IVA | Swedish Futures

Sweden's Competitiveness and Investment Priorities

Mapping Sweden's Competitiveness and Investment Priorities in Key Strategic Technologies

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Foreword

A little more than a year ago, Mario Draghi presented his report *The future of European competitiveness*, stating that unless EU countries make huge investments and bold reforms, the union's competitiveness will be at risk. Global competition, especially from the US and China, is intensifying at a dizzying pace, and the EU must act now to secure the union's future competitiveness and common security.

If Sweden (and the EU) wants to be a global leader in technology and innovation in the future, we need to know where we stand today. I am therefore proud to present a deeper analysis of our country's position when it comes to key strategic technologies.

The Royal Swedish Academy of Engineering Sciences (IVA) has commissioned **Pierre-Alexandre Balland** and **Andrea Renda** at the European think tank CEPS (Centre for European Policy Studies) to analyze Sweden's position in 48 key strategic technologies (KSTs) that are crucial to future prosperity, economic resilience, and national security. While previous studies have examined Sweden's performance in a limited number of technology areas, this is the first analysis to cover such a broad set of technologies.

With decisive and action-based data-driven insights – performed at country level – we can become a global leader in technology and innovation. By leveraging our strengths, addressing our vulnerabilities, and securing leadership in critical technologies, we can contribute to secure the EU’s future prosperity and economic resilience.

I would welcome that also other EU member states carry out a similar analysis to understand the current situation and define their strategy for the future.

I hope that you will make good use of the report, its findings and the datasets that the analysis is based upon. The report constitutes an important starting point for IVA’s initiative “Swedish Futures”, that aims for Sweden to be a world-leading technology and innovation country by 2035.

Professor **Sylvia Schwaag Serger**, President IVA

Executive Summary

48 Strategic Technologies (KSTs) that are crucial for Sweden's future prosperity, economic resilience, and national security

This report presents a comprehensive, data-driven assessment of Sweden's competitive standing in 48 Key Strategic Technologies (KSTs) that are crucial for its future prosperity, economic resilience, and national security. The analysis is based on three major datasets covering 2010–2025: scientific publications, patent documents, and investment data. The findings reveal a mixed landscape of established leadership, critical vulnerabilities, and untapped potential, demanding strategic action to secure Sweden's place in an intensifying global technology race.

Key Highlights

- **Sweden demonstrates global leadership in specific KSTs** and overall punch well above its weight – including in space technologies, autonomous vehicles, nuclear energy, batteries, and propulsion technologies. Its leadership in areas like 5G/6G mobile networks and maritime technologies appears stable. In space technology, Sweden holds 2.75% of global patents, outperforming all European nations except Germany and France.
- **The country could make stronger progress in foundational technologies** like Artificial Intelligence (AI),

as well as in personalized medicine, sensors, and data analytics. In AI, Sweden’s global patent share is just 1.21%, its investment share is only 0.42%, and its ranking in the Global AI Index fell from 17th in 2023 to 25th in 2024.

- **Some strategic domains show declining competitiveness over time**, signalling a need for intervention. For instance, Sweden's leadership in robotics and smart grids has declined, based on longitudinal analysis of patent activity over the past ten years.
- **Sweden shows strong scientific leadership that has not been converted into technological leadership** (patents) in several areas. This is evident in KSTs like MedTech, Synthetic Biology, semiconductors, and Virtual/Augmented Reality, where publication strength is high but patenting and investment are below the median.
- **Innovation is highly concentrated** in the regions of Stockholm, Västra Götaland, and Skåne. Analysis of the Stockholm region identifies clear opportunities for (1) incremental, low-risk investments in areas like smart grids, solar energy, and aeronautics and (2) high-risk, high-return "moonshot" initiatives in hydrogen, quantum technologies,

and semiconductors, (3) optimal investments to build on existing strengths in digital fields like AI, IoT, cloud computing, and cybersecurity.

- While Sweden has strong scientific collaboration networks, **technological cooperation on patents with other European hubs is sometimes underexploited**. For example, in AI, the Stockholm region has fewer-than-expected patent collaborations with key hubs in Germany, Italy, and the Netherlands.

Strategic Recommendations

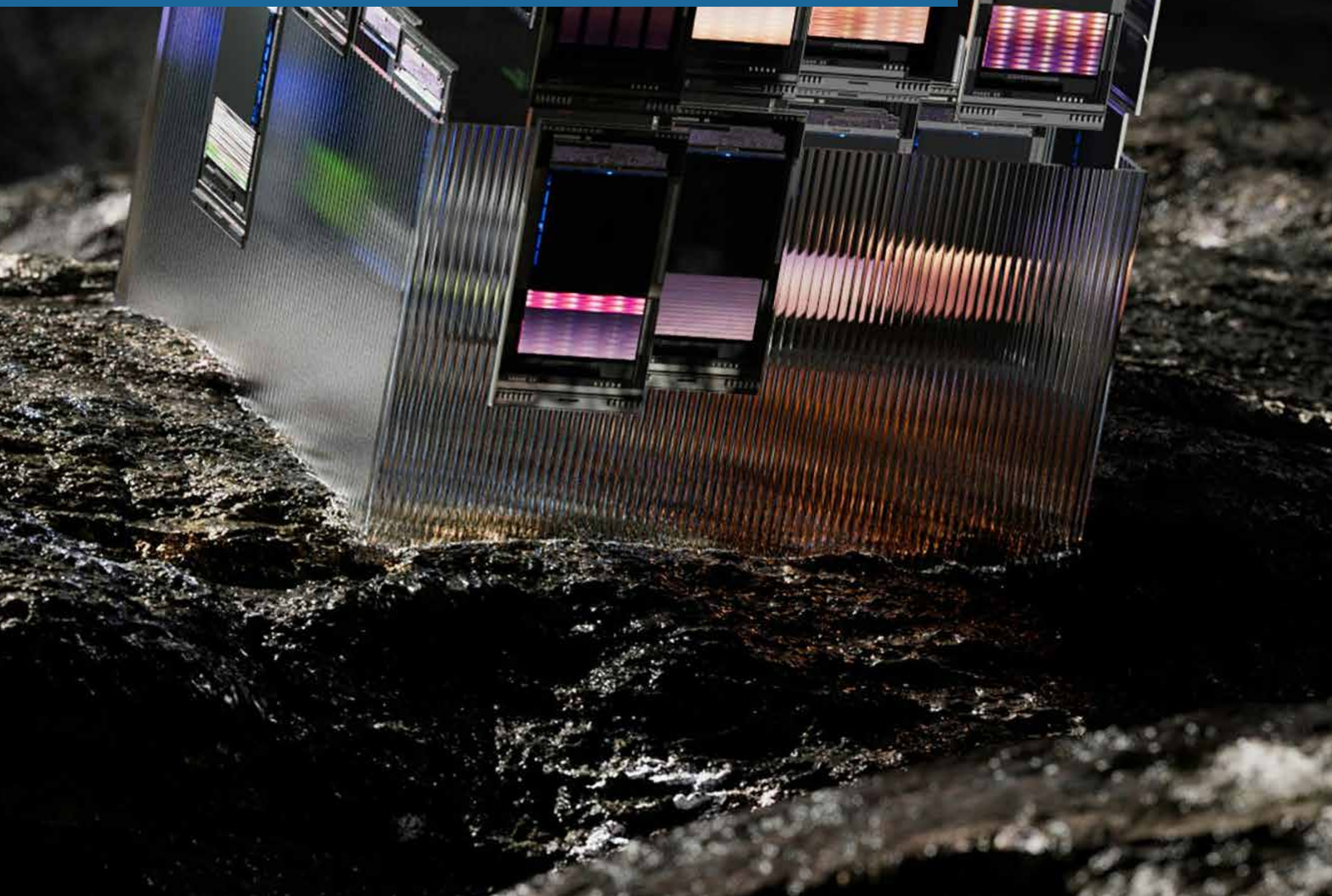
To address these findings, the report recommends that Sweden:

- **Establish a targeted investment program for priority KSTs**, focusing on high-potential but weakening areas to prevent further erosion of its leadership position.
- **Pursue high-complementarity collaborations** with EU partners in strategically aligned technologies to leverage mutual strengths and address gaps.
- **Encourage regional specialisation by aligning investments with the distinct opportunities in each region**, by pursuing highly related and complex opportunities but also by allowing very selected "moonshot" projects in areas with high potential returns.
- **Maintain and expand analytical capabilities** to continuously track Sweden’s competitive position and adapt its innovation strategy in a rapidly changing global landscape.

By acting decisively on these data-driven insights, Sweden can leverage its strengths, address its vulnerabilities, and secure its leadership in the technologies critical to its future.

Introduction: A Global Leader that Faces New Challenges

Sweden's innovation system operates in a challenging but potentially favourable economic environment



The global race for technological leadership is intensifying, driven by rapid innovation cycles, shifting geopolitical dynamics, and increasing interdependence of scientific, industrial, and policy domains. For Sweden, a highly industrialised, innovation-driven economy, leadership in Key Strategic Technologies (KSTs) will determine its capacity to generate sustainable growth, strengthen national security, and contribute to global problem-solving.

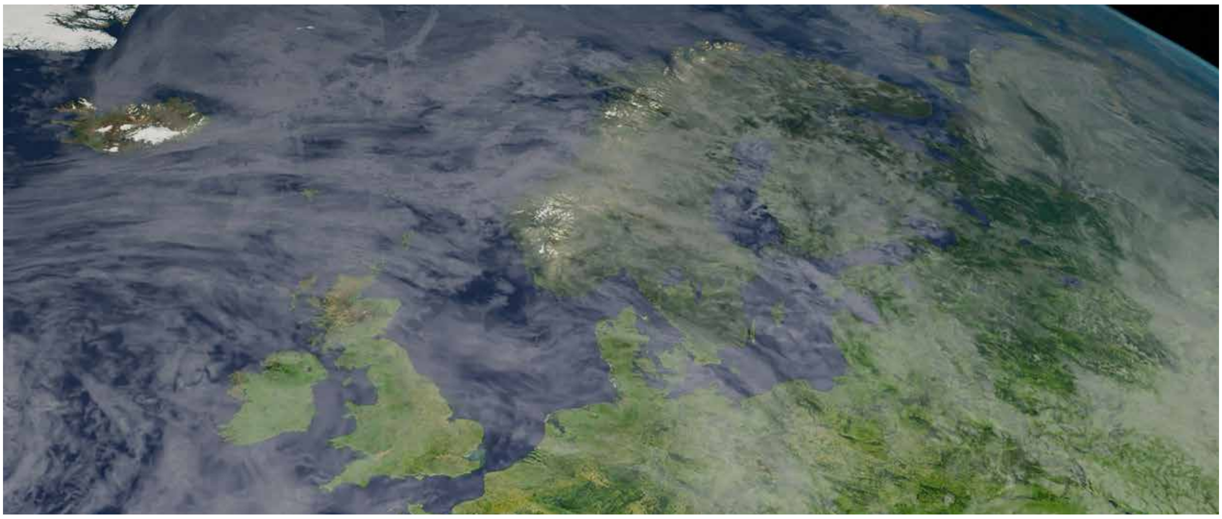
Sweden's innovation system operates in a **challenging but potentially favourable economic environment**. After a prolonged period of sluggish growth, Sweden entered 2025 with signs of recovery, though the rebound remains fragile. The OECD (2025) notes that GDP growth is projected to improve after stagnation in 2023–24, driven partly by resilient exports and a gradual easing of inflation pressures. The European Commission (2025) projects 1.1% growth in 2025 and 1.9% in 2026, helped by improved household consumption as uncertainty fades.

However, **the country's recovery is vulnerable to global shocks**. The Riksbank (2025) recently stressed that geopolitical tensions—including tariff disputes with the United States—pose persistent risks to both trade and investment. The Business Sweden outlook highlights that 80% of Swedish goods exports go to the EU Single Market or free trade partners, underlining both the benefits of integration and exposure to regional disruptions. Fiscal policy space exists thanks to low public debt—about 34% of GDP—and resilient revenues, but **rising defence expenditure and infrastructure commitments will constrain discretionary spending**. Still, Sweden continues to invest heavily in areas critical to technological capacity, such as digital infrastructure, green transition projects, and R&D.

In terms of innovation capacity, Sweden is consistently ranked among the EU's top innovation performers. A European Commission's report recently confirmed that Sweden leads the EU-27 in R&D intensity, with business expenditure at 2.65% of GDP—the highest in the Union and close to U.S. levels. Both R&D expenditure in the public sector (0.92% of GDP in 2025) and Venture Capital expenditures (0.33% of GDP in 2025) are significantly above the EU average. Public research spending, channelled through agencies like Vinnova, reinforces private sector innovation, and patent applications per capita are two to three times the EU average. Also, the OECD underlines that Sweden's strong skills base and diversified export structure underpin innovation competitiveness. However, both the OECD and European Commission warn that **scientific excellence has slipped slightly, in part due to shortages of highly skilled STEM professionals and weak strategic coordination across research institutions**. Without targeted reforms to strengthen the research system, the translation of high R&D spending into commercialised innovation could be suboptimal.

McKinsey’s long-term analysis adds that sustaining high-value innovation will require productivity gains not just in the internationally competitive manufacturing sector, but also in **local services and the public sector**. Sweden’s leadership in production efficiency could be matched by a leadership position in “innovation productivity,” ensuring R&D investment yields faster market applications.

A skilled workforce remains Sweden’s strongest innovation asset, but mismatches and demographic trends threaten this advantage. OECD data shows Sweden’s adult skill levels rank among the highest in the OECD, but PISA results have declined in recent years, and attainment gaps persist for students from disadvantaged or migrant backgrounds. The European Commission stresses that skills shortages—particularly in northern Swe-



den's green technology hubs—are constraining growth. Shortfalls in engineering, IT, and advanced manufacturing skills limit the ability of firms to scale innovation. Low uptake of targeted labour market programmes (e.g., "Introduction Jobs" for integrating newcomers) hampers inclusion. McKinsey suggests raising teacher quality, expanding vocational training, and linking retirement age to life expectancy to expand the labour force. For innovation policy, strengthening STEM education, supporting lifelong learning, and facilitating skilled immigration will be key.

Another important aspect of Sweden's future competitiveness is the availability of infrastructure. High-quality infrastructure supports Sweden's innovation system, from advanced broadband to integrated logistics. However, the European Commission identifies constraints in electricity transmission from north to south, which not only raise regional business costs but also limit the expansion of energy-intensive industries like data centres and advanced manufacturing. Addressing these gaps will be essential for both digital and green innovation. The Business Sweden's DigiTech sector review highlights Sweden's leadership in AI, IoT, and test-bed facilities, with over 30 active environments where firms can trial emerging technologies. Government-backed initiatives, combined with venture capital availability, position Sweden as a leading European hub for digital experimentation and scale-up.

Across all recent reports, several themes emerge for strengthening Sweden's technology and innovation capacity:

- Enhance research system effectiveness – Better align national research priorities, ensure STEM talent pipelines, and accelerate the translation of research into market solutions.

- Close the skills gap – Invest in teacher quality, vocational training, digital skills, and targeted integration programmes for underrepresented groups.

- Remove infrastructure bottlenecks – Expand energy grid capacity, support regional balance in electricity prices, and modernise transport links for innovation hubs.

- Leverage fiscal space for strategic investment – Use low public debt to sustain R&D, digitalisation, and green transition initiatives despite defence spending pressures.

- Boost innovation productivity – Apply efficiency principles from manufacturing to R&D processes, aiming for faster commercialisation cycles.

In this report, we offer a **detailed assessment of Sweden's position in 48 KSTs identified as vital for future competitiveness**. It provides a nuanced picture of Sweden's strengths and gaps, tracks changes over time, and proposes strategic investment priorities at both national and regional levels. We use an analytical framework that combines economic complexity metrics, data science tools, and interactive visualisations. This framework has been particularly used in the context of the smart specialisation policy (Balland et al., 2022), to evaluate the position of Europe in complex technologies (Di Girolamo et al., 2023), or to assess EU competitiveness in AI (Balland and Renda 2023). This framework was recently used in the Draghi report to assess the competitiveness of the EU in complex and strategic technologies.

Below, we integrate **three large-scale datasets on scientific publications** (250 million records from OpenAlex, covering

2010–May 2025); **patents** (7 million documents from the OECD RegPat database, 2010–2024) and **investment in startups** (Crunchbase Pro data, 2010–May 2025). It is important to note that the report therefore does not include private R&D investments in large companies. Each dataset is classified into 48 KSTs (see box 1 below) using machine learning algorithms, existing classification systems, and expert review. More specifically:

- The analysis of **patents** reveals the technological relatedness between key strategic domains, and is carried out based on normalised co-occurrences on the same patent documents, which is then used to build a recommender system and evaluate untapped technological potential.
- The analysis of **publications** unveils the scientific relatedness between key strategic domains, and is based on normalised co-occurrences on the same scientific publication. The results are used to feed the recommender system and evaluate untapped scientific potential.
- **Investment** analysis measures investment relatedness between key strategic domains. Here too, we rely on normalised co-occurrences on the same funded start-up. The results are used to validate our classifications.

Key indicators include **absolute and per capita counts, Revealed Comparative Advantage (RCA)**, and **relatedness density**. Composite indices are calculated by averaging and scaling patent, publication, and investment scores, balancing both absolute and relative strengths. This analysis allows us to identify which technologies require the largest investments to close gaps with other countries, but also to identify innovation opportunities to be leveraged at the level of Sweden.

Many of the figures and graphs included in this document are static representations of richer interactive tools. To gain the full benefit of this analysis, readers are strongly encouraged to explore the hyperlinks provided in the text and figure captions. These links lead to interactive visualizations that contain a wealth of additional data. For instance, while the main report offers deep dives into selected Key Strategic Technologies (KSTs), the complete analyses for all 48 KSTs are available online. Similarly, the detailed regional opportunity analysis has been conducted for all regions in Sweden and can be fully explored through the interactive visualizations.

Analysing Sweden's Competitiveness in Key Strategic Technologies

The global technological index balances both absolute and relative strengths of Sweden

How to read this report: a guide to consulting the data

This report contains summary data visualisations and graphs, which are shown in their "static", rather than interactive format. Readers should be aware that for each graph shown, there is an interactive version; and that graphs shown in the report are only a tiny subset of the 1,846 interactive graphs available to illustrate the state of the Swedish economy with respect to the 48 selected Key Strategic Technologies. Readers will find 3 graphs showing the interrelations between the 48 KSTs in terms of patents, scientific publications and startup investment; 144 interactive graphs on the competitive position of Sweden on each of the 48 KSTs along the same three dimensions, plus 1 summary graph; 24 interactive graphs on the competitiveness shifts of Sweden in all 48 KST over the past decade; 138 graphs on the existing ecosystems in Sweden for all 48 KSTs; and 768 graphs on the collaboration networks of Swedish regions along the three dimensions and all KSTs. We have also produced 768 graphs on the links between Swedish regions and the top 20 hubs on the selected KST and the chosen dimension (patents or publications). Key links to consult this material are available in the appendix to this report.

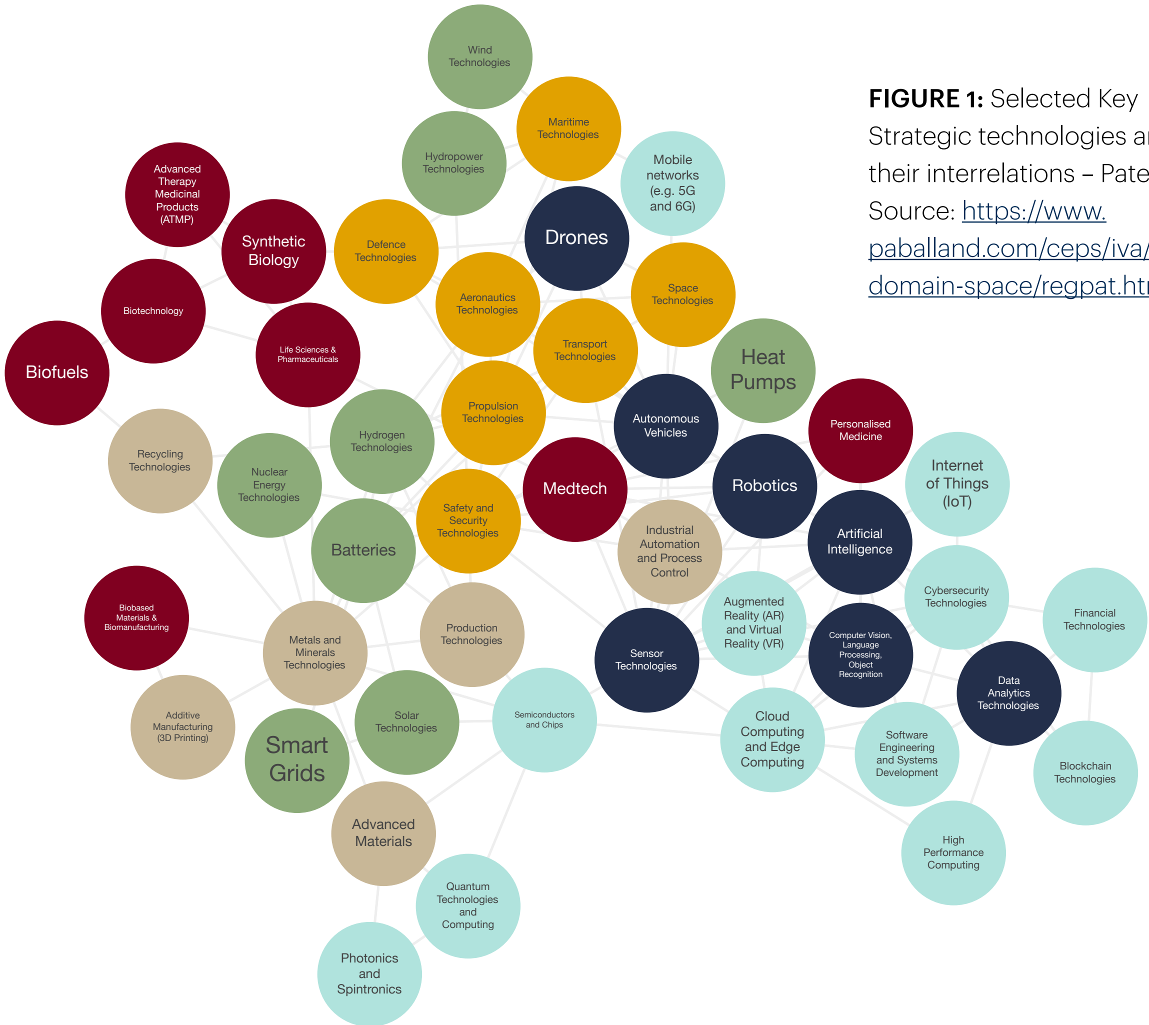


FIGURE 1: Selected Key Strategic technologies and their interrelations – Patents. Source: https://www.paballand.com/ceps/iva/domain-space/regpat.html

Being competitive in KSTs is particularly important in the context of a changing geopolitical landscape, increased technology insecurity, as well as rising importance of general-purpose technologies such as AI, which is expected to underpin the transformation of leading economies in the years to come. Even within KSTs, not all technologies are equally foundational; moreover, given public finance constraints and current re-prioritisation of investment at the national and EU level towards defence, it is important to note that not all KSTs are dual-use, and as such likely to cater to the country’s geo-economic needs.

One feature that is distinctive of each KST is its **links and hierarchical relations with other technologies**. Below, we show three graphs that show (statically) the interrelations between KSTs when measures in terms of co-occurrences in patent claims, scientific publications and investment. Figure 1 shows the inter-linkages in terms of patents: the interactive version shows how foundational technologies such as i.a. AI and Synthetic Biology are comparatively more linked to other, downstream technological domains such as autonomous vehicles or MedTech. This, in turn, means that even if Sweden holds a leading position in MedTech, lagging behind on AI may weaken its position and exacerbate its dependency on foreign technologies in the future. This, in turn, may alert policymakers and businesses that something has to be done to strengthen the country’s competitive position in the ever-changing global geopolitical landscape.

