nature research intelligence

UK Research and Innovation

The innovation and collaboration landscape in China – opportunities, risks and future engagement

Summary Report

Nature Research Intelligence

Contact
Steven Riddell
steven.riddell@springernature.com

Summary Report

The last four decades has seen substantial growth in the innovation and science landscape in China. Data from 2023 indicates China is second to the United States of America (USA) in terms of research and development (R&D) spending (adjusted by purchasing power parity). In 2023, China spent RMB (Renminbi) 3,327.8 billion (over £367 billion) on R&D, accounting for 2.64% of GDP. China is also home to 1.87 million researchers – approximately 25% of the world's R&D workforce (UK Science and Innovation Network summary: China; National Bureau of Statistics China).

The 14th Five-Year Plan (2021-2025) of the People's Republic of China was developed with a vision to achieve high quality, sustainable and innovation-driven development. The plan advocates for increased investment in R&D and domestic innovation to strengthen China's position in advanced industries. A common feature in the plan emphasises the role of open trade relationships and supporting international partnerships via projects such as the Belt and Road Initiative.

Looking forward, as China now embarks on its 15th Five-Year Plan, indications are that the country will double down on its commitment to high-quality, green development and accelerate investment towards emerging industries – underscoring China's ambition to modernize the industrial system. With a concerted focus on supporting technology development and commercialization, strengthening academic-industry collaborations through science parks and technology transfer offices, as well as offering financial and tax incentives to support start-ups, are key parts of the toolkit to achieve this endeavour. This ambition coincides with an increased emphasis on innovation collaboration by attracting Chinese and foreign academic leaders and businesses through capital and seed investment.

In meeting the United Kingdom (UK)'s long term missions, engaging in China's flourishing innovation ecosystem is seen as pivotal to unlocking new commercial opportunities and expanding the productive capacity of the UK economy across areas of shared strategic interests. The pursuit of any opportunities will need to ensure robust mitigation strategies are in place to manage risk in accordance with trusted research and innovation practices. Given the wealth of opportunity available through closer collaboration between the UK and China, the UK Research and Innovation (UKRI) China office commissioned Nature Research Intelligence to produce a report assessing the innovation and collaboration landscape in China.

This Summary Report aims to capture a selection of key takeaways.

Key Takeaways

1. The ability to test and adapt new technologies within China's substantial commercialization market and gain access to an immense talent pool and well-developed infrastructure, is making collaborations with Chinese partners a highly attractive proposition for UK innovators.
2. China has a flourishing landscape for innovation funding at both the central government level and the provincial level, with opportunity for entry and co-funding collaboration.
3. Innovative collaborations, where possible, should align with Chinese governmental planning but should look beyond borders where innovators are addressing global needs, not just Chinese needs.
4. Intellectual Property (IP) risk was identified as a crucial barrier to entering the Chinese market. However, with considerable progress to the IP laws in China, there are now significantly greater safeguards in place.
5. China's vast market, its complex regulatory systems and cultural differences in business etiquette require substantial local knowledge to navigate, which many small and medium-sized enterprises (SMEs) lack.
6. Despite the barriers and risks apparent for innovative collaboration, most can be negated with forward planning by innovators and support from funders and business enablers.

7. Face-to-face engagement and physical presence by foreign innovators in China are crucial to develop trust and form long-term innovative collaborations.
8. Long-term funding strategies are critical for foreign innovators to build secure and beneficial innovative collaborations with China.

Aims and Methods

To develop a more robust understanding of China's current innovation capabilities and potential strategies for future engagement, the study set out to address the following specific objectives:

- Assess the economic case for engagement with China on innovative collaboration, mapping China's sectoral strengths in commercialization and innovation to the UK's strategic priorities.
- Analyze China's academic research and innovation funding landscape, including the mechanisms that support international partnerships and business start-ups in China.
- Identify opportunities, barriers, and risks to collaborating with China by exploring how countries that are comparable to the UK are engaging on academic research and innovation in and with China.
- Gather evidence of how UK businesses are forging alliances within China's innovation ecosystem, highlighting successful engagement models for collaborating with and in China.
- Provide recommendations for future UK-China collaboration on commercialization and innovation, focusing on strategies for mutual benefit and risk mitigation.

To achieve these objectives, Nature Research Intelligence employed a mixed-methods approach that integrated bibliometric analysis, desk-based research, and qualitative interviews.

Bibliometric analysis

Bibliometric and patent analysis were undertaken on a dataset extracted from Dimensions and encompassing a five-year publication range from 2020 to 2024. Academic research outputs with an affiliation based in China, the UK, or the comparator countries (USA, Australia, Japan and Germany) formed the primary analytical method. Nature Research Intelligence also leveraged their in-house artificial intelligence topic model to match publications to scientific topics using semantic embedding similarity. Following this, an evaluation of topic growth was conducted within the research domains earmarked by UKRI to support the future economy. Patent counts assigned to these topics were extracted through a linkage method and segregated into those published in China by Chinese or UK assignees.

