Merck's organic thin-film transistor/OTFT material portfolio to accelerate commercialization of large-area flexible display applications. Available at: https://www.haythink.com/flexenable-announces-acquisition-of-mercks-organic-thin-film-transistor-otft-material-portfolio-to-accelerate-commercialization-of-large-area-flexible-display-applications/

11 Sony (2014). INCJ, JDI, Sony and Panasonic announce the establishment of JOLED Inc. A new integrated company in organic light-emitting diode display panels. Available at: https://www.sony.com/en/SonyInfo/News/Press/201407/14-0731E/

12 Rahmat, O. (2023). JOLED declaring bankruptcy: Japan Display takes over technology. *Display Daily*. Available at: https://displaydaily.com/joled-declaring-bankruptcy-japan-display-take-over-technology/

13 Japan Display Inc (2025). (Disclosure update) Transfer of intellectual property rights to newly established subsidiaries and subsidiaries share sale to Ichigo Trust. Available at: https://www.j-display.com/news/news_file/file/250626_2e.pdf

and kidney care provider DaVita.[14] Its patents were primarily inherited from Medtronic and Covidien (which Medtronic had previously acquired).[15]
- Global Graphene Group (G3) acts as a parent company, holding five subsidiaries (including Nanotek Instruments, Taiwan Graphene Company, Honeycomb Battery, Angstron Materials and Angstron Energy Company). Among them, Nanotek Instruments serves as G3's IP arm, responsible for acquiring and managing the group's patent assets,[16] of which 88 patents have been officially transferred to the parent company. Additionally, the group's two co-founders, Dr. Bor Z. Jang and Dr. Aruna Zhamu,[17] have also formally assigned the patent assets they filed early on under their individual names to G3.

Academic spinouts and university technology transfer:
- Chinese startup White Box Microelectronics' acquired patents (152 in total) came almost entirely from Southeast University. This highly concentrated patent transfer is rooted in close academic linkages and a strong industry–university–research technology commercialization partnership between the two parties. Dr. Bu Zhiyong, Chairman of White Box Microelectronics[18] and the Chief Engineer of the Shanghai Institute of Microsystem and Information Technology (SIMIT), Chinese Academy of Sciences, earned his Ph.D. in Communication and Information Systems from Southeast University.[19] Meanwhile, the underlying inventors of this transferred patent portfolio are the core research team of Southeast University's National Mobile Communications Research Laboratory.
- The 110 acquired patents of Wuhan Minsheng (also called Wuhan MEMSonics) came almost entirely from Wuhan University. This highly concentrated patent transfer represents academic spinouts and technology commercialization under an industry–university–research framework. Professor Sun Chengliang, the founder of MEMSonics, currently serves as a professor at the Institute of Technological Sciences, Wuhan University.[20] Following the establishment of MEMSonics, Professor Sun transferred and injected into the startup 110 patents developed and accumulated during his tenure at Wuhan University, covering core fields such as RF filters, piezoelectric microphones and piezoelectric ultrasonic sensor chips.[21]

14 Medtronic (2023). Medtronic, DaVita launch Mozarc Medical, aimed at introducing new solutions for patients with kidney failure. Available at: https://news.medtronic.com/2023-04-01-Medtronic,-DaVita-launch-Mozarc-Medical,-aimed-at-introducing-new-solutions-for-patients-with-kidney-failure
15 Medtronic (2014). Medtronic to acquire Covidien for USD 42.9 billion in cash and stock. Available at: https://news.medtronic.com/2014-06-15-Medtronic-to-Acquire-Covidien-for-42-9-billion-in-Cash-and-Stock
16 Global Graphene Group (2019). Global Graphene Group joins EU REACH Consortium . Available at: https://www.theglobalgraphenegroup.com/global-graphene-group-joins-eu-reach-consortium/
17 Global Graphene Group (2021). Company leadership. Available at: https://www.theglobalgraphenegroup.com/leadership/
18 36kr (n.d.). White Box Microelectronics Profile. Available at: https://pitchhub.36kr.com/project/2497803423178375
19 Shanghai Institute of Microsystem and Information Technology (2020). Dr. Bu Zhiyong's Profile. Available at: http://www.sim.cas.cn/kybm2016/kdwxjssys/dsxx2016/202001/t20200106_5483000.html
20 Baidu (n.d.). Sun Chengliang's Profile. Available at: https://baike.baidu.com/item/%E5%AD%99%E6%88%90%E4%BA%AE/62705618
21 MEMSonics (2026). Wuhan Minsheng's Profile. Available at: http://www.memsonics.com/list_23.html

Insights into patent selling: M&A exits, business closures and bankruptcy restructuring

Patent transfers among top deep science startups are predominantly driven by acquisitions, with Semiconductors among the leading sectors for outbound transfers

Table 3 Top 10 deep science startups by number of patents transferred out and their primary current assignees

	Deep science startup	Number of patents transferring out	Sector	HQ location	Primary current assignee
1	JOLED	604	Semiconductors	Japan	**Magnolia Blue** (595)
2	Megvii	505	Robotics and Autonomous Systems	China	**Yuanli Tuxin (Chongqing) Technology** (193), **Yuanli Jinzhi (Chongqing) Technology** (177)
3	Oculus	434	Others	United States	**Meta Platforms** (427)
4	Resonant	328	Semiconductors	United States	**Murata Mfg** (328)
5	Argo AI	284	Transportation	United States	**Volkswagen Group of America Investments** (142), **Ford Global Tech** (87), **LG Innotek** (97)
6	Spin Memory	157	Semiconductors	United States	**Integrated Silicon Solution Cayman** (157)
7	North	99	Others	Canada	**Google** (99)
8	Verily Life Sciences	80	Life Sciences	United States	**Google** (32), **Twenty Twenty Therapeutics** (17), **Dexcom** (13)
9	Nileworks	71	Food and Agritech	Japan	**NTT e-Drone** (68)
10	Global Graphene Group	70	Energy	United States	**Honeycomb Battery Co** (69)

Note: The number in parentheses following each current assignee's name indicates the number of patents transferred out by the deep science startup to that current assignee.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Compared to patent acquisitions, patent transfers out by deep science startups more directly reveal the redistribution of technology assets during market downturns, mergers and acquisitions (M&A) exits and bankruptcies (Table 3). At this stage, technology assets typically flow back or transfer from failed or acquired startups to industry giants, as in the following examples.

Asset restructuring, monetization and recovery under bankruptcy and liquidation:

- JOLED (sold 604 patents), a Japanese organic light emitting diodes (OLED) screen maker, went bankrupt in 2023. Its patents were bought by its parent company, JDI,[22] and finally moved to Magnolia Blue Inc., JDI's new patent-holding company.[23]
- Argo AI, an autonomous driving technology startup co-founded by Uber and Google veterans (which transferred out 284 patents), was dissolved in 2022 due to the withdrawal of investments by its two major shareholders, Ford and Volkswagen. Its patent assets flowed back to Ford (87 patents) and Volkswagen (142 patents), respectively. Additionally, 97 of its automotive light detection and ranging (LiDAR) patents were strategically acquired by the global electronics and automotive components giant LG Innotek in April 2023.
- Spin Memory, a semiconductor spinout of New York University, focused on developing new magnetic memory (MRAM) technology designed to replace traditional memory with faster speeds and longer lifespans. In mid-2021, the company ran out of funds due to the pandemic and business setbacks, forcing it to halt operations and liquidate.[24] During this process, Integrated Silicon Solution (Cayman) Inc., a globally renowned memory chip supplier, acquired Spin Memory's entire patent portfolio consisting of 157 patents.

Business restructuring and technology transfer under commercial distress:

- Nileworks, a startup in Japan's agritech sector, focused on developing advanced agricultural drones for precision pesticide spraying and crop growth monitoring. In 2019, it secured a 1.6 billion yen in funding from investors including Sumitomo Corporation, Sumitomo Chemical and Innovation Network Corporation of Japan (INCJ). However, unable to sustain the high costs of R&D and commercialization, Nileworks eventually fell into financial distress. In 2025, NTT e-Drone Technology acquired Nileworks' 68 core drone patents, and the Nileworks entity was subsequently dissolved. This major consolidation of Japan's domestic agricultural drone technology paved the way for a collaboration between NTT e-Drone and Sumitomo Corporation in February 2026 to jointly promote drones designed specifically for Japan's small and irregular farmlands.[25]

These cases suggest that within the deep science ecosystem, commercial operational failure is by no means equivalent to R&D failure. Because underlying technologies have real value, their patent assets can still serve as a high-value safety net even during a company's most challenging phases. This provides downside protection and substantial liquidation value for investors, parent companies, or technology successors.