Likewise, Figure 2 shows the links between KSTs in scientific publications, revealing (in the interactive graph) a similar de-

Analysing Sweden's Competitiveness in Key Strategic Technologies

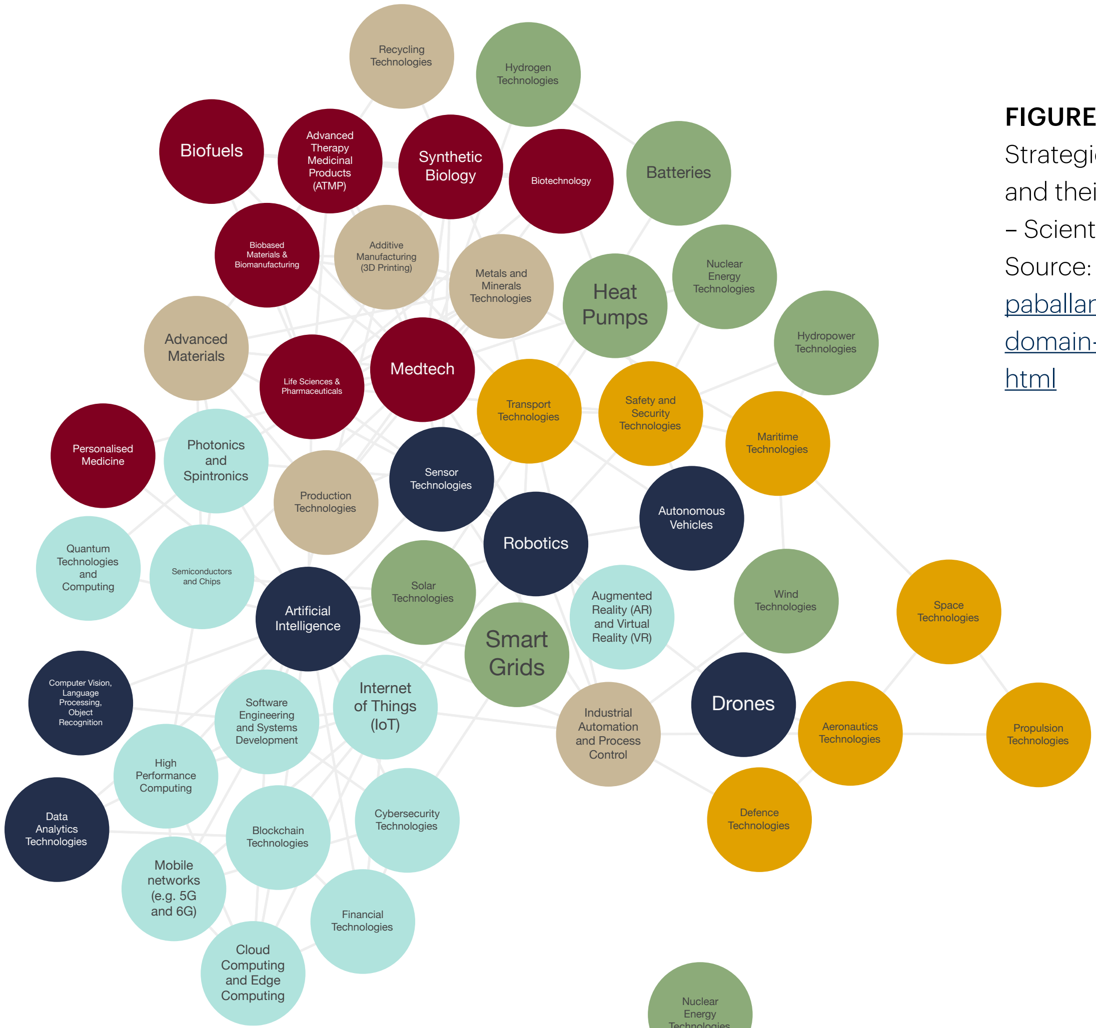


FIGURE 2: Selected Key Strategic Technologies and their interrelations – Scientific Publications. Source: https://www.paballand.com/ceps/iva/domain-space/openalex.html

FIGURE 3: Selected Key Strategic Technologies and their interrelations – Investment. Source: https://www.paballand.com/ceps/iva/domain-space/crunchbase.html

gree of centrality and "betweenness" of AI, synthetic technologies and industrial automation technologies.

The investment landscape appears even more integrated, with drones and robotics, MedTech and smart grids standing out alongside AI and other foundational technologies, as shown in the interactive graph (see, for the static version, Figure 3).

Below, in Section 3, we offer a brief analysis of select KSTs, whereas the complete files are available on separate, interactive websites.

How competitive is Sweden?

We combine four different technological ranking measures: patent count, per capita, RCA & relatedness density into a single score by averaging and scaling their values from 0–100. The global technological index balances both absolute and relative strengths of Sweden. Key indices for technology, science, and investment provide a comprehensive picture. More specifically:

- The **Technological Index** measures patent activity, RCA, and diversification potential. We combine four different technological ranking measures: patent count, per capita, RCA & relatedness density into a single score by averaging and scaling their values from 0–100.

- The **Scientific Index** assesses publication activity and research network integration. We combine four different scientific ranking measures: publications count, per capita, RCA & relatedness density into a single score by averaging and scaling their values from 0–100.
- The **Investment Index** reflects venture funding flows and capital intensity. We combine four different investment ranking measures: funding, per capita, RCA & relatedness density into a single score by averaging and scaling their values from 0–100.

These indices balances both absolute and relative strengths of Sweden. To represent them in two-dimensional graphs we use a colour scheme to reflect whether the investment index is above the median value (green) or below (red). All this leads to the creation of a four-quadrant area (Figure 4) in which the north-East area maps technologies in which Sweden holds global leadership (i.e. the scientific and tech indices are above median values); the North-West one shows domains in which Sweden has Scientific Leadership (i.e. the scientific index is above median values, but the technology one is below); the South-East quadrant shows areas of Technological Leadership (where the technology index is above average, but the scientific one is not); and finally the South-West quadrant shows areas in which Sweden lags behind in both respects.

We map the 48 KSTs into this summary graph, reaching the results shown in Figure 5. As shown in the picture, **key strategic technologies where Sweden has Global leadership include space technologies and autonomous vehicles, nuclear energy, batteries and propulsion technologies, robotics and additive manufacturing**. Even in those areas, however, some dark spots must be highlighted, for example in batteries, where

FIGURE 4: Structure of summary graph on Swedish competitiveness in key strategic technologies.

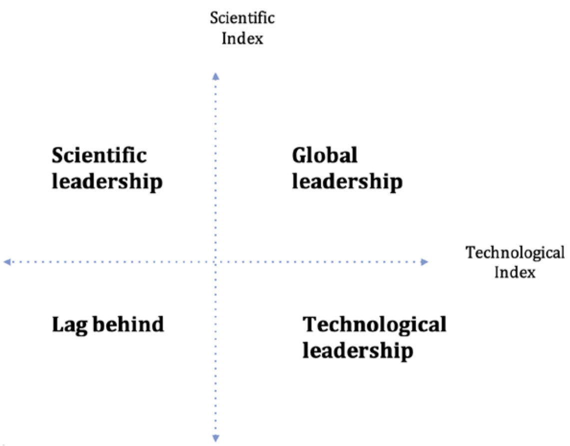
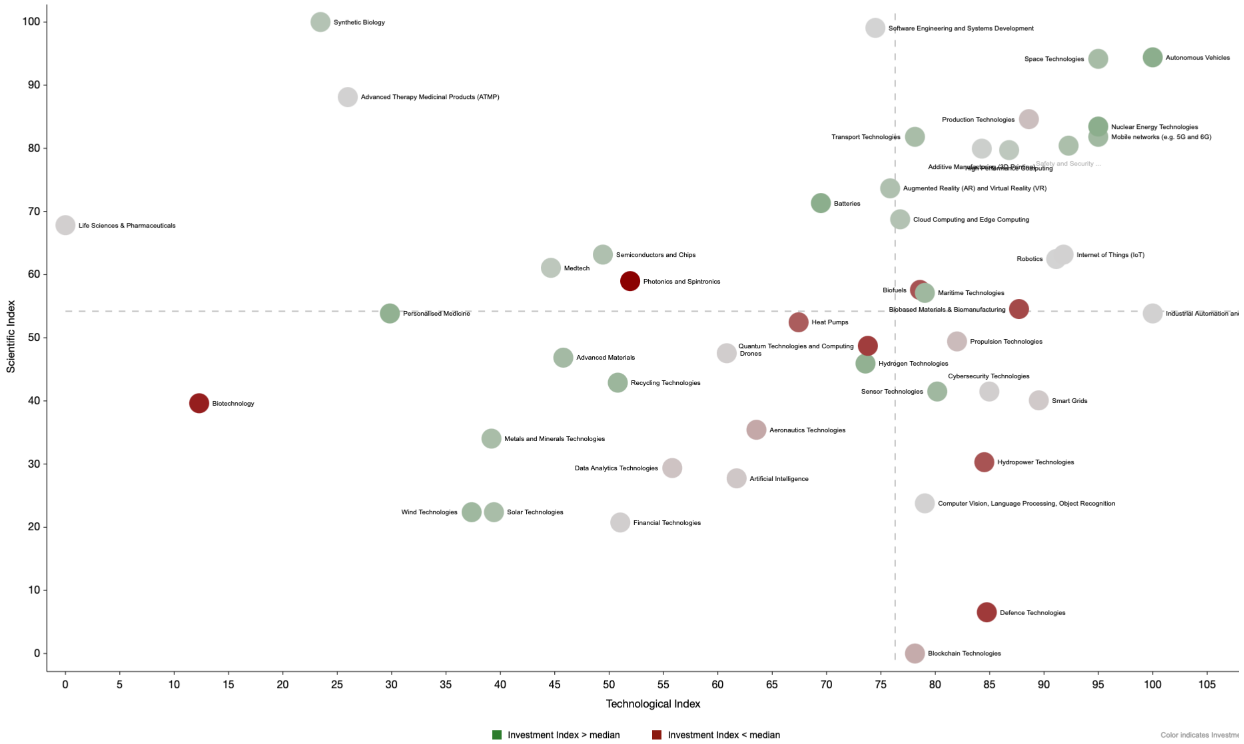


FIGURE 5: Summary Graph on Sweden's competitiveness position (2020-present).
Source: https://www.paballand.com/ceps/iva/position/sweden.html



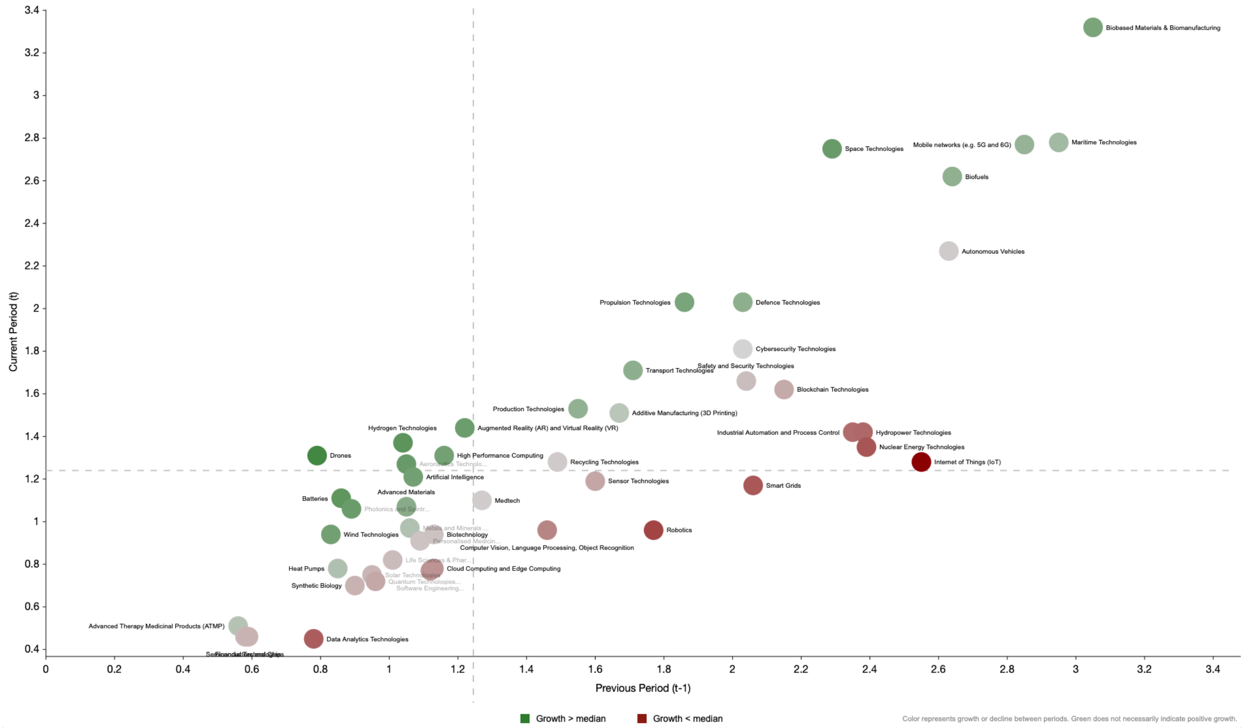
investment in ventures such as Northvolt have unfortunately led to initial hopes, and subsequent [collapse](). On the other side of the spectrum, **Sweden could improve its position in AI**, a foundational technology as already mentioned, in which also the investment index is below the median value; **and also in key technologies such as wind, personalised medicine, re-cycling, metals and minerals, sensors and data analytics**, all important areas for the twin transition and the deepening of digital technologies in industry.

In the remaining two quadrants, Sweden displays **scientific leadership in MedTech, Synthetic Biology and advanced therapy medicinal products;** and also in enabling KSTs such as **semiconductors and chips, and Virtual/Augmented Reality**. This means that the scientific potential is in place, but has not been adequately converted into technological leadership through patents. For these latter technologies, evidence from the investment index also shows a below-median performance in terms of startup funding, an alerting finding that also applies to robotics and AI. On the other hand, in KSTs such as **drones and aeronautics, IoT, defence and sensor technologies** and green technologies such as **hydropower and smart grids, the country exhibits technology leadership**, despite a comparatively low scientific leadership (yet see above regarding Sweden's approach to scientific publications, and possible justifications for the country's lag in this domain).

Is Sweden losing competitiveness over time?

It is also possible to assess how Sweden's competitiveness has evolved over time. In order to do this, we analyse changes in the key indicators presented in the previous section, compar-

FIGURE 6: Longitudinal analysis of patents (t = 2020–2024; t-1 = 2015–2019).
Source: https://www.paballand.com/ceps/iva/shift/regpat.html

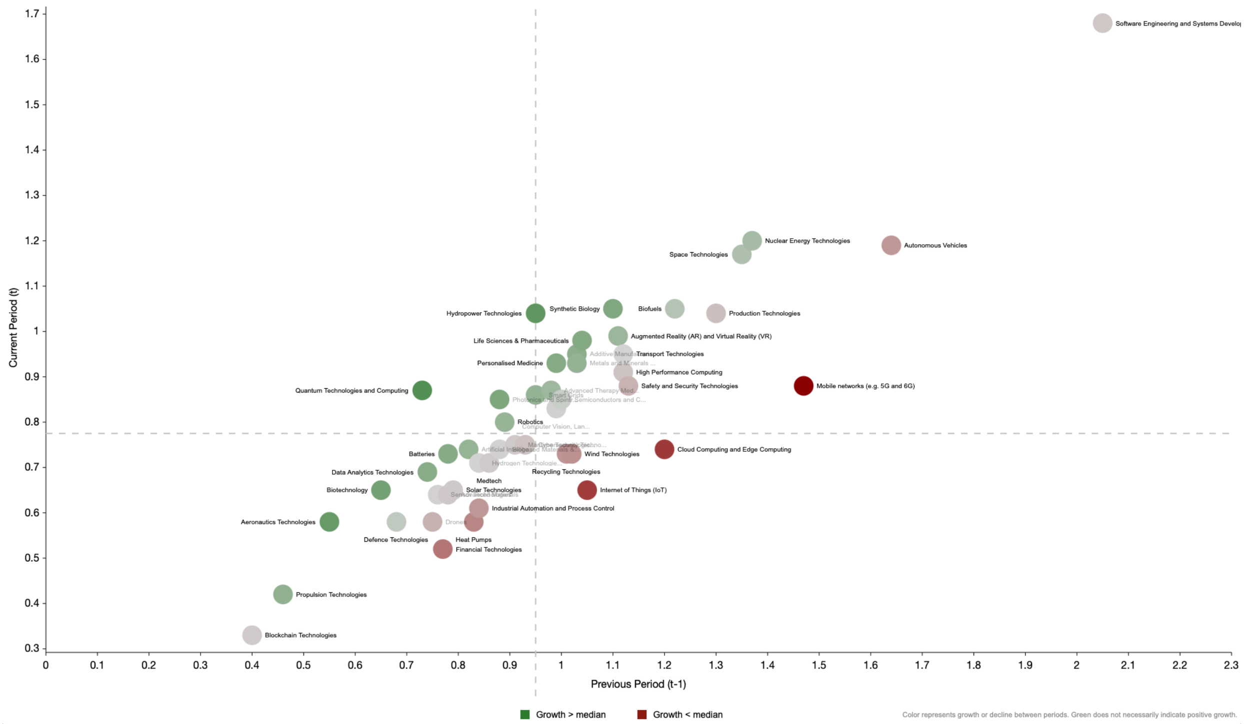


ing the period 2015–2019 *(t – 1)* with the 2020–2025 one *(t)*. This dynamic perspective helps us identify important shifts in Sweden's strengths across different areas and enables straightforward projections of future innovation trends. By tracking these changes, we can highlight where increased focus may be needed – such as doubling down on areas that are important but where Sweden's position is declining.

The graphs below compare the scores in the three variables (patents, scientific publications, investment) at time *t*, compared to the previous period *(t-1)*. Figure 6 provides a longitudinal analysis of patents, showing a core group of KSTs for which Swedish technology leadership appears stable (biobased materials and biomanufacturing, 5G/6G mobile networks, maritime and space technologies), all of which also punch above their weight in terms of startup investment; whereas there are areas where leadership has declined, for example (smart grids, robotics). A gradual relaunch of some KSTs is also visible in this graph, for example on **AI and drones**, which improved their positioning compared to the previous period. Interestingly, the competitiveness of Sweden in **life sciences**, based on patenting activities, seems to have weakened over the past decade. The same can be said of important KSTs for the technology stack, including sensors, IoT, robotics and data analytics.

Similarly, on scientific publications some KSTs exhibit steady growth, while others competitiveness indicators appear to be shifting downwards over time. Synthetic Biology, Nuclear, space, semiconductors and quantum belong to the former group, whereas growth in observed in key sectors such as quantum, hydropower, robotics. On the other hand, scientific excellence in cloud technologies and IoT appears to be slowing down.

FIGURE 7: Longitudinal analysis of scientific publications (2020-present; t-1 = 2015–2019).
Source: https://www.paballand.com/ceps/iva/shift/openalex.html



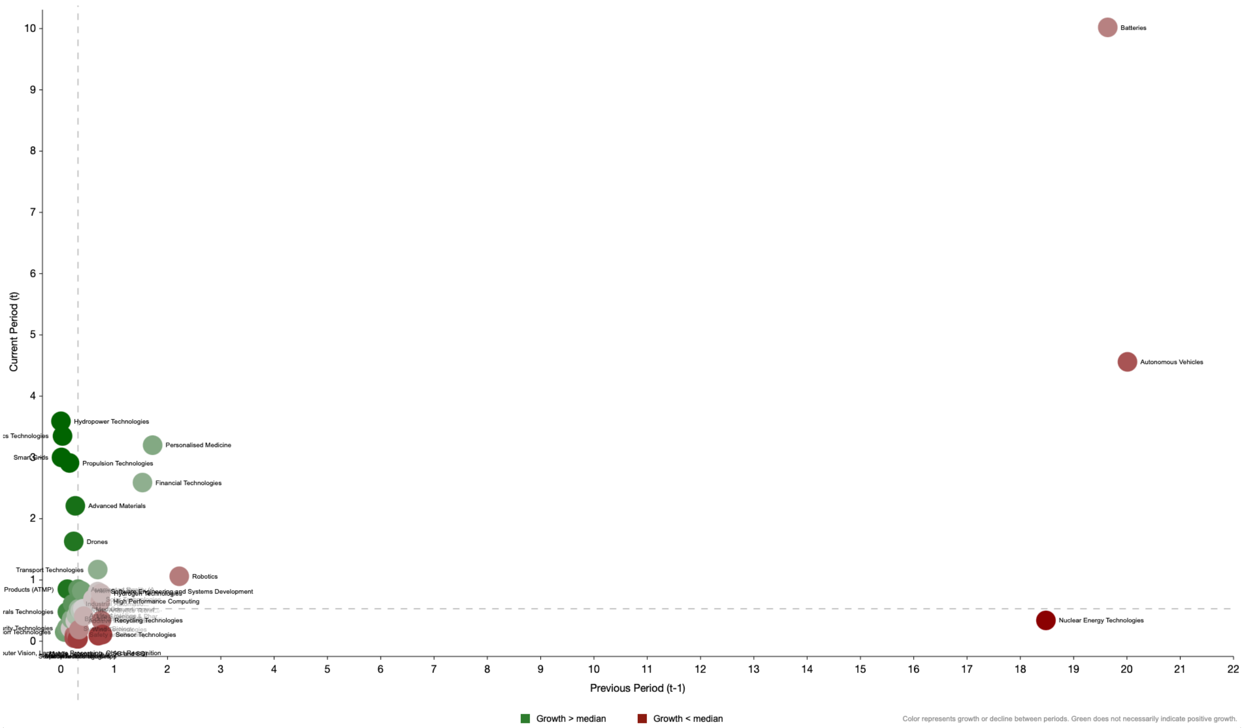
Finally, in terms of investment Figure 8 shows results that are much close to the origin, due to the weight of the U.S. and (to a lesser extent) China in global shares. Within this more limited perimeter, **batteries and autonomous vehicles** stand out as outliers (subject to the already spelled-out caveat regarding Northvolt). In automotive, new startups such as Einride and AstaZero stand out in a country that now hosts important international R&D collaboration platforms and input providers (e.g. Veoneer for sensors, Zeekr Technology Europe; KPIT Technologies; etc.) **Hydropower, aeronautics, propulsion technologies, drones and advanced materials are on the rise** in terms of global shares of investment. On the other hand, **mobile networks and recycling technologies** rank among the ones that have seen a decline in the global share of investment over the past period.

Overall, our longitudinal analysis reveals steady growth in patents and publications in some sectors; declines in global share in select high-impact technologies, leading to possible alarm bells for policymakers; and emerging opportunities in related fields where Sweden has latent capabilities. This trend analysis can inform targeted investment strategies, ensuring resources are allocated to areas with the highest potential returns.

Regional Opportunities in Sweden

In this section, we shift the focus from the national to the **regional level**, identifying which Swedish regions have the greatest potential to become global leaders in each of the 48 KSTs. More specifically, this component takes a **bottom-up approach**, following smart specialisation principles, to identify which specific investments in which Swedish regions have the

FIGURE 8: Longitudinal analysis of investment (2020-present).
Source: https://www.paballand.com/ceps/iva/shift/crunchbase.html



highest potential for global leadership in particular technologies. By analysing regional strengths using indicators like relatedness density and RCA, we evaluate matching between technologies and regions. The results, also presented as interactive visualisations, directly inform **where targeted investments** should be made for maximum impact.

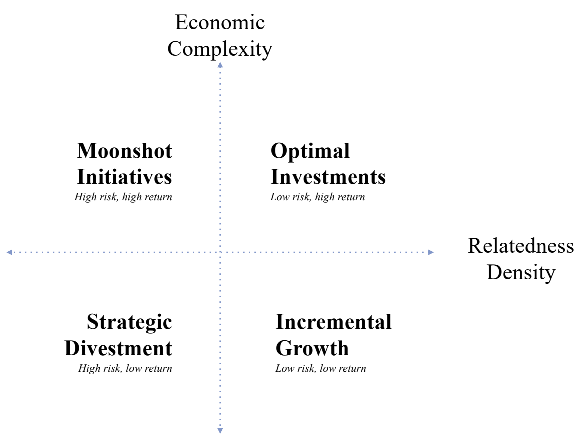
We use two main indicators to create another four-quadrant visualisation:

- **Relatedness density** quantifies how closely related a region's existing domains are to potential new domains. It is calculated as the share of related domains (already present in the region) out of all possible related domains for that target. A higher relatedness density means the region has a stronger foundation to diversify into that new domain.
- **Economic Complexity.** The core idea of the original method of reflections (and its eigenvector reformulation) is to measure complexity by capturing how diverse locations are and how exclusive the activities or technologies they host are, using iterative network metrics. Here we use a variation that is more robust to smaller techs: instead of using RCA or eigenvector centrality, we use a drop-shares scaling coefficient based on how quickly a technology's presence drops across top locations.