Desk-based research

Documents available online were sourced from a variety of outlets (e.g., government websites, open data websites, university websites, press releases and corporate websites) to support the analysis and draw up case studies.

Qualitative interviews

To complement the bibliometric and desk-based research, Nature Research Intelligence conducted 31 semi-structured interviews with 34 stakeholders across a range of organizations (e.g., funders, innovation agencies, government departments, businesses, research institutions) based in the UK, China, or the comparator countries. Conducted online between November 2024 and January 2025, the interviews explored China's innovation and funding landscape; opportunities, barriers and risks to collaboration; and strategies used by UK businesses and innovators when engaging with Chinese partners. Thematic analysis was used to extract key

insights, with anonymity respected unless participants explicitly consented to being named.

China's academic research and innovation landscape

China's research prowess

In 2023, China made headlines as it overtook the USA as the number one ranked country or territory for contributions to academic research articles published in the Nature Index group of high-quality natural-science journals. Based on data from Dimensions, China's academic research output shows significant growth from 2020 to 2023 (10.9% compound annual growth rate).

Benchmarking China's academic research output against several comparator countries (USA, UK, Germany, Japan and Australia) between 2020 and 2024, reveals that China leads by publication volume (4,532,375) – approximately 340,000 more than the USA (

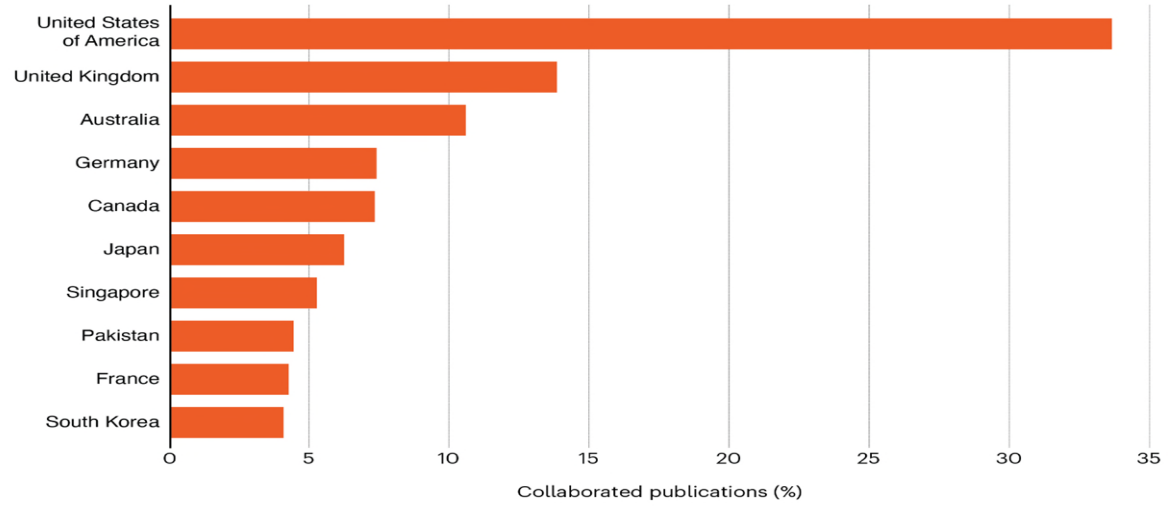
Table). While Chinese research outperforms the comparator set by the total volume of citations (43,901,886), the country sits third when comparing citations per publication (9.7), behind Australia and the UK.

Table 1: Benchmarking China's academic research output (2020-2024) with comparator countries

Country	Total publications	Total citations	Average citations per publication	% of highly 10% cited publications	% of highly 1% cited publications
China	4,532,375	43,901,886	9.7	9.8%	1.1%
United States of America	4,190,441	37,363,535	8.9	9.6%	1.3%
United Kingdom	1,306,836	14,317,844	11.0	12.4%	1.7%
Germany	1,180,713	10,581,440	9.0	9.8%	1.3%
Japan	1,020,111	5,351,650	5.3	4.5%	0.6%
Australia	632,490	7,785,591	12.3	13.5%	2.0%

The USA is the dominant academic research partner for China, contributing more than one third (33.7%) of all publications co-authored by China and an international partner (Figure 1). The UK (13.8%), Australia (10.6%), Germany (7.4%) and Canada (7.3%) round out the top five collaboration partners.

Figure 1: Top academic research collaboration partners with China between 2020 and 2024



The UK has four universities in the top 20 global collaborating partners with China, only Australia exceeds this count with six (based on co-authored research publications between 2020-2024). In this ranking University College London places 4th, producing more than 10,700 co-authored research publications with China. Oxford University places 7th (8,675 research publications) followed by Imperial College London placing 8th (8,625 research publications). The University of Cambridge, which places 14th, has the highest citation impact among the four UK universities in the top 20 positions - generating 30.1 average citations per publication.