Asset integration and corporate restructuring under mergers, acquisitions and spinouts:

- Oculus, a virtual reality (VR) technology company, was acquired by Facebook (now Meta) in 2014 for approximately USD 2 billion to expand into next-generation social and communication platforms. Following the acquisition and the parent company's rebranding to Meta, Oculus's underlying core technology assets were gradually integrated.[26] Its 434 VR patents were consolidated under Meta Platforms Technologies LLC, appearing in patent databases as a large-scale change of assignee.

22 Rahmat, O. (2023). JOLED declaring bankruptcy: Japan Display takes over technology. *Display Daily*. Available at: https://displaydaily.com/joled-declaring-bankruptcy-japan-display-take-over-technology/

23 Japan Display Inc (2025). (Disclosure update) Transfer of intellectual property rights to newly established subsidiaries and subsidiaries share sale to Ichigo Trust. Available at: https://www.j-display.com/news/news_file/file/250626_2e.pdf

24 Global University Venturing (2021). Spin Memory heads to liquidation. Available at: https://globalventuring.com/university/spin-memory-heads-to-liquidation/

25 Japan.co.jp (2026). NTT e-Drone and Sumitomo: The agriculture drones trying to protect Japan's food security. Available at: https://japan.co.jp/e/reports/ntt-sumitomo-agriculture-drones-japan-food-security-2026.html

26 Meta (2014). Facebook to acquire Oculus. Available at: https://about.fb.com/news/2014/03/facebook-to-acquire-oculus/

- RF filter company Resonant (involving the transfer of 328 patents) was acquired in its entirety by Japan's Murata Manufacturing in 2022,[27] with its core XBAR® patent technology – a high-performance piezoelectric monocrystal thin-film filter technology designed for 5G and higher frequency bands – fully transferred to Murata (328 patents).
- Canadian smart glasses startup North was acquired in its entirety by Google in 2020, with its team and technology (including 99 patents) integrated into Google to serve as a key cornerstone for its hardware business and future vision of ambient computing.[28]
- Global Graphene Group (G3) directly transferred 69 of its patents regarding solid-state batteries and high-capacity anodes to its subsidiary, Honeycomb Battery Company. This transfer served as an asset restructuring step prior to Honeycomb's Special Purpose Acquisition Company (SPAC) business combination and listing with Nasdaq-listed Nubia Brand International Corp. Upon the formal completion of the merger in February 2024, the combined company was renamed Solidion Technology, Inc. Integrating this patent portfolio under the subsidiary in advance secured complete and independent IP ownership for Solidion, providing critical technological assurance for its subsequent public market financing and the large-scale commercialization of solid-state batteries.[29]

Insights into patent transfers from academic institutions: China and the Republic of Korea lead in ownership transfers to deep science startups

Table 4 lists the top 10 academic institutions globally that transfer patents to the highest number of deep science startups. This list exhibits a pronounced concentration in East Asia, with Asian institutions occupying eight of the top ten positions (four in the Republic of Korea and four in China).

Seoul National University ranks first globally in both the number of transferred patents (72) and the number of deep science startups receiving patents (20). Combined with the strong performances of Yonsei University (38 patents transferred to 15 deep science startups), Korea Institute of Science and Technology (KIST; 24 patents transferred to 15 deep science startups) and Korea University (20 patents transferred to 13 deep science startups), this appears to correlate with a high operational efficiency in academia-industry transfer within the Republic of Korea.

Four top Chinese universities – Tsinghua University, Shanghai Jiao Tong University, Zhejiang University and Beihang University – collectively transferred over 180 patents to deep science startups. The receiving startups are widely distributed across China's strategic technology sectors, including semiconductors (such as Lynxi Technology), and smart robotics (such as Beijing Ruilai Intelligent Technology and Beijing Tage Zhixing Technology).

27 Murata (2022). Murata completes acquisition of Resonant Inc. Available at: https://corporate.murata.com/newsroom/news/company/general/2022/0329

28 Osterloh, R. (2020). Our focus on helpful devices: Google acquires North. *News from Google*. Available at: https://blog.google/products-and-platforms/devices/focus-helpful-devices-google-acquires-north/

29 Nubia Brand International Corp. (2024). Honeycomb Battery Company and Nubia Brand International Corp. announce closing of business combination. Available at: https://www.globenewswire.com/news-release/2024/02/02/2823012/0/en/honeycomb-battery-company-and-nubia-brand-international-corp-announce-closing-of-business-combination.html?_gl=1*pp90lg*_up*MQ..*_ga*MTQxOTE1MTQxMi4xNzkzNzEzMDc4*_ga_B6167QB2TF*czE3OTM3MTMwNzgkbzEkZzAkdDE3OTM3MTMwODUkajUzJGwwJGgyMDc5OTcwNTY3*_ga_ERWPGTJ5X8*czE3OTM3MTMwNzgkbzEkZzAkdDE3OTM3MTMwODUkajUzJGwwJGgw

Korean and Chinese institutions occupy eight of the top ten academic patent transferors to deep science startups

Table 4 Top 10 academic institutions transferring patents to deep science startups, ranked by number of recipient startups

	Institution	Institution location	Number of patents transferred to deep science startups	Number of recipient deep science startups	Top recipient deep science startups
1	Seoul National University R&DB Foundation	Republic of Korea	72	20	**Graphene Square** (Semiconductors, 12) **Bertis** (Life Sciences, 10)
2	Shanghai Jiao Tong University	China	50	16	**Zhejiang Na Innovation Energy** (Transportation, 10) **Nutshell Therapeutics** (Life Sciences, 6)
3	Yonsei University Industry-Academic Cooperation Foundation	Republic of Korea	38	15	**Quratis** (Life Sciences, 6) **GeneMedicine** (Life Sciences, 6)
4	Korea Institute of Science and Technology	Republic of Korea	24	15	**PharosiBio** (Life Sciences, 4) **MediThinQ** (Medical Devices and Digital Health, 3)
5	Tsinghua University	China	53	14	**Lynxi Technology** (Semiconductors, 14) **Beijing Ruilai Intelligent Technology** (Robotics and Autonomous Systems, 9)
6	French National Centre for Scientific Research (CNRS)	France	17	13	**Advanced BioDesign** (Life Sciences, 3)
7	Korea University Research and Business Foundation	Republic of Korea	20	13	**Absology** (Medical Devices and Digital Health, 6) **Navifra Corp** (Robotics and Autonomous Systems, 3)
8	Zhejiang University	China	25	11	**Xinlian Power** (Semiconductors, 6) **Zhejiang Xinhai Biotechnology** (Life Sciences, 5)
9	Beihang University	China	57	10	**Beijing Tage Zhixing Technology** (Robotics and Autonomous Systems, 32)
10	Eindhoven University of Technology	Netherlands	14	10	**Smart Photonics** (Semiconductors, 4) **Antennex** (Semiconductors, 2)

Note: The parentheses following each deep science startup's name indicate the sector of the startup and the number of patents transferred from the respective academic institution.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

The analysis of patent assignment and mobility clearly outlines the unique technology life cycle of deep science startups. In their early stages, they act as industrial adopters of cutting-edge research from universities (with 16.8% of acquired patents originating from academia), translating laboratory discoveries into commercial products. Later in their life cycle, through frequent spinouts, mergers and acquisitions, or even bankruptcies, they continuously channel or return these market-validated, high-value patent assets back to multinational giants. Ultimately, the growth trajectory of deep science startups appears closely tied to a broader process of technology flow – one that may contribute to the reallocation of frontier technologies and, in turn, shape the technology portfolios of global industry leaders.

Joint patent filings

In the IP strategies of deep science startups, joint patent filings serve as an important window to observe external collaborative R&D. For the purposes of this analysis, a co-filed patent application is defined as an application listing two or more distinct original applicants, at least one of which is a startup in the relevant comparison group. The measure is based on the applicants recorded at the time of filing, rather than subsequent assignees or current patent owners.

Because deep science R&D is technologically complex, capital-intensive and dependent on specialized infrastructure, startups rarely scale entirely in isolation. They often collaborate with collaborate with academia, industry players or peers to access research, manufacturing capabilities and complementary technologies.[30] The joint patent filings may represent one outcome of such collaboration.