These two indicators are located along two axes, as shown in Figure 9. This approach, based on the smart specialisation framework, allows us to identify different opportunities. In particular, **we distinguish technologies depending on their risk and potential return on investment**. Areas where the potential return is high, but risk is also high due to high complexity, are possible candidates for "moonshot initiatives"; whereas where return is high but investment risk is lower, we find "optimal investment" opportunities. On the other hand, low risk, low return areas are possible candidates for "incremental growth", whereas high risk, low return domains are associated with suggested "strategic divestment".

The graphs below exemplify our elaboration of data on patents, scientific publications and investment in specific regions. The colour scheme here reveals KSTs for which the relatedness competitive advantage (RCA) index is above 1. Figure 10 analyses the Stockholm (SE11) region from a technological perspective, highlighting areas in which complexity and relatedness

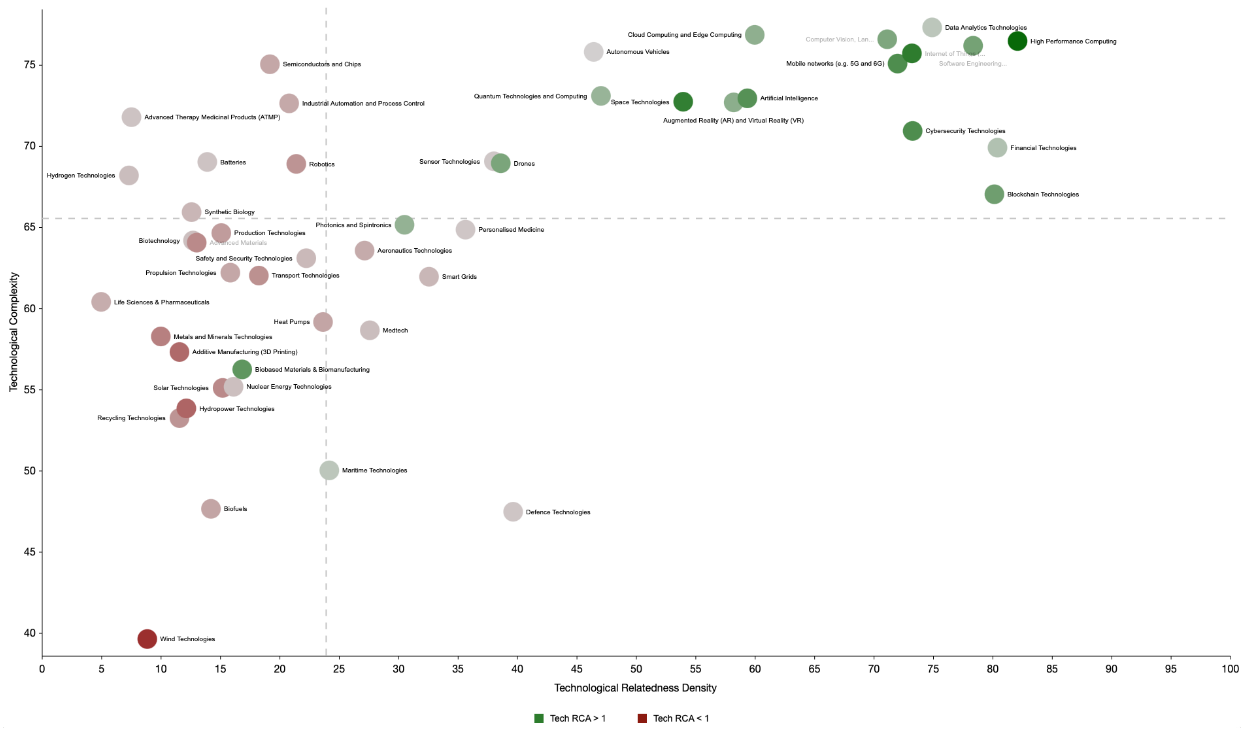
FIGURE 9: Measuring opportunities in regions: relatedness and economic complexity.



density are both high, and as such would deserve to be prioritised as investments with relatively low risk and high return. Important areas that are identified for "optimal investment" (low-risk, high-return) stand out, from AI to high-performance computing, quantum and cybersecurity, all foundational elements of the future technology stack that will irradiate all emerging industrial transformation domains (Bria et al. 2025). A lower number of KSTs is identified as candidate for "incremental investment" in Stockholm: these include Defence technologies, MedTech, Personalised Medicine, Smart Grids, Aeronautics, and to some extent Photonics and Spintronics and Maritime Technologies. A limited number of Moonshots are suggested by our results, being high-risk and high-return investments: from semiconductors to industrial automation and robotics, hydrogen and advanced medicinal products, there is room for prioritising these investments at the expense of KSTs where the risk is high and the potential return low. The latter includes a large group of the KSTs, located in the South-West quadrant of Figure 10.

Figure 11 repeats the exercise by looking at the Scientific Competitive Advantage index, largely confirming the findings of Figure 10.

FIGURE 10: Technological opportunities in the Stockholm region (2020–2024).
Source: https://www.paballand.com/ceps/iva/smart/regpat/stockholm-se11.html



Finally, Figure 12 shows the results with a colour scheme that refers to the investment RCA. Here, also due to the US and China’s disproportionate impact on the distribution, many KSTs feature a RCA below one, yet the region offers key opportunities in Autonomous Vehicles and Financial Technologies; whereas the data suggest a moonshot approach to Batteries (where however Northvolt already incarnated this ambition), and rather attractive low-risk opportunities in personalised medicine, smart grids and aeronautics.

Finally, it is possible to show a summary graph, which illustrates the combined results obtained for patents, publications and investment for each region and each of the 48 KST. These graphs provide a bird's eye view of optimal investments, potential moonshots, areas for consolidation and incremental growth and areas that may need divestment for each region of Sweden.

As shown in Figure 13, the region of Stockholm lends itself very well for low risk, high return investment (**"incremental investment"**) in energy technologies, specifically in smart grids and solar; in several transportation, aerospace and security technologies, including most notably aeronautics, transport technologies, propulsion, safety and security and defence. The area of personalised medicine is also a good candidate for low-risk, low-return investment.

The graph shows many areas where investment would feature low risk, and high return (so-called **"optimal investment"** areas). They include many digital technologies for which the risk of the investment is very low, such as 5G and 6G mobile communications, cloud computing and HPC, cybersecurity, financial technologies, augmented reality, blockchain as well as soft-

FIGURE 11: Scientific opportunities in the Stockholm region (2020-present).
Source: https://www.paballand.com/ceps/iva/smart/openalex/stockholm-se11.html

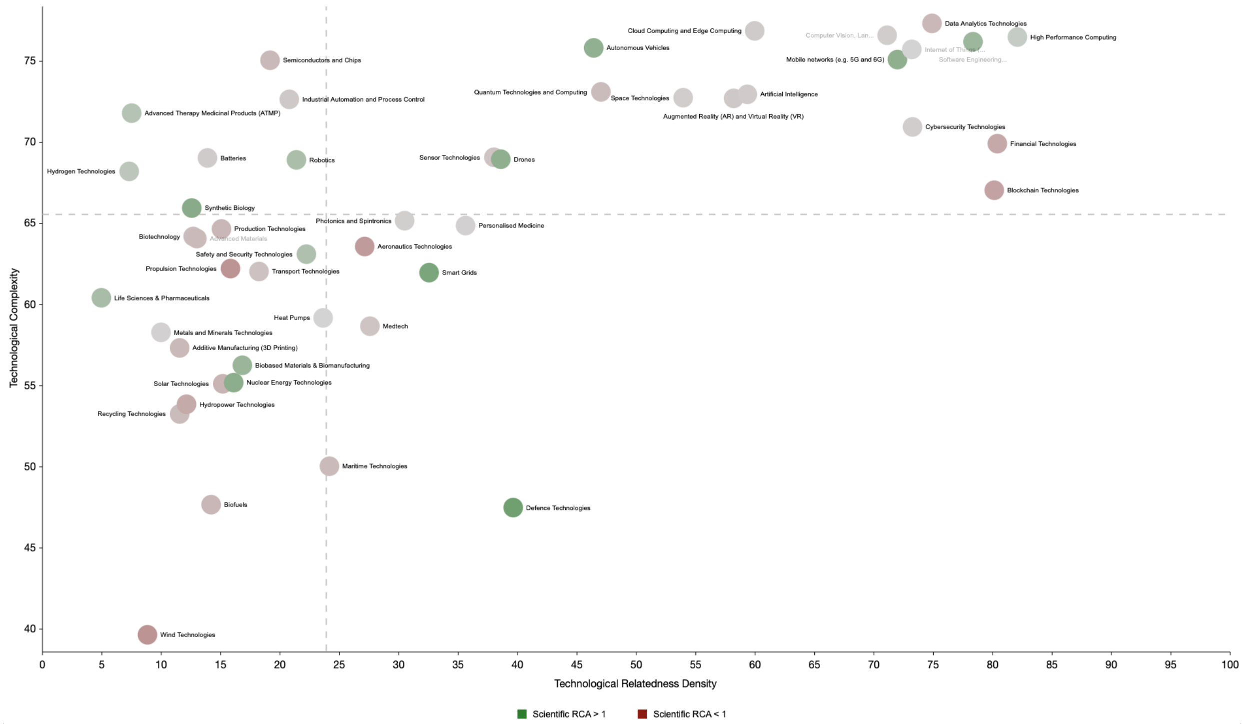
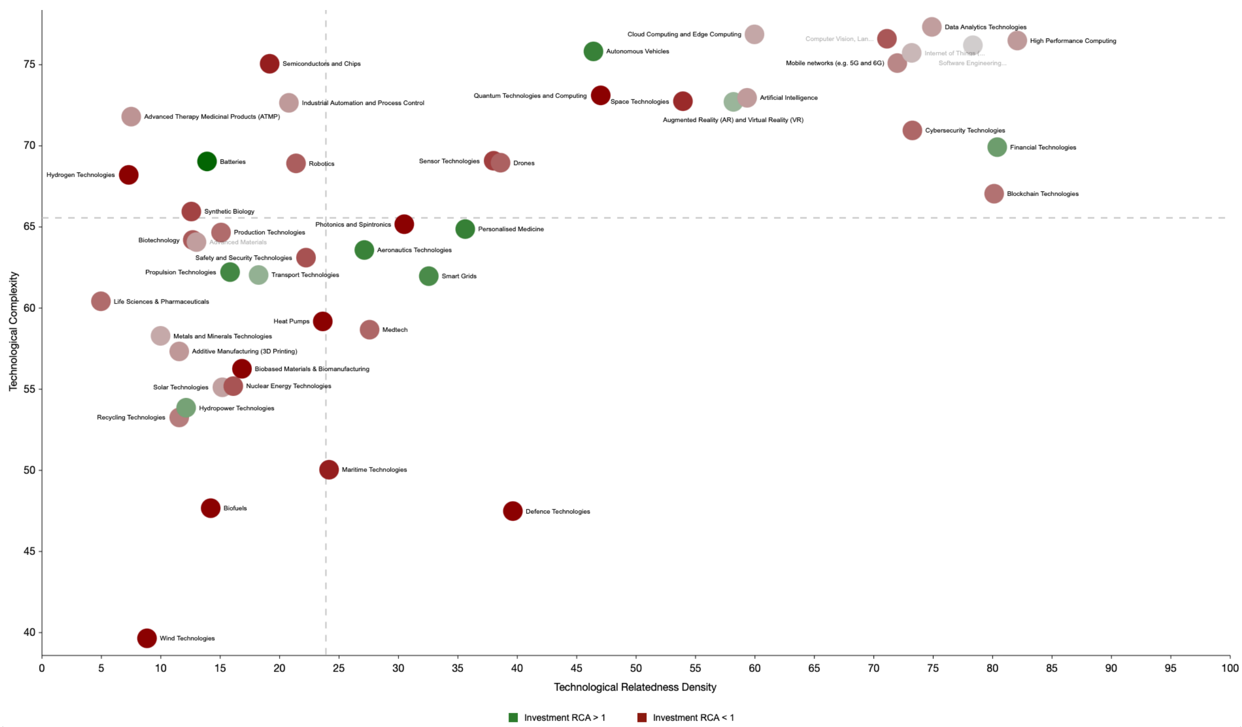


FIGURE 12: Funding opportunities in the region of Stockholm (2020-present).
Source: https://www.paballand.com/ceps/iva/smart/crunchbase/stockholm-se11.html

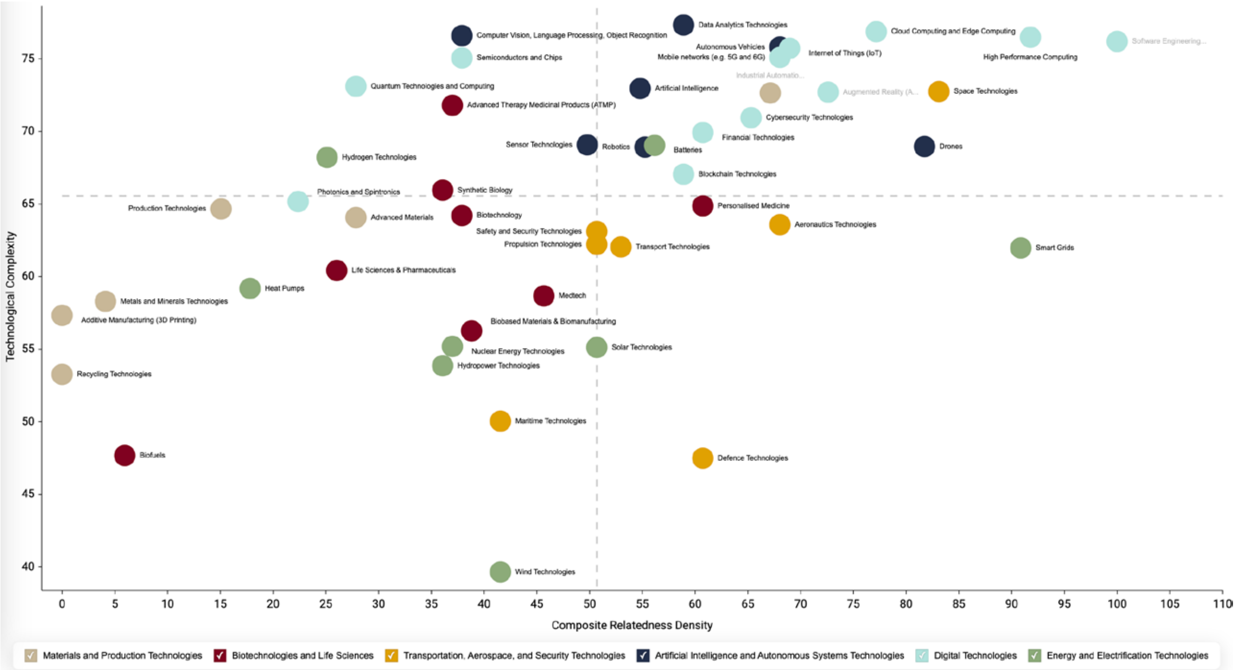


ware engineering. In the same category of optimal investment we find quite a few AI and autonomous systems technologies, such as AI, data analytics, autonomous vehicles, drones, IoT and robotics. Green technologies that would make for a low risk, high return investment include batteries. In the same basket we find also space technologies and industrial automation.

In the North-West quadrant of this graph we can locate high-risk, high-return investment, or **"moonshot initiatives"**, which would require a careful design and a mission-oriented approach, to then deliver what would be expected as very significant benefits. Particularly indicated for a moonshot in the region of Stockholm are some green technologies (hydrogen); quantum and semiconductors; computer vision, language processing and object recognition technologies; sensor technologies, and synthetic biology.

Finally, in the South-West quadrant we locate technologies that, based on our complexity and relatedness indices, are potential candidates for **strategic divestment**. Quite a few KSTs are features in this quadrant for the region of Stockholm, providing an indication to decision-makers on how to prioritise investment going forward. In particular, material and production technolo-

FIGURE 13: Summary graph – opportunities in the Stockholm region (data since 2020).
Source: https://www.paballand.com/ceps/iva/smart/regpat/stockholm-se11.html

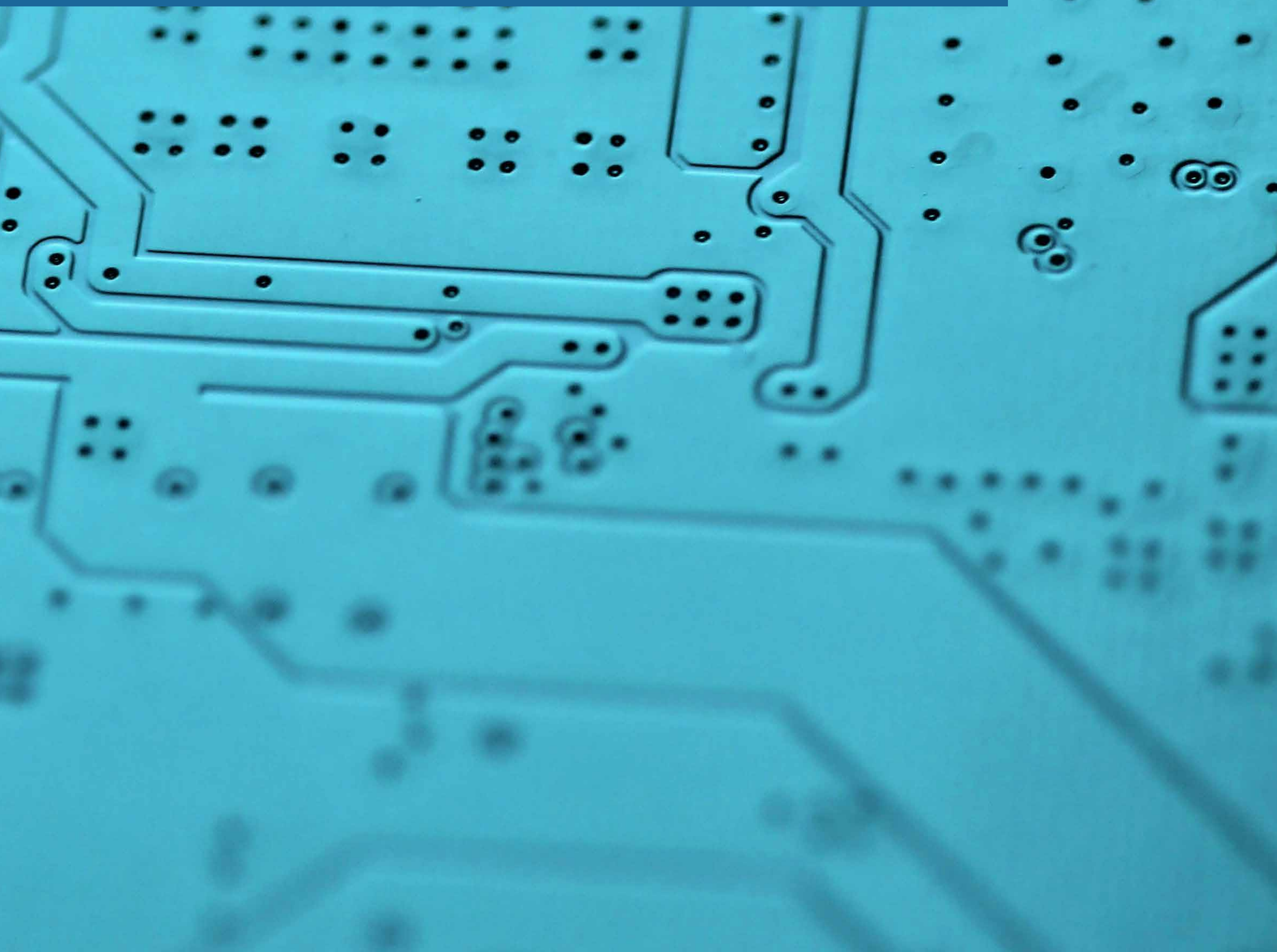


gies and biofuels appear to be among the KSTs for which return is unlikely to be high, and the riskiness of the investment is significant.

Our exercise was repeated for all regions of Sweden (all files are available as interactive visualisations). This altogether provides a wealth of information for policymakers to identify priorities for national and regional investment policy in the 48 KSTs selected for analysis.

Analysis of Selected Key Strategic Technologies

Given the centrality of some of the KSTs, we offer specific deep dives on Sweden's competitive position in select domains



Key Strategic Technologies can have a revolutionary impact on economic prosperity, national security, or the environment. Yet their ecosystems are complex, globally distributed, and continuously evolving. This makes it challenging to systematically assess the competitive advantage of countries and regions and to provide the most efficient R&I response. Our analysis of Sweden's competitiveness in key strategic technologies will help benchmark technological capabilities at the global scale, identify gaps in the innovation portfolio and opportunities for strategic investments, develop place-based actions and more generally stay ahead of emerging trends and adjust the overall innovation strategy.

Given the centrality of some of the KSTs, below we offer specific deep dives on Sweden's competitive position in select domains. We choose to venture into three KSTs: Artificial Intelligence, given its foundational role for many downstream markets and technologies (e.g. autonomous vehicles, drones, life sciences, etc.); Space technologies, given Sweden competitive position in this specific KST; and quantum computing, as a fast emerging KST that still has to unleash its full market potential, and promises to dramatically affect many downstream sectors in the future.

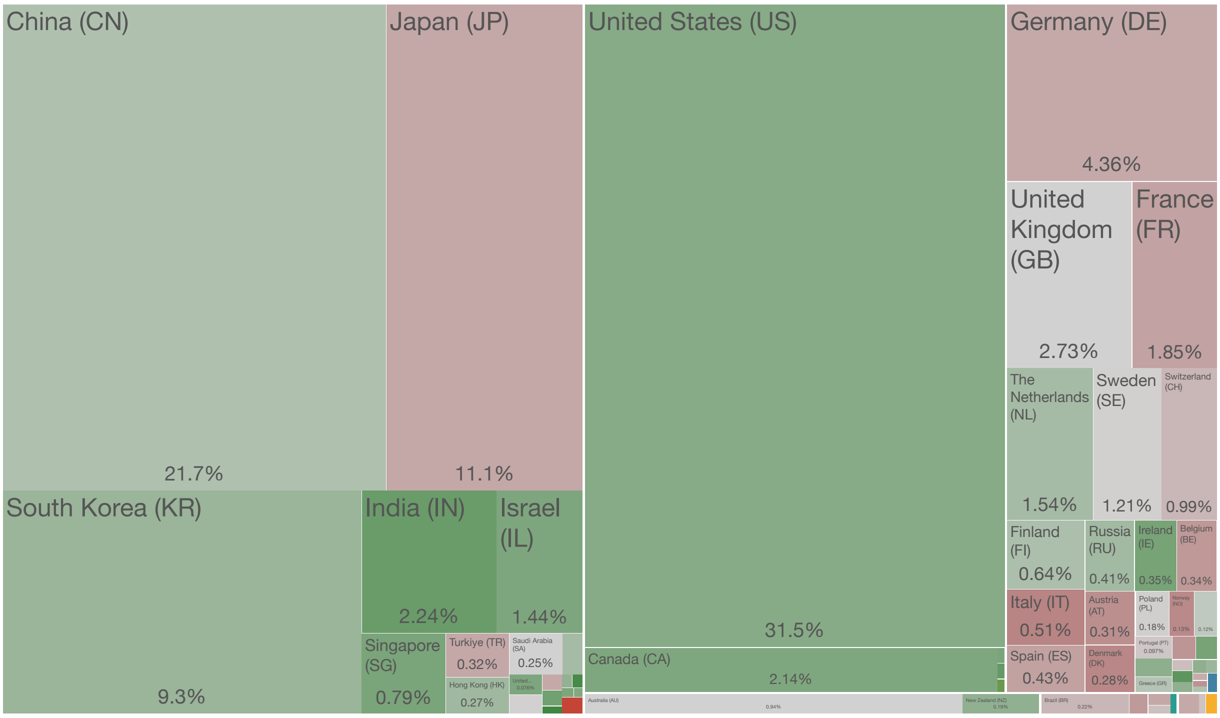
Artificial Intelligence

As a general-purpose technology, AI promises to exert a very pervasive impact on society and the economy in the years to come – a process that has already started and still has rather uncertain future prospects, mostly depending on the extent to which prospective breakthroughs (such as some form of Artificial general Intelligence) will materialise in the medium term. Undoubtedly, the wave of generative AI that entered the market since the release of ChatGPT at the end of 2022 has radically changed the perceived impact of AI, and gradually ushered into an era of massive uptake and the emergence of powerful new phenomena such as agentic AI. Today, policymakers are increasingly aware that AI has become a key driver of industrial and societal transformation, and failing to embrace it (or merely using solutions coming from other countries) is likely to severely undermine national competitiveness. Sweden is no exception: the Swedish AI Commission has warned in 2024 that the country's "future prosperity will be largely determined by how well we manage to take advantage of AI's opportunities and manage its problems".

