ANALYSIS

How to Do Trusted Research: China-Specific Guidelines for European Stakeholders

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HOW TO DO TRUSTED RESEARCH:
CHINA-SPECIFIC GUIDELINES FOR EUROPEAN STAKEHOLDERS

Analysis
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Executive summary

- This report formulates China-specific, evidence-based guidelines for European stakeholders, including higher education institutions (HEIs) and research centres in science, technology, engineering and mathematics (STEM) subjects.

- It is aimed at raising awareness of China's approach to science, technology and innovation (STI) by informing stakeholders about China's goals in Europe, as well as the state of knowledge protection in the EU. It also seeks to refute claims which downplay the attractiveness of Central Europe (i.e., Austria, the Czech Republic and Slovakia) for China by mapping the scope of scientific collaboration with Chinese subjects in STEM and the levels of awareness of knowledge security in collaboration with China. Interviews and online surveys provided an additional layer for the analysis and helped in understanding the structural reasons which led researchers to commence cooperation with Chinese partners.

- While the guidelines are informed by the findings in Central Europe, they are widely applicable in other member states and may contribute to initiating a more informed debate on knowledge security and trusted research at the level of the EU in general, and on the opportunities and risks of scientific collaboration with China in particular.

- For European partners, cooperation with China presents several challenges. China makes use of foreign technologies to boost its own technological base and enable domestic innovation, increasing the competitiveness of its industry and research sectors vis-à-vis European peers.

- Efforts to acquire advanced foreign technology abroad have been an inseparable part of China's drive to achieve progress in STI, spanning from legitimate international cooperation to illegitimate and 'grey zone' means.

- China has been clear that its ultimate goal is to substitute foreign technology with indigenous development and achieve dominance in key sectors across the board. This ambition has been coupled with a lack of reciprocity in European access to the Chinese STI sector.

- Chinese technology acquisition abroad is tied to Chinese military modernisation efforts as many of the technologies are of a dual-use nature. By engaging in technology cooperation and transfer with Chinese counterparts, European institutions may indirectly be supporting the growth of the military

power of China as a country that has officially been labelled a "systemic rival" by the European Union, and is increasingly becoming a security threat.

- The list of China's STI priority areas is broad and includes, inter alia, artificial intelligence, quantum technology, integrated circuits, deep space exploration, new materials, neuroscience and biotechnology. China is likely to seek some of these technologies abroad, since it cannot yet produce them domestically.

- The most technologically advanced countries have responded to China's quest for foreign technology by increasing efforts to safeguard their STI sectors. Still, current measures to mitigate the risks of technology transfer to China, though re-calibrated over time to address the changing challenges, seem incomplete and insufficient.

- The case-study conducted in Central Europe shows that the issue of trusted research and knowledge security is still in its nascent phase. Interviews with members of the academia uncovered a widely shared perception that China may not be interested in research cooperation due to the perceived superiority of its own research.

- Contrary to this assumption, there are areas where Central European HEIs and research centres produce world-class outputs. This fact, downplayed by the local researchers, has not gone unnoticed by China.

- Open-source data-mining led to the identification of researchers in STEM subjects with Austrian, Czech or Slovak affiliations whose research outputs were (co)funded by China. From 2006 to 2021, 685 research outputs in key scientific areas declaring exclusive funding from Chinese sources were published in Austria, approximately 200 research outputs in the Czech Republic and 41 outputs in Slovakia. Furthermore, the research cooperation, mainly in the fields of the development of new materials, agriculture, smart manufacturing and robotics, has been constantly increasing, especially in recent years.

- Dozens of Chinese funding agencies on both the national and provincial level provided funding for scientific research in Central Europe. Several research projects under scrutiny were financed by the Thousand Talents Programme. One of the research outputs also declared funding from the Central Military Commission, the highest national defence organisation in China, which is in charge of the overall administration of China's armed forces.

- To learn more about levels of awareness and the motivation driving researchers to enter into scientific cooperation with China, the authors contacted local researchers who had worked on research outputs co(funded) by China via online questionnaires.

- The survey revealed these researchers did not report any negative experience connected to cooperation with China which also correlates with the positive perception of Chinese funding. Unsurprisingly therefore, the research cooperation with Chinese counterparts was not perceived as a potential risk by 65 percent of the respondents who filled in the questionnaires.

- Respondents predominantly underlined the importance of previous positive experience with a Chinese partner and personal contacts or experience gained in China. They also highlighted that it has mainly been Chinese partners who initiated the research cooperation.

- The survey results showed a lack of knowledge regarding existing mitigation strategies for safeguarding research cooperation and significant gaps in the implementation of such strategies. Over half of the respondents did not know whether their institution had any specific internal mechanisms in place to be followed in the case of concerns about the motivation or the actions of an international partner. An additional quarter affirmed that no such mechanisms existed. Moreover, 40 percent of those surveyed claimed they did not know whom they would consult in the case of any concerns related to risks of possible cooperation with a foreign partner.

- Alarmingly, low awareness of potential risks can also be identified in terms of access to laboratories or research data by Chinese PhD students or researchers. An overwhelming majority of respondents claimed access to venues or data is not limited.

- As for expectations from the national government, a third of respondents would not wish to see any measures introduced by the state. 44 percent of the participating researchers do not know whether they would welcome more government support in terms of trusted research. Only a quarter of respondents were open to governmental support which should ideally consist of providing systematic information on potential risks, the organisation of seminars on trusted research and potentially the sharing of examples of bad and good practice and creating 'red lines'.

Recommendations

→ Based on the aforementioned analytical findings, the authors designed actor-specific guidelines in order to narrow down the knowledge gap and complement the existing actor-agnostic recommendations:

→ **Address the elephant in the room.** Adopting actor-agnostic regulations for safeguarding trusted research and knowledge security should not obscure the specific challenges connected with China's activities. China's global reach, far-reaching goals, increasingly revisionist agenda and the nature of its political regime make it a risk and a challenge like no other, one that deserves special attention reflected in an actor-specific approach.

→ **(Re)define "sensitive".** The majority of currently published guidelines use the term "sensitive research" which generally concerns dual-use and military material. However, none of the categories encompass emerging technologies. It is important to create flexible, responsive mechanisms designed to adapt to and keep up with the pace of technological development. The list of potentially vulnerable research areas should not be viewed as a 'no-go zone' but rather as motivation to conduct more careful due diligence and adopt more efficient preventive measures.

→ **Draw 'red lines'.** Creating a set of detailed questions and a checklist covering all potentially risky areas is a practical tool to ensure that all potential problems are considered. A particularly useful mechanism to evaluate the potential risks to research integrity might be a "risk matrix" that would complement the list of questions. A combination of the detailed questions and the matrix could then determine possible mitigation measures for the concerned research project or activity.

→ **Don't delegate, assist.** Measures targeting higher education institutions and research centres have to be designed with the aim of bringing research institutions on board as collaborative partners and stakeholders. While it is in the interest of HEIs and research centres to act responsibly, credibly and transparently, they quite often lack the experience and human and financial resources to identify and safeguard their "crown jewels." In all processes, HEIs and research centres should be supported by national administrations financially and legally.

→ **Create a national contact point.** State administrations should establish an independent point of contact that could provide advice and recommendations to all HEIs and research centres. Such a centre could help identify

the key aspects to consider while conducting due diligence and draw the 'red lines'. It could also be in charge of organising training and mentoring and serve as a contact point providing advice to companies, start-ups and spin-offs, which may not realise the potential security implications of their research or products.

- **Stay competitive.** In designing and reevaluating research funding schemes, European countries and their national agencies should not take for granted that European (or their allies') financial resources are the only game in town. Especially in the field of emerging technologies, research funding needs to ensure that the most promising activities stay European. For instance, there should be an acknowledgement of the risks associated with groundbreaking research by an accommodation and an acceptance of the uncertainty of such endeavour in the evaluation process.

- **Embrace the proactive approach.** European research institutions should not be primarily discouraged by being presented with the repercussions of not meeting the existing legal criteria for the protection of STI. Instead, they should be motivated to develop and nurture an environment for trusted research as a key advantage. An ideal system would thus create incentives for institutions to foster trusted research on their own initiative.

- **Expand the scope.** Existing cases suggest that research conducted in humanities or social sciences may also be subject to foreign interference. Also a general tendency to view applied research as more vulnerable may lead to overlooking the risks in basic or even highly theoretical research. However, it is in this area where China is found to be most lacking and thus hugely interested in utilising international cooperation to make progress.

Introduction

The People's Republic of China is a unique actor in the field of science, technology and innovation given its global reach, significant technological prowess, considerable financial resources and a clearly formulated intention to become a global technology leader and military power. At the same time, all these characteristics are coloured by a non-democratic political regime with revisionist foreign policy goals, making its specific mix of capabilities and objectives a particularly worrying concern for European countries.

Cases of China's breaching research security at various established European universities and research centres in the past few years have transformed the issue of trusted research and knowledge security into a serious concern for policymakers, the security community and academia. These developments have also incentivised stakeholders, both at the national and EU levels, to formulate guidelines for universities and research centres (see Table 3, page 28 and 29). These guidelines represent first attempts to deal with the issue, and are especially relevant for institutions and individual researchers focusing on various subjects in science, technology, engineering and mathematics (STEM), dual-use technologies, emerging technologies and commercially sensitive research areas.

Yet, a holistic, EU-wide approach to trusted research, which would support the integrity of the system of international research collaboration, is still missing. Moreover, most of the recommendations published by the national governments and the European Commission have been actor-agnostic, avoiding mentioning China, or any of the other specific international actors which were in the past associated with breaches of research security in Europe. Lastly, the reports which have already been published on the issue are mostly single-case studies. More comparative research analyses which would provide a basis for more complex, evidence-based guidelines have so far been rare.

The aim of this report is to address these shortcomings. It formulates China-specific, evidence-based guidelines for European higher education institutions (HEIs) and research centres in STEM subjects, based on a comparative case-study conducted in three EU member states – the Czech Republic, Slovakia and Austria.

While the guidelines are informed by the findings in Central Europe, the authors believe that they are widely applicable in other member states and may contribute to initiating a more informed debate on knowledge security and trusted research at the level of the EU in general, and on the opportunities and risks of scientific collaboration with China in particular.

Report outline, research scope and methodology

For a number of European governments as well as for the European Commission, China presents a sensitive political topic with the implication that China-specific policy measures could lead to further deterioration of already tense bilateral relations with, or even possible retaliation from, the Chinese side.[1] This attitude is immediately reflected in available European guidelines for strengthening knowledge security, which are, as a result, mostly actor-agnostic, shying away from directly mentioning China (or other problematic actors). On the one hand, the actor-agnostic approach, based on the need to promote trusted research and knowledge security in Europe regardless of the identity and the character of a potential threat, is generally valid. It certainly contributes to ensuring the long-term resilience of the European science sector. On the other hand, the actor-agnostic guidelines risk being too general and broad to effectively help European HEIs, research centres and individual researchers. The very recipients of the guidelines quite often do not understand the nature and scope of the challenge when it is too vaguely defined.

The actor-agnostic guidelines assume that European governments and HEIs define their own "crown jewels," i.e. the areas which require systematic screening and protection to ensure the country's scientific, military or economic edge and competitiveness. However, in a scoping exercise, which was conducted in 2020 and 2021, the authors interviewed Czech and Slovak representatives of HEIs and research centres. The interviews revealed that the identification of the areas which warrant protection may be a step too far for the institutions and individual researchers. Specifically, the interviewees mentioned difficulties in and unease with deciding which science subjects may be of interest to another power, especially if the power and its aims are not clearly outlined. There is a risk that research institutions will lack agency in the process, hence approaching the guidelines as yet another additional administrative burden which has been imposed on them by the state. As a result, the guidelines would be only formally accepted and not functionally integrated into research practice. The interviewees also raised concerns regarding the "politicisation" of science and downplayed the importance of research outputs originating in Central Europe for China. In the blunt words of one of the interviewed scientists: "there is nothing to steal here."

The preliminary scoping exercise conducted in 2020 and 2021 informed the authors' approach to the new research which started in November 2021 and of which this report is the culmination. This phase of the research was based on five main goals: First, it aimed at raising awareness of China's approach to science, technology and innovation by informing the stakeholders about its aims in Europe, as well as the state of knowledge protection in the EU. Second, it sought to refute claims which downplayed the attractiveness of the Czech Republic, Slovakia and Austria for China

by mapping the scope of scientific collaboration with Chinese subjects in STEM. Third, the authors designed questionnaires for Czech, Slovak and Austrian researchers which mapped the level of awareness of knowledge security in collaboration with China. Fourth, the authors triangulated the findings through in-person interviews with members of Czech and Slovak academia to understand the structural reasons which led researchers to commence cooperation with Chinese partners. Last, based on the previous steps, the authors designed actor-specific guidelines in order to narrow down the knowledge gap and complement the existing actor-agnostic recommendations.

To reach the stated objectives, the authors applied a reverse-logic approach to the problem, putting China at the centre of the initial research. They screened Chinese language materials to establish what China considers core technologies (关键核心技术) and cutting-edge fields from its perspective. Based on the review of Chinese documents, the authors compiled a "wish list" of technologies that China is likely to seek abroad, since it cannot yet produce them domestically.

In the second stage of the research, the authors worked with a hypothesis that while China may want to obtain certain technologies from producers in Asia-Pacific (such as in South Korea, Japan, Australia, etc.), with others it will focus on research innovators in the United States and Europe. Thus, the authors studied various barriers (i.e., technologically advanced countries' export controls, arms embargoes, investment screening mechanisms, etc.) focusing on core, cutting-edge and emerging technologies. In the subsequent stage they compared this set with China's "wish list" to determine which technologies China seeks but cannot easily obtain abroad.