It is worth noting that co-filing represents one observable form of collaboration, rather than a comprehensive measure of collaborative activity overall. Joint R&D, licensing, testing, industrial pilots and customer partnerships need not produce jointly owned patents, and are therefore not captured in the co-filing statistics presented above. For instance, Spirit-AI's frontier AI research was validated through an extensive industrial pilot with battery manufacturer CATL – a collaboration described entirely in terms of technology deployment and performance validation, without reference to joint patent filing.[31] In Singapore, start-ups similarly collaborate with established companies through sector-specific translation platforms and corporate-pilot partnerships to co-develop and validate solutions[32] – again, forms of collaboration that do not inherently generate jointly owned patents.

Macro-level characteristics of joint patent filings: deep science startups demonstrating a stronger propensity for collaborative innovation

The data in Figure 17 reveal the difference in the innovation ecosystems of deep science and non-deep science startups, with deep science firms exhibiting a higher rate of joint patent filings.

30 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

31 Han, F., L. Guo and D. Guo (2026). Spirit-AI: Science-driven entrepreneurship in embodied AI. In Global Innovation Index 2026. Hangzhou and Geneva: Spirit AI and WIPO. Available at: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2026-gii-2026-contributors-spirit-ai.pdf

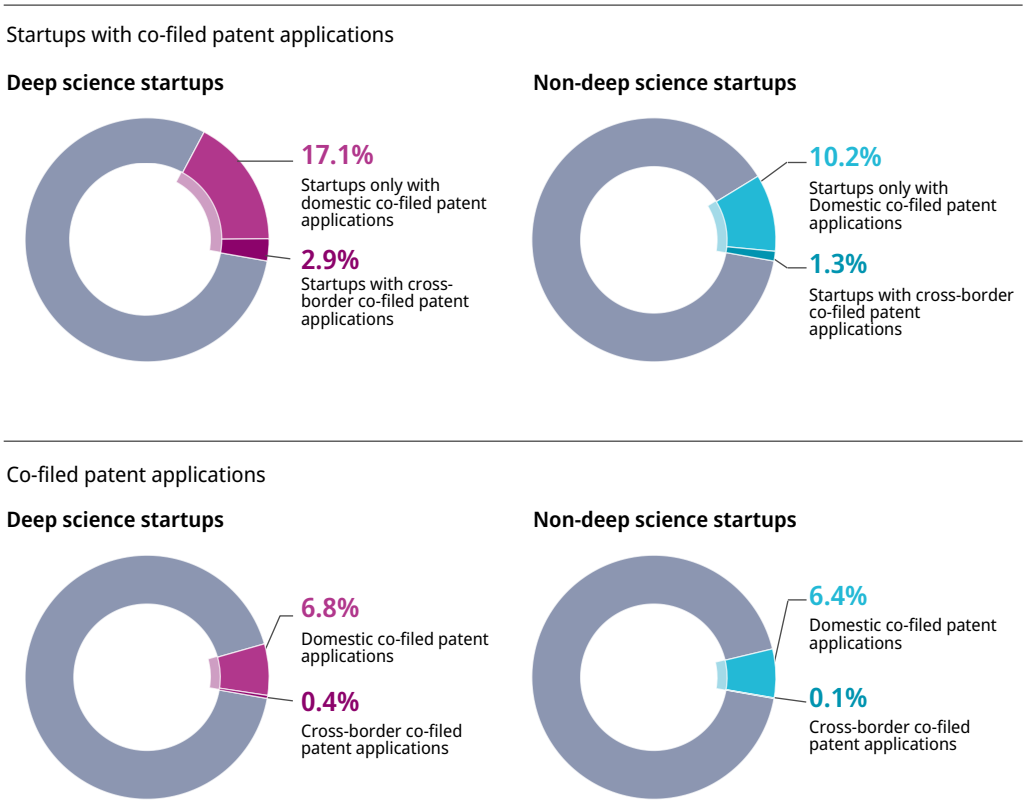
32 Tan, C.C. (2026). Nurturing a global hub for deep tech startups: Singapore. In Global Innovation Index 2026. Singapore and Geneva: National University of Singapore and WIPO. Available at: https://www.wipo.int/documents/d/global-innovation-index/docs-en-2026-gii-2026-contributors-singapore.pdf

Among deep science startups, 17.1% have participated in joint patent filings, a share significantly higher than the 10.2% recorded by their non-deep science peers. At the patent level, co-filed patents account for 7.2% of total patents held by deep science startups, which is also higher than 6.5% for non-deep science firms.

In terms of cross-border joint filings, the participation rate of deep science startups in co-applications with international partners (2.9%) is more than twice that of non-deep science startups (1.3%). Looking at total patent volume, these cross-border co-filed patents account for 0.4% of total deep science patents, which is four times the share of their non-deep science peers (0.1%).

Deep science startups are more likely to co-file patents, with notably stronger cross-border collaboration

Figure 17 Domestic and cross-border co-filed patent applications: deep science vs. non-deep science startups



Note: For cross-border co-filed patent applications, co-filings between subsidiaries of the same corporate group located in different countries are excluded. For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%.

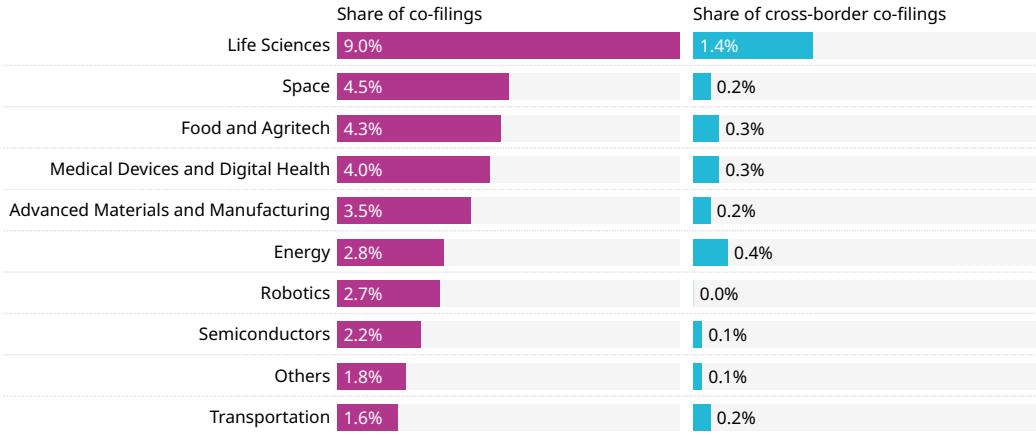
Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Differences across industries: Life Sciences leads in joint patent filings

Not all sectors within deep science share the same collaborative characteristics. Figure 18 illustrates the proportion of joint patent filings and cross-border joint patent filings across deep science sectors.

Life Sciences leads all sectors in both co-filing and cross-border co-filing rates

Figure 18 Share of co-filed and cross-border co-filed patent applications by sector among deep science startups



Note: Data exclude intra-group co-filings.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

The Life Sciences sector ranks first globally in both dimensions, with a joint filing rate of 9.0% and a cross-border joint filing rate of 1.4%. Biopharmaceutical R&D (such as antibodies and gene editing) relies heavily on foundational discoveries from universities and multi-center international collaborations, reflecting a highly collaborative patenting profile compared to other sectors.

The joint filing rate for Robotics and Autonomous Systems is 2.7%, but its cross-border joint filing rate is near zero (0%). This may be associated with the geographic concentration of robotics deployment and production within established manufacturing ecosystems.[33] It may also be associated with national-security sensitivities and export controls affecting certain dual-use robotics and autonomous technologies, which can restrict the cross-border transfer of controlled equipment, software, and technical information.[34,35] Such restrictions could potentially influence cross-border technological collaboration, although their contribution to the observed patent filing patterns cannot be established from the available data.

33 International Federation of Robotics (IFR) (2024). World Robotics: Industrial Robots 2024. Available at: https://ifr.org/img/worldrobotics/Executive_Summary_WR_2024_Industrial_Robots.pdf

34 Wassenaar Arrangement (2024). List of Dual-Use Goods and Technologies and Munitions List. Available at: https://www.wassenaar.org/control-lists/

35 European Commission (2023). Commission Recommendation (EU) 2023/2113 of 3 October 2023 on critical technology areas for the EU's economic security for further risk assessment with Member States. Available at: https://eur-lex.europa.eu/eli/reco/2023/2113/oj

Although the overall joint filing rate in the Energy sector is modest (2.8%), its cross-border joint filing rate (0.4%) is relatively notable and appears to correlate with global cross-border scientific collaborations in clean energy and novel battery electrode materials. Despite these collaborative efforts, cross-border joint patenting remains rare across the entire deep science ecosystem.