Our analysis of Sweden's position in AI reveals that the country accounts for 1.21% of relevant patents, which almost doubles the position of Finland, and is higher than what observed in comparable countries such as Switzerland. Still, this may not be enough for the country to play a leading role at the global level, in the absence of significant infrastructure, skills and relevant solutions especially in the domain of industrial transformation. As of September 2024, Sweden ranked 25th in the *Global AI Index*, down from 17th in 2023. In particular, government strategy was found to be a weak point. **Sweden's AI Strategy envisions a return to the top 10 by 2025—but progress has been slow**, especially in governmental strategy (44th in that category), infrastructure (21st), and development (17th). Sweden performs strongly in the operating environment (2nd) but needs to accelerate in strategy, talent, and commercial activities.

A recent OECD report charting the emerging international AI divide places Sweden on the side of fast adopters, alongside other Nordic countries; yet merely "using" AI, while important, is not going to be sufficient, especially if businesses in key sectors fail to implement AI as part of an overall redesign of their business model to achieve productivity gains. The coun-

FIGURE 14: Artificial Intelligence – Global share of patents (2020–2024). (Source: OECD RegPat Database). Source: https://www.paballand.com/ceps/iva/position/regpat/artificial-intelligence.html



try thus seems to be lagging behind in AI implementation compared with international peers. The domestic market's small size, talent competition, and conservative corporate culture are often cited as barriers. A recently announced 95 billion SEK investment in a greenfield AI data centre near Stockholm, supported by Nvidia among others, has revived hopes of infrastructure growth, yet the impact of this investment on digital sovereignty and technology security will have to be accurately weighed.

All in all, **there seems to be an urgent need for a reflection on the whole technology stack, with clarity needed on the country’s cloud strategy, as well as on overall infrastructure and skills policy**. Equally urgent is a strategy for the Digital Public Infrastructure, culminating in new use cases for digital public services, an area in which the country has been an early pioneer, but progress has remained sluggish especially in data governance and digital identity.

When it comes to scientific publications, Sweden’s relative weight appears to be a bit lower in the domain of AI. Figure 15 shows that **Sweden fares behind countries like the Netherlands, Poland and Switzerland among other countries**, a situation that does not reflect the technology potential expressed by patents. Many of these projects are funded through WASP, the Wallenberg AI, Autonomous Systems and Software Program. This is Sweden’s first and largest individual AI research program, with 6.2 billion SEK in funding, most of which comes from the Knut and Alice Wallenberg Foundation. WASP is focused on basic research and aims i.a. at recruiting around 80 leading researchers and graduating some 600 PhD students, and unites five core universities—KTH, Chalmers, Linköping, Lund, and Umeå—with additional involvement from Örebro, Uppsala, and Luleå.

FIGURE 15: Artificial Intelligence – Global share of scientific publications 2020–2025 (Source: OpenAlex). Source: https://www.paballand.com/ceps/iva/position/openalex/artificial-intelligence.html

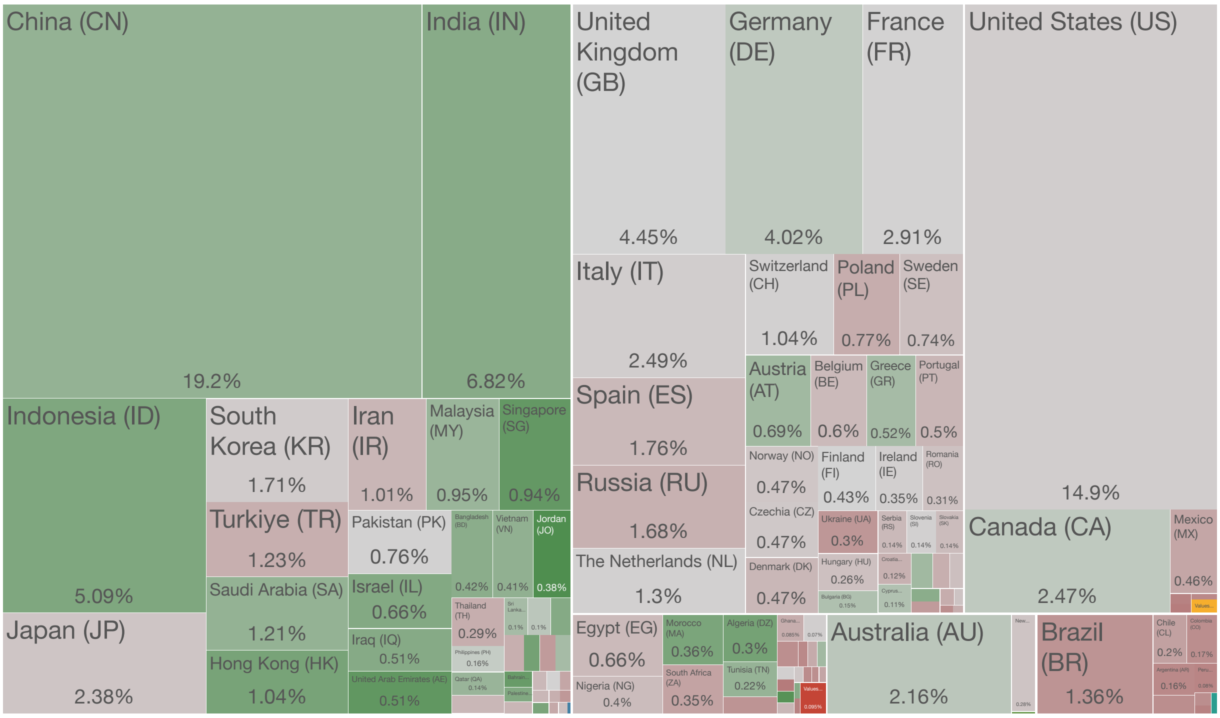


FIGURE 16: Artificial Intelligence – Global share of investment 2020–2025 (Source: CrunchBase Pro). Source: https://www.paballand.com/ceps/iva/position/crunchbase/artificial-intelligence.html

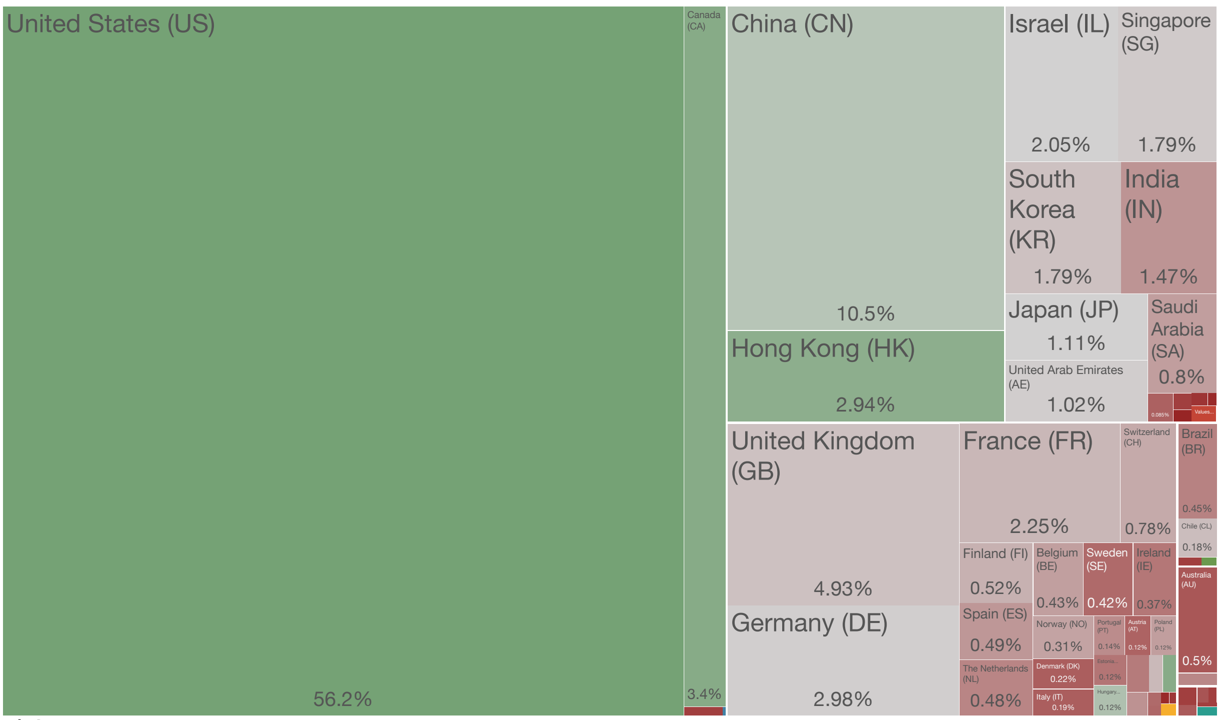
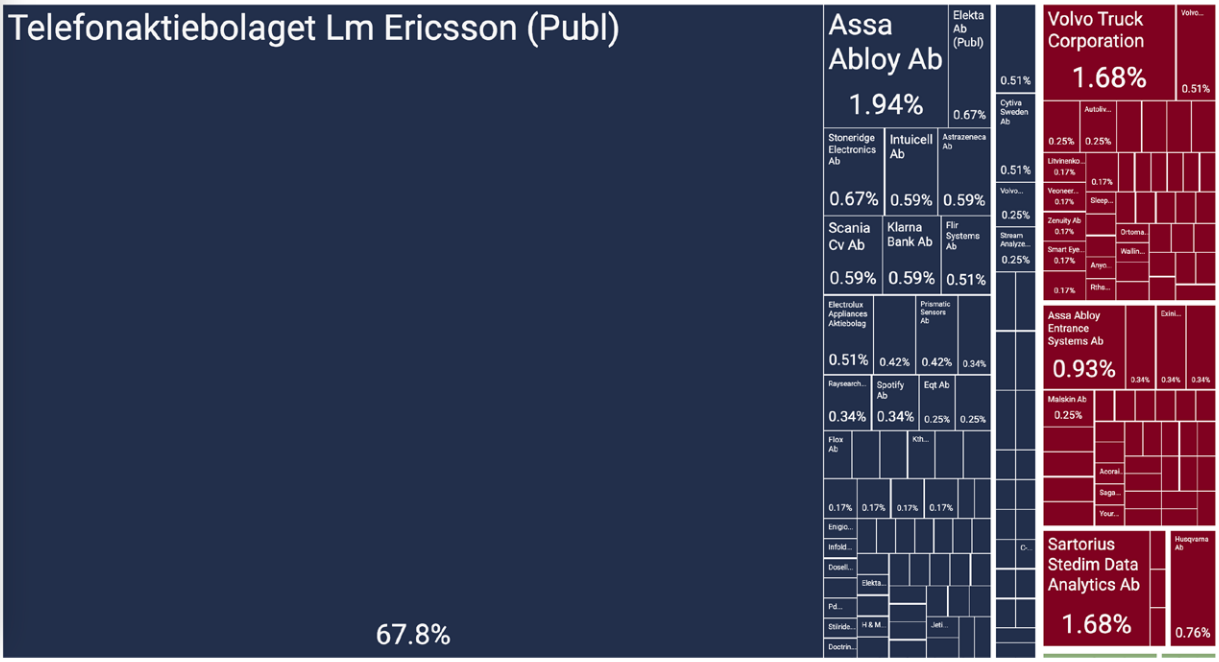


FIGURE 17: The AI ecosystem in Sweden – main patent portfolios 2020–2024.
Source: https://www.paballand.com/ceps/iva/position/regpat/artificial-intelligence.html



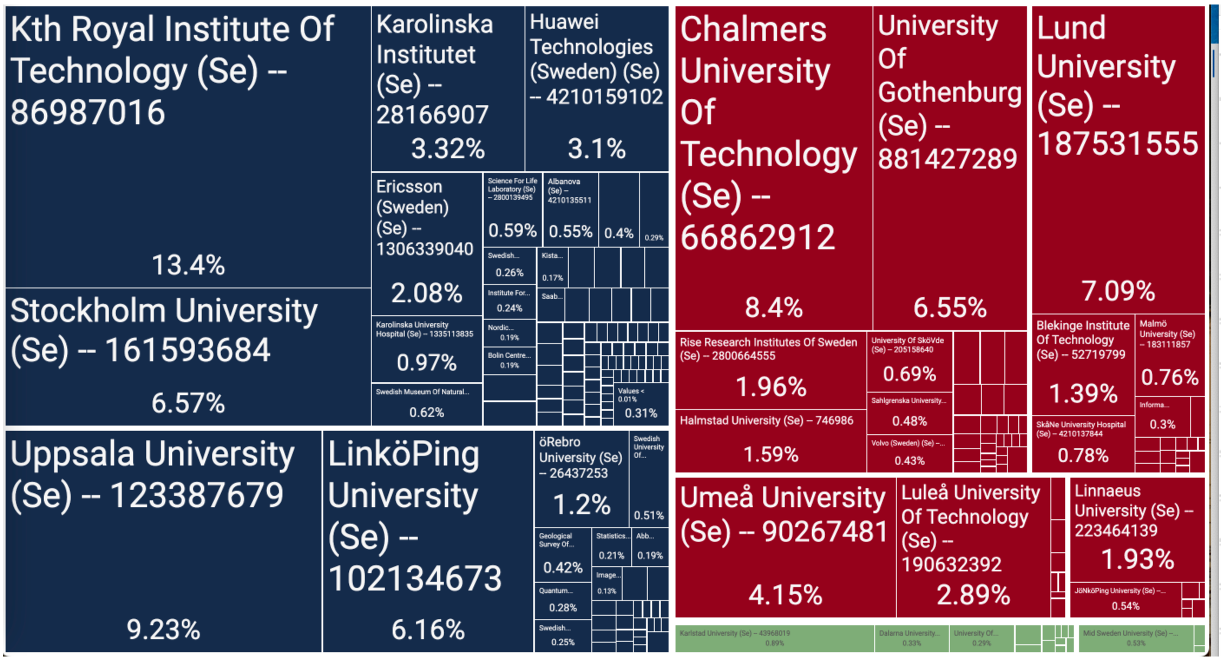
We then look at investment in startups, shown in Figure 16. Here, also due to the outsized weight of the United States, Sweden’s global share only reaches 0.42%, way below other (larger) European countries such as Germany, France and the UK, but also below Finland. That said, the area of Stockholm has seen a renewed buzz in AI investment in impactful start-ups, such as Legora in Legal Tech, Lovable, and Tandem Health recently raising large funding rounds. Robotics companies such as Furhat Robotics and Peltarion also lead the charge of innovative Swedish startups in the AI domain.

A look at the Swedish AI ecosystem

In this section, we take a micro-level view by examining the organisations – such as start-ups, large companies, and universities – that form the ecosystems around key strategic technologies. We choose the same three KST we had identified in Section 1: AI due to its extraordinary importance as foundational technology for industrial transformation in a variety of domains; Space due to Sweden's relative technology leadership and competitiveness as shown by our data (see Section 1.2.2); and quantum due to its infancy as emerging, general-purpose technology. Our analysis helps identify global leaders, national champions, and emerging players, as well as their locations and roles for each of these three industries. It also highlights potential recipients for targeted funding, opportunities for public-private partnerships, and possible European collaborators.

The Swedish AI ecosystem revolves around a number of extremely powerful and well-integrated players, with Ericsson standing out with almost 70% of the patents, mostly on telecoms AI innovation. Other large players include Volvo trucks, especially in autonomous driving technologies.

FIGURE 18: The AI ecosystem in Sweden – scientific publications 2020–2025.



On the side of scientific publications, the ecosystem features a more even distribution, with the Royal Institute of Technology, Uppsala University, Chalmers and Lund holding the highest shares. KTH currently ranks first in Sweden for AI research output, placing 30th in Europe and 138th globally, which reflects both its size and its central role in national research programs. Close behind, Lund University has secured the second spot nationally and 45th place in Europe, making it one of the most visible Swedish institutions on the international stage. Uppsala University follows in third place, ranking 47th in Europe and

180th globally, and continues to grow its influence through a wide array of interdisciplinary AI projects.

Much of this academic strength is tied to the Wallenberg AI, Autonomous Systems and Software Program (WASP, see above Section 1.1), which connects Chalmers, Linköping, Lund, KTH and Umeå, while also engaging partners such as Luleå, Uppsala and Örebro. Through WASP, these universities have been able to recruit leading researchers, launch doctoral schools, and strengthen collaborations with industry, making the program a backbone of Swedish AI science.

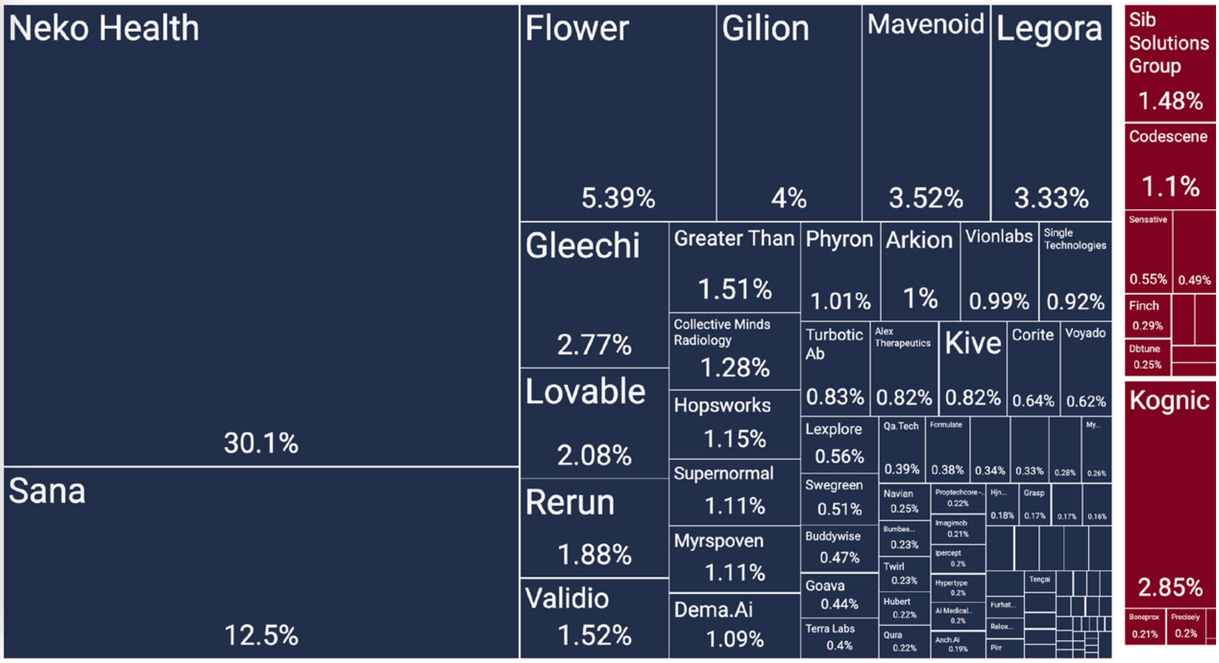
Finally, when it comes to investment in startups, Crunchbase Pro data prominently shows Neko Health, founded by Daniel Ek and Hjalmar Nilsonne, which offers a premium, AI-driven full-body scan that assesses multiple health dimensions in under an hour, coupled with immediate doctor consultations. Since launching in 2023, the company has performed 10,000 scans across Stockholm and London and amassed more than 100,000 people on its waiting list, with strong repeat engagement. Its financing story includes a Series A of €60M in mid-2023 and a Series B of $260M in early 2025, led by Lightspeed Venture Partners, pushing its valuation to approximately $1.7–1.8 billion.

Another important player in the startup ecosystem is **Sana Labs**, founded in 2016 and based in Stockholm, which is revolutionising enterprise knowledge and workplace learning through AI-powered platforms. It encompasses Sana Learn, which centralises personalized learning and analytics, and Sana Agents, modular AI assistants that automate complex workflows. In October 2024, the company raised $55 million in a round led by NEA, reaching a $500 million valuation and bringing its total funding to over $130 million. Sana has already attracted major enterprise clients, including Merck, Hinge Health, Electrolux, and Svea Solar.

AI in Swedish regions: networks of collaboration

In our data collection and analysis, we could map out opportunities for Swedish regions to collaborate with other EU regions in key technologies by identifying where their strengths are complementary. Using established methodologies from Balland & Boschma (2021), we create complementarity maps to highlight the most promising partnership opportunities. By comparing these potential collaborations with existing connections, based on co-inventor and co-publication data, we iden-

FIGURE 19: The AI ecosystem in Sweden – investment in startups 2020–2025.

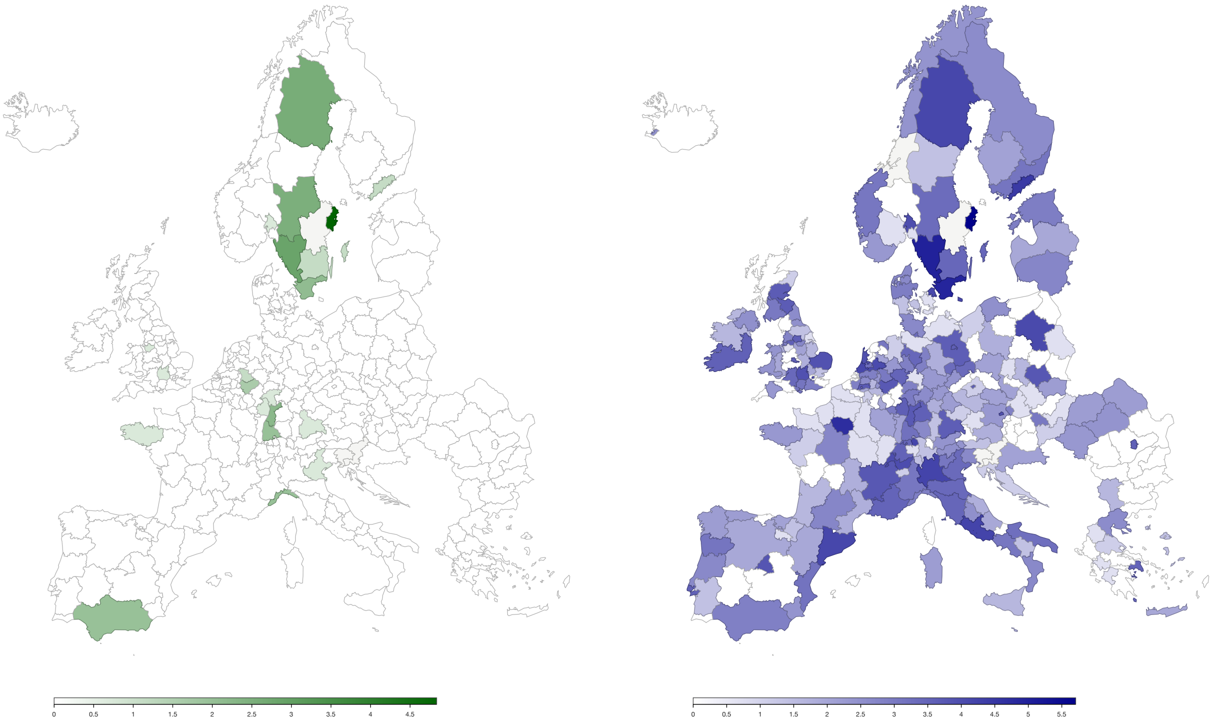


tify gaps and recommend where new or stronger partnerships could have the greatest impact.

Our analysis identifies high-potential collaboration opportunities across Europe by comparing Sweden's strengths with complementary capabilities in partner regions. Co-inventor and co-publication data are used to map existing and potential partnerships. This reveals i.e. underdeveloped relationships with certain European hubs, where targeted engagement could yield high returns. The data collected allow a comprehensive analysis of the collaboration networks of individual companies and research institutions, and also specific regions. Below, we go back to our select KSTs and explore regional and ecosystem collaboration networks.