In the next step, the authors narrowed down the focus onto Central Europe, specifically the Czech Republic, Slovakia and Austria, and reviewed the measures which are already in place to mitigate the risks of cooperation with Chinese entities. In order to gain a clear understanding of the current patterns of cooperation between Central European researchers and China in specific research fields, the authors explored the data available in the Web of Science (WoS) database, specifically, funding provided by various Chinese institutions. Data-mining of the WoS database led to the identification of researchers cooperating with China who displayed an affiliation to research institutions based in Austria, the Czech Republic or Slovakia. Additionally, the excerpts of the texts specifying the funding of the research were reviewed manually. This step made it possible to identify various Chinese agencies providing funding to either a whole research project or single researchers involved in the given research activity. The authors also documented trends in the quantity of incoming Chinese students to Central Europe, focusing on the STEM subjects defined by China as critical.

To learn more about levels of awareness and the motivation driving researchers to enter into scientific cooperation with China, the authors combined quantitative and qualitative data, contacting the Czech, Slovak and Austrian researchers identified in the previous stage via online questionnaires. Additional in-person interviews with leading researchers and relevant university officials provided another analytical layer for the report.

The last stage consisted of drafting policy recommendations (guidelines), duly incorporating the preferences, interests as well as limitations of the institutions concerned. Though the perception of China by Central European academia and policy

circles is varied and heterogenous, the research confirmed the initial assumption that the level of awareness of risks posed by China among STEM researchers in Central Europe is low. The proposed recommendations for the national authorities seek to address this structural shortcoming.

How to read this report

In the process of designing the research outline, the authors identified several possible challenges, thus they feel it necessary to provide a short commentary on the intentions of the report. First of all, the report does not claim that all cooperation with China is inherently problematic or dangerous. Furthermore, the participation of Czech, Slovak and Austrian researchers in research projects (co)financed by Chinese funding agencies or the hosting of students from China at HEIs and research centres should not be interpreted as posing a direct security risk. It is, in fact, in reflection of a strong, legitimate interest in maintaining and developing cultural and academic cooperation with China that the guidelines have been formulated. They are intended to help HEIs, research centres and individual researchers to maintain cooperative links with China while raising awareness of implicit risks and urging the application of due diligence.

Secondly, all data obtained from WoS or through questionnaires and interviews were anonymised. While the identity of specific Czech, Slovak and Austrian researchers who declared solely Chinese funding when publishing their research outputs is known to the authors of the report, the aim of the report is not to 'name and shame'. Its goal is to map the trends in scientific cooperation with China while refuting the claims that China has no interest in Central Europe research activities and results.

Thirdly, the data retrieved from WoS, which formed a basis for further analysis, are to a large extent determined by the logic of the search engines and the functioning of the WoS database. Due to the AI-powered classification of the research outputs, questions persist on how exactly information on Chinese funding enters the database and how to interpret the findings. The data indicate Chinese funding of research outputs, however, they do not automatically imply that a non-Chinese researcher was directly supported by Chinese funding. For instance, the funding indicated by the WoS may have been assigned to a Chinese member of the research team. Even though each of the outputs found in WoS database was meticulously cross-checked by the authors of the report, the data should be viewed rather as a trend.

Finally, the authors strongly believe that the autonomy of HEIs and research institutions, including the freedom to search for research partners and foreign sources of funding, should not be limited. The guidelines thus aim to bring research institutions on board as collaborative partners and stakeholders, as it is in their interest to act responsibly, credibly and transparently. In this goal they should be supported by national administrations financially and legally.

China's strategy in science, technology and innovation

China presents a unique challenge in terms of science, technology and innovation (STI) development. In accordance with the Chinese leader Xi Jinping's timetable for "rejuvenation of the Chinese nation" by the middle of the 21st century, China intends to become a technology superpower. Under the increasingly authoritarian and centralised socioeconomic system, STI is firmly tied to achieving national goals. Moreover, owing to the top-down and whole-society nature of Chinese efforts under the party-state structure, the difference between public and private entities in China is blurred, as all are ultimately required to serve the larger goals of national development.

Efforts to acquire advanced foreign technology abroad have been an inseparable part of China's drive to achieve progress in STI, spanning from legitimate international cooperation to illegitimate and 'grey zone' means, employing a wide array of actors on the Chinese side under the general concept of "opening to the outside world" and "going out" since 1979. This has included investments into foreign companies with advanced technologies, (forced) technology transfer in the case of incoming foreign direct investments (FDI), intellectual property theft under concerted commercial espionage campaigns, attraction of foreign talent, as well as STI cooperation with foreign HEIs and research centres and private companies across the world.

For European partners, cooperation with China presents several challenges. While they are not unique to China per se, what is unique is the extent to which they are amplified by the interplay of the characteristics of the Chinese authoritarian system, the mobilisation of China's massive resources and the comprehensive power that can be employed by the state.

The first challenge to Europe concerns the issue of China making use of foreign technologies to boost its own technological base and enable domestic innovation, increasing the competitiveness of the Chinese industry and research sectors vis-à-vis European peers. China has been clear that its ultimate goal is to substitute foreign technology with indigenous development and achieve dominance in key sectors across the board. Moreover, this ambition has been coupled with a lack of reciprocity in European access to the Chinese STI sector as well as the common occurrence of questionable practices on the side of Chinese partners.

A second challenge arises from the fact that Chinese technology acquisition abroad is tied to Chinese military modernisation efforts as many of the technologies are of a dual-use nature, having national security applications. By engaging in technology cooperation and technology transfer with Chinese counterparts, European institutions may be indirectly supporting the growth of the military power of China as a country that has officially been labelled a "systemic rival" by the European Union,[2] and is increasingly becoming a security threat.[3]

Finally, there are also noteworthy ethical issues involved in cooperation with China. Under the authoritarian turn of the Chinese government, there have been growing efforts to integrate modern technologies with the tools of digital surveillance and oppression, bolstering the state's repressive capacities. This has especially been the case in the targeting of China's ethnic minorities, in particular, but not limited to the Muslim minority of Uyghurs. Technologies have been developed in China that employ advanced AI for racial profiling and complement the existing state toolbox of oppression. In other areas, there have been concerns about ethical norms concerning research and its applications, including but not limited to developments in gene-editing technology.

Cooperation with China should not and cannot be completely severed. China is an important international partner for European countries in many areas and for the large part, cooperation does not pose immediate risks. However, in some cases, STI cooperation with China might mean aiding the development of a rival geopolitical power that presents a security threat as well as a value challenge to the liberal democracies of Europe. Therefore, it is in the interests of the EU member states to pay specific attention to Chinese efforts to acquire advanced technologies and devise relevant protection measures that would enable the non-problematic cooperation to continue while guarding against risks.

LOGIC OF CHINA'S APPROACH TO STI

While global attention to China's STI policies has been mostly connected to the period under Xi Jinping's governance since 2012, progress in STI has long been understood by China's leaders as a key component in bolstering China's economy as well as international power, and ultimately, keeping the ruling Chinese Communist Party (CCP) in power.

Chinese leader Xi Jinping has talked about the "changes unseen in a century" in his speeches, reflecting the official view of geopolitical shifts. Beijing understands, by the use of this term, the combined forces of the ongoing 4th technological revolution and the transformation of the international balance of power that are seen as enabling China to take advantage of its continuing "period of strategic opportunity" and emerge on top of the international competition. As such, STI has been increasingly seen as an area of intense international competition reflecting the changing geopolitical situation, in which China needs to stay on top.

As in other areas of socio-economic development, China has adopted a top-down approach to STI development, characterised by long-term planning across successive strategies. Science and technology was one of the "four modernisations" (四个现代化) that were adopted by Beijing to revive the nation's economy after the death of Mao Zedong and has underpinned the era of "reform and opening up" from 1978. Based on Deng Xiaoping's understanding that "science and technology are the primary production force," in 1995, Jiang Zemin announced the strategy of invigorating China through science and education (科教兴国).[4] The strategy argues that "strength in science and technology has become an important deciding factor in a country's comprehensive power and international standing." Together with the "talent superpower" (人才强

国) strategy, the concept was incorporated into the 11th five-year plan approved in 2006, forming a basis of China's STI strategies ever since.[5]

China has been aware of the shortcomings in its own STI development, stemming from its position as a latecomer. To address these shortcomings, international cooperation and the introduction of technologies from abroad has become a cornerstone of China's efforts to modernise its STI base and gain a leg up in the international competition. As part of its opening to the world, China has vigorously supported getting hold of advanced foreign technologies. For example, China has issued lists of "encouraged technologies for import," motivating companies to acquire technologies from abroad in which China was found to be lacking.[6] In terms of international cooperation, the establishment of joint research and development institutes or laboratories with foreign institutions, the engagement of Chinese scientists in international academic exchanges and gaining positions in international academic organisations, and also attracting foreign talent both in terms of foreign scientists as well as returnee Chinese students and scholars have been supported throughout Chinese policy documents. According to key STI policy documents, international cooperation should be used to "master key technologies as quickly as possible," with the authorities motivating both research institutes and companies to engage in international research cooperation.

The final goal, however, has long been to establish homegrown capacities in the core technology sectors and eventually replace foreign technology by means of "indigenous innovation." As stated by the 2006 Outline of the 11th Five-Year Plan for National Economic and Social Development (国民经济和社会发展第十一个五年规划纲要) "internationally, China will be for a long period of time under enormous pressures from developed nations who possess economic and science and technology superiority."[7] The document states clearly that in core technologies, China should be wary of being reliant on foreign imports and that the long-term interest of China is to develop a self-sufficient STI base. The logic of achieving this goal has been directed by the maxim of "introduction, digestion, absorption and re-innovation" (引进和消化吸收再创新).

China's efforts in the area are epitomised by the Made in China 2025 plan (中国制造2025)[8] that was released in 2015. The document focuses on manufacturing capacity in key areas, laying out the goal of making China a global manufacturing leader by 2049. In terms of international cooperation, the document outlines that the Chinese government will "encourage the overseas transfer of high-end equipment, advanced technology and strong industry". After global criticism regarding Made in China 2025, the plan has been deemphasised in official messaging,[9] but the underlying logic of Chinese industrial policy planning has remained the same. The desire to improve self-sufficiency was further highlighted after the eruption of a trade war with the US under the Trump administration and the sanctions imposed on key Chinese technology companies since 2018. Chinese officials have grown especially concerned about the possibility of "stranglehold" (卡脖子), chiefly by the US, in core technologies where China is still dependent on imports.[10] The orientation of China on the internal market, domestic innovation and reducing dependence on overseas markets has found expression also in the "dual circulation" economic strategy, put forward in 2020. These efforts may increase in urgency in light of the Western sanctions on

Russia after the invasion of Ukraine, which have highlighted the West's ability to cut a country from key technology imports.

Different Chinese strategies highlight that China's STI development is tightly tied to national security. The concept of civilian-military fusion (军民融合) has been long discussed by Chinese leaders in different forms, but it was elevated to the level of national strategy only in 2015. Civilian-military fusion calls for creating synergies between the economic development of civilian industry and the ongoing military modernisation.[11] The concept can also be found in the Innovation-Driven Development Strategy (创新驱动发展战略) published in 2016. The document calls for supporting two-way transfer and transformation of military-civil technology.[12] The 13th Five-Year Special Plan for S&T Military-Civil Fusion Development (十三五科技军民融合发展专项规划) from 2017 encourages the participation of universities, research institutes and professional institutions in conducting R&D in the area of civil and military fusion. Chinese actors are also encouraged to cooperate with international partners, including by establishing overseas R&D centres, technology transfer hubs, science and technology centres, etc.[13]

CHINA'S STI PRIORITY AREAS

China's successive key framework documents on STI strategy identify shortcomings in terms of China's own STI capacities, with different key areas and technologies pinpointed throughout different policy documents. These are in turn selected for prioritisation in state support and financing as well as international cooperation.

The Medium- and Long-Term Plan for Science and Technology Development (国家中长期科学和技术发展规划) for years 2006-2020 lists 11 priority areas for economic and social development and national security with 68 priority areas requiring government STI support.[14] Moreover, it identifies 16 special major projects. Another key policy document, the 2010 Strategic Emerging Industries (战略性新兴产业) Initiative, was aimed at supporting innovation in key emerging industries in order to achieve an advantageous position in international competition.[15] The document lists seven strategic emerging industries, where China should become a major global innovation and manufacturing centre. Made in China 2025 puts forward 10 key priority sectors where China should achieve manufacturing dominance. The most recent key strategy document charting priority areas in STI developments is the 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035 (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要).[16] The document prioritises research in 7 cutting edge fields and development of 8 core manufacturing industries, highlighting the focus of current Chinese efforts.

TABLE 1: CHINA'S STI PRIORITY AREAS

1	Artificial intelligence
2	Quantum information
3	Integrated circuits
4	Neuroscience
5	Genetics and biotechnology
6	Clinical medicine and health
7	Deep space, earth deep sea and polar exploration
8	High-end new materials
9	Major technical equipment
10	Smart manufacturing and robotic technology
11	Aerospace engines and gas turbines
12	BeiDou industrialization applications
13	New energy vehicles and intelligent (connected) vehicles
14	High-end medical equipment and innovative drugs
15	Agricultural mechanical equipment

Source: "Zhonghua renmin gongheguo guomin jingji he shehui fazhan di shisi ge wu nian guihua he 2035 nian yuanjing mubiao gangyao," 中华人民共和国国民经济和社会发展第十四个五年规划和*2035*年远景目标纲要 *[Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035],* State Council of the People's Republic of China, March 12, 2021, http://www.gov.cn/xinwen/2021-03/13/content_5592681.htm.