In general, only 2.9% of deep science startups participate in cross-border joint filings, and these patents account for 0.4% of the total patent volume. Even in Life Sciences – the most active sector for collaboration, the rate of cross-border joint filings is 1.4%, while all other sectors fall below 0.4%.

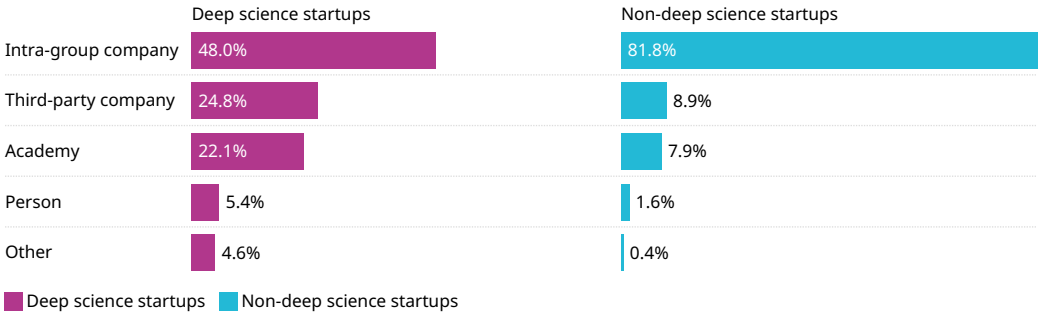
The relatively low participation in cross-border joint patent filings may reflect differences in public research funding frameworks, critical-technology considerations and regulatory requirements related to international collaboration. It may also reflect the operational complexity of jointly filed or jointly owned IP, which can require extensive coordination among partners regarding prosecution, maintenance, licensing, enforcement and commercialization.

Types of joint filing partners: a comparison between intra-group filings and external ecosystem collaboration

The distribution of joint filing partner types reflects a clear difference in the R&D models of deep science and non-deep science startups (Figure 19).

Deep science startups favor external commercial and academic collaborations, while non-deep science startups rely on internal group resources

Figure 19 Distribution of co-filing partner types: deep science vs. non-deep science startups



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%. Percentages represent the proportion of patents involving each entity type. Sums exceed 100% due to co-assignments (patents with multiple distinct entity types as assignees).

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

For non-deep science startups, among all of their co-filed patents, 81.8% of their joint filings occur internally (intra-group, such as between different subsidiaries under the same parent company), reflecting a highly centralized and internalized IP management structure. Their shares of co-filed patents with external third-party companies and academic institutions are only 8.9% and 7.9%, respectively.

In contrast, among all co-filed patents held by deep science startups, intra-group filings account for 48.0%, meaning that more than half of these patents involving the external ecosystem. Specifically, co-filed patents with third-party companies account for 24.8%, while those involving academic institutions reach 22.1% - nearly three times the share of their non-deep science peers.

A micro-level perspective: the academia–industry–government triangle and Chinese enterprises' collaborative scaling

Table 5 presents the top 10 deep science startups globally by the number of joint patent filings.

Chinese deep science startups occupy a prominent position on this list, taking seven of the ten spots. ChangXin Memory Technologies (96 joint patent filings), United Imaging Healthcare (92 joint patent filings), PhaBuilder (50 joint patent filings) and Shenzhen Yuanrong Qixing Technology (45 joint patent filings) are highly active in joint applications. This appears to correlate with a key characteristic of China's policy-supported integration of academia and industry, where startups form close ties with universities, national research institutes and public research hospitals to collaboratively develop core technologies, including semiconductor memory, high-end medical equipment, synthetic biology and autonomous driving.

Aside from a few exceptions (such as ADC Therapeutics with MedImmune, and BeiGene with the inventors themselves), most of the startups on the list partner with universities, public research institutes, or research hospitals. This suggests that foundational innovation in deep science relies heavily on academic knowledge and research infrastructure.

An in-depth look at the specific technical collaborations among these top-ranked deep science startups reveals three typical models of global deep science R&D cooperation.

Joint R&D between large corporations and deep-tech startups. Swiss biotech company ADC Therapeutics entered into an equity investment and joint development agreement with MedImmune, the biologics R&D arm of multinational pharmaceutical giant AstraZeneca. Through joint R&D (with a cumulative total of 144 jointly filed patents), the two parties established a deep partnership, combining ADC Therapeutics' cutting-edge pyrrolobenzodiazepine (PBD) payload technology with MedImmune's advanced antibody engineering capabilities to achieve complementary advantages. By agreeing to share development costs and profits, they have not only accelerated the clinical development of new drugs but also effectively reduced financial and commercial risks for both sides.[36]

The industry–university–research collaborative model among startups, corporate enterprises and academic institutions. The smart transportation and autonomous driving startup Shenzhen Yuanrong Qixing Technology (also known as DeepRoute.ai) has established a close industry-university-research-application collaborative innovation network. On the academic R&D front, DeepRoute.ai has partnered with the School of Vehicle and Mobility at Tsinghua University (nine jointly filed patents) since 2021 on joint research and patent co-filing to develop a Vehicle-Road-Cloud Integrated Smart Driving System.[37] On the industrial application front, DeepRoute.ai has teamed up with industry giants like Dongfeng Motor

36 Startupticker (2013). MedImmune and Auven invest USD 40 million in ADC Therapeutics. Available at: https://www.startupticker.ch/en/news/medimmune-and-auven-invest-usd-40-million-in-adc-therapeutics

37 Securities Daily (2023). DeepRoute.ai Partners with Tsinghua University to develop energy-efficient autonomous vehicles, cutting energy consumption by 6.9% compared to human drivers. Available at: http://www.zqrb.cn/gscy/qiyexinxi/2023-01-11/A1673429848822.html

(30 jointly filed patents) to conduct R&D, complex road testing and pilot operations for Level 4 autonomous driving, accumulating road-test data.[38] This collaboration integrates the technological innovation of startups, the industrial resources of corporate enterprises and the scientific research capabilities of universities, thereby accelerating the R&D and commercialization of autonomous driving technologies.

University spinouts commercializing technology with ongoing joint R&D. DIOSynVax, a digital synthetic vaccine development company, was spun out in 2017 with the support of Cambridge Enterprise, the commercialization arm of the University of Cambridge.[39] Built upon the foundational scientific research of Cambridge, the company has maintained a close joint R&D partnership with its parent university since its inception. It has co-filed 18 patent applications with Cambridge Enterprise and 19 with the University of Cambridge. Additionally, DIOSynVax has co-filed 12 collaborative patent applications with the University of Regensburg in Germany. This partnership stems from technological complementarity: DIOSynVax is responsible for designing the vaccine's core (the antigen) using AI, while the University of Regensburg provides the delivery vehicle (vector technology) to introduce the vaccine into the human body. Their combination provides foundational technological protection for the safe development of broad-spectrum universal vaccines.[40] This model illustrates the pathway through which university scientific research is commercialized by creating spinout companies, and technological progress is continuously driven by sustained university–industry collaboration.

38 TMTPost (2025). DeepRoute.ai: Still in the dark before dawn. Available at: https://www.tmtpost.com/7565622.html?rss=souhu

39 University of Cambridge (2026). New 'universal vaccine' technology could protect us from future virus outbreaks. Available at: https://www.cam.ac.uk/research/news/new-universal-vaccine-technology-could-protect-us-from-future-virus-outbreaks

40 Schmidt, B. (2023). Innovative corona vaccine developed. University of Regensburg. Available at: https://www.uni-regensburg.de/en/biology-preclinical-medicine/faculty/information-on/news/entry/28-09-2023_innovative-corona-vaccine-developed

Top deep science startups strengthen R&D through joint patent filings with academic and corporate partners

Table 5 Top 10 deep science startups by number of co-filing patents and their primary co-filing applicants

	Deep science startup	Number of co-filing patents	HQ Location	Sector	Primary co-applicants
1	BeiGene	152	China	Life Sciences	Inventors as co-applicants
2	ADC Therapeutics	144	Switzerland	Life Sciences	**MedImmune** (144)
3	ChangXin Memory Technologies	96	China	Semiconductors	**Beijing Superstring Academy of Memory Technology** (79)
4	United Imaging Healthcare	92	China	Medical Devices and Digital Health	**Shanghai Advanced Research Institute Chinese Academy of Sciences** (15), **Ruijin Hospital Affiliated to Shanghai Jiao Tong University School of Medicine** (11)
5	FLOSFIA	53	Japan	Semiconductors	**Kyoto University** (18)
6	PhaBuilder	50	China	Life Sciences	**Tsinghua University** (36)
7	Shenzhen Yuanrong Qixing Technology	45	China	Transportation	**Dongfeng Motor Group** (30)
8	Space Engine	45	China	Space	**Xi'an Jiaotong University** (10)
9	DIOSynVax	37	United Kingdom	Life Sciences	**The Chancellor Masters and Scholars of the University of Cambridge** (19), **Cambridge Enterprise** (18)
10	Yunzhou Intelligence Technology	37	China	Robotics and Autonomous Systems	**Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai)** (7), **Jiangsu Ocean University** (7)