Figure 20 shows the analysis of the collaboration network of the Östra Mellansverige region in the AI sector, based on the patents dataset. We chose this region as it is the future host of one of the AI factories to be deployed in the EU under the EU's InvestAI initiative, and a reflection of Sweden involvement with the EuroHPC Joint Undertaking since 2019. The Factory (named Mimer) is based in Linköping, and will feature a dedicated AI-optimised supercomputer, providing powerful compute resources and broad access to both academia and industry for R&D. It is part of a EuroHPC goal to bolster AI across life sciences, materials science, autonomy, gaming, and more. The project is managed by NAISS and coordinated with RISE and Linköping University. Mimer a research-grade supercomputing facility geared toward innovation across domains such as life sciences, materials science, autonomous systems, and gaming. This facility offers free access for startups and SMEs, as well as paid access for industry and public institutions. It also provides services like training workshops, collaborative development environments, and support in deploying AI at scale. MIMER is

FIGURE 20: Technical and scientific collaborations of the Östra Mellansverige region in Artificial Intelligence (since 2020). Source: https://www.paballand.com/ceps/iva/net/regpat/%C3%B6stra-mellansverige-(se12)-artificial-intelligence.html; https://www.paballand.com/ceps/iva/net/openalex/%C3%B6stra-mellansverige-(se12)-artificial-intelligence.html



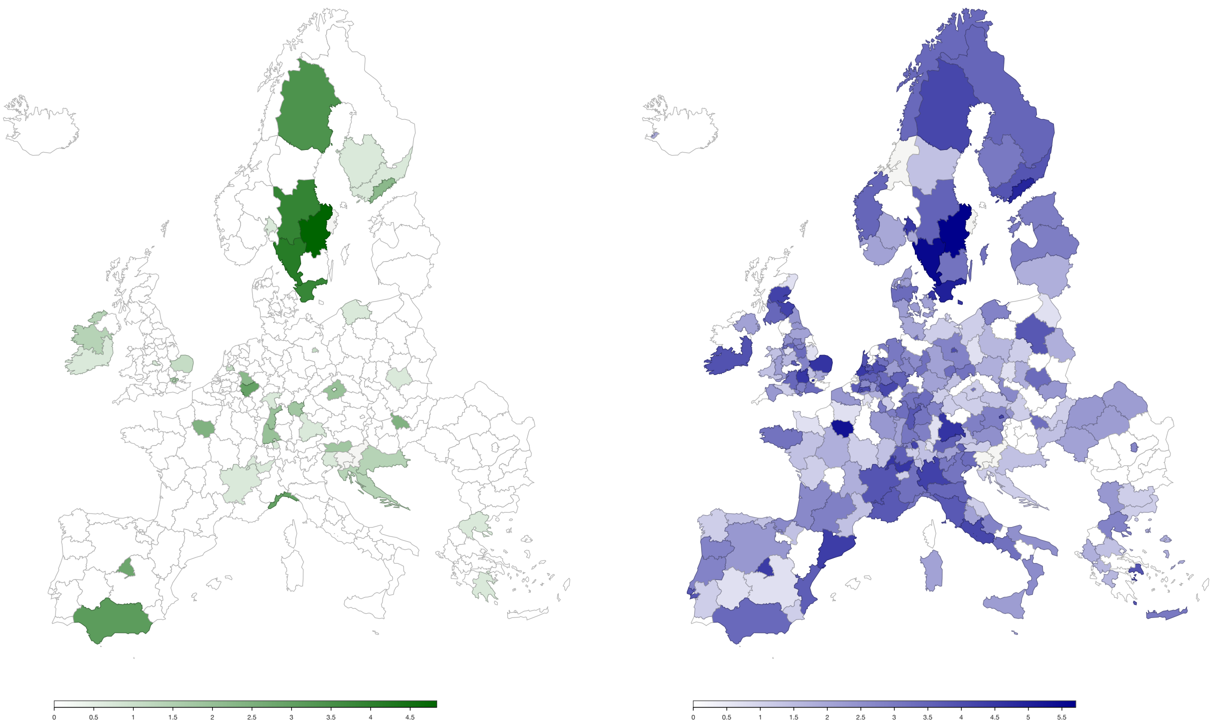
embedded in a network of European AI Factories, sharing best practices, data frameworks, and fostering cross-border innovation.

At a first glance, the level of technological cooperation between the region and the rest of Europe appears relatively limited, whereas the network of scientific collaborations is strong and well distributed across Europe. At the same time, investment in additional compute infrastructure seems to have concentrated in the Stockholm region, where a Consortium (including Ericsson, AstraZeneca, Saab, SEB, Wallenberg Investments) recently partnered with NVIDIA to deploy a large-scale AI supercomputer infrastructure combining DGX SuperPODs with Grace Blackwell GB300 systems. NVIDIA also announced its intention to open its first AI Technology Centre in Sweden to support this effort. A commercial AI cloud infrastructure (branded as an "AI Factory") also launched in Stockholm's tech hub, Kista, at North's SWE01 data centre, featuring more than 2,000 NVIDIA GPUs (including H200 and GB series), providing GPU compute capacity to Swedish industries with full data sovereignty and sustainability practices.

The technical and scientific collaboration networks of the Stockholm region are reported in Figure 21.

The substantial amount of data we collected enables us to predict possible links between Swedish regions and other European regions, both in terms of co-occurrence in patenting and in scientific publications. The information can be very valuable as it indicates those cases for which links are currently underexploited, or well established (even more than could be predicted). For policymakers and investors, this information can

FIGURE 21: Technical and scientific collaborations of the Stockholm region in Artificial Intelligence (since 2020). Source: https://www.paballand.com/ceps/iva/net/regpat/stockholm-(se11)-artificial-intelligence.html; https://www.paballand.com/ceps/iva/net/openalex/stockholm-(se11)-artificial-intelligence.html



lead to highlighting cases in which a region with a significant potential on given KSTs could better exploit links and collaborations with other, thriving parts of Europe.

In the figures below, we have selected the top 20 regional hubs in a given KST, and have charted the links between a given Swedish region and those hubs in the selected KST. The graph shows a value of zero whenever the links found as exactly as could be expected. The value is positive whenever the links are more than expected (a value of 0.5 means that there are 50% more links than expected); whereas a negative value shows that the links are less than could be expected. With a degree of oversimplification, one could refer to the positive or negative values in the graph as cases in which a region is punching above or below its weight in terms of collaborations with other parts of Europe.

As shown in Figure 22, the **Stockholm region features very significant links with many of the top 20 hubs in Europe**, including in Switzerland, the UK, the Netherlands, Spain and Germany. Links that are less exploited, and could potential be the subject of future collaborative initiatives, include several hubs in Germany and Italy, as well as North Holland and Rhone-Alpes.

On the scientific publications side, Figure 23 shows well exploited collaborations with other Swedish regions as well as with different hubs in Germany, Finland, and the UK. Much less exploited are links with the majority of the other top 20 hubs in AI, including important areas for KSTs where Sweden performs well, such as Darmstadt, the Geneva and Zurich regions, Inner London.

FIGURE 22: Links between the Stockholm region and the top 20 leading European hubs on AI: (1) patents.

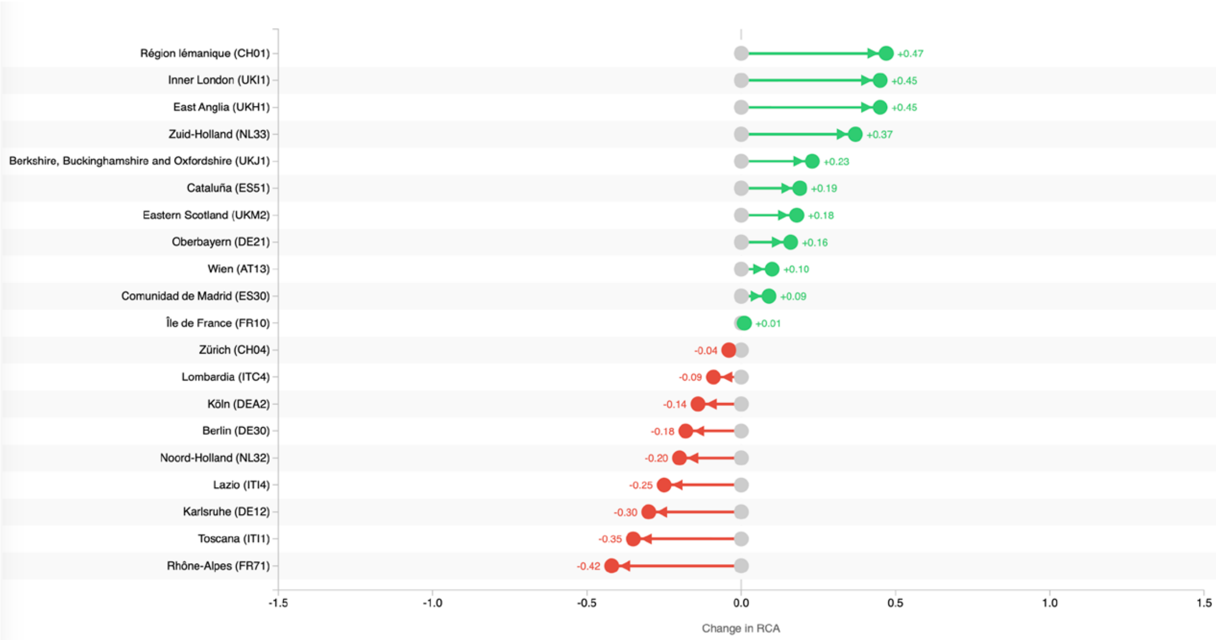
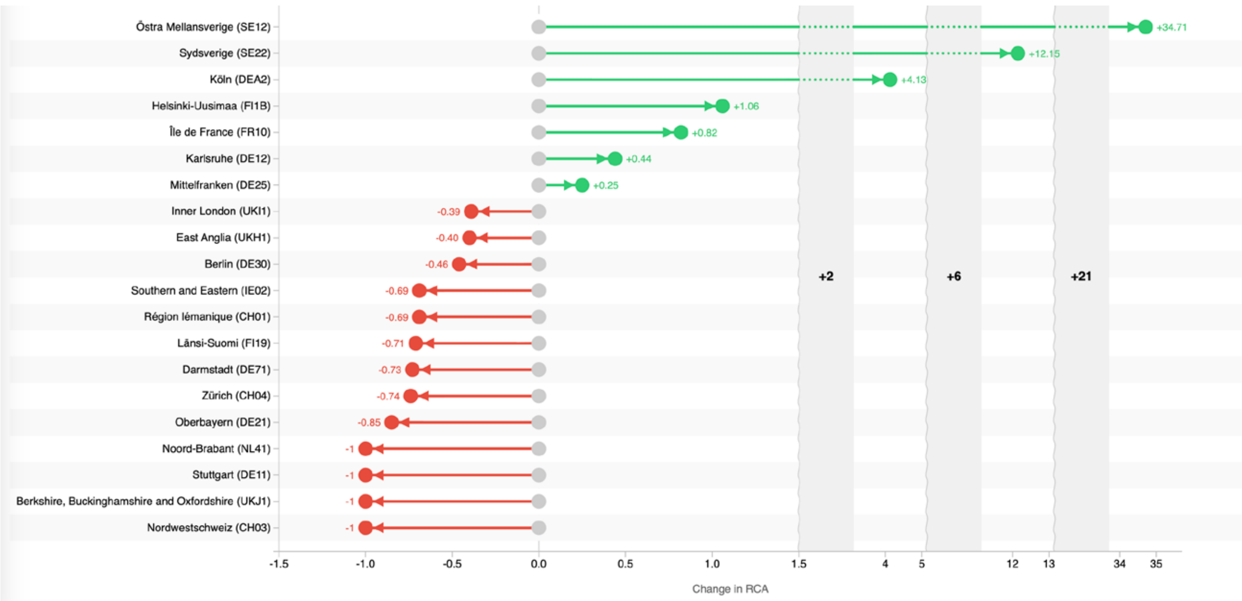


FIGURE 23: Links between the Stockholm region and the top 20 leading European hubs on AI: (2) publications.



Space Tech

Sweden is rapidly consolidating its role as a **leading European space actor**. From launching its first military satellite to establishing a mainland orbital spaceport, the country is strategically enhancing both civilian and defence space capabilities. Supported by a robust industrial base and international partnerships, Sweden is thus uniquely positioned to drive sovereign access to space in the coming decade. Among other key developments, a landmark Technology Safeguards Agreement (TSA) signed with the United States in June 2025 has enabled American launch providers to operate from Swedish soil, reinforcing the role of Esrange Space Centre near Kiruna as Europe's first mainland orbital spaceport. This facility is now at the heart of partnerships with U.S. firm Firefly Aerospace and South Korea's Perigee, and hosts Europe's Themis reusable rocket prototype, scheduled for vertical take-off and landing tests in late 2025.

On the defence front, Sweden launched its first military communications satellite, GNA-3, in August 2024 aboard a SpaceX Falcon 9, marking a significant leap in national security capabilities. The Swedish Armed Forces' dedicated Space Division, established in 2023, has since received over 1 billion SEK to develop rapid-launch satellite infrastructure, aligning closely with NATO interoperability goals. Sweden’s 2025 defence and security space strategy emphasizes resilience, deterrence, and reduced reliance on foreign-controlled space assets.

Industrial and research capacity remain strong. The Swedish Space Corporation (SSC) continues to manage satellite communications, space traffic management, and high-altitude testing, while Beyond Gravity AB (formerly RUAG Space) supplies mission-critical components to European and U.S. space missions. The Swedish National Space Agency (SNSA) funds cutting-edge research, including advanced computing initiatives such as the RISC-V in Space Workshop held in Gothenburg in early 2025.

These efforts potentially position **Sweden as a pivotal European gateway to space—combining sovereign launch capability, robust industry, and active participation in both civilian and defence-oriented missions**. With sustained investment, deepened transatlantic partnerships, and a growing focus on autonomous space technology, Sweden is set to punch above its weight in shaping Europe’s access to and influence in space over the next decade.

FIGURE 24: Space technologies – Global share of patents (2020–2024). (Source: OECD RegPat Database). Source: https://www.paballand.com/ceps/iva/position/regpat/space-technologies.html

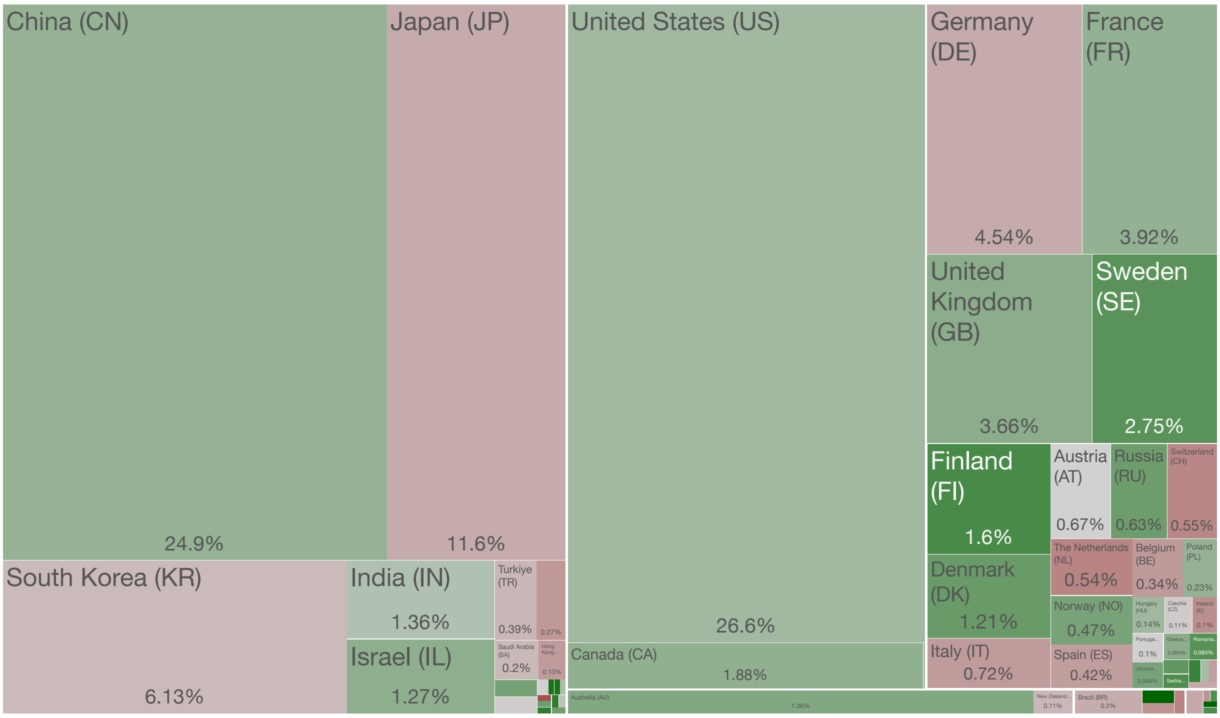


Figure 24 shows Sweden's global positioning in terms of space-related patents (2020–2024, OECD RegPat data). As shown, Sweden holds 2.75% of the patents in this sector, otherwise dominated by the United States and China, almost at par. At European level, only Germany and France outperform Sweden on this specific dimension.

When it comes to scientific publications, Sweden's relative weight is however lower in relative terms. Figure 25 shows that in a world where Europe performs comparatively well, and large European countries broadly match the weight of the United States, Sweden counts for 1.17% of global research output.

Finally, a look at investment in startups in the space sector shows an environment dominated by the United States and (far behind) the United Kingdom, but also notably shows a remarkable positioning of Finland. In this specific dimension, as shown in Figure 26, Sweden disappears from the map with a global share of 0.05%.

The Swedish Space Tech ecosystem

Space technologies are one of the domains in which Sweden shows global leadership. The situation, in terms of patents and ecosystem, is very similar (and if anything, even more concentrated) than that of Artificial Intelligence, with Ericsson accounting for approximately two third of all the patents awarded and reported in the OECD RegPat (most likely with a patent portfolio focused on telecommunications-related patents applied in the satellite communications contexts, rather than hardware). Here, there are two other relatively big players, Husqvarna and Volvo Trucks. These two companies, however, appear to be only marginally involved in the space business for

FIGURE 25: Space technologies – Global share of scientific publications 2020–2025 (Source: OpenAlex).
Source: https://www.paballand.com/ceps/iva/position/openalex/space-technologies.html

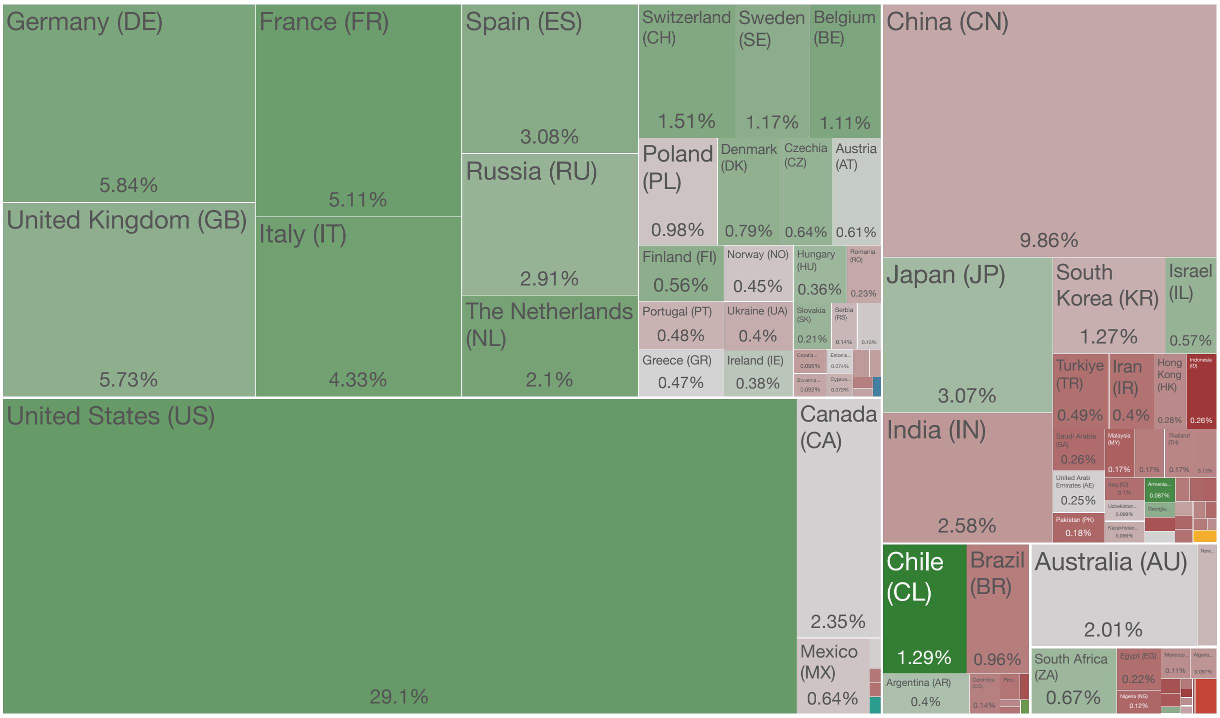
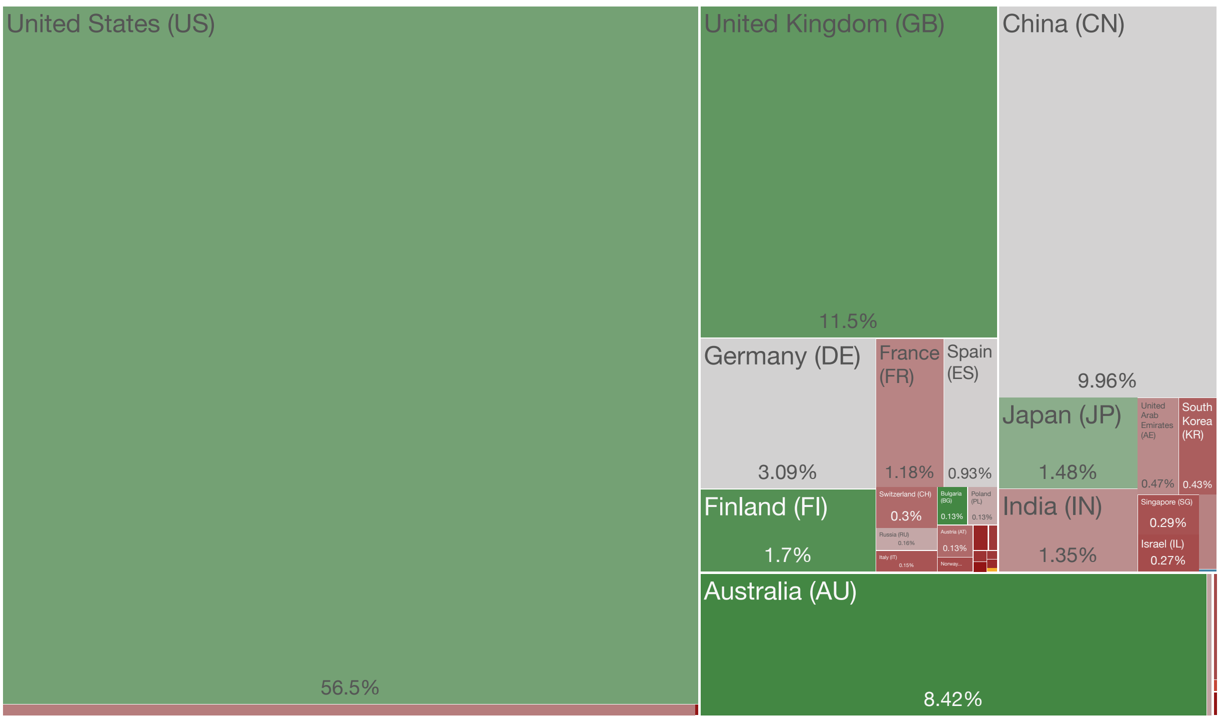


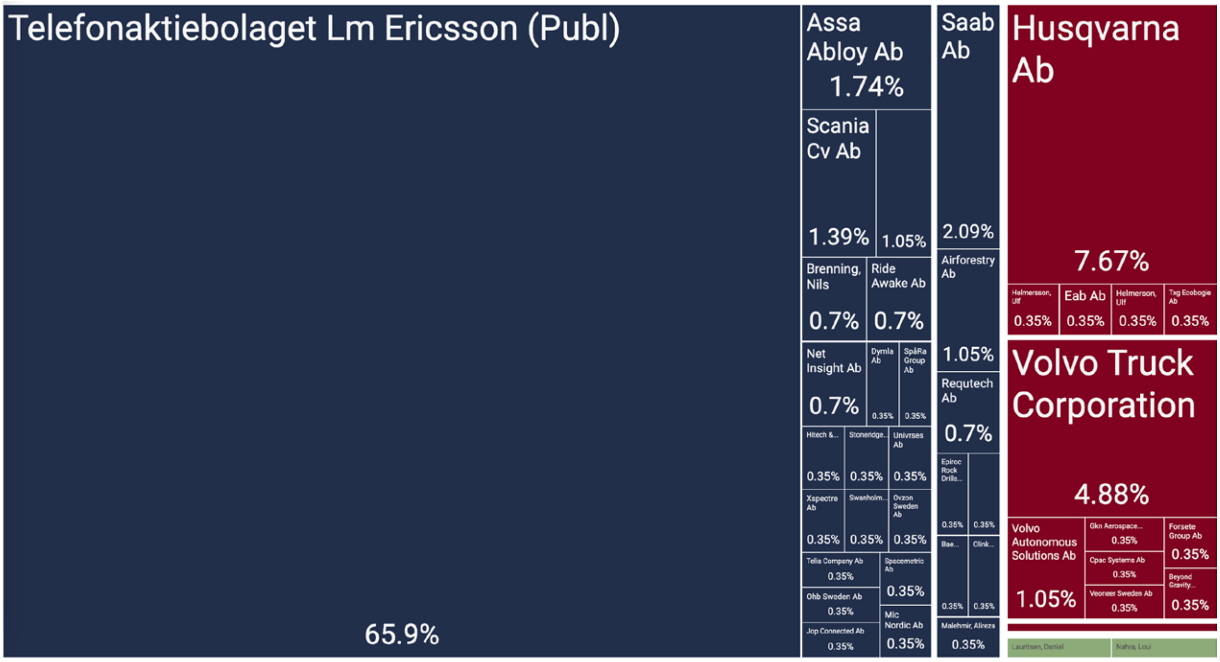
FIGURE 26: Space technologies – Global share of investment, 2020–2025 (Source: CrunchBase Pro).
Source: https://www.paballand.com/ceps/iva/position/crunchbase/space-technologies.html



now (Husqvarna is active in Earth-bound robotics and navigation; Volvo divested the Aero division in 2012, and the truck division is not directly involved in the space industry).