SAFEGUARDING SCIENCE, TECHNOLOGY AND INNOVATION

As apparent from the previous chapter, STI represents a strategic sector that China considers to be a core aspect of its economy and future development into a leading superpower. The major conduit for China to make rapid progress in these technologies has been to acquire them abroad, using various means, from legitimate (such as purchases and investment) to illicit (intellectual property theft or espionage). Foreign universities and research institutions have become a key target of these efforts, not least due to their open environment, actively oriented towards international cooperation without prejudice towards the home country of any partners.

At the same time, China's quest for foreign technology has been increasingly met with efforts from the most technologically advanced countries to safeguard their STI. With China's growth of comprehensive national power, increasing domestic authoritarianism, and the worsening of foreign relations between China and the

global West under Xi Jinping since 2012, the human rights and geoeconomic logic of STI protection has increasingly supplemented the purely security one in motivating efforts to limit China's access to certain technologies.

This chapter aims to analyse measures employed by the countries leading the technology race in order to safeguard their STI sectors. Regarding the diversified STI protection toolbox, the subchapters discuss the issue of export controls, investment screening mechanisms and visa restrictions.

The chapter predominantly focuses on measures implemented by the United States, which has been at the forefront of efforts to safeguard STI, as well as on the EU, whose regulatory framework is most directly applicable to Central European countries. The approaches of the EU and the US have differed in their overall logic as well as in the instruments used, but there has been significant convergence on both counts in recent years.

Whereas some restrictions on STI are country-agnostic, applicable to other countries than just China, other measures have directly targeted China. In general, the EU has been trying to construct an approach that would not be discriminatory towards specific countries and would be actor-agnostic. On the contrary, the US has increasingly seen the need to adopt policies that directly respond to China's challenge. This has been partly due to political considerations, as the EU has not adopted the US view of China as primarily a geopolitical competitor, owing also to lack of consensus among member states. Recently, there has been a convergence between the US and EU approaches based on the understanding of a need to safeguard critical sectors of the economy, including the STI sector, especially with regard to emerging technologies.

EXPORT CONTROLS

Export controls are one of the chief instruments that can be utilised to limit the transfer of foreign technology abroad. Export controls can be motivated by considerations of national security, foreign policy objectives, compliance with human rights commitments as well as economic considerations. In terms of relevance to international academic cooperation, it is important to note that various export controls are not only applicable to the transfer of technology products, but also to intangible technology transfer, which can be defined relatively broadly to encompass transfer of technology via data transmission or by individuals, including teaching.

Arms embargo is a special type of export control that is applicable to the transfer of military items and technologies. Regarding China, there is no UN-sanctioned arms embargo in place. However, several Western countries and organisations applied an arms embargo on China after the Tiananmen massacre in 1989, including the US, UK and the EU.

Whereas the US embargo was enacted in the US law, banning exports of all military items, both lethal and non-lethal, in the case of the EU, the arms embargo is not legally binding, as it only stems from a political declaration adopted before the Maastricht Treaty came into force in 1992.[17] As such, some member states have interpreted the arms embargo as allowing the export of certain defence-related technology and equipment to China, such as non-lethal military items. The non-binding

arms embargo on China is complemented by the legally binding Council Common Position governing the control of arms exports adopted in 2008.[18] The rules set out various criteria that need to be considered before the issuance of arms export licences, including the use of exported arms in domestic oppression, human rights abuses, the potential to lead to domestic or international instability and others. The rules cover items listed in the Common Military List,[19] which is regularly updated for new items. While these measures have tried to bring about convergence in EU member states' arms control regimes, also linking the EU rules to international agreements, the arms control regimes ultimately still remain a national competence. This applies also to the Czech Republic, which has sold military material to China despite the embargo. The 2020 report of the Ministry of Trade and Industry notes military material exports of more than 32 million EUR from the Czech Republic to China between 2010 and 2020.[20]

While academic cooperation may not be directly impacted by arms embargoes, there is a much wider field of **dual-use items**, which can have both civilian and military applications, and that are the subject of international research cooperation. The very existence of arms embargoes and restrictions of direct sales of military items has motivated China to seek technologies for military use also via nominally civilian technology cooperation, which has made this diverse array of technologies more relevant in terms of STI protection.

While academic institutions are unlikely to be directly implicated in direct transfer of items that are subject to the arms embargo on China, there is a risk concerning ties with Chinese institutions with military links, the hosting of researchers affiliated with the People's Liberation Army (PLA) as well as cooperation of individual researchers on defence-related projects. In the Czech Republic, 14 out of 26 public universities have cooperated with Chinese universities that have been identified as having close links to the Chinese defence sector by the Australian Strategic Policy Institute (ASPI) Defence University Tracker.[21] There are numerous cases in Europe where visiting researchers from China have been found to have military connections they have not disclosed.[22] For example, a Chinese Professor Hu Changhua worked at the University of Duisburg-Essen, without the university knowing that he was a major general in the PLA and headed a military laboratory for missile testing.[23] In other cases, local researchers undertook research cooperation with direct military application.

An example from the Czech Republic is the work of Svatopluk Zeman, a Czech explosives expert from the University of Pardubice, who was found to have cooperated with Chinese research institutions and companies engaged in weapons development for the People's Liberation Army.[24] Another example found in the Czech Republic is the cooperation of a laboratory of the Brno University of Technology,[25] led by Professor Jiří Jaromír Klemeš, with Xi'an Jiaotong University in China. According to the ASPI's research,[26] the Chinese university is linked to the PLA and focuses on the defence industry and nuclear research.

The vast majority of national legislation on dual-use technologies comes from multilateral export control regimes, including the Australia Group, the Missile Technology Control Regime (MTCR), the Nuclear Suppliers Group (NSG), the Wassenaar Arrangement and the Chemical Weapons Convention (CWC). The Wassenaar Ar-

rangement institutes a list of dual-use items to be submitted to export control in 10 categories. As a non-binding regime, it serves as a platform for discussion among 42 participating countries which then implement the export controls into their national regulations. Apart from Singapore and Israel, most of the world's technologically advanced economies are parties to the Wassenaar Arrangement.

Both the US and the EU have implemented dual-use controls based on international regimes, which have mostly targeted proliferation of weapons of mass destruction and global terrorism, meaning that China has not been a key focus per se. However, within their own dual-use controls frameworks, the original national security concerns guiding the dual-use controls have increasingly been bolstered by geoeconomic and human rights considerations. At the same time, new emerging technologies with potential national security implications have been included in the respective regimes.

The US national system comprises a wide range of measures employed by various administrative authorities. The essential base is defined by Commerce Control Lists[27] created by the Bureau of Industry and Security (BIS), containing an exhaustive list of technologies organised into a system of ten categories based on the international framework. The Commerce Country Chart[28] restricts exports to China in almost all defined categories, including Chemical and Biological Weapons, Nuclear Nonproliferation, National Security, Missile Technologies, Regional Stability and Crime Control. The Crime Control and Detection category focuses on items that may be used for human rights abuses, concentrating predominantly on law enforcement tools and firearms.[29]

Besides these general export requirements, the US also established the Consolidated Screening List containing parties for which the US Government maintains restrictions on exports, reexports or transfers of items. The database comprises lists introduced by various US departments, including for example Denied Persons List, Nonproliferation Sanctions List, Specially Designated Nationals List, Sectoral Sanctions Identifications List, etc. These tools are also designed to alert exporters that additional due diligence ought to be conducted before pursuing further cooperation. Concerning China, at the time of writing, the search engine shows over 900 entities.[30] In addition, various US departments and agencies are also responsible for export control in specific sectors,[31] including defence, chemicals and drugs, fish and wildlife, etc. EU has also established its Consolidated list[32] of individuals and entities subject to EU financial sanctions. However, this list is not publicly available and an authorised account is needed to enter the database. The EU also provides an EU Sanctions Map[33] that systematically summarises the restrictive measures adopted against various countries. However, China is not included on the map.

Crucially, US export controls are not applicable only to direct exports from the US. US export controls may also be applicable to products with a certain proportion of components of US origin. This may consequently create pressure on technology partners of the US, as was apparent in the case of the Dutch company ASML.[34]

The EU legislation on the export of dual-use technologies was updated in 2021.[35] As in the case of military exports, the national legislation on dual-use items has allowed for flexibility in applying the controls. While some member states apply the EU legislation directly, others have instituted their own legislation that goes beyond EU requirements. In the EU-wide regulation, apart from the listed categories defined

by the Wassenaar Arrangement, so-called "catch-all" controls can apply also to other items, if there is a suspected military end-use or for reasons of public security and human rights considerations. The amended regulation also allows for putting licensing requirements on cyber surveillance technologies for unlisted items in cases of the intended use of the items for internal oppression and human rights abuses. In 2020, the US expanded its regulations to include human rights considerations to the licensing process under the Export Administration Regulations (EAR).[36] The inclusion of cyber surveillance technologies into the national regulations showed that the process may be lengthy and not in line with the pace of emerging technologies development, making it hard to adapt the legislation to swift technological advancements.

The Czech export controls of dual-use items are designed based on the international control regimes. The Czech legislation adopts EU regulations mechanisms.[37] Besides the list of dual-use items, the designated ministry may also include other items in the export controls, based on the "catch-all" principle.[38]

Slovak export controls regarding dual-use technology are based on the international and EU regimes but also take into account any potential threat to "foreign policy or security interests" of the country.[39] The Ministry of Economy is entrusted with awarding export licenses.

In Austria, it is the Ministry of Economy, Research and Science that oversees the export control agenda. The factors to be considered in awarding licences in Austria include obligations under international law and international regimes, human rights, the internal situation in the destination country, maintenance of peace, international security and regional stability, consequences for the security interests and international relations of Austria and of the other EU member states, implications in view of terrorist activities and international organised crime, risk of diversion to undesired use as well as sustainable development. Both in Austria and Slovakia, no specific guidelines on the relevance of export controls for international research cooperation have been drafted, in spite of their increasing relevance.

Despite not being currently relevant for research cooperation with China, it is crucial to observe the regulations applied in the context of the war in Ukraine. The EU approved a sanctions package banning both direct and indirect technical assistance in various research areas to Russia and Belarus.[40] The term "technical assistance" means the transmission of instructions, advice, training, consultation or the transfer of knowledge or skills, including in oral form. Consequently, this set of measures also applies to selected research fields (such as transport, communication, energetics, military and dual-use technologies, etc.) and therefore limits cooperation between scientists from Russia and Belarus and European universities and research institutions.

REGULATIONS TARGETING EMERGING TECHNOLOGIES

There has been an ongoing debate on the need to update the dual-use regulations to account for emerging technologies that can have national security implications. In contrast to earlier export controls, which targeted proliferation of military technologies that were predominantly developed and financed by the state during the Cold War,

the current discussion on emerging technologies concentrates on sectors developed by private businesses which may oppose export controls as they may undermine their activities and pursuance of R&D.[41] The intertwined nature of the global market and the necessity to import various components from different countries to create the final product, makes the formulation of export controls incredibly arduous. In fact, the political and economic objectives are difficult to align as evident in the number of semiconductor export licences issued to suppliers of Huawei and SMIC from the US Department of Commerce, despite them being blacklisted.[42]

TABLE 2: EMERGING TECHNOLOGIES LISTS AS DEFINED BY THE US AND THE EU

US	EU
Additive manufacturing	Additive manufacturing (3D printing)
Advanced computing technology	Computer science and engineering, information and communications technology
Advanced materials	Chemistry and advanced material science
Advanced surveillance technologies	
Artificial intelligence and machine learning	Artificial intelligence and machine learning
	Avionics and aerospace engineering and design
Biotechnology	Biology and (nano)biotechnology
Brain-computer interfaces	
Data analytics technology	
	Electrical engineering
	Energy and environmental technology
Hypersonics	
Logistics technology	
Microprocessor technology	
	Naval technologies
	Nuclear physics and engineering
	Optical engineering
Position, navigation and timing technology	
Quantum information and sensing technology	Quantum technologies
Robotics	Robotics and process automation

Source: Data retrieved from the U.S.-China Economic and Security Review Commission and the European Commission

In the US, the primary intention behind introducing a list of "emerging technologies"[43] in order to broaden export controls to other sectors is rooted in linkages between national security and efforts to enhance the economic and scientific competitiveness of the country.[44] Both the US and the EU have identified crucial synergies in their efforts to clearly define emerging technologies with respect to their potential in defence and security, suggesting a more coordinated approach in the future. The EU-US Trade and Technology Council established several joint working groups, including groups focusing on potential impacts of misuse of technologies on human rights issues, spreading disinformation and interference with democratic processes.[45] Additionally, in September 2021, the EU published a summary on current dual-export controls covering the list of emerging technologies.[46] It may consequently be assumed that this factsheet may serve as a basis for further enlargement of export controls and inclusion of the defined emerging technologies in the future.

Further multilateral cooperation motivated by the US and Japan's effort to prevent China from gaining their technologies can be envisioned. This framework would be established for a small number of countries with advanced technologies, potentially representing some of the technologies included in the emerging technologies lists, such as semiconductors, quantum cryptography, and artificial intelligence.[47]

INVESTMENT SCREENING MECHANISMS

Apart from arms embargoes and export controls, another important legal tool in terms of safeguarding domestic STI are investment screening mechanisms, addressing the acquisition of domestic entities by extra-EU actors, including those from China. While investment screening mechanisms have a much larger scope and mostly cover the activities of commercial entities, there are also certain activities in the academic sector that fall under the scope of the legislation. This includes, for example, investments in university-affiliated private entities that are working on transferring university-based research into commercial application.