Note: Data exclude intra-group co-filing patents. The number in parentheses following each co-filer's name indicates the number of patents co-filed with the deep science startup.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

A perspective on academic institutions: wide-scale incubation versus deep strategic partnerships

France's CNRS leads globally in deep science IP collaboration, driving joint patent filings with over 90 startups

Table 6 Top 10 academic institutions co-filing patents with deep science startups, ranked by number of co-filing patents

	Institution	Institution location	Number of co-filing deep science startups	Number of co-filing patents	Top co-filing deep science startups
1	French National Centre for Scientific Research (CNRS)	France	91	158	**Greenerwave** (Semiconductors, 9)
2	Tsinghua University	China	24	125	**PhaBuilder** (Life Sciences, 36), **Seetrum** (Semiconductors, 17)
3	University of California	United States	41	98	**Laboratory for Advanced Medicine** (Life Sciences, 10), **Topera** (Life Sciences, 10)
4	French National Institute of Health and Medical Research (INSERM)	France	52	94	**TargEDys** (Life Sciences, 6)
5	French Alternative Energies and Atomic Energy Commission (CEA)	France	23	87	**Aledia** (Semiconductors, 28), **ISORG** (Semiconductors, 22)
6	Beijing Superstring Academy of Memory Technology	China	1	79	**ChangXin Memory Technologies** (Semiconductors. 79)
7	Seoul National University R&DB Foundation	Republic of Korea	21	74	**G-Flas** (Life Sciences, 13), **Graphene Square** (Semiconductors, 10)
8	Kyoto University	Japan	19	61	**FLOSFIA** (Semiconductors, 18), **Megakaryon** (Life Sciences, 12)
9	Shanghai JiaoTong University	China	19	49	**Hechen Biotechnology** (Life Sciences, 7), **Shanghai Tangfeng Energy Technology** (Energy, 7)
10	Korea Advanced Institute of Science and Technology	Republic of Korea	10	43	**Tomocube** (Medical Devices and Digital Health, 19), **Dot** (Medical Devices and Digital Health, 9)

Note: Data exclude intra-group co-filing patents. In the parentheses following each deep science startup's name, the sector indicates the sector to which the deep science startup belongs, and the number indicates the number of patents co-filed between the startup and the respective academic institution.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Table 6 lists the top 10 academic institutions globally that co-file patents with the highest number of deep science startups. The data reveal two distinct IP strategic models adopted by academic institutions to support deep science innovation:

- **One-to-many model.** Represented by the French National Centre for Scientific Research (CNRS; collaborating with 91 deep science startups on 158 joint filings), the University of California (41 startups, 98 joint filings) and the National Institute of Health and Medical Research (Inserm; 52 startups, 94 joint filings). These public research giants act as institutional pillars of technology dissemination, adopting a highly open approach to diffuse, share and collaboratively develop underlying technology patents with a broad base of startups.
- **One-to-one model.** Typified by China's Beijing Changcun Supercomputing Storage Chip Research Institute. This institution collaborates with only one startup – ChangXin Memory Technologies – yet has co-filed up to 79 patents with them. This highly focused, single-partner collaboration model is particularly prominent in capital-intensive and high-barrier sectors such as semiconductor memory, which require a concentrated allocation of R&D resources to overcome highly complex engineering challenges.

Insights into cross-border joint patent filings: high barriers, intensive capital and strategic partnerships

Table 7 presents the top 10 deep science startups globally by cross-border joint patent filings, alongside their co-applicants, revealing key characteristics of collaboration in top-tier deep science innovation.

Life Sciences leads significantly in cross-border collaborative networks. Within the top 10 list, seven startups belong to the Life Sciences sector, with only B-Temia (Medical Devices and Digital Health), Sense Photonics (Transportation) and Synhelion (Energy) as exceptions. This pronounced sectoral concentration appears correlated with the industry structure of life sciences. As previously noted, the Life Sciences sector ranks first globally in both its overall joint filing rate (9.0%) and its cross-border joint filing rate (1.4%). The underlying scientific discoveries for cutting-edge biotechnologies, such as gene editing, immunotherapy and cancer screening, frequently originate from diverse global academic sources. Furthermore, pharmaceutical development requires global, multi-center clinical trials and relies on the global distribution and regulatory compliance networks of multinational pharmaceutical corporations.

Swiss biotechnology firm ADC Therapeutics ranks first globally with 144 cross-border co-filed patents, a volume over five times that of second-ranked CRISPR Therapeutics (27 patents). As detailed earlier (see Table 5), these cross-border collaborations consist entirely of its strategic partnership with UK-based biopharmaceutical company MedImmune, a subsidiary of AstraZeneca.

ADC Therapeutics dominates cross-border co-filings, with Life Sciences accounting for seven of the top 10 deep science startups

Table 7 Top 10 deep science startups by number of cross-border co-filed patents and their co-assignees

	Deep science startup	HQ Location	Number of cross-border co-filings	Sector	Primary co-applicants
1	ADC Therapeutics	Switzerland	144	Life Sciences	**MedImmune Ltd** (United Kingdom, 144)
2	CRISPR Therapeutics	Switzerland	27	Life Sciences	**Bayer Healthcare LLC** (United States, 17), **Vertex Pharmaceuticals Inc.** (United States, 6)
3	Artiva Biotherapeutics	United States	17	Life Sciences	**GC Cell Corp.** (Republic of Korea, 16), **Affimed GmbH** (Germany, 2)
4	DIOSynVax	United Kingdom	15	Life Sciences	**University of Regensburg** (Germany, 15), **The Chancellor, Masters and Scholars of the University of Cambridge** (United Kingdom, 9)
5	B-Temia	Canada	13	Medical Devices and Digital Health	**Safran Electronics & Defense** (France, 13)
6	Sense Photonics	United States	13	Transportation	**The University Court of the University of Edinburgh** (United Kingdom, 13)
7	Synhelion	Switzerland	10	Energy	**Eni SpA** (Italy, 10)
8	Ablbio	Republic of Korea	9	Life Sciences	**I-Mab** (China, 9)
9	SK Biopharmaceuticals	Republic of Korea	9	Life Sciences	**Jazz Pharmaceuticals plc** (Ireland, 4), **Neuronex Inc.** (United States, 3)
10	GRAIL	United States	8	Life Sciences	**The Chinese University of Hong Kong** (China, 8)

Note: Data exclude intra-group co-filing patents. In the parentheses following each co-assignee's name, the country indicates the co-assignee's HQ country, and the number indicates the total patents co-filed between the co-assignee and the respective deep science startup.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Although Switzerland has a smaller startup base than the United States or China, its three startups on the list (ADC Therapeutics, CRISPR Therapeutics and Synhelion) are disproportionately represented, securing the top two global positions in cross-border joint filings. The co-applicants of these Swiss deep science startups are widely distributed across Germany, Italy, the United Kingdom and the United States. This suggests that Switzerland holds a prominent position as a global hub for life sciences and corporate headquarters, supported by its strong integration into European and transatlantic R&D networks.