When it comes to scientific publications, the situation is very different. Stockholm university leads in terms of publications, with over 20% of the total reported in the OpenAlex database. There, the Department of Astronomy is engaged in both theoretical and observational astrophysics, ranging from exoplanet formation to cosmology. Recent high-impact findings include the discovery of a planet-forming disk unusually rich in carbon dioxide (identified using data from the James Webb Space Telescope) and fresh insights into the birth of red galaxies captured through JWST’s MIRI infrared camera. Moreover, Stockholm University played an instrumental role in Sweden’s **MATS satellite mission** (“Mesospheric Airglow/Aerosol Tomography and Spectroscopy”), launched in November 2022 and featuring a collaboration with many other players in the ecosystem, including KTH, Chalmers, the Swedish National Space Board, OHB Sweden, and ÅAC Clyde Space. Finally, the university is now pushing the frontiers of scientific innovation with a new, AI-powered “digital twin of the Universe”, a novel method published in *Monthly Notices of the Royal Astronomical Society* in August 2025.

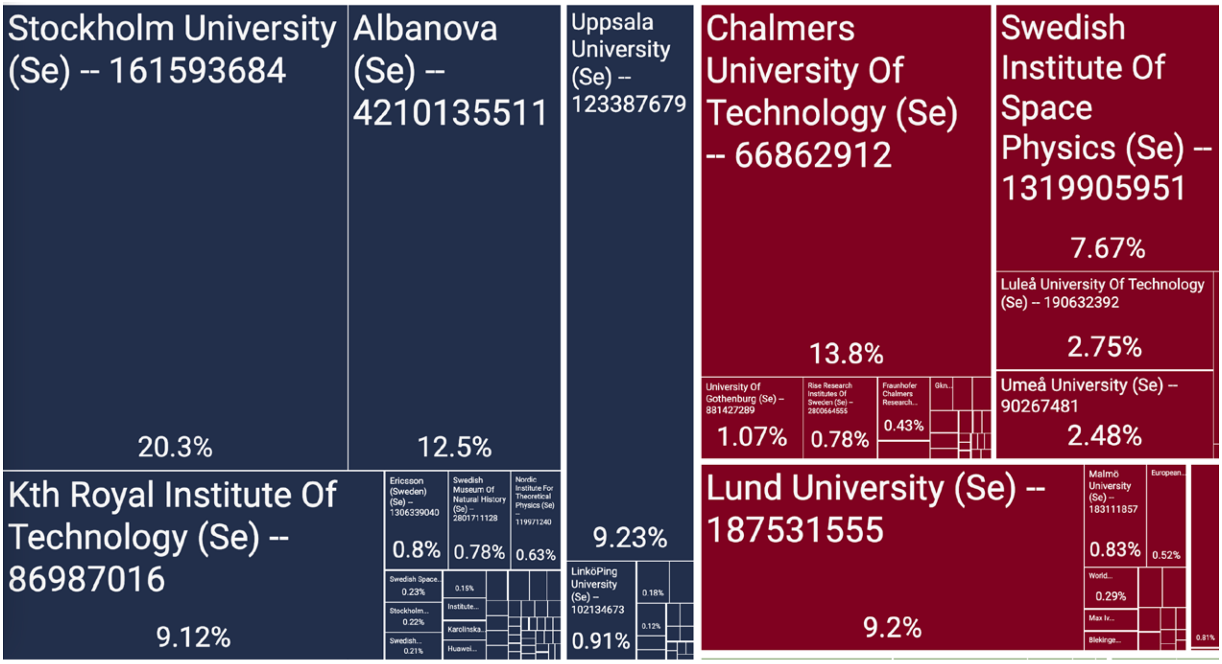
FIGURE 27: The space ecosystem in Sweden
– main patent portfolios (2020–2024).



Besides Stockholm, important players include the Swedish Institute of Space Physics (IRF), a government research institute under the Ministry of Education and Research. IRF has a rich history of delivering space-focused research and instruments—starting from the Viking and Freja satellites to contributions on Cluster, Mars Express, BepiColombo, Solar Orbiter, and JUICE missions. It also supports research through its SpaceLab facility, enabling industry and academia to test space hardware in simulated conditions. Another important entity in this ecosystem is the AlbaNova University Center, Stockholm's flagship interdisciplinary research and education hub bringing together physics, astronomy, and biotechnology under one roof and hosting i.e. the Nordic Institute for Theoretical Physics (NORDITA). Among academic universities, Chalmers University of Technology (which hosts the Onsala Space Observatory) and Lund University (Lund Observatory), and also Uppsala and Luleå host significant activities in space-related research.

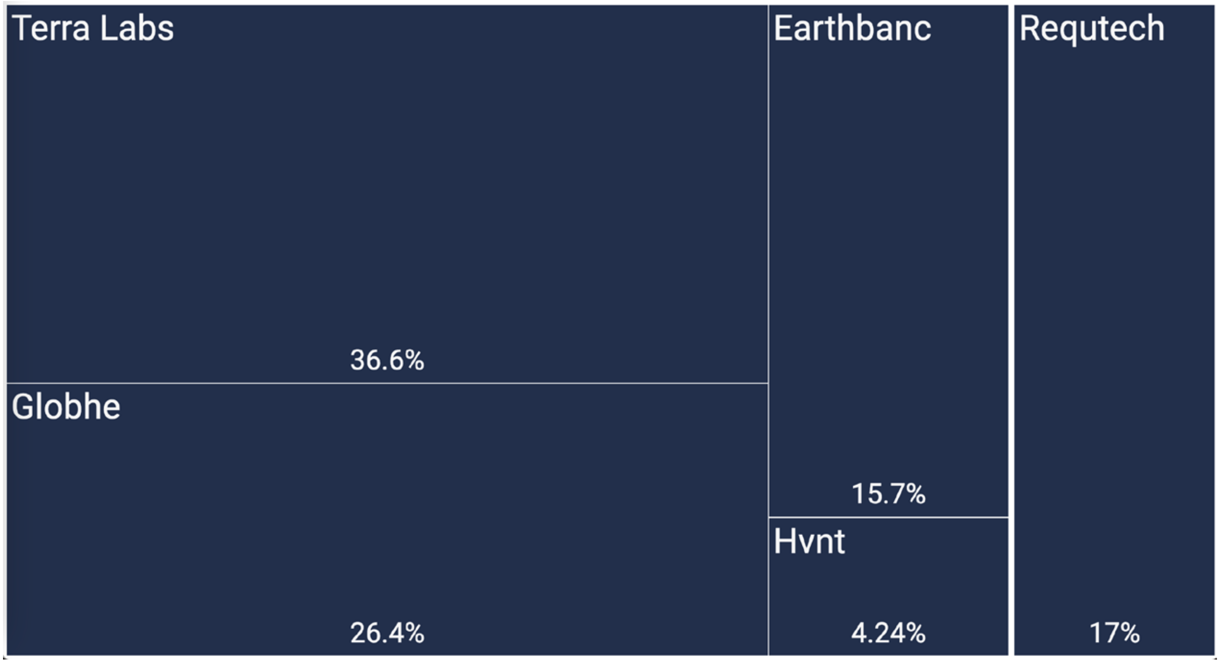
Finally, when it comes to investment, the landscape appears less developed, suggesting a difficulty in translating scientific excellence into concrete market opportunities. Among the few startups that received significant investment is **Terra Labs**, founded in 2023 in Stockholm by former iZettle executives Peder Stahle (CPO) and Adam von Corswant (CTO), which offers a real-time forest and land monitoring platform powered by satellite imagery and AI. The company raised SEK 6 million in pre-seed funding from Cofounded Kapital, then secured €4 million in seed funding from Norrsken VC in March 2024 at a SEK 200 million pre-money valuation. Terra Labs is also in a strategic partnership with Södra to launch an AI-powered forest planner app by autumn 2025.

FIGURE 28: The space ecosystem in Sweden – scientific publications (2020–2025).



Another interesting and promising startup is **Globhe**, which accounts for 26.4% of the investment reported in Crunchbase Pro. It operates a global drone-data marketplace called Crowd-droning®, connecting organisations to over 11,000 local drone operators across more than 147 countries, all via a single plat-form. Its core mission is to enable efficient, high-resolution Earth observation for digital twins, environmental monitoring, infrastructure inspection, and more. After a pre-seed of SEK 7M in 2021, it raised a SEK 20M seed round in 2023 from venture and impact investors. In April 2025, Globhe was recognized by

FIGURE 29: The space ecosystem in Sweden – investment in startups (2020–2025).



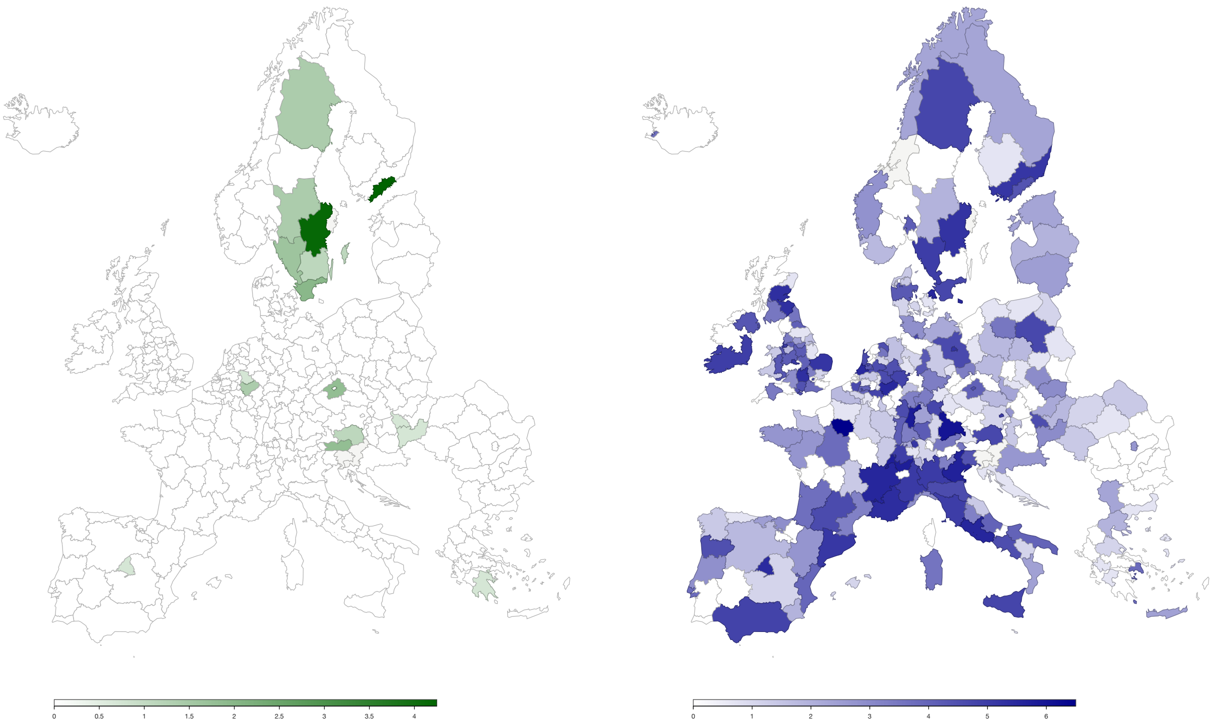
Impact Loop and *Teknikföretagen* as one of the Top 150 tech leaders in Sweden creating impact. This highlights its growing influence in leveraging drone technology for societal and environmental benefit.

Space technologies and Swedish regions: networks of collaboration

Figure 30 reports is the analysis of the collaboration network of the Stockholm region in the space sector. The Stockholm region is Sweden's administrative and strategic hub for space technology; it hosts the Swedish National Space Agency (SNSA), which funds national research and manages ESA/EU ties. The Swedish Space Corporation (SSC), headquartered in Solna, runs ground stations and Esrange operations. Stockholm is also home to the ESA Phi-Lab Sweden, focusing on AI and space data innovation. The Swedish Space Data Lab provides open access to Earth-observation datasets for AI applications. In defence, the Air Force's Space Division in Solna develops satellite launch and surveillance capabilities. Overall, Stockholm is the "entry point" and the overall hub for partnerships in Sweden's space ecosystem. That said, Figure 30 shows a rather extensive network of academic collaborations, but much less intense activity in R&I cooperation. We found evidence of collaborative patents only between Stockholm and two other Swedish regions, plus the areas of Graz in Austria, where a Science Park and TU Graz carry out research on space.

Repeating this exercise for all other regions of Sweden provides similar results: important academic links, but rather limited cooperation for innovation and patented solutions.

FIGURE 30: Technical and scientific collaborations of the Stockholm region in Space Technologies, since 2020. Source: https://www.paballand.com/ceps/iva/net/regpat/stockholm-%28se11%29-space-technologies.html; https://www.paballand.com/ceps/iva/net/openalex/stockholm-%28se11%29-space-technologies.html



To add granularity to our finding, we were able to identify the top 20 regional hubs in Europe, and have mapped the links between Swedish regions and those hubs. For the case of space technologies, Figure 31 confirms that when it comes to patents, significant collaboration exists only with two other Swedish regions, one region in Finland and the area of Köln. Among all other hubs, there is no sign of collaboration and thereby our results all show a “- 1”.

On publications, as expected, the situation is significantly better, as shown in Figure 32. Stockholm cooperates extensively with all top 20 hubs, particularly in Switzerland, Germany, Spain, France, Italy, the Netherlands and the UK.

Quantum computing

Sweden is considered to be well positioned in another foundational, convergent technology that promises to massively impact future industrial developments, i.e. quantum computing. Specifically, the country can rely on a deep research basis, strong public funding, coordinated innovation platforms, emerging start-ups, and collaboration across regions. The Wallenberg Centre for Quantum Technology (WACQT), funded by the Knut and Alice Wallenberg Foundation (KAW), is the national flagship quantum R&D program, coordinated by Chalmers university, with key contributions from KTH and Lund University. WACQT spans four pillars: quantum computing, sensing, simulation, and communications. The prime objective of WACQT is to create a 100-qubit quantum computer (in 2024, a 25-qubit processor was created).

FIGURE 31: Links between the Stockholm region and the top 20 leading European hubs on Space tech: (1) patents.

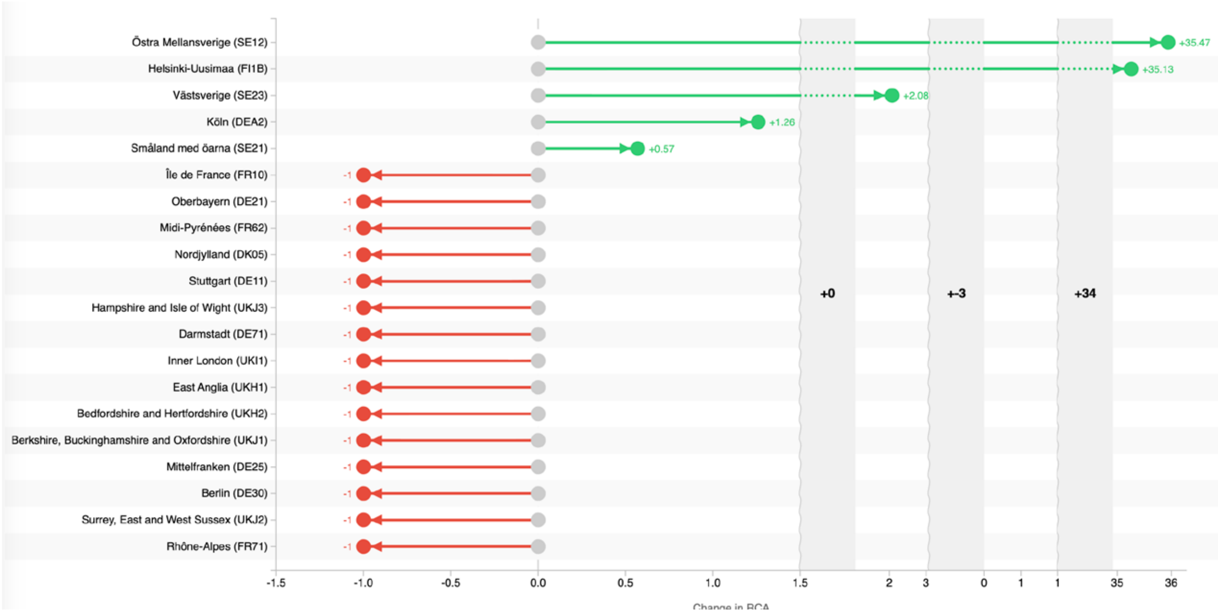
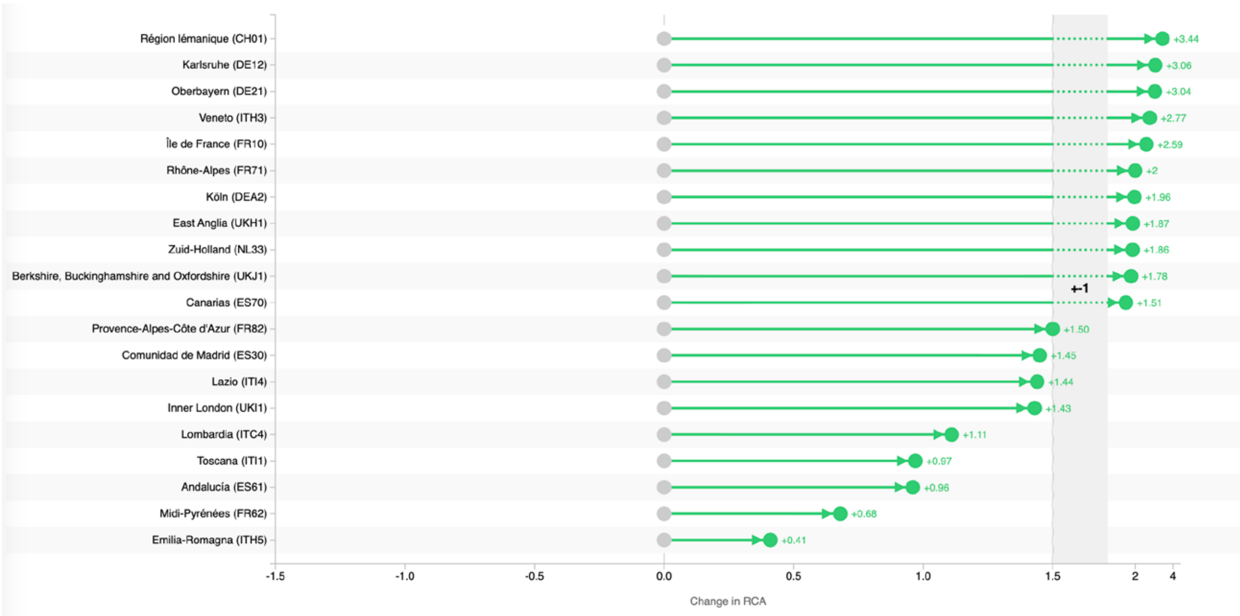


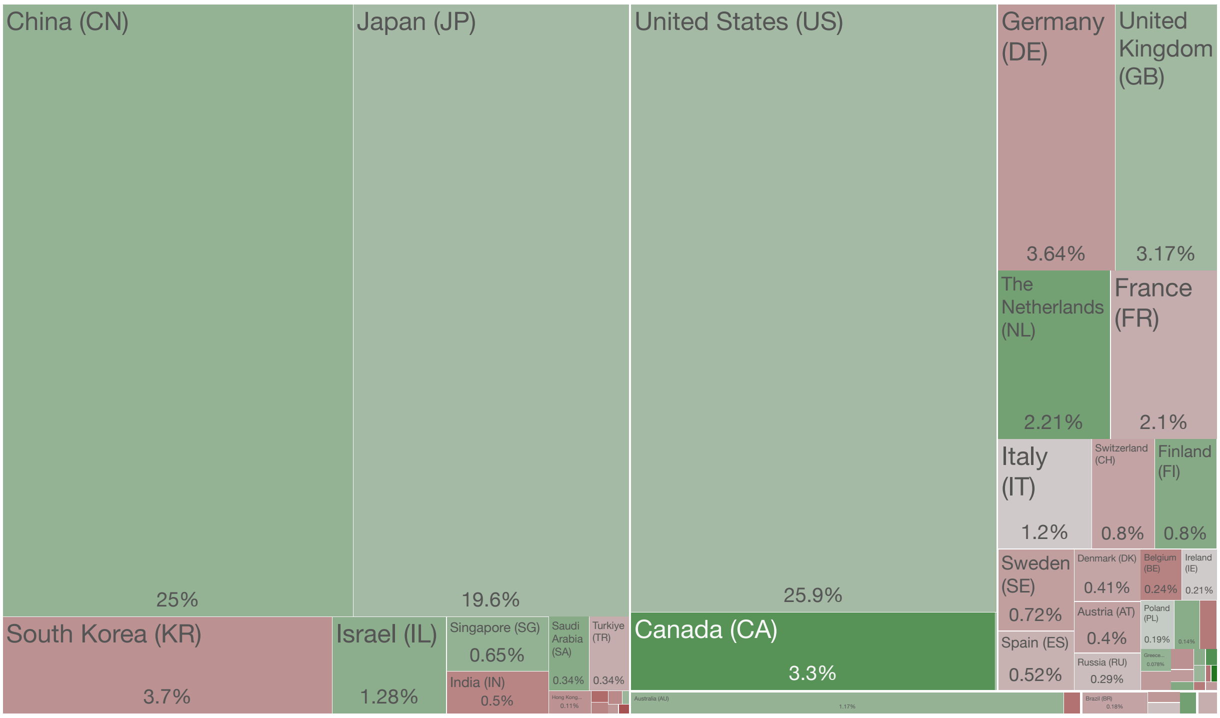
FIGURE 32: Links between the Stockholm region and the top 20 leading European hubs on Space tech: (2) publications.



The Swedish government has deployed a broad Quantum Technology Strategy for 2025–2030, backed by a proposed SEK 6.5 billion to drive research, education, infrastructure, commercialization, and innovation across the quantum ecosystem. In 2024 also a **Quantum Sweden** was launched as a national collaboration platform with funding from Vinnova. Hosted at **Chalmers Industriteknik**, it connects R&D centres (including WACQT), universities, startups, and industry partners like **Ericsson**, **Scalinq**, and **Con-science** to foster innovation and commercialisation. Through this initiative in 2025 **RISE** won an innovation challenge to develop single-photon sources, in collaboration with **Linköping University** and startups such as **PLT** and **Xtal Works**.