Research commercialization and patent performance in China

Commercialization of research is recognised as a key indicator for innovation. Government support and strategic policies aimed at boosting innovation, such as the "Made in China 2025" initiative and the "14th Five-Year Plan", are instrumental in China's achievements to translate innovation into commercial applications. Moreover, "Industry-University Research Collaboration" programs are enabling companies to leverage academic resources to facilitate knowledge and technology transfer. In fact, China has invested in developing high-tech parks and technology transfer offices, creating spaces where businesses can access cutting-edge innovation and resources.

Alongside these initiatives, the Chinese government are encouraging private companies to invest in innovation commercialization by providing a range of financial incentives, including tax relief, grants and subsidies. Indeed, a rising number of venture capital firms in China are specializing in sectors like AI, biotechnology and clean energy, often partnering with state-backed funds to support early-stage start-ups.

A proxy measure for innovation can be derived from the number of patents published by a patent office. Between 2020 and 2024, there have been more than 25 million patents published in China, with an average of 5 million per year, far exceeding the patent count of the comparator countries (Table 2).

Table 2: Number of patents published in China and in comparator countries between 2020 and 2024

Country	Patent count	Number of cited patents	% of cited patents
China	25,114,899	4,426,397	17.6%
United States of America	3,817,954	1,304,615	34.2%
United Kingdom	191,585	7,753	4.0%
Germany	407,353	58,057	14.3%
Japan	2,559,211	209,722	8.2%
Australia	283,839	6,891	2.4%

Corporate entities dominate the top twenty organizations with a patent published in China between 2020 and 2024 (Table 3). The State Grid Corporation of China (165,991) leads with twice as many patents as second-ranked Huawei Technologies (80,025).

Table 3: Top 20 organizations in China who have had a patent published between 2020-2024

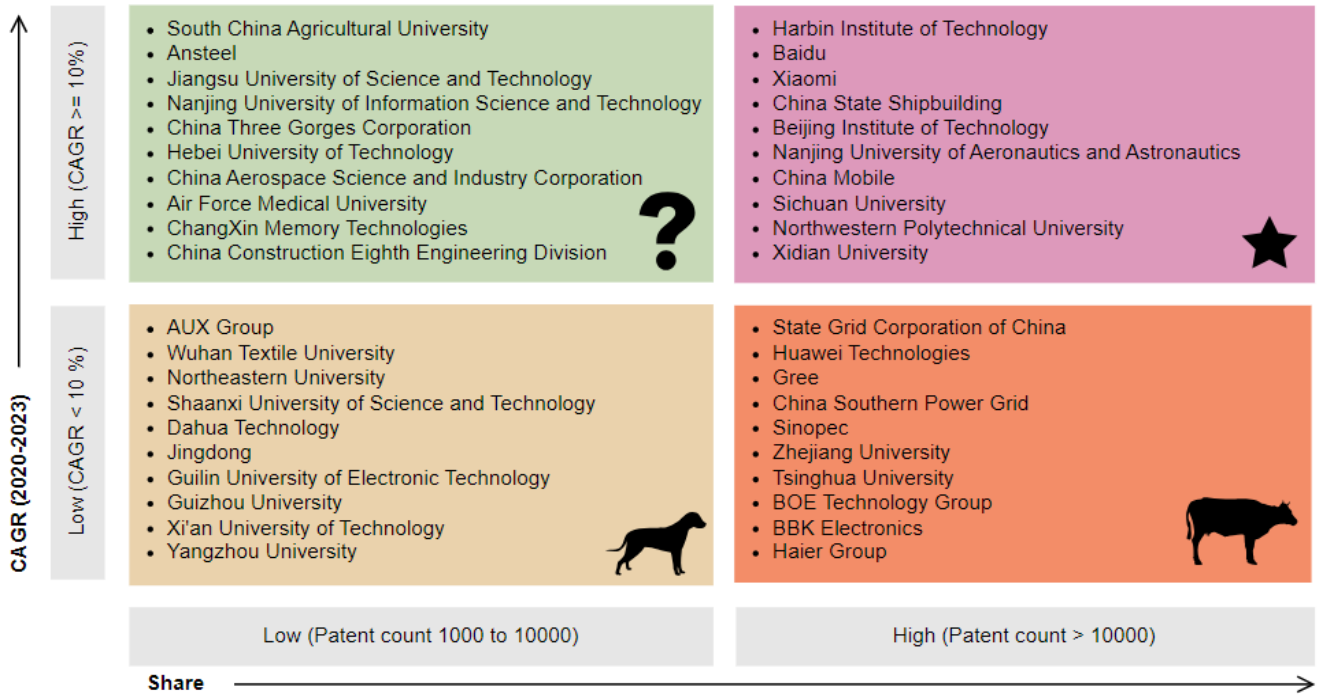
Patent Assignee name	Organization type	Patent count	Patent citations (Number of patents citing the patents)
State Grid Corporation of China	Company	165,991	142,493
Huawei Technologies	Company	80,025	75,482
Gree	Company	72,180	46,297
China Southern Power Grid	Company	62,777	47,104