In the US, the Committee on Foreign Investment in the United States (CFIUS), established in 1975, is responsible for reviewing transactions involving foreign investment and foreign persons to prevent impacts on national security. In 2018, its authority was expanded by the Foreign Investment Risk Review Modernization Act (FIRRMA) which allowed review of non-passive, non-controlling investments by foreign parties in US businesses and real estate transactions. This control authority reviews investments to US business involved in critical technology, infrastructure or sensitive personal data (TID) and it also reviews access of the foreign persons to nonpublic technical information, board membership, observer rights or any other form of involvement in TID. Similarly, CFIUS reviews real estate purchases located within or near areas crucial for national security, such as airports, maritime ports, military installations, etc.[48] Officially, these regulations do not target China. On the other hand, the ability to review non-notified transactions suggests that CFIUS has recently devoted special attention to China.[49] Based on its 2020 annual report, CFIUS reviewed 117 non-notified transactions involving Chinese investors. Previously,

reviews of non-notified transactions were rather rare, accounting for a low number of cases.[50]

On the EU level, a foreign direct investment (FDI) screening mechanism was adopted in 2019, becoming fully operational in October 2020. The mechanism creates a framework for coordinating investment screening on the EU level, allowing the exchange of information, giving the Commission a role in issuing opinions on certain investments and setting core requirements for member state-level screening regulations. The screening mechanism provides for the screening of extra-EU investments based on the grounds of security and public order. As such, the mechanism lists the factors that may be taken into consideration when screening the investment, including effects on critical infrastructure, critical and dual-use technologies, supply of critical inputs, access to sensitive information and freedom of the media. Moreover, ultimate state ownership, involvement in activities against security and public order in a member state or in criminal activities can also be taken into account. The mechanism also covers "programmes of EU interest," which includes the Horizon 2020 research scheme. The screening mechanism is explicitly not targeting any specific country, but it has been passed mostly in reference to the growing interest of Chinese investors, often with links to the Chinese state, in sensitive EU sectors and technologies.[51] As such, the investment screening is a key step in terms of defining the key areas of interest for economic security, including STI, where foreign investment may undermine EU strategic interests.

In the Czech Republic, the FDI screening law was passed in 2020, targeting investments in sectors relevant for national security and public order.[52] The legislation applies to all relevant foreign investments in cases where the ultimate beneficial owner comes from non-EU countries, and is thus not discriminatory. The legislation provides for two regimes for screening of investments: the first category includes a limited number of critical sectors, where investments require a mandatory permission from the authorities. These sectors include critical infrastructure, defence, IT systems and dual-use technologies. In all other cases, investors are not required to gain prior permission from the government, although there is a mandatory consultation requirement in the case of certain investments. Moreover, even investments in non-listed sectors can still be subject to a screening procedure should the government decide to do so in consideration of potential security risks. This can be done before the completion of the investment but also within a five-year time frame after its completion. The results of the screening can be approval, conditional approval and prohibition; in the case of retrospective application of the law, divestment can be ordered.

Slovakia implemented its FDI screening mechanism in the novelisation of the law on critical infrastructure in 2021. The law applies to the screening of investment to businesses designated as part of the critical infrastructure in the energy, pharmaceutical, metallurgical and chemical industries.[53] A separate law for FDI screening applying to investments across the board that are found to have an impact on the "security and public order" of Slovakia, mirroring the EU mechanism, is currently (September 2022) undergoing an intergovernmental consultation process.

In Austria, a new FDI screening act came into force in 2020, transposing the requirement of the EU mechanism. A screening instrument was previously included in the Foreign Trade Act of 2011.[54] The new mechanism applies to investments in

defence equipment/technology, critical energy and digital infrastructure, water, data sovereignty, research and development in pharmaceuticals and health products, media, supply of critical resources and critical technologies and dual-use items.

As is the case with all the relevant legislation, investment screening does not specifically target China, but it is clear that the national security aspect of Chinese investment has been one of the key motivations for the EU and national legislation. The coverage of emerging technologies in the investment screening legislation is limited by the existing dual-use legislation. Therefore, the same limitations, involving a focus on a relatively narrow scope of technologies directly applicable for military end-use are also relevant to investment screening.

VISA RESTRICTIONS

Visa restrictions for researchers are another tool that can be used to safeguard sensitive STI from being taken advantage of by China. However, visa restrictions that target specific countries can also be one of the most controversial measures, as they can hamper the normal academic exchange, especially if applied too broadly.

The UK operates an Academic Technology Approval Scheme (ATAS) that is applicable to all foreign postgraduate students or researchers (apart from those from exempt countries) planning to study in the UK in select fields of study.[55] This includes research related to Advanced Conventional Military Technology (ACMT), weapons of mass destruction (WMDs) or their means of delivery. In the EU, the visa background checks for the Schengen Area are mostly limited to citizens of countries that are under EU or UN sanctions related to WMD proliferation.[56]

While the UK and EU measures do not target China per se, the US has gone the farthest in directly limiting visa opportunities for Chinese researchers to study in the US. In May 2020, then US President Donald Trump issued an executive order that suspended the entry of all Chinese students and researchers above undergraduate level with links to the PLA and its civil-military fusion efforts.[57] As the order also applied to existing visas, more than 1000 Chinese nationals have had their visa revoked.[58] The growing restrictions in the US might also mean that Chinese students and researchers will prefer European institutions for their studies.[59]

RESEARCH GUIDELINES

Accompanying the growing array of legal requirements on the transfer of technologies, governments around the world have paid increasing attention to including academic institutions in the process, ensuring their compliance with existing regulations but also promoting general risk awareness regarding cooperation with international partners. This has led to the appearance of guidelines on research cooperation, designed either by government agencies, independent university bodies or individual research institutions.

The following chapter provides a comprehensive summary of relevant guidelines from around the world and their strengths that may serve as inspiration for Austria,

TABLE 3: SELECTION OF TRUSTED RESEARCH GUIDELINES (AVAILABLE IN ENGLISH)

Country	Published	Author	Name	China-specific	Strengths
Australia	2021	Australian Government – Department of Education, Skills and Employment	Guidelines to Counter Foreign Interference in the Australian University Sector	NO	Governance, risk frameworks, criteria to assess research potential
Australia	2020	Australian Strategic Policy Institute	Hunting the Phoenix	YES	Talent-recruitment programs
Australia	2018	Australian Strategic Policy Institute	Picking flowers, making honey	YES	Chinese military collaboration with foreign universities
Belgium	2019	Vlaamse Interuniversitaire Raad	Recommendations for implementing a human rights assessment at the Flemish universities	NO	Human rights assessment risk
Canada	2019	Government of Canada – Universities Working Group	Mitigating economic and/or geopolitical risks in sensitive research projects	NO	Risk matrix, focus on economic and geopolitical risks
Canada	2021	Government of Canada – Universities Working Group	National Security Guidelines for Research Partnerships	NO	Ethical and privacy concerns related to sensitive data, emerging technologies
Czech Republic	2021	Ministry of Interior of the Czech Republic	Counter Foreign Interference Manual for the Czech Academic Sector	NO	Awareness raising, recruitment processes
Czech Republic	2021	Financial Analytical Office	Handbook: Technical Assistance and Intangible Transfer of Technology	NO	Guidance on transfer of (in)tangible technology
European Union	2020	European Commission	EU compliance guidance for research involving dual-use items	NO	Guidance on dual-use export controls
European Union	2021	European Commission	Tackling R&I foreign interference	NO	Includes students and administrative staff among targeted individuals focus on idenfitifation of "crown jewels"
Germany	2020	German Rectors Conference	Guiding questions on university cooperation with the People's Republic of China	YES	Balancing both opportunities and risks
Germany	2019	Federal Office for Economic Affairs and Export Control	Export Control and Academia Manual	NO	Guidance on export controls
Germany	2020	Global Public Policy Institute	Risky Business: Rethinking Research Cooperation and Exchange with Non-Democracies	PARTLY	Awareness raising, cooperation with authoritarian countries

Country	Published	Author	Name	China-specific	Strengths
Netherlands	2019	The Hague Centre for Strategic Studies	Checklist for Collaboration with Chinese Universities and Other Research Institutions	YES	Safeguarding academic freedom, data protection
Netherlands	2020	Leiden Asia Centre	Towards Sustainable Europe-China Collaboration in Higher Education in Research	YES	Awareness raising
Netherlands	n.d.	Dutch Association of Universities	Framework Knowledge Security Dutch Universities	NO	Summary of existing measures, includes risks of unethical and inappropriate use of research results
Netherlands	2022	Joint initiative of the Dutch knowledge sector and governmental departments	National knowledge security guidelines: Secure international collaboration	NO	Active role of the government and inter-institutional cooperation, guidance for HR department
Sweden	2020	The Swedish Foundation for International Cooperation in Research and Higher Education	Responsible internationalisation: Guidelines for reflection on international academic collaboration	NO	Designing strategic cooperation, ethical aspects
United Kingdom	2021	Universities UK	Managing risks in Internationalisation: Security related issues	NO	Safeguarding of university reputation and values
United Kingdom	n.d.	Centre for the Protection of National Infrastructure, National Cyber Security Centre	Trusted Research Guidance for Academia	NO	Due diligence, cyber security
USA	2021	National Science & Technology Council	Recommended Practices for Strenghtening the Security and Integrity of America's Science and Technology Research Enterprise	NO	Institutional level of measures, penalties for violations
USA	2019	Human Rights Watch	Resisting Chinese Government Efforts to Undermine Academic Freedom Abroad	YES	Academic freedom
USA	2020	Association of American Universities & Association of Public and Land-grant Universities	University Actions to Address Concerns about Security Threats and Undue Foreign Government Influence on Campus	NO	Awareness building, trainings
USA	2019	University of Rochester	International Research & Global Collaboration	NO	Transparent foreign financing

Source: Authors' own compilation

the Czech Republic and Slovakia in addressing the challenges arising from research cooperation with China.

Perhaps due to the high number of students studying there, Australia was the first country to introduce some form of guidelines, already in November 2019, with an updated version released in 2021.[60] Australian guidelines especially address the issue of governance and establishing risk frameworks at universities. Briefly, these guidelines emphasise the need for accountable authorities responsible for risk mitigation, creating internal reporting and evaluation mechanisms and training for university staff. Importantly, the guidelines also consider students as a potential target, likely due to the recent reports of Chinese influence on academic freedom.[61] The updated version of the guidelines also broadens the range of criteria to consider while assessing the potential of the research. Besides the usual adherence to export controls and sanctions, it also lists attractiveness of the research (especially in areas in which Australia is a world leader), commercial value and its potential future use.

The US guidelines published in January 2021, similarly emphasise university level research safeguarding.[62] They specifically elaborate due diligence and outline various categories of information that should be disclosed and examined before pursuing cooperation with an individual or a higher education institute or research centre. Interestingly, the US guidelines also emphasise the need to introduce penalties for violations of disclosure requirements.

The United Kingdom has published two versions of guidelines for the academic sphere. From the first manual published by Universities UK,[63] the Central European countries may take advantage of the chapters covering the safeguarding of university reputations and values as being very elaborate. Concerning research security, it lists the necessity of proper due diligence and compliance with export controls. It also clearly defines academic activities that may be subject to export controls. In addition, the second set of guidelines, published by the Centre for the Protection of National Infrastructure (CPNI)[64] and the National Cyber Security Centre, clearly delineates risks associated with research activities and includes questions to consider while assessing the sensitivity of research. It also includes a comprehensive checklist[65] to systematically assess research proposals and potential partners. Moreover, it provides detailed guidance[66] for conferences and travels, including concrete cybersecurity measures.

Germany too has already devoted significant attention to establishing some principles of academic cooperation as there are several documents available. For instance, the guidelines developed by the German Rectors' Conference in 2020 are very detailed and contain an exhaustive list of specific questions that guide researchers to assess the potential risks, considering a wide range of issues.[67] These guidelines are unique in their actor-specific approach, mentioning China directly in the title. Counter-intuitively, this document aims to provide guidance on fostering a strategic partnership with China, including balancing both opportunities and risks. For instance, while mentioning the compatibility of Chinese funding with university principles, it also emphasises adequate support of both researchers and students from China in the campuses. Apart from the guidelines, the Federal Office for Economic Affairs and Export Control introduced a comprehensive document on export controls and their application in academia.[68]

In the Netherlands, the Hague Centre for Strategic Studies introduced a China-specific checklist for collaboration with Chinese partners. This set of guiding questions focuses predominantly on safeguarding academic freedoms and data protection.[69] The Dutch government has also created a national contact point for knowledge security which is designed to answer questions related to international collaboration, such as transfer of knowledge, influence over academic work or ethical problems.[70]

Dutch governmental departments and research institutions have also published a complex set of guidelines in January 2022 which, besides other issues, address the importance of cooperation and information sharing between various institutions and emphasize the need for active involvement of the national government. This document also highlights the importance of identifying the sensitive knowledge within a research institution that could be used in an inappropriate or unethical manner or affect national security.[71]

Canada launched the "Safeguarding your research" website[72] in September 2020, which gathers information related to research cooperation, including case studies of potentially risky scenarios.[73] The Canadian guidelines mention broadly the potentially sensitive research areas, encouraging researchers to consult not only export controls and possible dual-use of the technology, but also to consider the sensitivity of datasets and personal information acquired, potential ethical, moral and privacy concerns, including, for example, potential abuse of the technology for surveillance and military/political oppression.[74] The Canadian government has also introduced a "risk matrix" to estimate economic and geopolitical risk in sensitive research projects.[75] Annex A to the guidelines lists research areas that may be vulnerable, such as advanced materials manufacturing, energy generation and neurotechnology.[76] Finally, Canadian authorities have issued a detailed checklist[77] for travels abroad, highlighting various risks of research intrusion.