PCT international filing routes

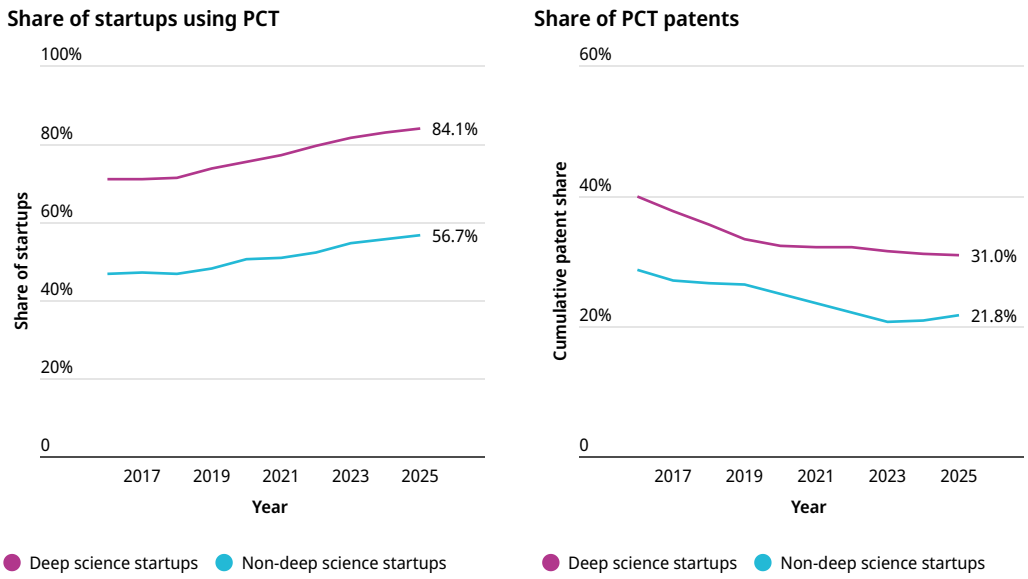
For deep science startups, their target markets and potential commercial partners are typically distributed across multiple countries worldwide.[41]

This section analyzes startups that choosing the Patent Cooperation Treaty (PCT) route – a unified, streamlined process for filing patent applications in multiple countries, which is administered by WIPO.[42] The analysis highlights key factors in designing a cross-national patent strategy.

Figure 20 compares the use of the Patent Cooperation Treaty (PCT) route among patent-holding deep science and non-deep science startups.

While 84% of deep science startups use the PCT route, far exceeding the share among their non-deep science counterparts, PCT applications account for only 31% of their total patents

Figure 20 Share of startups and share of patents using PCT: Deep science vs. non-deep science startups



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

41 WIPO (2026). Global Innovation Index 2026 - Special theme 2026: Powering entrepreneurs at the frontier of science, turning pilots into pipelines. Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/special-theme-2026-powering-entrepreneurs-at-the-frontier-of-science-turning-pilots-into-pipelines.html

42 The Patent Cooperation Treaty (PCT) is an international patent law treaty concluded in 1970, administered by the World Intellectual Property Organization (WIPO), between more than 140 Paris Convention locations. The PCT makes it possible to seek patent protection for an invention simultaneously in each of a large number of locations by filing a single "international" patent application instead of filing several separate national or regional patent applications. The granting of patents remains under the control of the national or regional patent offices, which is referred to as the "national phase"

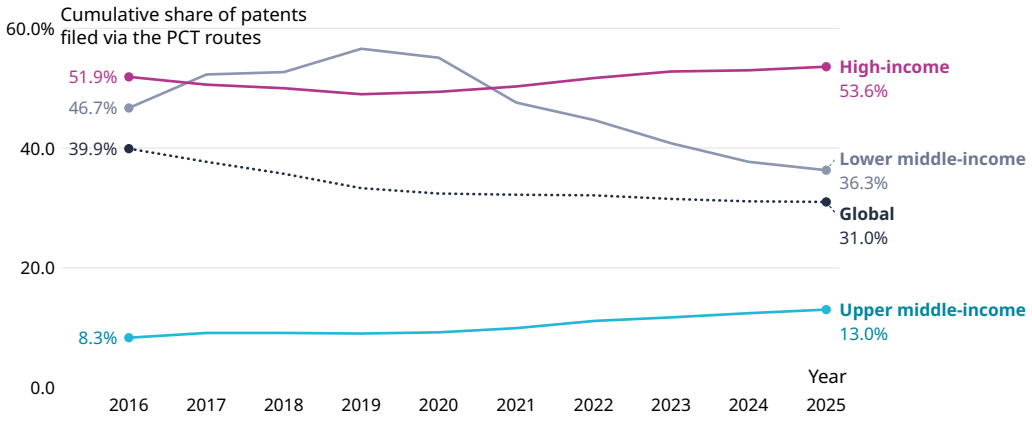
Globally, as high as 84% of deep science startups have adopted the PCT route, compared to 57% for their non-deep science counterparts. Among deep science startups, the share using the PCT route has followed a steady upward trend over the past decade (2016–2025), indicating the importance of international patent protection to these companies.

Although 84% of deep science startups use the PCT route, only 31% of the patents they hold have been filed through this international route. The data suggest that, given the high cost of international patent filing, startups do not seek patent protection across all markets without careful consideration. Instead, they carefully select which patents to file abroad, strategically choosing which core assets to protect internationally based on their target markets, commercial relevance and budget constraints, while maintaining more localized or incremental innovations solely within their home jurisdictions.

Between 2016 to 2025, the share of PCT patents among all patents held by deep science startups declined, from nearly 40% to 31%. This decline does not, however, necessarily indicate a weakening of companies' intent to seek international patent protection. Instead, it primarily reflects the rapid growth in patenting by deep science startups overall, with domestic patent applications growing significantly faster than PCT applications, thereby reducing the PCT share of the total.

The cumulative share of PCT patents exceeds 50% in high-income economies, while both high-income and upper middle-income groups show an overall upward trend

Figure 21 Cumulative share of patents filed via the PCT route by income group



Note: For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with $p = 0.5$), the overall margin of error is approximately ±0.98%.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Breaking this down by income group reveals distinct patterns across the three categories studied (Figure 21). High-income economies maintain a high and relatively stable cumulative PCT share, reaching 53.6% in 2025 – the highest among the three groups studied. Upper middle-income economies, whose patents predominantly originate in China, consistently show the lowest share among the three groups, though it has risen slowly from approximately 8.3% to 13.0% by 2025. Lower middle-income economies, whose patents predominantly

originate in India, present a distinctive pattern: their share rose to approximately 55% around 2019 before declining substantially and continuously, falling to 36.3% by 2025. These figures should be interpreted in the context of the group's very small patenting volume. Lower middle-income economies account for just 0.3% of all deep science startup patents globally and 0.4% of global PCT patents. Consequently, fluctuations in their PCT share have little effect on the overall global trend.

A seemingly paradoxical phenomenon merits attention: while the cumulative PCT share is declining globally, high-income economies maintain a relatively stable share and upper middle-income economies show a gradual increase. This apparent contradiction can be explained by a structural dilution effect. Patent volumes from upper middle-income economies, dominated by China, have grown particularly rapidly. Although the PCT share within this group has risen gradually, domestic patenting has grown even faster. As a result, patents from these economies account for an increasing proportion of the global total, diluting the overall PCT share despite the stable or rising shares observed within individual income groups.

Alongside the PCT route, startups can seek international patent protection through the Paris Convention route, which involves filing separate patent applications directly in each country or jurisdiction where protection is sought.[43] While the PCT route is clearly the dominant choice, the Paris Convention route remains an option for deep science startups. Overall, 17% of patent-holding deep science startups have used the Paris Convention route, the same proportion as among non-deep science startups. This share has increased only gradually over the past decade, from 12% to 17% for both groups. The 17% using the Paris Convention route and the 84% using the PCT route are not mutually exclusive groups: many startups have used both routes and are counted in both proportions. Only 3% of patent-holding deep science startups have used the Paris Convention route without also using the PCT route. Similarly, patents filed abroad exclusively through the Paris Convention route account for just 5% of patents held by deep science startups, compared with 2% for non-deep science startups.

Growth stage

For deep science startups, the accumulation of IP is not a one-time event, but a dynamic process closely related to their financing process, team expansion and technological maturity. This section introduces the startups' growth dimension and, through analyzing the patent performance of startups in the early stage, breakout stage and late stage, reveals the unique life cycle patterns of deep science enterprises.

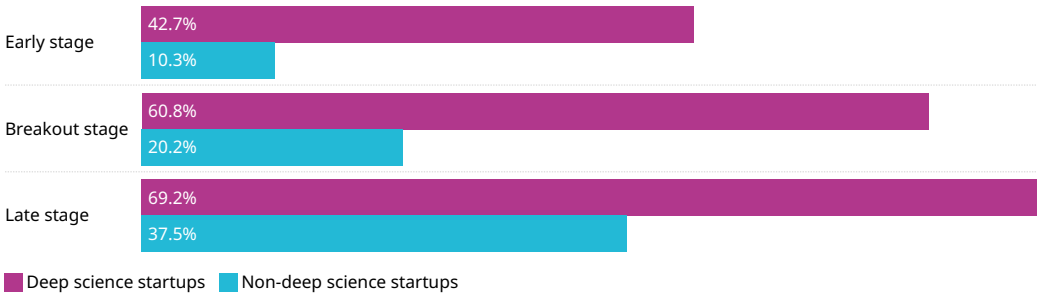
Patent adoption rates: The reliance on patents among deep science startups far exceed those of their non-deep science peers throughout their entire life cycle

Figure 22 compares patent adoption rates between deep science and non-deep science startups founded between 2010 and 2025 across different stages of growth.