Sinopec	Company	62,567	27,351
Zhejiang University	Education	53,672	48,509
Tsinghua University	Education	44,596	45,747
BOE Technology Group	Company	40,915	37,611
BBK Electronics	Company	39,930	39,048
Haier Group	Company	38,270	18,167
Harbin Institute of Technology	Education	36,089	30,855
Metallurgical Corporation of China	Company	34,743	14,584
Huazhong University of Science and Technology	Education	33,347	32,129
Midea Group	Company	32,001	16,359
Xi'an Jiaotong University	Education	31,462	32,255
Peking University People's Hospital	Healthcare	31,172	6,383
South China University of Technology	Education	30,842	34,333
University of Electronic Science and Technology of China	Education	30,825	33,184
TCL	Company	29,941	30,834

To better understand where enterprises rank by share and growth of published patents in China, the Boston Consulting Group Matrix (BCG Matrix) was implemented. The matrix examines the compound annual growth rate (CAGR) of patents between 2020 and 2024 against the overall share of patents, attributing entities in China into four quadrants (Figure 2):

- **Question marks:** Patent assignees with low market share and significantly high CAGR
- **Stars:** Patent assignees with high market share and significantly high CAGR
- **Cash Cows:** Patent assignees with high market share and low CAGR
- **Dogs:** Patent assignees with low market share and low CAGR

Figure 2: BCG matrix of share and growth of patent assignees in China



Across all quadrants there is no clear sector which dominates, except for "Stars" which is led by academic institutions such as Harbin Institute of Technology and Beijing Institute of Technology. The "Cash Cows" feature consumer technology (e.g., Huawei, BBK Electronics) along with state-owned energy enterprises (e.g., State Grid Corporation of China, China Southern Power Grid). This group could be indicative of strong expertise and dedicated resources in patent creation and submission.

The "Question marks" should be monitored. This group has high growth in patents published between 2020 and 2024, but a low share. Organizations in this group are affiliated to a mix of technology, construction, energy and academic sectors.

Defined as the "Dogs", this group has a low share of patents (<1,000) and low growth (<10% CAGR). It is made up of mostly academic institutions (e.g., Wuhan Textile University, Northeastern University) who may have less expertise in patent development or are potentially starting to build capability in patent applications.

Importantly, patents published in China are not exclusive to Chinese organizations. The top twenty international organizations who have had a patent published in China are primarily comprised of technology and automotive companies from Japan and South Korea.

China's innovation funding landscape

China has become a hotspot for innovation-focused funding. Through offering financial and tax incentives to support start-ups (China Briefing) and expanding funding for science parks and technology transfer offices (Lexology), China is making great efforts to foster technology development, commercialization, and market expansion within the country. Of particular note, the State Council recently announced revised NSFC Regulations, effective January 1, 2025. Marking a first update in 17 years, the revisions focus on diversifying funding mechanisms by encouraging joint contributions from local governments, enterprises, and organizations.

Local Science and Technology (S&T) Committees in China play a critical role in developing regional innovation by offering various grant programs. The committees are responsible for implementing national S&T policies at

the provincial and municipal levels, cultivating collaboration between enterprises, research institutions and governmental bodies. Testament to this, TusPark – a flagship for the Zhongguancun National Innovation Demonstration Zone – has benefitted from provincial funding and now gathers over 1,000 technology companies and R&D institutions. TusPark has integrated resources from a range of sectors including government, industry, university, finance, intermediaries, trade and media to develop an ecosystem of scientific innovation and entrepreneurship.

The progress China has made in driving increased innovation outputs was recently evidenced by the World Intellectual Property Organization's (WIPO) Global Innovation Index for 2024 – an international ranking of innovation capabilities across 133 economies. The index measures innovation across seven broad themes: institutions; human capital and research; infrastructure; market sophistication; business sophistication; knowledge and technology output; and creative outputs. China has continued to ascend the ranks - from 35th place in 2023 to 11th place in 2024. Among all innovation capability indicators in 2024, China ranks 1st globally for creative goods export, domestic market scale, high-tech exports, industrial design, trademarks, utility models and PISA scales in reading, maths and science. Figure 3 provides a map of the top ranked Chinese city clusters and the top patent field for each.

Figure 3: Map of the 26 Chinese cities by intensity featured in the Global Innovation Index 2024.