In January 2022, the European Commission issued a working version of the guidelines on foreign interference in research and innovation.[78] The EU guidelines introduce a set of measures previously unseen in other guidelines. Regarding the research areas to protect, these guidelines suggest that research institutions identify their "crown jewels" based (inter alia) on security and economic interest from third countries. To improve the awareness of research risks, the guidelines suggest to integrate academic freedom and integrity into the core curriculum of any education programme. They also stress training for all staff, ranging from senior researchers to students and administrative officials.

In relation to the update of the export controls regime, the EU Commission released a guideline document for member states in 2021, aimed at research institutions and individual researchers.[79] The guidance does not dictate specific internal compliance measures, but advises on how to avoid breaching export control regulations in practical terms.

In Central Europe, the issue of research protection has not yet gained significant attention. In terms of international cooperation, the focus has been on supporting internationalisation and cooperation with international partners while potential risks pertaining to security, ethical and human rights concerns have mostly been neglected. However, this has slowly been changing with the growing realisation of the potential challenges of cooperation with partners in authoritarian countries, including China.

In the Czech Republic, the process has mostly been a reactive one, coming from specific negative experience. The Ministry of Interior of the Czech Republic published guidelines in 2021[80] in response to the case of Chinese interference at Charles University,[81] the oldest and most prestigious public university in the country. China-related scandals at the university were pivotal in starting the debate on foreign interference. The Charles University initiated the guidelines by approaching the Ministry of Interior and subsequently adopted the guidelines by the university rector's decree.[82] The most important task of the Czech guidelines is to raise awareness in the country and stir the debate among other Czech universities. This explains the explanatory character of the guidelines, aiming at pinpointing a variety of potential techniques of interference. One of the most detailed chapters is devoted to individual researchers, delineating, for instance, the process of recruitment, open-information abuse, and risks connected to international travels.

In the Czech Republic, the legal requirements related to compliance with export control legislation are a major challenge for higher education institutions and research centres, however, there has not been much guidance on this front from the government so far. The only exceptions are the guidelines from the Financial Analytical Office on the issue of technical assistance and intangible technology transfers and their management under the EU and national export control legislation as well as sanction regimes.[83] These guidelines provide practical recommendations for HEIs and research centres on how to assess potential risks in these areas.

In contrast to the neighbouring Czech Republic, no guidelines for cooperation between Slovak universities and their international partners have been published so far. In 2021, the Slovak Centre of Scientific and Technical Information under the Ministry of Education published a Declaration on Fostering the Culture of Scientific Integrity in Slovakia,[84] which however, only tackles the issue of scientific integrity, chiefly touching upon how to address ethical issues and scientific misconduct. There is also no public guidance from the government to research institutions on the issue of export controls. The only relevant guidance in this field are the recommendations from the National Technology Transfer portal for researchers on how to protect their intellectual property.[85]

In Austria, the Best Practice Guide for Research Integrity and Ethics was published by the Austrian Higher Education Conference in October 2020.[86] The guide mostly discusses research integrity and ethics but also tangentially touches upon the issue of potential dual-use of research. However, there is no specific discussion of this issue as it relates to international cooperation.

Evidently, few of the guidelines refer to specific actors, even Australia and the Czech Republic designed the guidelines without mentioning China, despite the experience with China's interference being the primary motivation behind their creation. This approach, however understandable from the point of view of political actors in various countries, creates a number of problems which effectively undermine the very purpose of the guidelines. If the actor is not specified in the guideline, researchers may not address threats based on knowledge of previous cases and may fail to identify research areas of special interest which need to be protected. Similarly, focusing on specific actors may contribute to a considerably more proactive approach, since

more specific risks may be identified and mitigated more effectively. It also helps to identify the trends and patterns, enabling future planning.

Of all guidelines analysed for this report, in (few) cases where the guidelines do mention China, they provide a detailed overview of the risks posed by cooperation with China, such as talent-recruitment programmes and the implications of technology transfers to the modernisation of the People's Liberation Army. As the Table 3 suggests, several areas of trusted research have already been addressed in detail. Nonetheless, the authors of this report have identified a crucial gap in terms of defining potentially sensitive areas and going beyond solely referring to export controls (focusing on military and dual-use items) or generally alert the researchers to assess the vulnerability of their research. Indeed, the list of potentially sensitive areas is longer and it needs to be addressed more specifically.

A crucial aspect in fostering an environment conducive to protecting the STI at academic institutions is to create a partnership between the government and academic institutions. In the US, the FBI established the National Security Higher Education Advisory Board (NSHEAB) to "foster outreach and promote understanding" as early as 2005.[87] NSHEAB brought together senior leaders from US research universities and the intelligence community as well as other government agencies. While NSHEAB was disbanded due to restructuring in 2018, it can serve as a blueprint for similar cooperation and information sharing mechanisms. In the UK, a research Collaboration Advice Team (RCAT) was established within the Department for Business, Energy and Industrial Strategy (BEIS) in 2021. The team is to work with researchers on the issues of export controls compliance, cybersecurity, intellectual property protection and other research security issues.[88]

The state of research cooperation with China: case-study of Austria, Czech Republic and Slovakia

The authors' interviews with Czech and Slovak members of academia uncovered a widely shared perception that China may not be interested in research cooperation due to the perceived superiority of its own research. Contrary to this conjecture, there are areas where Central European HEIs and research centres produce world-class research. Some of the research has not been, for security reasons, accessible to the public, yet other cases were widely reported on.

A piece of research focusing on optoelectronic medicine, namely nerve cell regulation using light, conducted by Brno University of Technology in the Czech Republic, may serve as one example of high quality research with potential commercial, but in some cases also military implications. The aim of this specific research is to develop an implantable device that can wirelessly stimulate the nervous system. The applicability of the research is, of course, quite broad and can be used to address other issues in neuroscience.[89] Further examples include ELI Beamlines laser centre at the Institute of Physics of the Czech Academy of Sciences[90] who conducts research of extreme physical phenomena, such as simulation of processes inside stars.[91] Also scientists from the University of South Bohemia in České Budějovice conduct unique research on the reproduction and genetics of fish in order to preserve biodiversity.[92]

There is a clear military application connected to the research on ultra-high temperature ceramics at the Technical University in Košice, Slovakia.[93] This category of new materials find their application in aerospace technologies development, as they allow for developing technologies able to withstand the extreme temperatures of hypersonic flight.

Austria, on the other hand, is a leader in life sciences, as evidenced for example by the contributions to the CRISPR gene editing technology. The groundwork for this research was first laid at the Vienna BioCenter, a cluster of biotechnology institutes and companies in Vienna, with further contributions from CEMM, Research Center for Molecular Medicine of the Austrian Academy of Sciences.[94] Quantum research has been conducted at the Institute for Quantum Optics and Quantum Information, producing radically new approaches to quantum information processing or experiments with ultra-cold quantum matter.

In order to gain a perspective on the current patterns of cooperation between Central European researchers and China in specific research fields, the authors explored the data available in the Web of Science database (WoS), namely the funding provided by various institutions from China. WoS includes journal articles and conference outputs which represent the most influential contributions in the field (i.e., with the highest h-index), considering separate index scales for sciences, social

sciences, humanities, etc., to ensure comparability of various research areas. Consequently, the resulting dataset is to a large extent determined by which information was crawled by the algorithms used in the database.

Firstly, to narrow down the research areas and create a list of fields of particular interest to China, authors consulted Chinese sources and documents referring to priority areas in which China intends to strengthen its technological and scientific capacities. Based on the 14th Five-Year Plan (2021-2025), a list of 15 research areas was compiled, accompanied by specific keywords to be applied to filter the researchers active in these fields in the WoS database.

The keywords were further combined with additional filters for the country of origin (i.e., Austria, the Czech Republic, or Slovakia) and the source of funding (i.e., China), resulting in final lists of research outputs. Subsequently, the resulting lists were reviewed and filtered manually, identifying the researchers indicating an affiliation to research institutions based in Austria, the Czech Republic or Slovakia. Additionally, the excerpts of the texts specifying the funding of the research were reviewed manually. This allowed the identification of various Chinese agencies providing funding to either the whole research project or individual researchers involved in the research. Funding from non-Chinese resources was also indicated in the dataset.

Given the sheer size of the dataset and the seemingly non-problematic character of large multinational projects supported by EU funding schemes (such as those under the EU Horizon programme), only those projects which declared funding exclusively by Chinese entities or based on bilateral cooperation (cooperation between Austrian, Czech or Slovak and Chinese institutions) were considered for further analysis.

Besides gathering data from WoS, to provide more rigorous evidence on the current state of academic cooperation between Central Europe and China, this research also focused on the number of students from China studying in the three Central European states.

The data helped in identifying institutions and individual researchers who were subsequently addressed via surveys or were interviewed.

CHINA'S INTEREST IN AUSTRIAN, CZECH AND SLOVAK STEM RESEARCH

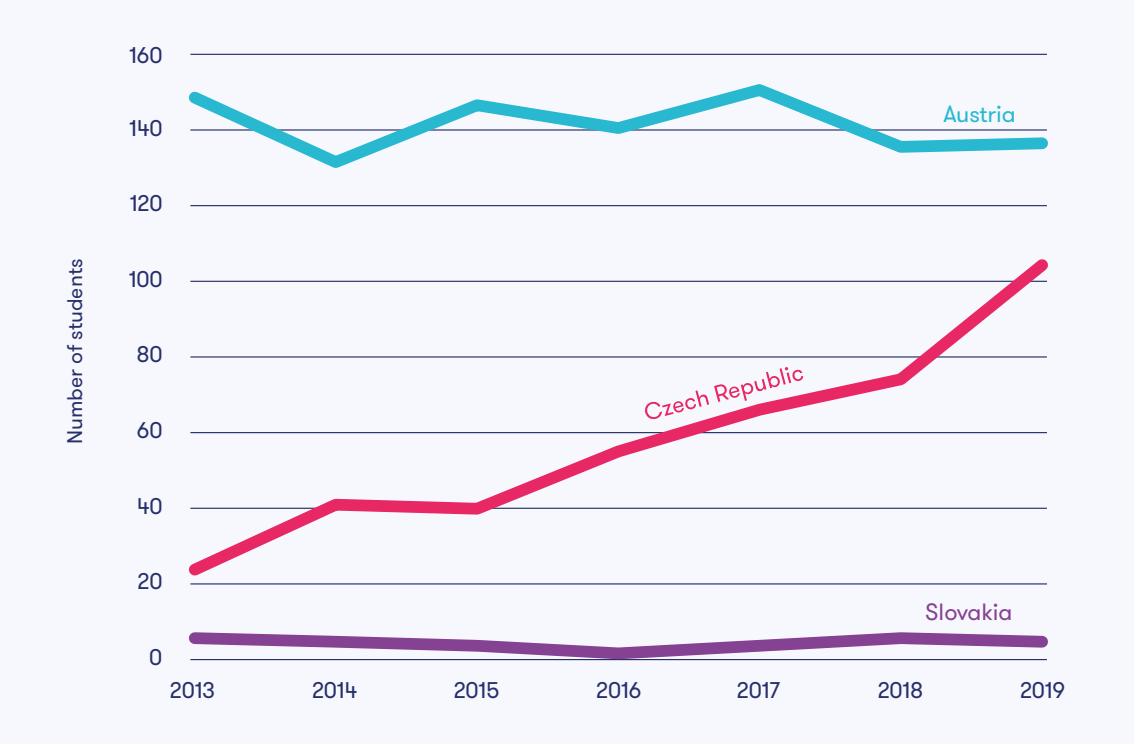
As evident in Graph 1, the number of PhD students from China has been the highest and rather constant in Austria, whereas in Slovakia, the numbers remained low. On the other hand, the data for the Czech Republic deserve more detailed attention as the number of PhD students has risen considerably in the examined period.

As evident from Graph 2, the number of incoming Chinese PhD students to the Czech Republic has been continuously increasing during the examined period. A similar tendency was found in the case of bachelor and master students, however, it is the number of PhD students which is crucial as these students may have access to laboratories and collaborate on research with other academics. Therefore (although not necessarily) these PhD students may represent a potential risk for research integrity.

Approximately half of the Chinese PhD candidates studying in the Czech Republic have focused on natural sciences, technical areas and agriculture. Consequently, they may be involved in projects that would fit into the Chinese list of priority areas. Despite not being classified as sensitive by export controls or other legislative measures, the priority areas defined by China may also include the country's (so far non-designated) "crown jewels" areas.