However, **Sweden's competitiveness in this domain is not fully evident from our data on patents**. In this domain, Sweden holds a 0.72% share. Major players dominating the landscape include IBM, Google, Microsoft, IonQ, Origin Quantum, etc. Swedish entities are not prominently listed. That said, for what concerns university patents, it must be recalled that R&D culture in Sweden implies features that are not found in other countries: one of them is the so-called Professors' Privilege (i.e., the researchers own the right to patent, rather than the universities).

FIGURE 33: Quantum technologies – Global share of patents, 2020–2024 (Source: OECD RegPat).
Source: https://www.paballand.com/ceps/iva/position/regpat/quantum-technologies-and-computing.html



Compared with U.S. or Chinese players (where universities patent aggressively), Swedish institutions are less visible and therefore historically place less emphasis on protecting IP at early stages. This is particularly relevant for the case of quantum since Sweden's specialisation in this domain is mostly concentrated in hardware fundamentals (superconducting qubits, cryogenics, microwave filtering, quantum optics), *i.e.* "pre-commercial" areas where the science is still being refined and patents appear often premature. In this space, moreover, often actors prefer to keep breakthroughs as trade secrets or within consortia, especially where dual-use technology is concerned. Sweden's defence and telecom industries (Saab, Ericsson) are certainly engaged in quantum research, but often through confidential collaboration agreements rather than openly available patents.

Data related to scientific publications are slightly more positive, with Sweden performing better than Finland, and similarly to Denmark. A bibliometric study by the Swedish Research Council, referenced in the *Swedish Quantum Agenda*, found that Sweden has a strong and active research base in quantum technologies, with a broad geography of research groups and robust international collaboration. However, it did not indicate leadership in total publication volume relative to other countries (shown in Figure 34, where Sweden accounts for 0.87%). This said, **Sweden does not appear among leading nations in terms of volume of publications, H-index, or share of highly cited papers** (leading organisations in Europe include CNRS in France, Oxford, Delft, ETH Zurich, and the Italian Research Council).

Finally, **the analysis of investment in quantum startups does not show Sweden as a major player**, contrary to neighbouring

FIGURE 34: Quantum technologies – Global share of scientific publications 2020–2025 (Source: OpenAlex). Source: https://www.paballand.com/ceps/iva/position/openalex/quantum-technologies-and-computing.html

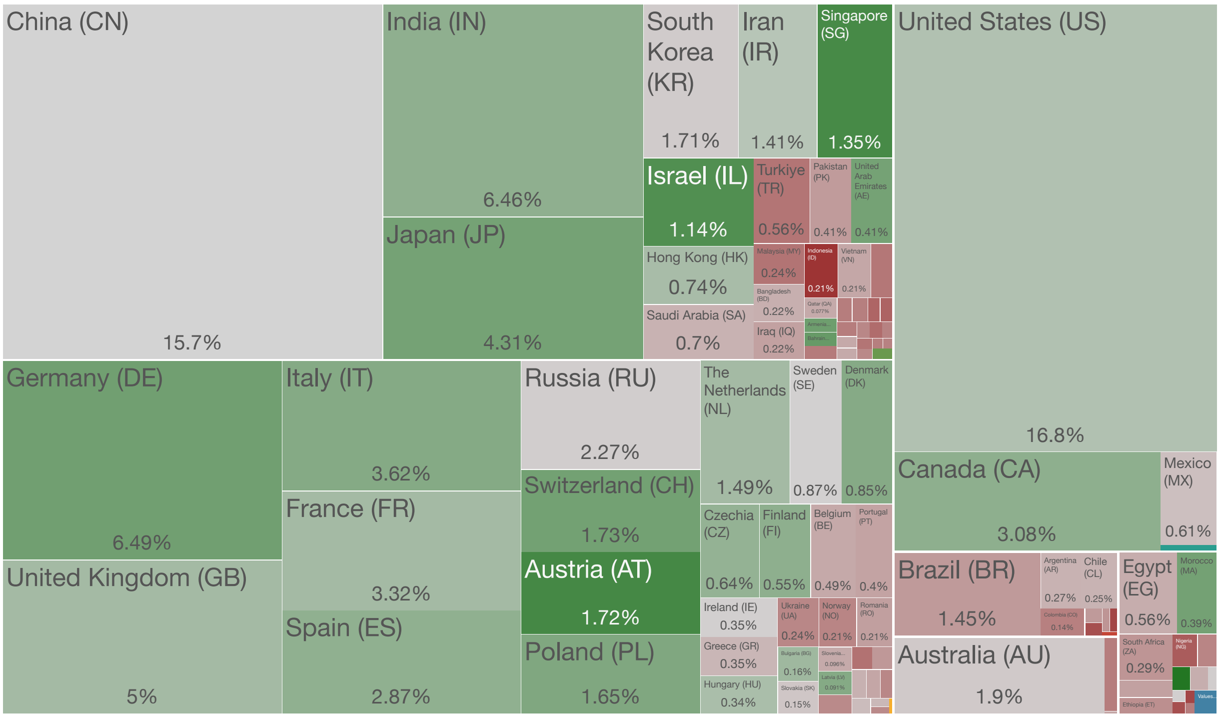
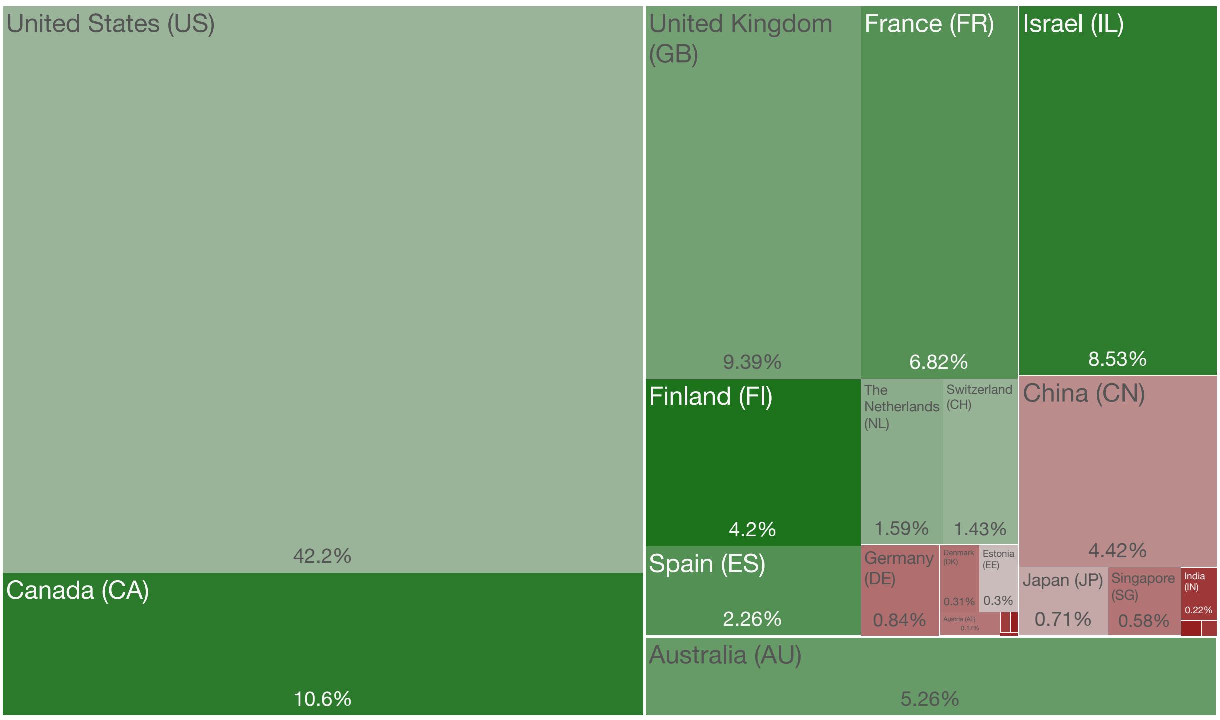


FIGURE 35: Quantum technologies – Global share of investment in startups, 2020–2025 (Source: CrunchBase Pro. Source: https://www.paballand.com/ceps/iva/position/crunchbase/quantum-technologies-and-computing.html



countries like Finland, which accounts to a significant share of investment (4.2%). That said, some initiatives and programme incubated by Swedish institutions have already spun off successfully (e.g., Atlantic Quantum, SCALINQ, ConScience AB), especially from the Chalmers hub.

The Swedish quantum ecosystem

The prominence of Ericsson in terms of patenting activity, which we already reported for AI and space, is even more evident when it comes to quantum technologies and computing. Here, Ericsson represents an even bigger share of the total patents, over 71%. It is followed by smaller players with tenuous links to core quantum research, such as Nanosc and Smoltek; and by very small ventures in their early stages in the quantum industry, such as Sweden Quantum AB, one of several promising WACQT-derived spin-offs supported by Chalmers and the Wallenberg Centre for Quantum Technology, which developed a HERD filter that is at prototype stage with a pending patent. Others include Atlantic Quantum, QET Sweden, Deep Light Vision, quCertify, and SCALINQ AB.

The scientific publications domain features a number of leading institutions, led by Chalmers University of Technol-

FIGURE 36: The quantum ecosystem in Sweden
– main patent portfolios, 2020–2024.

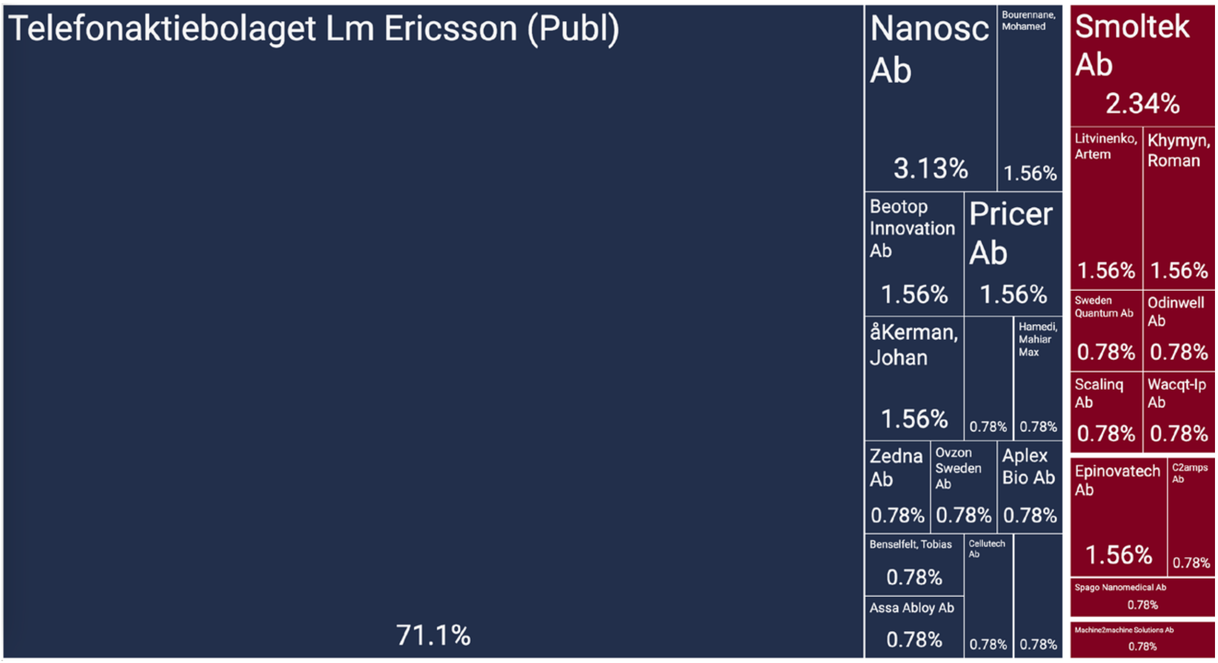


FIGURE 37: The quantum ecosystem in Sweden
– scientific publications, 2020–2025.

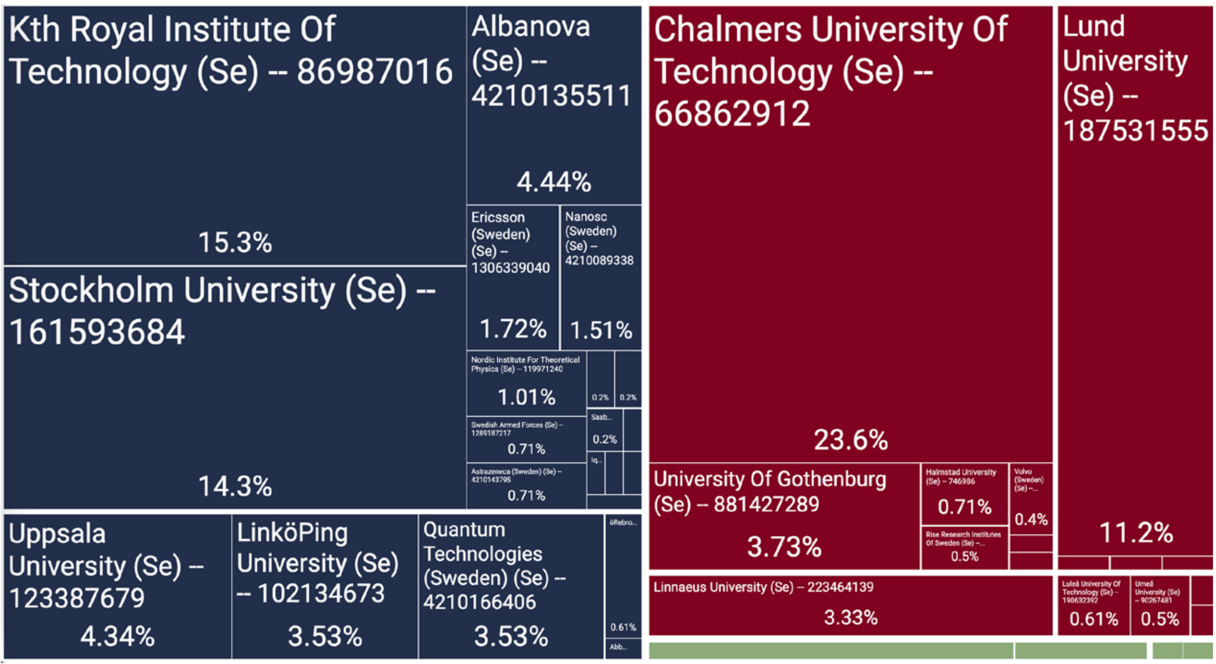
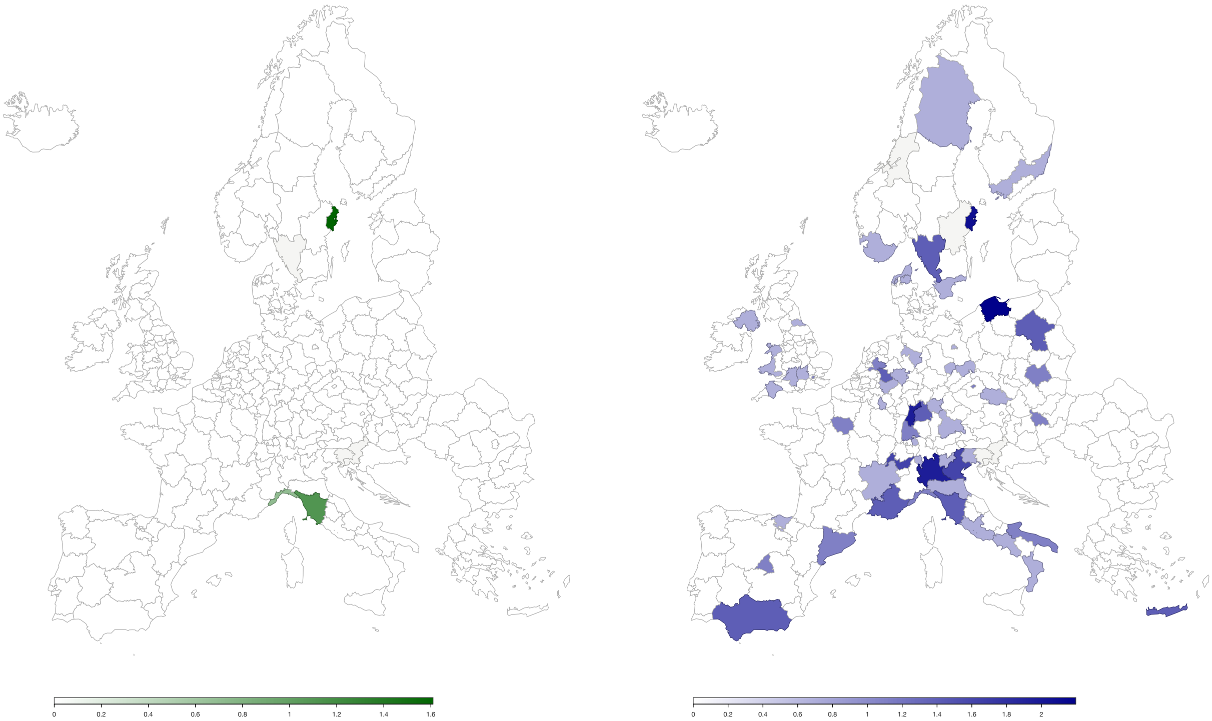


FIGURE 38: Technical and scientific collaborations of the Västsverige region in Quantum Technologies and Computing, since 2020.



ogy, home to WACQT and the country’s strongest quantum hardware program. Notable players include KTH Royal Institute of Technology, with major contributions in quantum communication, cryptography, and photonics; Stockholm University (active in quantum optics, foundations, and theory, often collaborating with KTH); Linköping University (focused on quantum materials, semiconductors, and nanotechnology for devices); Lund University (nanofabrication and quantum photonics); Uppsala University (quantum materials, superconductivity, and simulations), Linnaeus University (quantum foundations and interdisciplinary quantum-like models); and RISE, the Research Institutes of Sweden (applied work in quantum metrology and secure communications). Together these institutions form a distributed but complementary ecosystem.

When it comes to investment in startups, the situation appears still rather under-developed. The most significant investment over the past years, as already mentioned was in Atlantic Quantum, which raised SEK 95 million (~$9 million) in a seed round in 2022 and secured an additional $1.8 million U.S. Air Force grant in late 2024. Other promising spin-offs from Chalmers' WACQT program (e.g., Deep Light Vision, QET Sweden, quCertify AB, SCALINQ, and Sweden Quantum AB) have benefitted from academic and grant-driven support (e.g., via Vinnova or EU funding), and in some cases have developed patented products. However, their private venture capital traction remains limited and publicly undisclosed as of mid-2025.

Quantum technologies and Swedish regions: networks of collaboration

It is very interesting to see how the nascent quantum ecosystem in Sweden is collaborating with the rest of the continent. The Swedish region leading in quantum research appears to be Västra Götaland/Västsverige (home to Chalmers University of Technology in Gothenburg, which in turn hosts Wallenberg Centre for Quantum Technology), Sweden's most expansive academic program in quantum computing, simulation, communications, and sensing. For this reason we have selected this region for our illustrative graphs in this report (again, all reports are available in interactive mode). Figure 38 shows the technical and scientific cooperation in the region, showing a remarkable lack of collaboration in patenting, limited to two Italian regions (Toscana and Liguria); whereas the network of scientific collaborations is way more widespread.

We then moved on to observing the existing and missing links between the Västsverige region and the top 20 hubs in Europe, and the findings confirm what we saw above: the region only has active collaborations with Stockholm and two Italian regions, at least for what concerns active patents.

FIGURE 39: Links between the Västsverige region and the top 20 leading European hubs on Quantum: (1) patents.

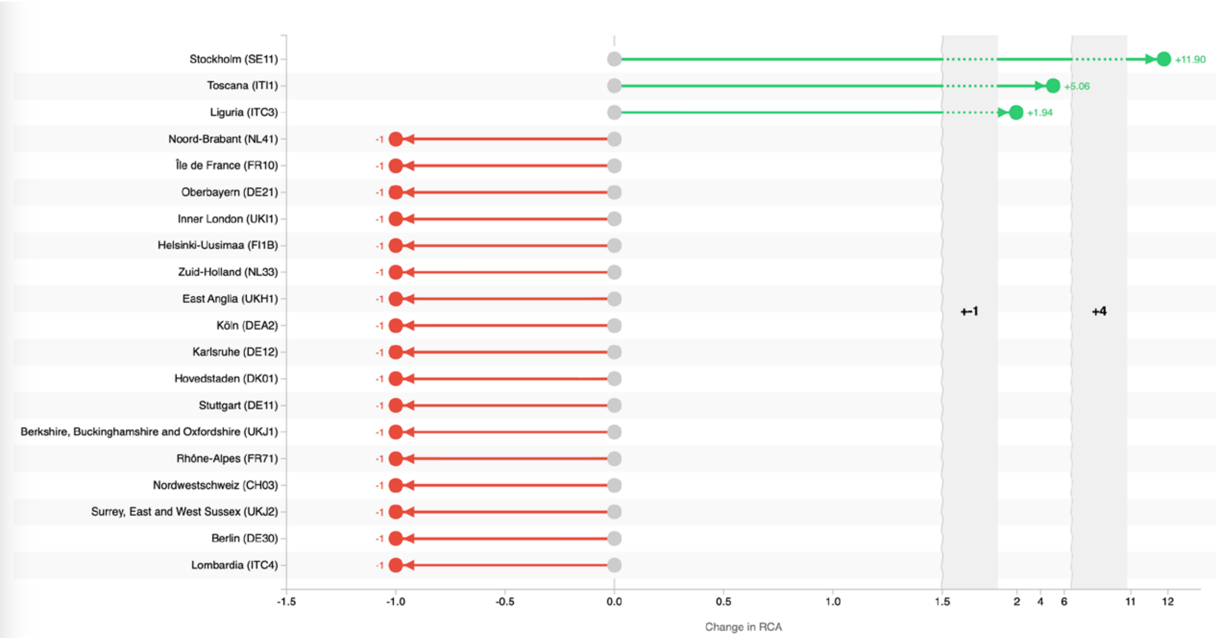
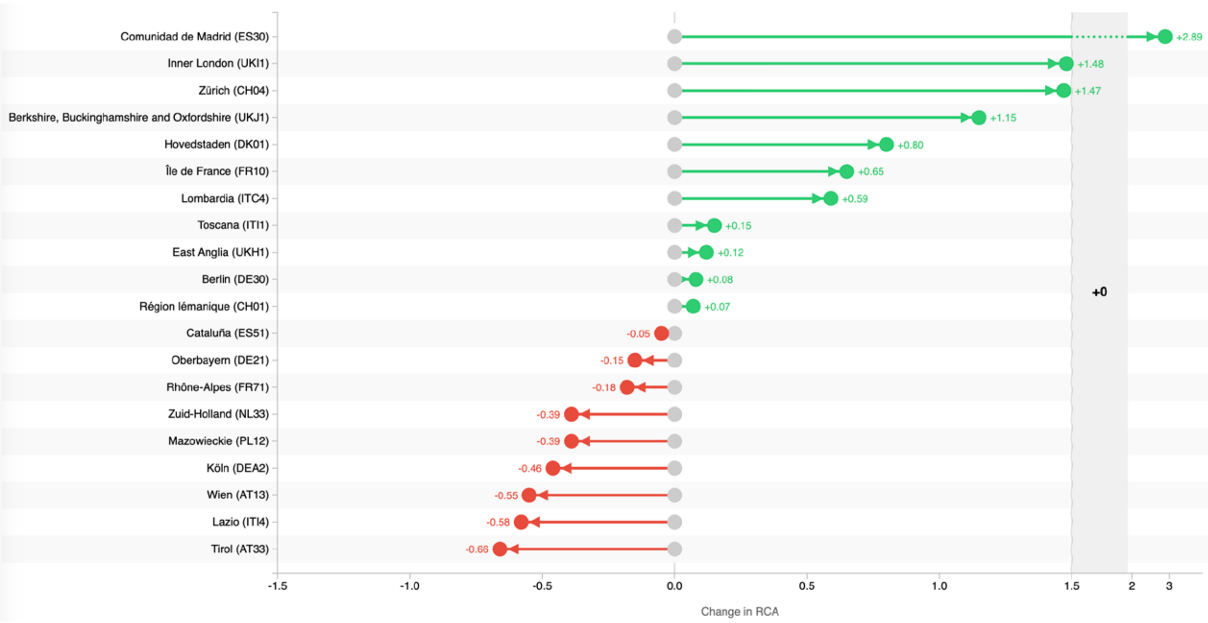


FIGURE 40: Links between the Västsverige region and the top 20 leading European hubs on Quantum: (2) publications.