Chinese funder opportunities

China's funding mechanisms are often tied to national goals, such as advancing high-tech industries, fostering global competitiveness, and addressing societal challenges. Through the "14th Five-Year Plan", the Chinese government are explicitly promoting international collaboration, making them accessible to foreign entities partnering with Chinese institutions. Examples of key funders or specific funding programs for innovation include:

- The Ministry of Science and Technology (MOST)
- The National Natural Science Foundation of China (NSFC)
- The National Development and Reform Commission; The Commission of Science, Technology and

Industry for National Defense; The Ministry of Industry and Information Technology; The Ministry of Education; and other ministries and commissions
- The Belt and Road Initiative and the Silk Road Fund
- The China Innovation Fund for Technology-based Firms
- The Science and Technology Innovation Board (STAR Market)
- Provincial and Municipal Innovation Funds
- China Development Bank Innovation Loans
- Local governments, including provincial and city governments, especially in economically advanced areas (e.g., Shenzhen, Shanghai, Beijing, Hangzhou, Suzhou)

Government spending and policy development are pivotal levers for the Chinese government to help crowd in private sector investment into R&D and innovation. In 2023, China's R&D spending reached about 2.5% of GDP, with a strong focus on applied research (National Bureau of Statistics of China). The "Made in China 2025" initiative and the "14th Five-Year Plan" prioritize funding to high-tech industries like AI, biotechnology, and clean energy, focusing on reducing reliance on foreign technology and creating globally competitive industries.

China has implemented a variety of policy measures designed to support innovation. These include strategic planning by multiple government ministries to create innovation programs targeting talent and new enterprises. The qualitative research supported this finding, indicating that R&D investment is "effectively bottomless" and demonstrating China's commitment to advancing innovation. It was also apparent that if the central government believes it is important to create a new policy [for R&D or innovation], fresh measures will be implemented. New policy cascades to provincial and city governments, allowing for a flexible approach to local governance, and only somewhat guided by the central policies.

International research funder opportunities

China remains an attractive partner for many funders who support research collaborations between countries, broadening the scope of innovative and academic research with China. One note of caution is that the volume of funding calls offered by some countries has slowed in recent years, owing to the sensitivity of certain research topics and the broader geopolitical context, which impacts upon collaboration.

Many countries around the world offer cross collaboration funding for research with China. Examples include Australia, USA, Japan, Germany, The Netherlands, Canada and France.

- The European Commission is the top international funder for academic research conducted in China, awarding almost 1,700 grants (USD 8,363 million). Notable areas for funding include artificial intelligence, green energy, and health.
- The National Science Foundation (USA) and National Natural Science Foundation of China fund convergent research with significant sustainability and social impact, particularly engineering research on sustainable regional systems.
- In collaboration with the Chinese Academy of Sciences (CAS) and Cooperation China (CAS), the Merian Fund supports joint inter- and transdisciplinary teams of Dutch and Chinese researchers and stakeholders in areas related to sustainable drinking water and sustainable farming.
- Canada's International Development Research Centre partners with Chinese researchers on developmental projects, including in areas related to health systems, food security, and digital innovation.

International business collaborations

Collaborations between foreign owned businesses and entities in China were found across a wide variety of sectors, including clean energy and life sciences. Typically, these ventures utilized local expertise and made good

use of China's well-developed infrastructure.

Case studies were identified with the following key performance indicators (KPIs) considered:

- Length (years) of joint venture or innovation project
- Projected economic growth derived from the collaboration
- Domain-specific measures (e.g. renewable energy capacity generated, agricultural yield gains)
- Cost savings realized
- Alignment to strategic goals

Some prominent examples are provided below:

Australia – China: Goldwind Australia, a subsidiary of Goldwind, one of China's largest wind turbine manufacturers, has formed multiple successful partnerships in Australia's renewable energy market. A major construction of the *Gullen Range Wind Farm (165.5 MW)* showcases the successful integration of Chinese wind turbine technology with local Australian expertise. These projects have created significant renewable energy capacity, with the Gullen Range turbine servicing approximately 60,000 homes.

Japan – China: INESA (Group) Co., Ltd., a state-owned Chinese company specializing in smart city solutions partnered with Fujitsu, culminating in a venture aimed at developing comprehensive smart manufacturing solutions. This collaboration aligned closely with China's national strategy to drive competitive gains in domestic manufacturing. According to a report by SNS Insider, the market was valued at USD 606.3 billion in 2023 and is projected to reach USD 3,052.7 billion by 2032.