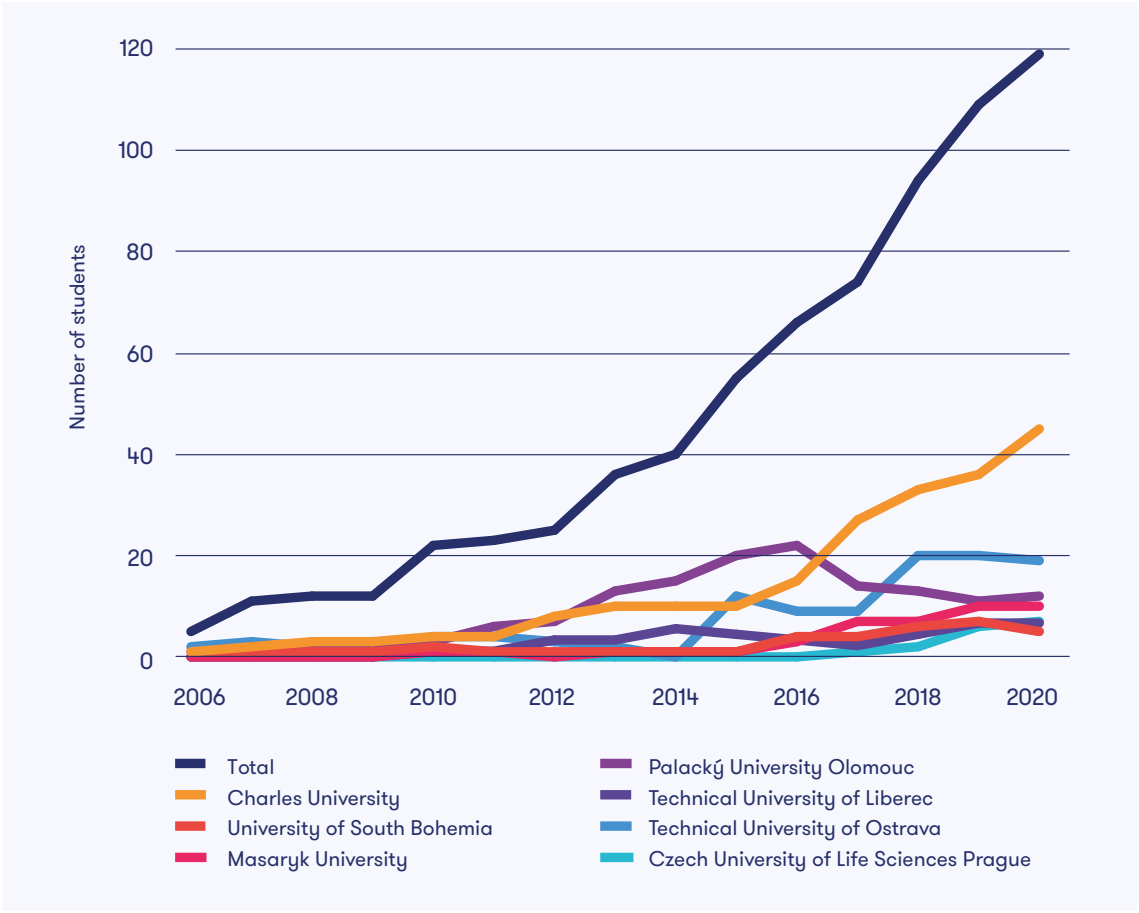
The analysis of the large dataset on Austrian research projects identified 685 research outputs declaring exclusive funding from Chinese sources and over 200 outputs funded on a bilateral basis. Therefore, the proportion of these funding categories amounted to half of the total examined research outputs as evident from the Graph 3.

GRAPH 1: CHINESE PHD STUDENTS AT CENTRAL EUROPEAN UNIVERSITIES (2013–2019)



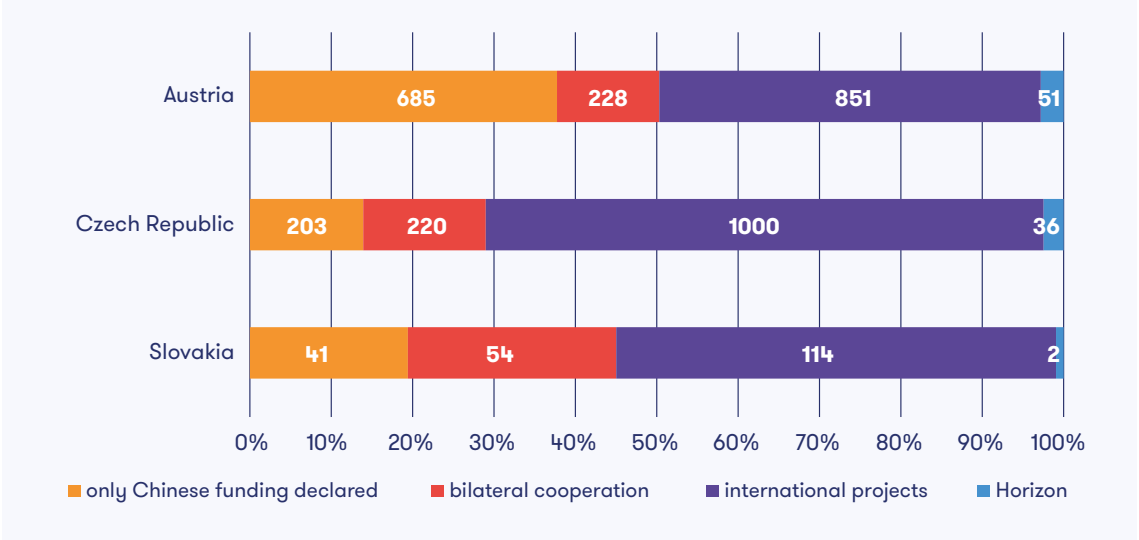
Data retrieved from OECD Statistics.

GRAPH 2: CHINESE PHD STUDENTS AT CZECH UNIVERSITIES (2006–2020)



Data retrieved from the Ministry of Education, Youth and Sports of the Czech Republic.

GRAPH 3: RESEARCH OUTPUTS FROM PROJECTS (CO)FUNDED BY CHINA WITH INVOLVEMENT OF RESEARCHERS WITH AUSTRIAN, CZECH OR SLOVAK AFFILIATIONS (2006–2021)



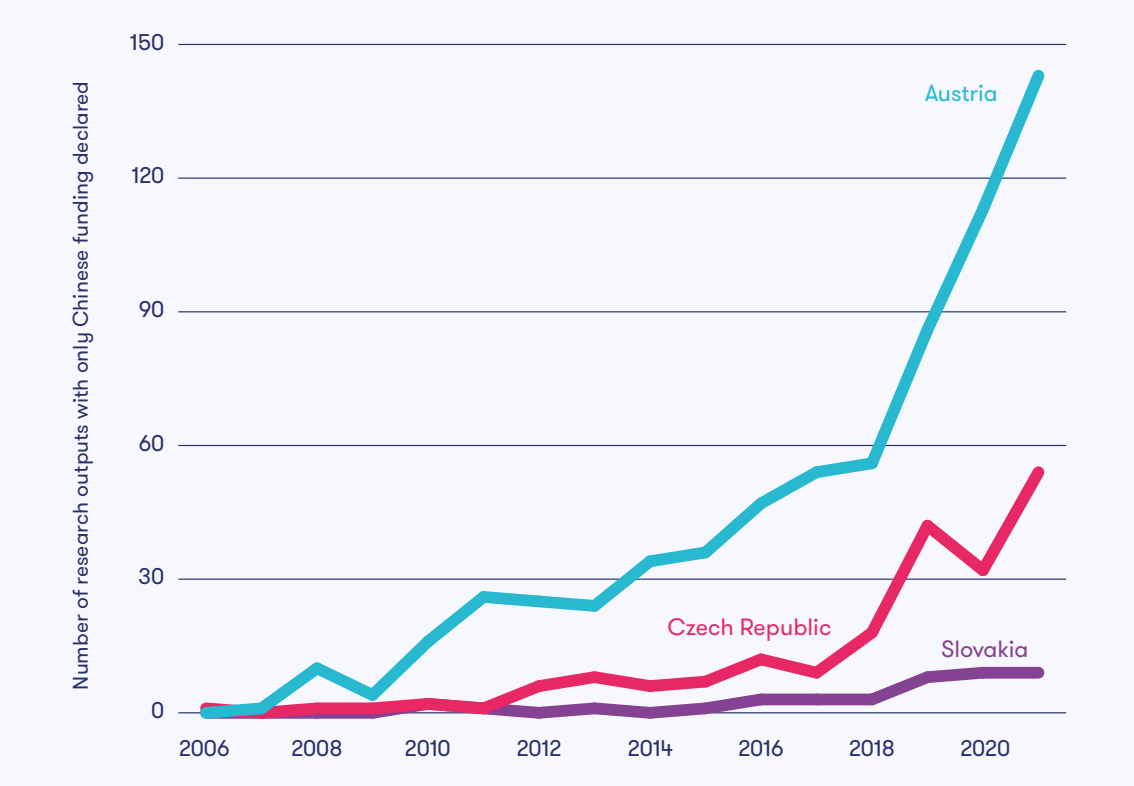
Data retrieved from Web of Science.

TABLE 4: NUMBER OF LOCAL RESEARCHERS INVOLVED IN SCIENTIFIC COOPERATION IN STEM RESEARCH FIELDS WITH CHINESE ENTITIES (2006–2021)

	only Chinese funding declared	research funding based on bilateral cooperation	total
Austria	284	277	**561**
Czech Republic	63	178	**241**
Slovakia	18	27	**45**
	365	**482**	**847**

Data retrieved from Web of Science.

GRAPH 4: EVOLUTION OF THE NUMBER OF RESEARCH OUTPUTS DECLARING SOLELY CHINESE FUNDING WITH INVOLVEMENT OF RESEARCHERS WITH AUSTRIAN, CZECH OR SLOVAK AFFILIATIONS (2006–2021)

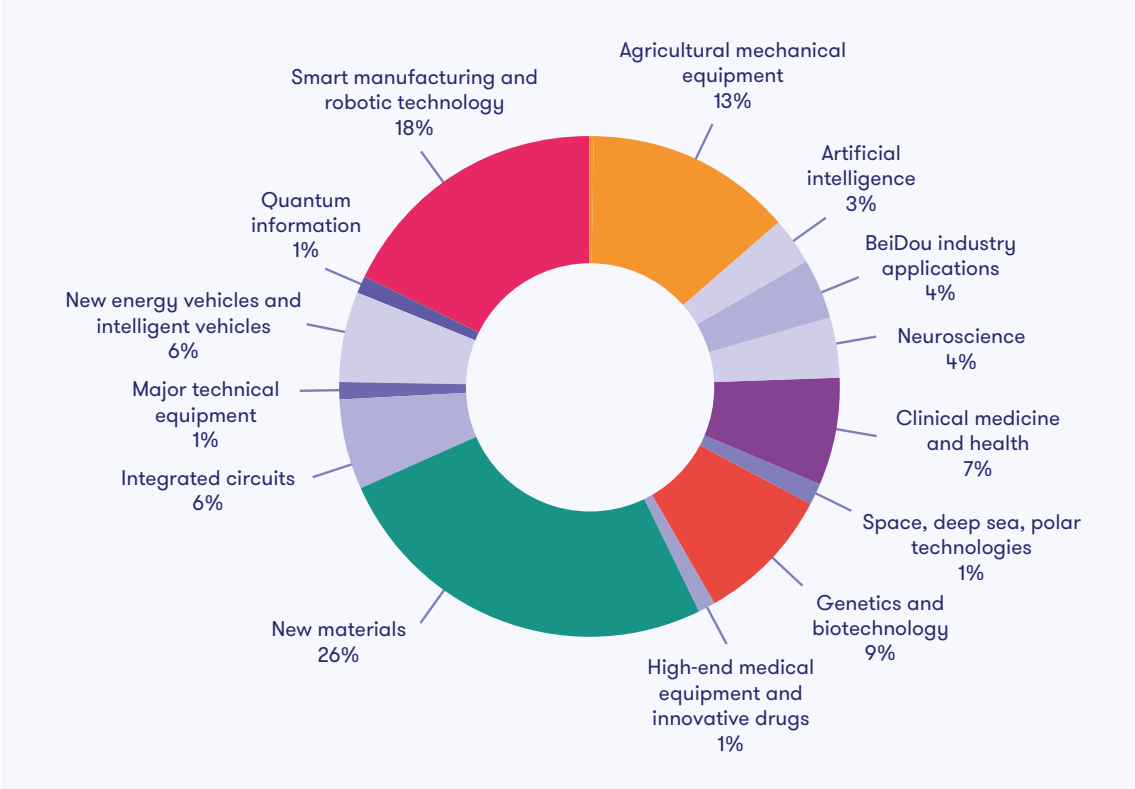


Data retrieved from Web of Science.

It was possible to identify 203 research outputs in the research areas defined as priority in Chinese documents that declared funding solely from Chinese sources and to which authors with Czech institutional affiliations contributed.

In the case of Slovakia, there was a low number of cases of research cooperation found through the WoS database, in comparison to the Czech Republic and Austria –

GRAPH 5: RESEARCH AREAS AND OUTPUTS DECLARING SOLELY CHINESE FUNDING WITH INVOLVEMENT OF RESEARCHERS WITH CZECH AFFILIATIONS (2006–2021)



Data retrieved from Web of Science.

41 projects where research outputs declared funding solely from Chinese sources and 54 that were funded on a bilateral basis. Therefore, because of the low numbers, it is important to consider the results carefully and view them rather as a trend.