When it comes to scientific publications, Västsverige is connected to several hubs, including notably the regions of Madrid, London, Zürich, Oxford, Copenhagen, Paris and Milan. Less strong links are found with other important hubs, such as Warsaw, Barcelona, Rome and others.

Conclusion: Seizing Emerging Opportunities for Sweden in a Changing Global Landscape

Sweden enters the mid-2020s as a global innovation leader, but data suggest that it must guard against complacency

Sweden enters the mid-2020s as a global innovation leader, but data suggest that it must guard against complacency. Strong macroeconomic fundamentals, a deep-rooted innovation culture, and well-developed infrastructure provide a solid base. Yet without decisive action on boosting the research and innovation ecosystem, especially on those key technologies that provide the foundations for future industrial transformation, the next years may see an erosion of the country's competitiveness. Sweden should not only maintain its high R&D investment but also ensure it delivers tangible gains in productivity, resilience, and sustainability. Doing so will secure its position at the forefront of technological innovation—both in Europe and globally—while meeting the challenges of an increasingly volatile economic and geopolitical landscape.

Our analysis of 48 KSTs suggests avenues for action, which may have to be validated after a discussion with policymakers and the business sector. As a matter of fact, it is important to acknowledge that **governments today need to look beyond the possibility frontier of their economy, and invest in solutions that will strengthen, besides competitiveness, also economic security and resilience in the years to come**. In doing so, they may also want to look beyond what our data can measure: for example, patent data may not fully represent pure software-related inventions; scientific publications are less likely to be massively produced when industrial cooperation is largely aimed at sharing tacit knowledge and exploit geographical proximity; and investment in startups is also less likely when technologies are more mature.

That said, our proxies unveil several interesting findings, which can be the basis for discussion with policymakers and the main actors of the Swedish innovation ecosystem, in view of a significant relaunch of the country's industrial and innovation policy.

First, in an overall excellent R&I ecosystem, there seems to be **a general difficulty for Sweden to translate scientific excellence into innovative ventures**. Our data and graphs systematically show better results in terms of scientific publications and collaborations, including a bigger share on global output, compared to what happens for patents and investments. Even if one considers the Swedish ecosystem as not particularly oriented towards a "patent-first" strategy, it must be recalled that global investment in new ventures, in most of the 48 KSTs selected for this study, is still deeply affected by patents as signals, as well as intangible assets that guide companies' valuation by investors. Our data on startup investment place very often Sweden below neighbouring countries, and reflect market conditions that appear to fall short of the dynamism that the country's research community could potential express.

Second, Sweden should consider investing in those KSTs that are particularly foundational for the industrial transformation of tomorrow, and particularly **Artificial intelligence**, where the country could better coordinate its initiatives, starting with the ones on compute infrastructure to then link them to those industry verticals where the country features the highest levels of competitiveness. The "deepening of AI uptake" message contained in the Draghi report, specifically focused on AI for industry, implies the formulation of a comprehensive strategy for the whole technology stack, and the specific stacks in industries where Sweden is a leading player. These, as shown our data, include life sciences, MedTech, autonomous vehicle and drones, robotics and additive manufacturing, and to some extent nuclear energy, batteries and propulsion technologies. The fact that Sweden appears to lag behind in AI can reverberate on its competitiveness in all these sectors, as evidenced by our findings that an erosion of competitiveness is visible over the past years.

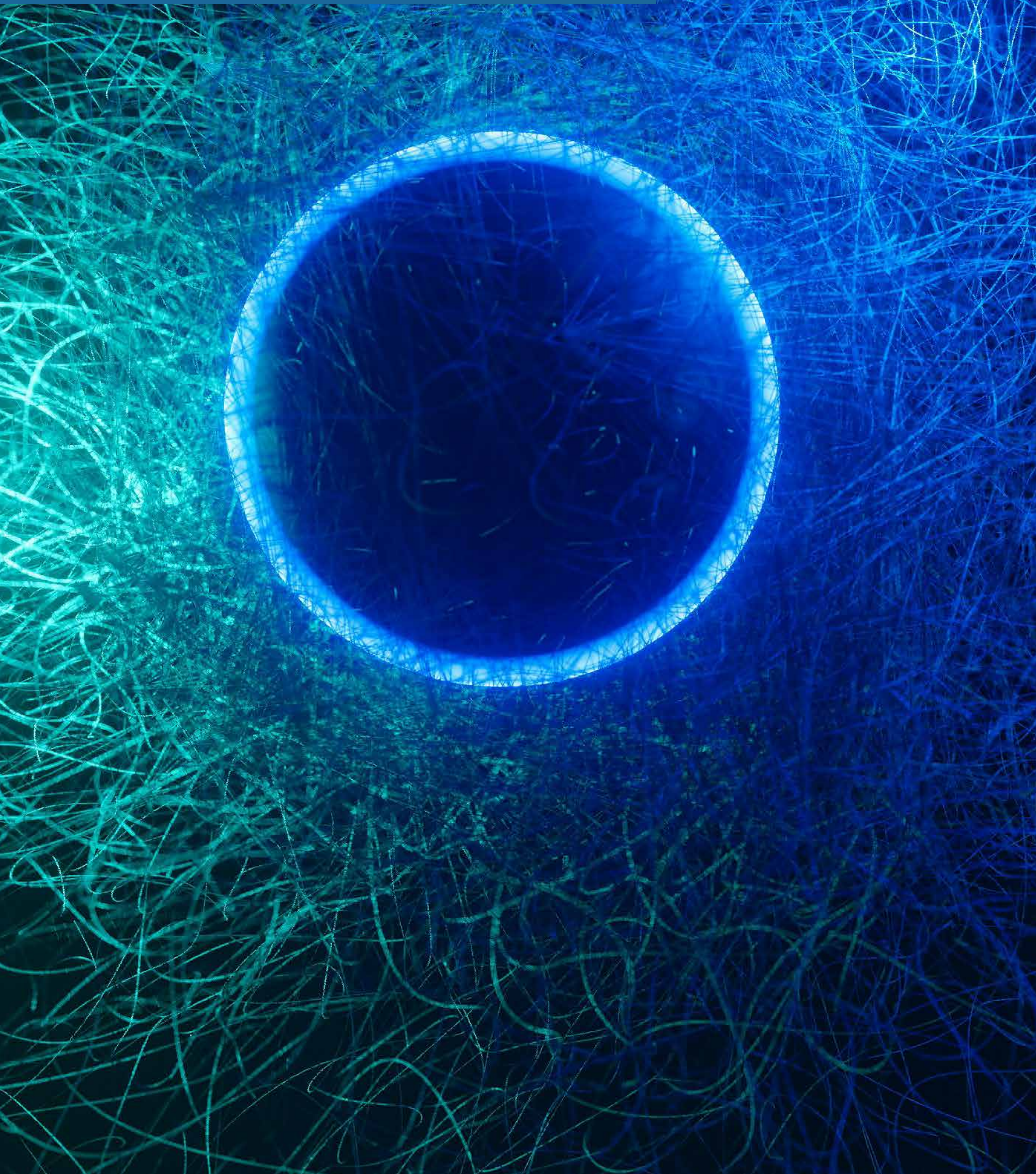
Third, **in several areas that are key for future transformation and competitiveness, Sweden is developing and consolidating scientific leadership that struggles to translate into technological leadership and innovation in the market.** Lack of suitable skills, excess market concentration and insufficient contestability of incumbent positions in key industrial domains could partly explain this lack of competitive dynamics. But a possible additional factor is emerging from our data: in many KSTs, while Swedish universities entertain a vast and deep network of scientific collaborations with peers in other regions and countries in Europe and at the global level, the same cannot be said for patenting activities and technological networks, which appear to be less developed, and very often confined within the Swedish territory.

Fourth, there are **opportunities for boosting specific ecosystems and international networks by looking at the potential of individual Swedish regions.** Data shown (as a small sample of the whole dataset) in Sections 1.1.2 and Section 2 (for three select KSTs) highlight optimal investments and moonshot opportunities for each of the regions, and point at specific sectors that may be subject to strategic, gradual divestment to help prioritise resource allocation. The region of Stockholm, for example, seems to be well-equipped for further investment in Defence technologies, MedTech, Personalised Medicine, Smart Grids, Aeronautics, and to some extent Photonics and Spintronics and Maritime Technologies; and could be a suitable focus for moonshots on semiconductors, industrial automation and robotics, hydrogen and advanced medicinal products. The same exercise can be repeated for each of the Swedish regions, which can compose an "optimal regional investment mix" to be validated and refined through contextualisation, consultation and discussion with policymakers and business leaders.

Fifth, while this report intentionally presents our data analysis with minimal contextualisation, **in reality the opportunities and challenges that Sweden faces for the future cannot be analysed in isolation, without placing them in the current geopolitical and European context.** In particular, the current geo-political situation and the new priorities being set by the European Commission are extremely relevant for the future of Sweden. The Clean Industrial Deal, the Rearm Europe initiative, the proposal for FP10, the future R&I programme of the EU post-2028, the InvestAI strategy and the consequent debated on AI gigafactories and the "CERN for AI", and the Eurostack debate (Bria et al. 2025) on technological sovereignty are only some examples of a series of developments that open up new opportunities for Sweden to consolidate and relaunch its competitiveness. This, however, requires enhance situational awareness of what is happening in Brussels and beyond; good analytics backing Sweden’s proposed role in specific investment and programmes (e.g. in the “CERN for AI”); and openness to deeper cross-regional cooperation with other European regions with related technological specialisation.

Against this backdrop, this report provides a basis for Swedish institutions and key stakeholders for evidence-based and foresight-informed decisions for the future of the country and its regions. In a nutshell, this means focusing investments on high-impact, high-potential KSTs where Sweden can lead globally; strengthening regional ecosystems to distribute innovation benefits nationwide; expanding European collaborations, especially in areas with high complementarity; and maintaining a robust data infrastructure to monitor progress and adjust strategies

Appendix



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Methodological Appendix

Data. The empirical foundation of this study rests on three large-scale datasets. Patent data come from the OECD REG-PAT database, covering European and international patent documents from 2010 to 2024. Scientific publications are sourced from OpenAlex, which provides a comprehensive coverage of global research output from 2010 to 2025. Start-up investment data are taken from Crunchbase Pro, covering venture funding and deal flows between 2010 and 2025. All three datasets are reclassified into 48 Key Strategic Technologies using a bespoke machine learning and expert validation process, described below.

Classification. The classification of technologies into patents, scientific topics, and investment categories follows a three-step methodology designed to maximise robustness and reproducibility. The first step involves embedding a clean list of descriptive keywords for each technology into 3,072-dimensional vectors using advanced language models. The same embedding process is applied to all CPC patent classes and all OpenAlex scientific topics. By computing cosine similarity between vectors, we generate candidate matches. This approach captures semantic similarity beyond literal wording, ensuring that linguistically different terms that denote the same concept, such as "3D printing" and "additive manufacturing," are mapped together. The second step refines this candidate list using measures of relatedness. Whereas embeddings capture semantic proximity, relatedness ensures that the similarity is meaningful in empirical innovation systems. Relatedness is computed from the normalized co-occurrence of CPC codes within the same patent, of topics within the same publication, or of technologies within the same funded startup. This step prevents spurious semantic matches by anchoring classifications in actual technological, scientific, and investment networks. The third step is a systematic manual review, during which we examine candidate matches, apply thresholds, and remove false positives. This is particularly important for technologies with fuzzy boundaries such as artificial intelligence or synthetic biology, whereas more codified fields like nuclear fission are less ambiguous. The final outcome is a robust crosswalk between technologies and classification systems. Unlike keyword searches or regex-based methods, which require exhaustive lists of terms and often miss synonyms or return irrelevant results, this approach combines semantic precision with empirical validation.

Indicators. To assess competitiveness, three composite indices were developed. The Technological Index aggregates patent counts, per capita intensity, revealed comparative advantage (RCA), and relatedness density. The Scientific Index combines publication counts, per capita intensity, RCA, and relatedness density. The Investment Index brings together startup funding, per capita intensity, RCA, and relatedness density. Each index is scaled from 0 to 100, balancing both absolute and relative performance. These indices allow us to place Sweden's technologies into quadrants that distinguish between global leadership, scientific leadership, technological leadership, and lagging areas. Relatedness density quantifies how easily a region could branch into a new technology based on the presence of related activities in its existing portfolio (see formula as described in Balland, 2017 and the EconGeo R package). Complexity captures how exclusive or sophisticated a technology is, based on its distribution across urban areas as a variation of the scaling method proposed by Balland et al. 2020).

Limitations. There are several methodological limitations that should be acknowledged. Patent data capture tangible inventions and underrepresent service-led inventions. Scientific publication data do not fully capture industrial research and may be influenced by country-specific publication practices. Startup investment data are skewed towards fields with high venture capital intensity and therefore underestimate mature technologies that are not VC-driven. These caveats underline the importance of careful interpretation of results and expert validation of the optimal investment allocations.

Links to interactive graphs

DOMAIN SPACES	LINK
Patents https://www.paballand.com/ceps/iva/domain-space/regpat.html	
Publications https://www.paballand.com/ceps/iva/domain-space/openalex.html	
Startup investment https://www.paballand.com/ceps/iva/domain-space/crunchbase.html	

COMPETITIVENESS SHIFTS (3 FILES)	LINK
Patents https://www.paballand.com/ceps/iva/shift/regpat.html	
Publications https://www.paballand.com/ceps/iva/shift/openalex.html	
Startup investment https://www.paballand.com/ceps/iva/shift/crunchbase.html	

COMPETITIVENESS OF SWEDEN (144 FILES)	LINK
https://docs.google.com/spreadsheets/d/1mDNpr2r3_GPye2U2HFshDnX9EzkHjFhuv8Oiqt-KZrrI/edit?usp=sharing	
Summary graph https://www.paballand.com/ceps/iva/position/sweden.html	

OPPORTUNITIES FOR SWEDISH REGIONS (24 FILES)	LINK
https://docs.google.com/spreadsheets/d/1Vz1grGEoPL7RbNAVz8UlWm0kMsUk1UvT-i4Umb-KDY-E/edit?usp=sharing	

SWEDISH ECOSYSTEMS (138 GRAPHS)	LINK
https://docs.google.com/spreadsheets/d/1-63M4zEAJNX5_kHjVBUmzLb_RunYADVjh-X8_KU-4GYI/edit?gid=0#gid=0	

COLLABORATION NETWORKS OF SWEDISH REGIONS (768 FILES)	LINK
https://docs.google.com/spreadsheets/d/1KZ4pM5OQ1-8Dqer_x_mdv-kTXtjaIXWBKeREkik-dXx4/edit?usp=sharing	

Methodological Q&A

This methodological note in a Q&A format details the methodology used to map Sweden's competitiveness and investment priorities in Key Strategic Technologies (KSTs), expanding upon the core concepts, data sources, complexity metrics, and known limitations.

Q: Which core data sources underpin the analysis, and what time window is covered?

A: The analysis integrates three large-scale datasets, each covering activity reclassified into 48 Key Strategic Technologies (KSTs):

- Patent data: Sourced from the OECD REGPAT database, covering the period 2010–2024, used to measure technological activity, Revealed Comparative Advantage (RCA), and relatedness between technologies,.
- Scientific publication data: Sourced from OpenAlex, covering global research output from 2010 to May 2025, used to measure scientific output, RCA, and scientific proximity.

- Startup investment data: Sourced from Crunchbase Pro, covering venture funding and deal flows between 2010 to May 2025, used to assess entrepreneurial activity and investment specialization.

Q: How many KSTs were analyzed, and why is their classification critical?

A: The analysis covers 48 Key Strategic Technologies (KSTs), which are considered crucial for Sweden's future prosperity, economic resilience, and national security. The classification process is critical because it ensures that records across patents, publications, and investments are accurately mapped to the specific technological domains.

Q: What is the methodology used for classifying patents, publications and investments into KSTs?

A: The classification methodology is designed to maximize robustness and enrich semantic similarity with empirical validation. We operate in three main steps.

1. A clean list of descriptive keywords for each KST, along with all CPC patent classes, OpenAlex scientific topics, and Crunchbase industry tags, were embedded into 3,072-dimensional semantic vectors using text-embedding-large (the embedding model underlying GPT-5). Candidate matches were generated by computing cosine similarity between these vectors, allowing the process to capture semantic similarity even if different terminology is used (e.g., "3D printing" vs. "additive manufacturing")

2. Semantic similarity was subsequently validated using empirical relatedness (normalized co-occurrences). This step eliminates semantically similar but empirically irrelevant matches by requiring normalized co-occurrence of CPC codes on the same patent, topics in the same publication, or technology tags in the same funded startup. Co-occurrence are normalized using cosine similarity.

3. Borderline cases and potentially ambiguous domains underwent systematic manual review to ensure conceptual coherence and remove residual false positives, leading to a robust crosswalk between technologies and classification systems. This is important to note that the manual review

is mostly used to define thresholds, but results are not sensitive to hard rules.

Q: What are the four underlying component measures of the technological, scientific, and investment indices?

A: The scientific, technological and investment indices measure Sweden's relative performance in each technology domain by combining four complementary indicators:

1. Absolute Counts (scale) computes the raw number of patents, publications, or investments associated with a technology. This captures overall scale, which is important for complex technologies, and inherently favors larger countries.

2. Per-Capita Counts normalize absolute activity (patents, publications, or funding) by the population of different countries, highlighting deviation from proportional expectations.

3. Revealed Comparative Advantage (RCA) using the standard Balassa formulation evaluate if a country is relatively

more specialized in a technology compared to the global average. Values greater than one indicate Sweden holds a relative specialization in that specific technology.

4. Relatedness Density measures the share of technologies in which a country already has an RCA above 1, indicating how easily Sweden could diversify into a given technology based on its existing capabilities. This use the formula described by Balland

Q: How are the different indicators combined to form unified technology, science, and innovation indices to compare country performance?

A: For each domain and each data source (Regpat, OpenAlex, Crunchbase), every country is ranked along the four dimensions described above, with rank 1 indicating the strongest performance. The composite index (for instance underlying this graph) is calculated as the negative average of these ranks – so that higher values correspond to stronger capabilities – and is then rescaled to a 0–100 range to ensure comparability across sources. This yields a unified measure of technological strength that reflects scale, specialization, structural coherence, and intensity.

Q: How should the resulting quadrants be interpreted?

A: We can then position any technology on a two-dimensional map defined by the Technological Index (x-axis) and the Scientific Index (y-axis) described above, which naturally produces four quadrants. North-East (Global Leadership) includes technologies where Sweden performs above the median on both indices. North-West (Scientific Leadership) captures technologies with a strong scientific base (above median) that has not yet translated into technological strength (below median). South-East (Technological Leadership) represents technologies where Sweden shows strong technological capabilities (above median) despite a comparatively weaker scientific foundation (below median). South-West (Lagging) includes KSTs where Sweden falls below the median on both scientific and technological dimensions. The medians are computed relative to the selected set of technologies, ensuring that the distribution always spans all four quadrants. Investment strength is represented graphically by the color of the technology, indicating whether the Investment Index (reflecting venture funding flows) is above the median value (green) or below the median value (red).

Q: How is relatedness density specifically calculated using proximity matrices?

A: In this report, we do not derive proximity (technological relatedness) from co-exports within the same country as in Hidalgo et al. (2007). Instead, we follow the smart specialization paper of Balland et al. (2019) and compute proximity directly from normalised co-occurrences – using cosine similarity – of pairs of technologies appearing within the same patent, publication, or investment. This produces a technology–technology proximity matrix grounded in actual co-appearance patterns across all three data sources. Importantly, our proximity matrices are not restricted to the 48 focal technologies, they cover the entire technology universe, ensuring that the relatedness metrics are not relative to the preselected set. Once the proximity matrix is constructed, relatedness density is computed exactly as in the standard formulation: for a given country and target technology, it measures the share of that technology's weighted links that point to technologies in which the country already has RCA > 1.

Q: How is technological complexity measured?

A: To measure the complexity of technologies the report uses an approach inspired by urban scaling research, particularly the work of Balland et al. (2020). The core intuition is that complex technologies are those concentrated in the largest, most productive urban areas at the global scale, while ubiquitous technologies are found everywhere. The measure builds on principles from urban economics where large cities tend to specialize in complex economic activities, simple, foundational activities are distributed broadly across all city sizes and the concentration pattern reveals underlying complexity. The method is based on a urban areas – technology matrix where cells indicate counts of activity (patents in this case). Locations are sorted in descending order by their total activity level, creating a hierarchy from largest to smallest producers. An algorithm performs multiple runs that progressively include more locations, top 10 locations only, top 15 locations, top 20 locations, and so forth. For each run of n locations, we calculate each technology's concentration share as (Sum of technology activity in top n locations) / (Total technology activity across all locations) × 100. This produces a value between 0–100% indicating how much of a technology's activity is concentrated in the top locations. Technologies whose concentration shares decline rapidly are considered simple or ubiquitous.

The final complexity score is computed by averaging each technology's concentration shares across all runs. Higher scores indicate technologies concentrated in major hubs (complex). Lower scores indicate technologies distributed broadly (simple). The method can be applied to three types of data and is more robust to variation in counts than the seminal Hidalgo & Hausmann paper. It is important to stress that this method is output-based rather than input-based: it infers complexity from the observed spatial patterns of activities at the global scale, under the assumption – well established in economic geography – that highly sophisticated capabilities tend to accumulate in large, dense innovation ecosystems. In other words, the geographic pattern of production is treated as a revealed manifestation of the underlying know-how required to operate in a given domain. While this principle holds for most technologies, it may be violated in a few special cases where activity is deliberately located away from major cities – such as domains dependent on natural resources or security-sensitive sectors, where spatial dispersion reflects constraints rather than capability.

Q: Explain the four opportunity types identified in the regional quadrant framework.

A: The regional analysis combines relatedness density (ease of entry/low risk) on the horizontal axis and complexity (potential return/risk) on the vertical axis, aligning with smart specialisation principles operationalized by Balland et al. (2019). This produces four strategic quadrants (1) Optimal Investment shows technologies with high relatedness and high complexity – low-risk, high-return opportunities where the region already has strong foundations for sophisticated activities; (2) Moonshot Initiatives where technologies have low relatedness but high complexity so high-risk, high-return domains that require mission-oriented, highly coordinated interventions; (3) Incremental Growth with high relatedness but low complexity so low-risk, moderate-return opportunities that build on existing but less sophisticated strengths and finally (4) Strategic Divestment with low relatedness and low complexity – high-risk, low-return areas where maintaining or expanding activity offers limited strategic value.

Q: What are the acknowledged limitations of using patent data for this analysis?

A: Patent data is the deepest knowledge source for measuring technological activity, but it might underrepresent specific areas: pure software-related inventions, tacit knowledge (non-codified know-how), and early-stage or secrecy-driven research.

Q: What are the limitations associated with using scientific publication data?

A: Publication data does not fully capture industrial research.

Q: What is missing from the investment data used in the analysis?

A: The startup investment data primarily covers venture funding and deal flows, favoring VC-intensive fields. It is important to note that the report does not include private R&D investments made by large, established companies. Although it is not possible to capture private R&D investments inputs at a global scale and at this granular level, R&D outputs are likely to show up in patent data. So, all together these 3 sources capture the key angles of a competitiveness analysis.

Q: Would you recommend adding additional data for deeper analyses?

A: Incorporating labour-market data – such as online job postings from Lightcast and skill-supply data from sources like Revlio – would add a valuable dimension, especially in the US and EU context (data is not reliable for China and other parts of the world). These datasets help capture real-time demand and supply of capabilities. Additional and non-trivial data sources could include systematic web-scraping of company websites to extract granular information on firm activities, technologies, and strategic orientations that other datasets may miss. Web traffic, social-media signals, product databases, and trade data could also be integrated to provide a more comprehensive, multi-layered view of the innovation and industrial ecosystem.

Q: How are patents geographically attributed in the analysis?

A: In the analysis, patents are attributed to countries and regions based on inventor addresses rather than the location of the patent owner or legal applicant. This methodological choice is intended to better reflect where technological knowledge is actually developed, rather than where intellectual property is formally held. It is particularly important for international comparisons, as multinational firms often centralize patent ownership in a limited number of jurisdictions, which could otherwise distort the geographical distribution of R&D capabilities.

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