Israel – China: Teva's most recent partnership in China was announced on February 26, 2024, with Jiangsu Nhwa Pharmaceutical Co., Ltd. This collaboration focuses on the marketing and distribution of AUSTEDO (deutetrabenazine), a treatment for chorea associated with Huntington's disease (HD) and tardive dyskinesia (TD) in adults. The partnership aims to expand patient access to AUSTEDO in China by leveraging Jiangsu Nhwa's strong presence in the neuro-psychiatric health sector. The collaboration brings expertise in R&D, manufacturing, and commercialization of neurological and psychiatric drugs. Teva sees this as part of its "Pivot to Growth" strategy, aiming to increase AUSTEDO's global market presence, which generated over USD 1.2 billion in revenue in 2023 (China Daily).

Benefits and opportunities for collaborating with China

The insights derived from this report clearly showcase the significant commercial opportunities for international businesses looking to collaborate with China, as outlined below:

- **Large commercialization market:** China's large population presents significant opportunities for international businesses to introduce and commercialize products, as well as manufacture at scale.
- **Regulatory speed:** The regulatory environment in China allows for quick commercialization of emerging technologies through, for example, relaxed regulations in designated pilot zones.
- **Testing, adapting and scaling-up:** China is open to testing new innovations, working internationally.
- **Infrastructure, talent and innovation capacity:** The country leads in critical technologies, making collaboration essential for accessing and advancing key innovations.
- **Cost-effectiveness:** China remains cost-effective due to its sophisticated industrial base, operational efficiency, and availability of high-quality talent.
- **Mutual knowledge exchange:** Collaborating with China fosters significant learning and expertise exchange, bridging cultural and procedural gaps.

Sector-specific opportunities for the UK to collaborate with China on innovation

Key opportunities for innovative collaboration should be driven by global needs while navigating geopolitical sensitivities around trusted research and innovation. The UKRI areas for future impact – net zero, healthy living, agriculture and sustainable food production, and digital technologies – present strong investment opportunities that not only address global challenges but also deliver tangible benefits to the UK economy. However, any collaboration opportunity intersecting with national security, particularly in critical and emerging technologies, should be approached with caution or avoided altogether.

Focusing on provincial government innovation priorities, which tend to be more specific than national-level strategies, offers clear advantages for innovative collaboration. While the full report did not map out each province's innovation priorities, a deeper dive into the sectoral alignment and identification of future collaboration models is strongly recommended as a next step.

Analysis of academic research, patent data, and qualitative interviews reveals key opportunities aligned with UKRI impact areas. Nature Research Intelligence Topics, along with insights from experts interviewed for this report, pinpoint the most promising areas for UK-China collaboration to drive innovation and commercialization, as detailed below. Further exploration is needed on these themes and topic areas to identify the benefits and risks around collaboration.

Net Zero	**Healthy Living**	**Agriculture and Sustainable Food Production**	**Digital Technologies**
• Catalytic conversion of carbon dioxide to methanol • Zinc-ion battery technology • Radiative cooling technologies and materials • Metabolic engineering of Escherichia coli for carbon source utilization • Diamond-based quantum technologies * • Transcritical carbon dioxide refrigeration and heat pump systems • Offshore renewables • New energy vehicles	• Artificial Intelligence in healthcare and medical communication • Drug delivery systems • Artificial Intelligence in medical imaging and diagnosis • Digital inclusion for older adults • Antimicrobial resistance and infections in healthcare settings • Ageing population • Medical devices • Biopharmaceuticals	• Precision Agriculture • 3D food printing technology applications • Postharvest biology and food quality • Hydrogels and superabsorbent polymers in agricultural and biomedical applications • Plant biostimulants and crop yield enhancement • Aerial applications in agriculture and threshing technology • Pichia pastoris in recombinant protein production • Sustainability (e.g., coastal ecosystems) • Climate change	• Virtual reality technologies (e.g., try-on technology, education and literacy) • Optics (e.g., optical system design and optimization, liquid lenses and optofluidic systems, optical phased arrays and beam steering technologies) * • Architecture, design, visual arts, photography and advertising

* This area may be unlikely as a focus for future collaboration due to sensitivities and potential dual use application

Growth Mission: Net Zero

In the UK Government's *Plan for Change*, a key mission is to make Britain a clean energy superpower, where the UK economy is powered entirely with clean energy by 2030. The economic opportunities that come from renewable energy are clear – most notably, a reduction in energy bills and far less exposure to price shocks from volatile international fossil fuel markets and geopolitical events. China is a promising partner for the UK in its

pursuit of clean energy development and to achieve its growth mission. In fact, clean energy was the top driver of China's economic growth in 2023, accounting for 40% of the expansion of its GDP.

An evaluation of topic growth within the Net Zero subject domain identified '*zinc-ion battery technology*' and '*radiative cooling technologies and materials*' as leading opportunities for UK-China collaboration based on mutual research strengths and forecasted publication growth. A 2024 Nature article highlights the significant advantages that zinc offers for renewable energy storage owing to its abundance, affordability and accessibility.