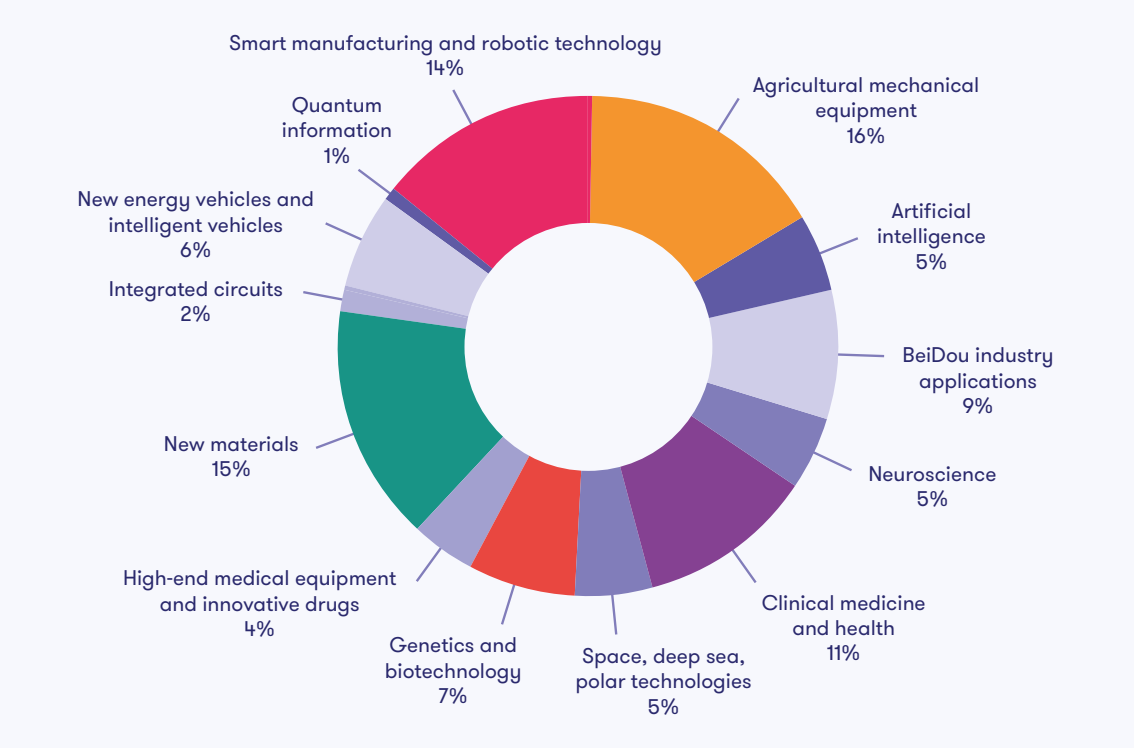
Importantly, it is crucial to bear in mind that the gathered dataset is not (and does not aim to be) an accurate and exhaustive list of research projects funded by China. The resulting dataset aims to bring early evidence on the research cooperation between China and Central European researchers and research institutions.

The first joint research outputs in the selected research areas identified by the WoS database appeared in 2006 in the case of the Czech Republic, and in 2007 in the case of Austria. As evident in the graph, the research cooperation has been constantly increasing, especially in recent years.

The first research outputs declaring funding from China with involvement of Slovak researchers were identified in 2010, later than in the case of the Czech Republic and Austria. Given the tendency of development in these countries, representing a few research outputs at the onset of research cooperation with China and steeper curve in more recent years, it may be hypothesised that cooperation with Slovakia may intensify in the coming years once Chinese scientists, universities and institutions become more established partners for research cooperation.

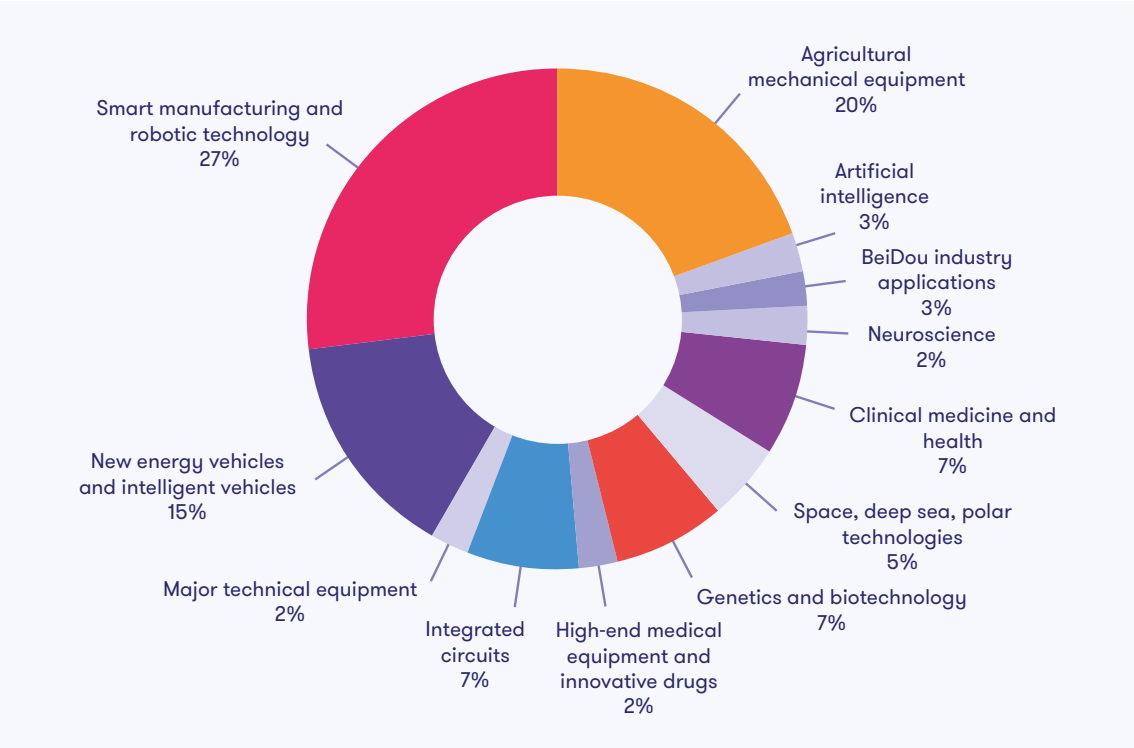
Most research cooperation has been found in the areas of development of new materials, agriculture and smart manufacturing and robotics. In Austria and the Czech Republic, research outputs have been identified in all priority areas as defined

GRAPH 6: RESEARCH AREAS AND OUTPUTS DECLARING SOLELY CHINESE FUNDING WITH INVOLVEMENT OF SCIENTISTS WITH AUSTRIAN AFFILIATIONS (2007–2021)



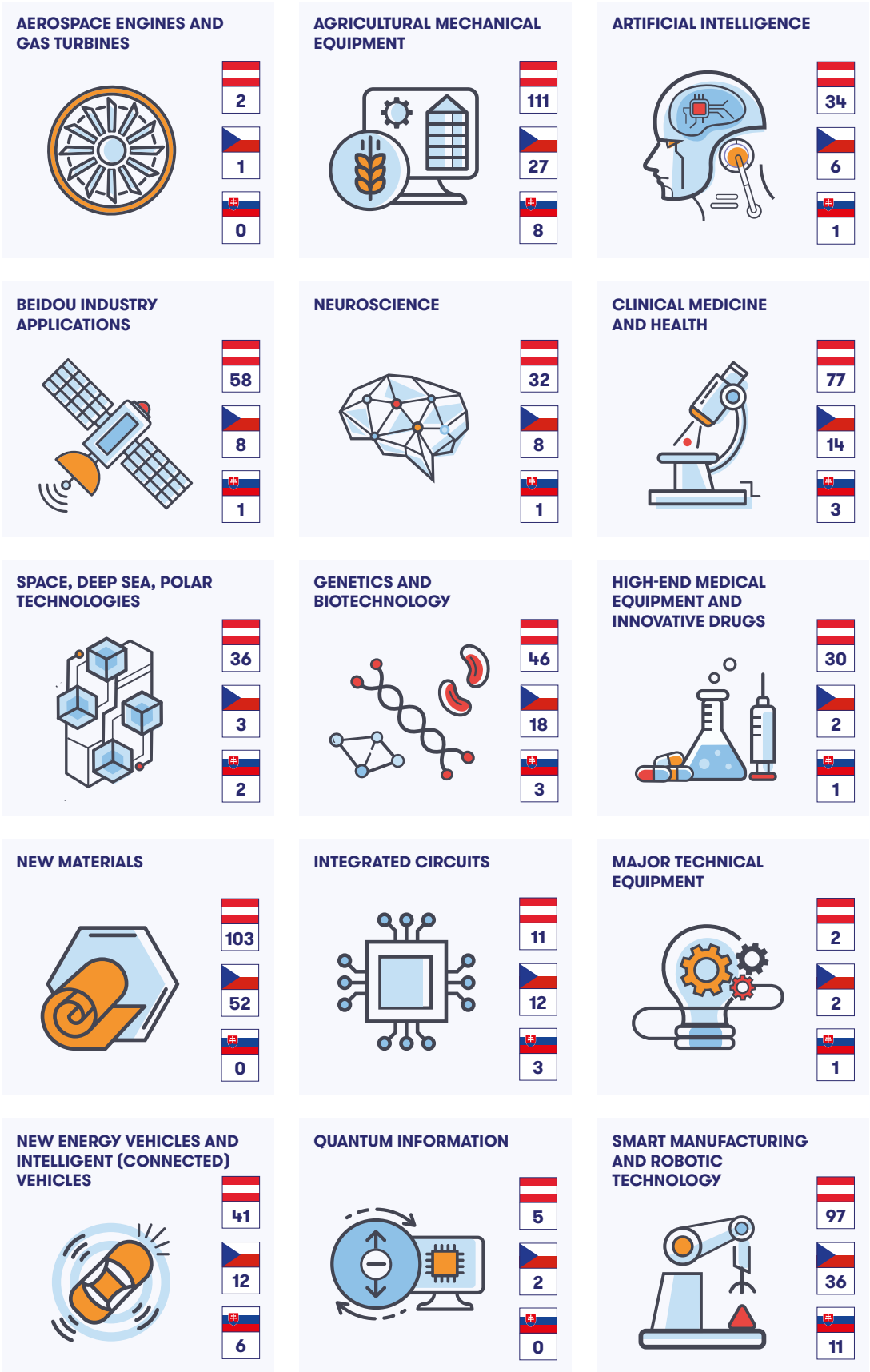
Data retrieved from Web of Science.

GRAPH 7: RESEARCH AREAS AND OUTPUTS DECLARING SOLELY CHINESE FUNDING WITH INVOLVEMENT OF SCIENTISTS WITH SLOVAK AFFILIATIONS (2010–2021)



Data retrieved from Web of Science.

GRAPH 8: RESEARCH AREAS AND OUTPUTS DECLARING SOLELY CHINESE FUNDING WITH INVOLVEMENT OF RESEARCHERS WITH AUSTRIAN, CZECH AND SLOVAK AFFILIATIONS (2006–2021)



Data retrieved from Web of Science.

by China's technology list. In Slovakia, we have identified joint research outputs in all but three priority areas.

In terms of the funding sources of the research, there were dozens of Chinese funding agencies providing finances on both the national and provincial level. Several projects were also funded by the Thousand Talents Programme which deserves further attention. This funding scheme aims to identify and recruit foreign researchers and some countries, such as the US and Canada, have issued warnings regarding the potential threats of this and similar talent programmes for research integrity.

Interestingly, one of the research papers included in the dataset also declared funding from the Central Military Commission, the highest national defence organisation in China (operating under both the state and the Chinese Communist Party system), which is in charge of the overall administration of China's armed forces and is chaired by Xi Jinping.[95]

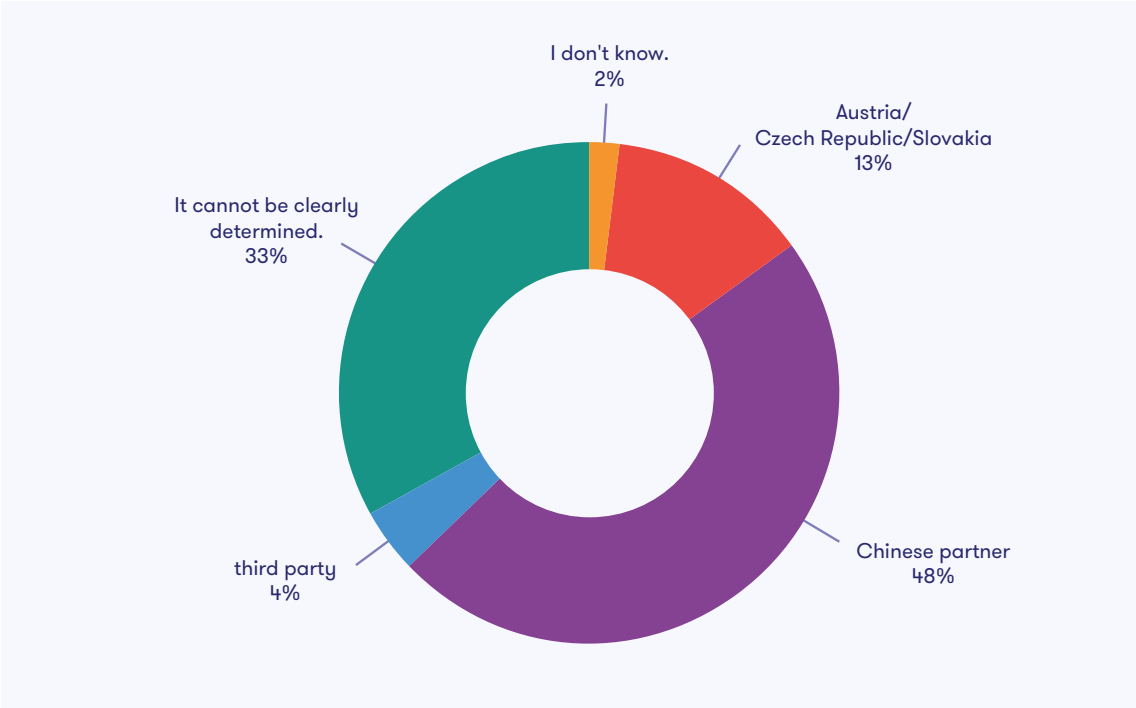
MOTIVATION DRIVING COOPERATION WITH CHINA

The following chapter presents findings of a survey conducted in Austria, the Czech Republic and Slovakia among researchers who have, based on the evidence and detailed analysis of research outputs included in the WoS database, had previous research collaboration with Chinese counterparts, (co)funded by Chinese funding agencies. The survey was conducted in June 2022 on a cohort of 718 researchers based in the three countries. The survey gathered 63 responses, comprising 19 from Austria (four percent response rate), 36 from the Czech Republic (16 percent response rate) and eight from Slovakia (26 percent response rate).