43 The Paris Convention for the Protection of Industrial Property, established in 1883, allows an applicant to file a patent application in one member country and, within 12 months, file corresponding applications directly in other member countries while retaining the original filing date (known as the "right of priority"). Unlike the PCT, which provides a single, unified international filing procedure administered by WIPO, the Paris Convention route requires separate, individual applications to be filed – and prosecuted – directly with the national (or regional) patent office of each country where protection is sought.

Patent holding increases with growth stage and is consistently higher among deep science startups

Figure 22 Share of patent-holding startups across growth stages: deep vs. non-deep science startups, 2010–2025



Note: Early-stage companies are those with under USD 15M VC funding, under 50 employees and under USD 100M valuation. Breakout companies are companies which have either USD 15M or more funding, 50 or more employees, or USD 100M or more valuation but have less than USD 100M or more funding, 500 employees and USD 500M valuation. Late-stage companies are companies which have either raised USD 100M or more VC funding, 500 or more employees, or USD 500M or more valuation. For the patent search on non-deep science startups, a sampling approach is used. Under a 95% confidence level (with p = 0.5), the margin of error is approximately ±1.14% for early-stage, ±1.85% for breakout-stage and ±2.69% for late-stage startups.

Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

Globally, the share of patent-holding deep science startups increases substantially as firms advance through their growth journey. At the early stage, 42.7% of deep science startups hold patents. This proportion rises sharply to 60.8% at the breakout stage and reaches 69.2% at the late stage.

A comparison between deep science and non-deep science startups reveals that, although patent adoption rates increase as firms progress through successive growth stages in both groups, deep science startups already exhibit a patent adoption rate of 42.7% at the early stage, surpassing the rate observed among non-deep science startups even at the late stage (37.5%).

Moreover, across all income groups and growth stages, deep science startups consistently exhibit significantly higher patent adoption rates than their non-deep science counterparts.

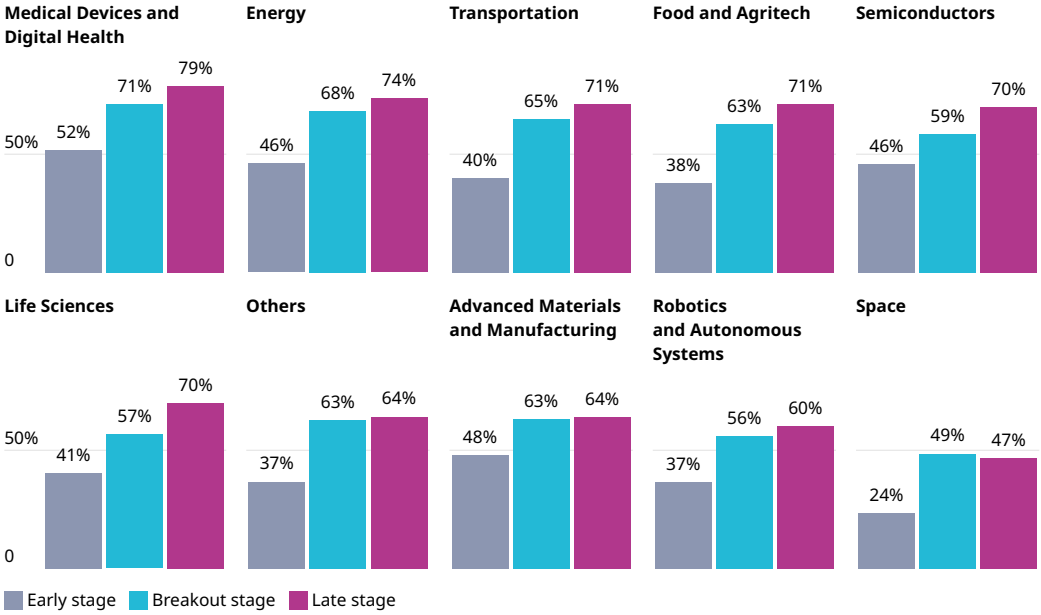
Beyond the increase in patent ownership rates, deep science startups also consistently maintain larger average patent portfolio size (that is, the number of patents held by each company) than their non-deep science counterparts at every stage of growth.

Sector breakdown by growth stage: the unique shift to trade secrets among late-stage space startups

Across most industries, including Life Sciences, Semiconductors, and Robotics and Autonomous Systems, patent adoption rates follow a clear upward trajectory as firms grow, with late-stage companies typically exhibiting the most comprehensive patent portfolios (Figure 23).

Patent adoption rates rise with startup maturity across nearly all sectors, with Space as the only exception showing a late-stage decline

Figure 23 Share of patent-holding deep science startups by sector and growth stage



Source: WIPO, based on GII 2026 Dealroom–WIPO Deep Science Startup Tracker and patent data from Patsnap (March 2026).

In the Space sector, the patent adoption rate is slightly lower among late-stage startups (46.7%) than among breakout-stage startups (48.6%). Given the small difference and the relatively limited number of firms in these groups, this pattern should be interpreted cautiously and may reflect differences in sample composition rather than a change in firms' patenting strategies over time.

Conclusions and key takeaways

This report presents a large-scale empirical analysis of the patent portfolios of over 24,000 deep science startups worldwide, providing a systematic assessment of the underlying dynamics that shape patent protection, knowledge diffusion and commercial survival in this emerging form of entrepreneurship.

Deep science startups are not merely explorers of frontier science. They serve as critical translators of scientific discoveries into products and technologies that transform the physical world. Through a comprehensive patent analysis across geography, income group, technology and sector, as well as the startup life cycle, this WIPO Technology SPARK report reveals several structural shifts occurring within the deep science IP ecosystem. These transformations are relevant to how policymakers, investors and entrepreneurs interpret patenting behavior in this space.

It is worth reiterating that patents represent one lens onto a broader IP strategy. The structural shifts and takeaways below should be read as evidence of how deep science ventures use patents specifically – nor as a complete account of how these ventures build, protect and extract value from their innovations. Trade secrets, regulatory exclusivity and data assets remain significant complements to the patent-centric findings presented here, particularly as deep science increasingly intersects with software and data-driven business models. Extending this empirical approach to these other IP forms remains an important direction for future research.

Ongoing structural shifts

Building on the findings presented throughout this report, three broader patterns emerge that may characterize the evolving relationship between science, IP and entrepreneurship in this sector.

Innovation may be shifting from isolated breakthroughs toward interconnected systems. Historically, innovation has often been associated with breakthroughs within a single scientific discipline. The patterns observed in this report suggest that deep science innovation could increasingly be characterized by convergence across fields – as seen, for instance, in the growing overlap between semiconductor and quantum-related patenting, or the intersection of AI, materials science and robotics within transportation-related applications. This may suggest that future technological advantages could depend less on individual patents and more on interconnected patent networks spanning multiple disciplines and institutions, with competition increasingly occurring between innovation ecosystems rather than between individual firms alone.

The economic value of patents may be extending beyond the boundaries of the firms that hold them. Unlike in many software or service industries, where the closure of a company can result in the loss of much of its associated economic value, the evidence in this report suggests that patent assets in deep science sectors may often retain value independent of the originating firm's commercial outcome. Cases of bankruptcy restructuring, investor recovery and divestiture – discussed earlier in this report – indicate that high-value technology assets can continue to circulate within the broader innovation ecosystem even after a startup ceases operations. This suggests that patents may function not only as a competitive asset, but also as a channel through which technological value is preserved and reallocated.

The starting point of deep science entrepreneurship may differ structurally from more conventional startup models. While many startups are typically established before substantial R&D activity begins, the findings in this report suggest that deep science ventures more frequently follow a trajectory in which core technologies are developed within universities, public research institutions or corporate labs prior to incorporation. This is reflected in the relatively high share of startups whose earliest patent priority date predates their founding, as well as the prevalence of patent transfers from research institutions. These patterns suggest that the foundations of future competition in this space may increasingly take shape within research institutions, well before companies are formally established.

Key takeaways

The patterns identified in this report speak to several decision contexts relevant to different actors in the deep science ecosystem.

For **governments and policymakers**, the data show that patent adoption and filing costs vary considerably by startup stage – early-stage firms face barriers linked to filing costs and technology transfer from universities, while mid-to-late-stage firms accumulate large patent portfolios alongside growing cash-flow pressure. These stage-specific patterns may be relevant to broader discussions on how support for deep science startups is structured across different phases of the life cycle. Given that a substantial share of deep science startups' foundational patents originate in universities and public research organizations prior to incorporation, the report's findings on TTO-mediated patent transfer may also be of interest to institutions evaluating the efficiency of licensing and transfer mechanisms.