Growth Mission: Healthy Living

In the UK's mission to build an NHS fit for the future, a key reform is to roll out new technologies and digital approaches which can ensure the earlier detection and management of chronic diseases and deliver more personalised care. Through collaborating with Chinese partners and being able to testbed new solutions in China's rapidly expanding healthcare market, UK 'healthtech' firms can not only bring about direct economic benefits from the sale of new healthcare products domestically and abroad, but also create a halo effect of reducing the number of people out of work due to poor health and thereby raise labour market participation and economic growth.

'Artificial intelligence in healthcare and medical communication' is a standout topic for collaboration between the UK and China from Nature Research Intelligence's topic growth assessment within the Healthy Living subject domain. '*Medical image segmentation using deep learning techniques*' emerges as a leading topic for patent production in China.

Growth Mission: Agriculture and Sustainable Food Production

The UK Department for the Environment, Food and Rural Affairs (DEFRA) has made sustainable food production and food security a central priority in recent years, as outlined in documents such as the 2022 Government food strategy. The Sustainable Farming Incentive is seen as a primary vehicle to incentivise farmers to improve soil quality and support regenerative practices such as agroforestry. China are turning to 'smart agriculture' to realize a more digitally advanced and efficient agricultural system, as detailed in its Smart Agriculture Action Plan 2024-2028. With the Chinese 'AgTech' industry expected to boom, and the wider agricultural market forecast for a 4-5% GDP growth rate annually over the next five years, it would be prudent for UK firms to engage with Chinese partners in order to catalyse innovation and drive the commercialisation of new products.

'Weed detection and management in precision agriculture' and '*postharvest biology and food quality*' are several topics drawn out from the topic growth analysis as collaboration opportunities for the UK to engage with China in academic research and innovation. A 2021 Nature article critically evaluated gene editing as a tool to alter the pathways that determine fruit and vegetable quality, especially after storage. Through modifying the genetic makeup of postharvest crops, gene editing is forecast to have a measurable impact on reducing postharvest loss and waste in the next five to ten years.

Growth Mission: Digital Technologies

The timely announcement of funding for UK's growth-driving creative industries is designed to help thousands of creative businesses grow across the UK. With creative industries worth approximately £125 billion to the UK economy, this public investment program is a key part of the UK's industrial strategy. China's expanding middle class is driving the growth in the country's creative economy, such as in architecture, visual arts and photography. Furthermore, China is poised to play a significant role in the creative software market – which is projected to achieve a compound annual growth rate of 4.5% from 2025 to 2029. For creative UK firms, China can be seen as fertile ground in testing, developing and commercialising new creative technologies and for generating foreign exchange earnings.

'Virtual reality technologies' (e.g., try-on technologies, metaverse) ranked highly for mutual research strength across the UK and China and for forecasted publication growth. Moreover, China's Three-Year Action Plan for Metaverse Industry Development highlights the strategic steps being taken to advance next generation internet initiatives. The report recognizes these technologies as promising areas for innovation between the UK and China.

Barriers and risks in collaborating with China

During the exploratory phase of this project, desk-based research and qualitative interviews revealed significant challenges facing international partnerships involving China. These risks are profiled below, categorized into distinct themes:

- **Geopolitical tensions:** There was strong emphasis on the influence of USA-China relations and how shifts in USA policies have a substantial ripple effect on other countries' engagement with China. This was also noted as impacting the alignment of UK policies.
- **Complex regulatory environment:** China's regulatory landscape is often described as complex and opaque, with laws intentionally vague, leaving room for local interpretation and varying enforcement.
- **Market and infrastructure challenges:** The vastness and complexity of the Chinese market presents significant barriers, particularly for SMEs. Navigating this market requires substantial local knowledge, which many SMEs lack.
- **Ethical considerations:** The development of dual use technologies poses notable risks, alongside concerns regarding human rights and ethical supply chains.
- **Intellectual property (IP):** IP risk remains a primary concern for foreign companies operating in China and features prominently in UK Government guidance on overseas business risks.
- **Data security**: China's data laws are often perceived as vague, leading to challenges in compliance and disputes over data breaches.
- **Lack of transparency and trust:** Issues around transparency in business dealings and the visibility of government policies create significant concerns.
- **Identification of partners:** The ability to identify the right, trusted partners, was a key risk mentioned by many.
- **Cultural differences:** Differences in business etiquette, communication styles, language, and navigating China's complex political landscape can pose significant barriers to effective collaboration.
- **Lack of long-term funding and strategic outlook:** China's long-term strategic focus contrasts sharply with the often fragmented, short-term approaches and funding strategies seen in foreign countries like the UK.

Despite these obstacles, insights from the qualitative interviews uncovered a number of best practices to mitigate some of the risks described above. Two common mitigations were related to concerns around data security and intellectual property.

In recent years, China has become increasingly stringent about data possession, enacting laws that designate almost all data as owned by the state. This presents complications in joint academic research projects, as data from these projects are automatically subject to Chinese legal standings once shared, even if initially collected by researchers working and collecting data outside of China. As such, interviewees stressed the importance of setting up robust and clear agreements with Chinese partners regarding data ownership. Measures may include establishing data sharing pilot zones, and setting up protocols for how entities can access approvals for data exports.

Regarding intellectual property (IP) concerns, China has strengthened its IP laws and enforcement mechanisms in recent times. In fact, the establishment of specialized IP courts has improved the ability to enforce patents

and reduce IP infringement. Nonetheless, conducting comprehensive due diligence on potential Chinese partners to evaluate their financial stability, reputation, business practices and history of IP protection is advised to help minimise operational risks and increase the likelihood of successful partnerships. Moreover, seeking guidance from the funding or innovation agency supporting the work, as well as from relevant government bodies, such as the British Embassy and trade councils, can provide a safety net of support. Other safeguards could be implemented in the form of recruiting local lawyers and filing patents, not only in China, but also globally through mechanisms like the Patent Cooperation Treaty (PCT).

Recommendations for future UK-China engagement on business innovation

Interviewees provided clear recommendations for UK-China business collaborations, emphasising the importance of a long-term strategy, 'patient' finance, and leveraging complementary strengths to enhance innovation partnerships between the UK and China. Key recommendations for businesses include:

- **Consider timing and speed:** Timing is crucial, as current funding cycles can hinder the ability to act swiftly on opportunities, leading to delays in potential collaborations and joint breakthroughs.
- **Develop a long-term strategy:** A long-term strategy is essential for effective collaboration with China, particularly due to China's political system, which supports focused and sustained strategic planning.
- **Ensure physical presence:** Participating in major trade shows and expos in China offers a direct route for businesses to build visibility. To gain traction and succeed in China's competitive innovation landscape, businesses may also need to localize and adapt innovations for the Chinese market.
- **Consider Hong Kong as a gateway:** Hong Kong can serve as a strategic entry point into the Chinese market and was identified as a viable approach for international businesses.
- **Risk mitigation strategies:** Businesses should consider and plan for risk as early as possible by:
    - ***Carve out time for face-to-face meetings and country visits:*** Particularly important in the early stages of establishing a partnership, physical interactions help develop deeper and more personal connections and assist in breaking down cultural barriers which are essential for fostering trust.
    - ***Build strong partnerships:*** Joint ventures with reputable Chinese partners can help navigate the regulatory landscape and provide expertise on maintaining IP protection within China.
    - ***Data ownership:*** Set up robust agreements on data sharing with Chinese partners, such as protocols for how entities can access approvals for data exports.
    - ***Engage legal experts and consider IP protection:*** Recruit local lawyers to ensure their documentation is robust and in compliance with local laws. To ensure comprehensive IP protection, companies are also advised to protect their IP by filing patents, not only in China, but also globally through mechanisms like the Patent Cooperation Treaty (PCT).
    - ***Set ground rules and clear responsibilities:*** Clear task delineation and contingency planning for handling leadership changes or other unforeseen circumstances were outlined as important.
    - ***Make use of government resources and other support:*** Several business engagers recommended that organizations draw on the support and resources from government departments, such as the Department for Business and Trade.

Proposed follow-up actions for funders/government to strengthen UK-China innovation collaboration

The recommendations below put forward a selection of suggested follow-up actions for UKRI, other funders, and government departments to effectively support and promote innovation collaboration for businesses

engaging with China. These proposals are informed by data analysis, identified research gaps, and qualitative feedback, ensuring they maximize national benefit while fostering mutually beneficial partnerships with China.

To strengthen innovative collaboration, funders and government departments should:

- **Enhance and diversify funding models**: Increase targeted funding to unlock innovative collaboration opportunities with China and support businesses in overcoming barriers and risks associated with entering the Chinese market.
- **Strengthen knowledge-sharing and networking opportunities:** Organize sector-specific briefings, symposia, and workshops led by experts to facilitate expert-led trade missions. Additionally, curate business-to-business (B2B) brokerage events with enhanced business support, helping develop actionable post-visit roadmaps.
- **Provide specialized business support and guidance:** Connect businesses with specialist international business advisors. Create knowledge banks and case study repositories to address common market-entry barriers in China, along with specialized support for IP and data management. This includes connecting businesses with respective Intellectual Property Offices in China for expert advice and assistance.

To maximize the strategic impact of collaboration with China, the following analytical activities should be prioritized:

- **Patent and innovation analysis:** Conduct advanced analytics of patent data in the areas of net zero, healthy living, agriculture and sustainable food production, and digital technologies.
- **Academic Research-Patent linkages and sectoral gap insights:** Examine the links between academic research outputs and patents, uncovering the academic research which has been cited by patents, as well as to identify high-impact collaborator networks.