For **venture capital investors**, the report's findings on post-failure patent monetization (e.g., JOLED, Argo AI) indicate that patent assets in deep science sectors can retain and realize value independently of the originating firm's commercial survival, which may be a relevant consideration in downside-scenario analysis.

For **founders**, the report's findings that a substantial share of deep science startups incorporate with patents already filed – often transferred from universities or public research organizations – indicate that IP ownership questions frequently arise prior to formal incorporation. The prevalence of external and cross-institutional co-filing among deep science startups (17.1% globally, with 22.1% involving universities and research institutions) further indicates that collaborative IP arrangements are a common feature of this entrepreneurship model, rather than an exception.

Appendix

Patent search and matching strategies

For details on the patent search and matching strategies, please refer to the Global Innovation Index 2026, Appendix V: Methodology, Section 2, Matching deep science startups to global patent data.[1]

Data coverage and limitations

The following notes detail the analytical scope and data coverage limitations of this report.

Scope of startups. This analysis focuses on deep science startups and spinouts founded since 2010 that have raised at least one round of venture capital (VC) funding. Non-VC-backed firms are excluded from the data set.

Patent data timeliness. The patent data are based on Patsnap records up to March 2026. Due to the standard 18-month patent publication lag, the most recent filings may be underestimated; therefore data for patent applications filed in 2024 and 2025 should be considered preliminary and incomplete.

Geographic coverage. Coverage in the Dealroom startup database is strong across most high- and middle-income economies but remains limited for Sub-Saharan Africa and other low-income regions. The report acknowledges these limitations where relevant and avoids making broad assumptions where data are thin.

Sampling methodology

Given the exceptionally large population of non-deep science startups, this report adopts a stratified sampling approach to ensure the feasibility and scientific rigor of data retrieval and analysis. By extracting a globally representative sample of non-deep science startups, conducting patent search and matching, we infer the characteristics of the overall population based on this sample. In terms of sampling precision, this study strictly adheres to statistical standards, ensuring that the overall proportion estimation achieves a 95% confidence level with a margin of error within approximately ±1%. The specific sampling methodology is as follows:

1 Available at: https://www.wipo.int/web-publications/global-innovation-index-2026/en/appendix-v-methodology-of-the-special-theme.html#h2-2-2-matching-deep-science-startups-to-global-patent-data

1. Overall sampling design

The total population consists of 195,416 VC-backed non-deep science startups. This study adopts a multi-stage stratified random sampling design with proportional allocation and minimum sample size constraints.

The sampling objectives are as follows:

Overall level: To construct a globally representative sample with an overall proportion estimation corresponding to a 95% confidence level and an approximate ±1% margin of error.

Launch year level: To ensure that the sample distribution broadly reflects the population distribution over time, with adequate precision for temporal analyses.

2. Stratification framework

The sampling frame is stratified by two dimensions:

Dimension	Description	Categories
Primary stratification	HQ location	205 distinct locations
Secondary stratification	Launch year	17 years (2010–2026)

3. Sample size determination

3.1 Overall target sample size

The base target sample size is calculated using standard proportion estimation formulas, for proportion estimation with:
- 95% confidence level
- ±1% margin of error
- Conservative assumption p = 0.5

3.2 Location-level allocation

Sample allocation to each location follows a modified proportional allocation with minimum thresholds:

Allocation rules:

Proportional base	$n_i = n \times (N_i / N)$
Minimum floor	$n_i \geqslant 20$ for locations with $N_i \geqslant 20$
Census for small locations	$n_i = N_i$ for locations with $N_i < 20$

Calculate proportional allocation for all locations, then identify locations below the minimum threshold (n < 20) and set to minimum or census, then distribute the difference across remaining locations proportionally.

3.3 Launch year requirements

Launch year representation follows approximate proportional allocation with the understanding that:
- Each year should be represented roughly proportional to its population share.
- Minimum effective sample per year: approximately 100–150 observations for meaningful temporal analysis.
- These are expected outcomes of the location-stratified sampling, not rigid quotas requiring post-hoc adjustment.

4. Sampling procedure

Within each HQ location stratum:

Step 1: Secondary stratification by launch year

Allocate the location's total sample size (n_i) proportionally across launch years based on the within-location year distribution

Formula: $n_{iy} = n_i \times (N_{iy} / N_i)$

Where:
- n_i = total sample size for location i
- N_{iy} = population size for location i, year y
- N_i = total population in location i

Step 2: Simple random sampling

Apply simple random sampling within each location × year cell

Probability structure

This produces a two-way stratified random sample (by location and year) where:

Probability Type	Formula	Characteristic
Selection probability for unit j in location i, year y	$\pi_{iyj} = n_{iy} / N_{iy}$	Known and equal within each stratum
Overall selection probability	$\pi_j = n_{iy} / N_{iy}$	Non-zero for all eligible units

5. Sampling weighting and analysis

5.1 Design weights

Each sampled startup receives a **design weight** equal to the inverse of its selection probability:

$w_j = 1 / \pi_j = N_{iy} / n_{iy}$

Where:
- i = startup's HQ location
- y = startup's launch year
- N_{iy} = population size in stratum (location i, year y)
- n_{iy} = sample size in stratum

The design weight represents the number of population units represented by each sampled unit and must be used in all estimation procedure.

All inclusion probabilities are known, non-zero and determined prior to sampling.

5.2 Adjustment for non-response

If unit non-response occurs, design weights must be adjusted to mitigate potential bias. Acceptable approaches include:
- **Response propensity weighting**. Estimation of response probabilities using auxiliary variables, followed by inverse-probability adjustment.
- **Non-response class adjustment**. Formation of homogeneous classes using auxiliary variables and adjustment within classes.
- **Post-stratification or calibration**. Adjustment of weights to align with known population totals (for example, by location, year or other reliable benchmarks).

The choice of method should be guided by data availability and evaluated for its impact on bias and variance.

5.3 Analytical requirements

All statistical analyses must be conducted using design-based survey estimation methods that account for:
- Stratification (location × launch year)
- Unequal selection probabilities (weights)
- Finite population corrections where applicable

This includes:
- Weighted point estimates (means, proportions, totals)
- Design-consistent standard errors
- Confidence intervals and hypothesis tests based on the sampling design

Standard statistical procedures that ignore the sampling design (such as unweighted analyses or models assuming simple random sampling) must not be used for official inference.

5.4 Variance estimation

Sampling variance must be estimated using established survey sampling techniques. Acceptable methods include:
- Taylor series linearization (default method)
- Replication methods, such as Bootstrap

Variance estimation must incorporate:
- Stratification identifiers (location × year)
- Final analysis weights
- Finite population corrections (where sampling fractions are non-negligible)

For domain (subpopulation) estimates, including industry categories, variance estimation must properly account for the full sample design rather than treating domains as independent samples.

5.5 Treatment of census strata

For strata where $n_{iy} = N_i$ (i.e., full census of the stratum):
- Sampling variance within the stratum is zero.
- These units must still be included in weighted estimation of population parameters.
- Variance contributions arise only from non-census strata.

6. Methodological scope

This sampling design supports:
- descriptive population estimates with known precision;
- analytical comparisons across locations and years;
- statistical inference to the defined population of VC-backed non-science-based startups;
- regression and modeling using appropriate survey-weighted methods; and
- hypothesis testing with valid standard errors and confidence intervals.

Key methodological strengths: This approach maintains probability sampling principles throughout, ensuring:
- every unit has calculable, non-zero probability of selection;
- simple random sampling within each stratum; and
- valid confidence intervals and hypothesis tests.

Limitations: design effects from stratification typically range from 1.2 to 1.5, slightly reducing precision compared to simple random sampling.

The *WIPO Technology SPARK report on Patenting in Deep Science Startups and Spinouts* provides an in-depth analysis of how deep science startups worldwide use patents to protect innovation, attract investment and expand into international markets.

This WIPO IP Analytics publication is a companion report to the special theme chapter of the 2026 *Global Innovation Index: Powering entrepreneurs at the frontier of science*, matching venture capital-backed deep science startups included in the Dealroom–WIPO Deep Science Startup Tracker with global patent data. It examines how their patenting activities vary across countries, income groups, industries, and stages of development. The report also sheds light on patenting strategies across deep science sectors, as well as national differences in patent adoption, technology transfer and use of the Patent Cooperation Treaty (PCT) System.

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

wipo.int