The relatively low response rate may have been caused by several factors, stemming from timing (the end of an academic year) to a general dislike for responding to questions connected to China for fear of featuring in a 'naming and shaming' campaign as China has become a rather sensitive topic. The unwillingness to participate in (even anonymous) research on China has been observed by the authors when working on other projects mapping China's influence in Central Europe. Thus the results of the questionnaire should be treated not as a statistically representative sample, but more as an additional source of qualitative information, providing a glimpse on motivation driving cooperation with China on the side of Central European researchers in STEM areas.

The survey results show some of the researchers denying involvement in research (co)funded by China. There are several possible explanations available. It might have been caused by a mistake of the WoS database algorithms which might have falsely determined the sources of funding. Nevertheless, all the research outputs were also cross-checked manually, thus this explanation seems improbable. Secondly, the WoS database does not differentiate between funding provided for the research as such and additional funding provided, for example, for an individual researcher (i.e., from China) participating in the research. Consequently, in these cases, the researchers from Central European countries may have not been aware of all sources of funding. Lastly, despite the anonymous character of the survey, the researchers might have decided not to mention their cooperation with China for personal reasons highlighted above.

GRAPH 9: WHICH PARTY INITIATED THE RESEARCH COOPERATION?



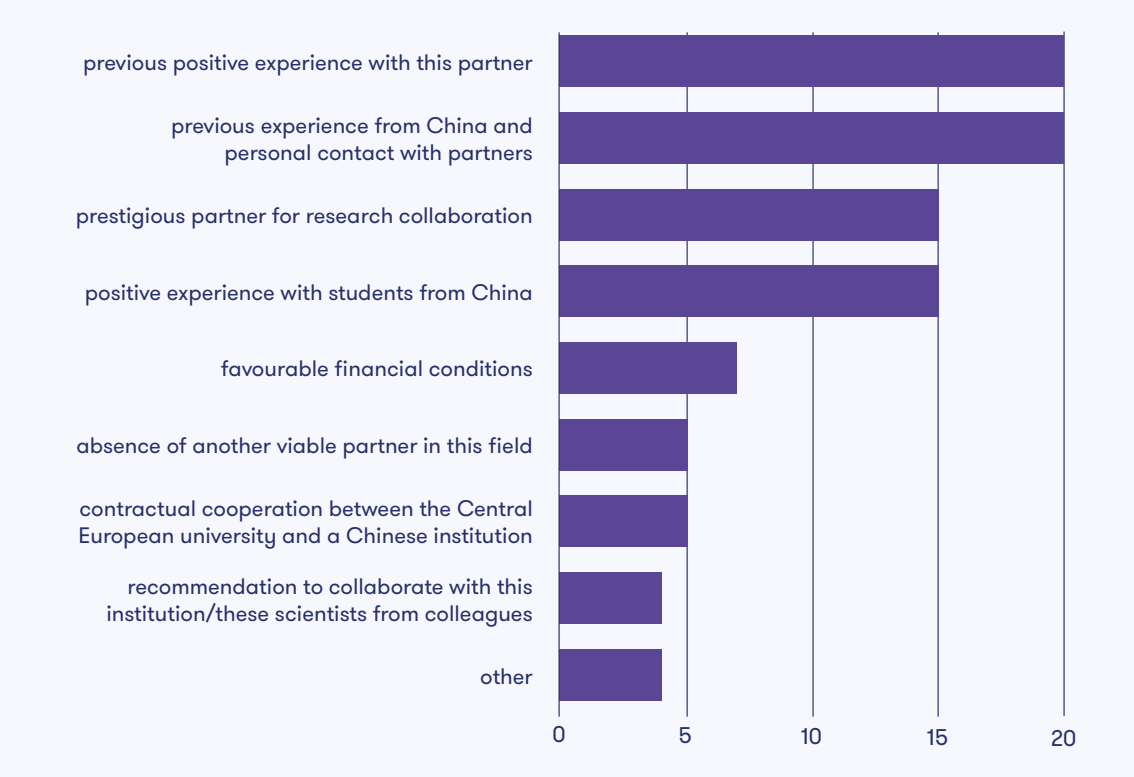
Data gained from the survey of research cooperation between Central Europe and China conducted by the authors.

As Graph 9 shows, almost half of the collected responses indicated the Chinese partner as the initiating party of the research cooperation. On the other hand, only 13 percent of the researchers indicated their university or research centre as incentivising the joint research.

The vast majority of the researchers did not mention any problems occurring during research cooperation with China, with only individual cases referring to infringement of intellectual property rights, violation of ethical principles in science, commercial use of research without the knowledge of all authors or pressure to continue with the research collaboration. In general, it may be stated that the collected responses denied a negative experience which also correlates with the positive perception of Chinese funding. Yet it has to be stressed that the survey was specifically targeting researchers who, based on WoS data, cooperated with Chinese counterparts and the results thus may suffer from a bias. Quite often, the researchers mentioned that they would not have been able to conduct the research without the Chinese financial support or have gained research samples without the Chinese partner's infrastructure.

It has to be noted that the survey was concluded before the Czech media reported an incident between a Chinese researcher involved in the top-tier laser centre Eli Beamlines and his colleagues from the Czech Academy of Sciences, on June 9, 2022. The Chinese researcher stormed out of a science fair organised by the academy, in reaction to the display of a photo of the Dalai Lama at the exhibition prepared by Sinologists on human rights abuses in China. He then sent an e-mail to his colleagues, in which he called them "Nazis" and requested the dismissal of those Sinologists involved in organising the science fair from the academy and an apology from the

GRAPH 10: REASONS FOR COLLABORATING WITH CHINESE SCIENTISTS, UNIVERSITIES OR RESEARCH INSTITUTIONS



Data gained from the survey of research cooperation between Central Europe and China conducted by the authors.

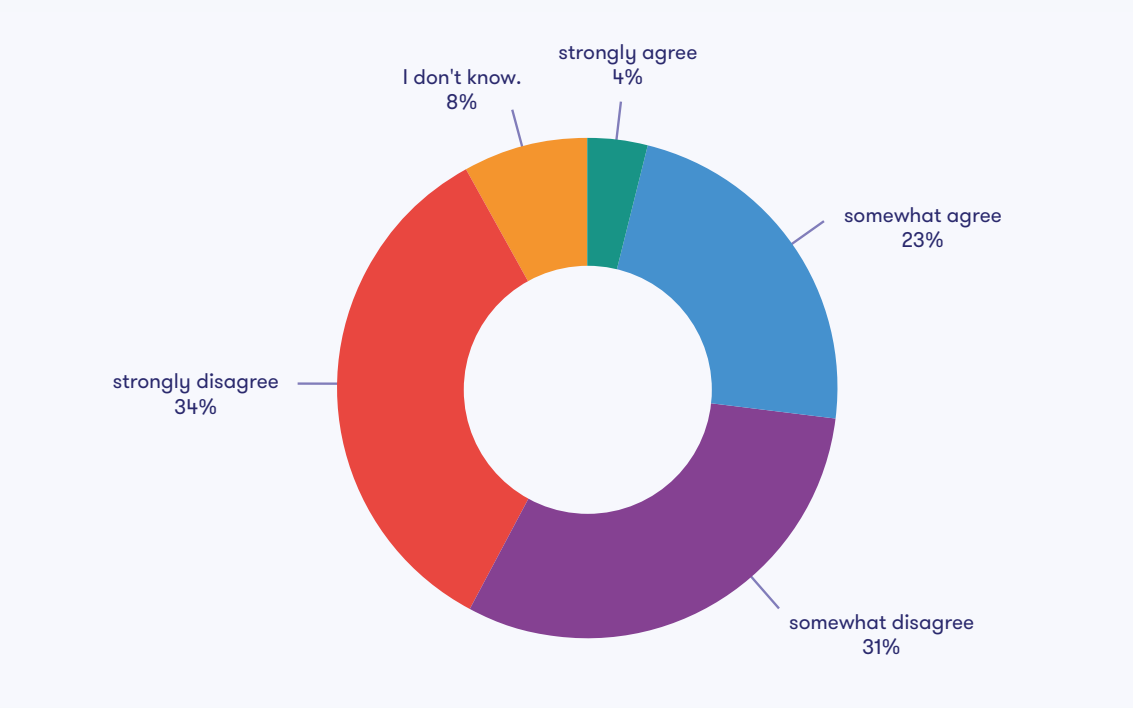
Czech government. The academy subsequently terminated the contract with the Chinese researcher.[96]

Regarding the motivation driving collaboration with Chinese counterparts, the respondents predominantly underlined the importance of previous positive experience with the Chinese partner and previous personal contacts or experience gained in China. Similarly, positive experience with Chinese students and perceptions of the counterpart as a prestigious partner ranked high among the incentives for research cooperation with China.

Overall, students from China tend to be viewed strongly positively, especially in the Czech Republic, with the researchers mentioning greater dedication, a more active approach and better study results compared to local students. A more detailed look at data from Austria shows a more polarised view with several researchers sharing the Czech researchers' views, whereas others cited problems with the language barrier, or a need for more guidance. Research cooperation with Chinese scientists, universities or research institutions was not perceived as representing a potential risk by 65 percent of the respondents who filled in the questionnaire (Graph 11).

Perhaps most importantly, the survey results showed a lack of knowledge regarding existing mitigation strategies for safeguarding research cooperation and significant gaps in the implementation of such strategies at HEIs or research centres. Whereas over half of the respondents did not know whether their institution had any specific internal mechanisms in place to be followed in case of concerns about

GRAPH 11: DO YOU AGREE THAT THERE ARE POTENTIAL RISKS FOR YOUR RESEARCH WHEN COLLABORATING WITH CHINESE COUNTERPARTS?



Data gained from the survey of research cooperation between Central Europe and China conducted by the authors.

the motivation or the actions of international partner, another quarter affirmed that no such mechanisms existed. Forty percent mentioned that they do not know whom they would consult in case of any concerns related to risks of possible cooperation with a foreign partner. Similarly, half of the respondents did not know whether their institution organises training or seminars for staff in the area of trusted research. A further 21 percent stated that training on these topics is not under consideration.

An absence of awareness of potential risks may also be identified in terms of access to the laboratories or research data by Chinese PhD students or researchers. 89 percent of respondents claimed access to venues or data is not limited. Additionally, the survey results showed a considerable lack of precautions employed while traveling to China. From those attending an in-person conference in China, only 16 percent of the respondents took any precautions and only 25 percent reached out to someone in order to get advice on security prior to the conference.

As for expectations from the national government, 44 percent of the participating researchers do not know whether they would welcome more government support in terms of trusted research. An additional 30 percent of respondents would not wish to see any measures introduced by the state. Only a quarter of respondents were open to governmental support which should ideally consist of providing systematic information on potential risks, the organisation of seminars on trusted research and potentially also sharing examples of bad and good practice and creating 'red lines' (e.g., a black list of foreign HEIs and research centres). Several respondents suggested the establishment of a contact point or a help desk which would help the institutions and individual researchers to evaluate security risks.

Conclusions and recommendations

By the middle of this century, China intends to become a technology superpower. In order to achieve this goal, as well as upgrade its indigenous research, China utilises foreign technologies to boost its own technological base and enable rapid domestic innovation. In some cases, Chinese technology acquisition abroad is closely tied to military modernisation efforts. Generally, the list of China's STI priority areas is broad and includes, inter alia, artificial intelligence, quantum technology, integrated circuits, deep space exploration, new materials, neuroscience or biotechnology.

The most technologically advanced countries have responded to China's quest for foreign technology by increasing efforts to safeguard their science, technology and innovation sectors. Still, as this report has argued, current measures to mitigate the risks of technology transfer to China, though re-calibrated over time to address the changing challenges, seem incomplete and insufficient.

To start with, the systems of export controls were designed for trade exchange in military and nuclear material and dual-use goods. However, they seem inadequate in addressing the current phase of rapid technological progress, especially in emerging technologies. Moreover, the interconnected nature of the global market and the necessity to import various components from different countries to create the final product, makes the formulation of export controls incredibly arduous. Similarly, targeting emerging technologies in the investment screening legislation has also been limited, as it focuses on a relatively narrow scope of dual-use technologies directly applicable for military end-use while leaving out other, potentially risky areas. Another tool for safeguarding sensitive STI against China's activities are visa restrictions. However, visa restrictions that target populations from specific countries can also be one of the most controversial measures, and as well as hampering useful aspects of academic exchange, especially if applied too broadly.

Last but not least, an important safeguarding mechanism applied in a self-regulatory manner are the guidelines for higher education institutions and research centres. Yet, for political reasons, the available guidelines often shy away from directly mentioning China, thus obscuring the risks associated with the country's activities and making it difficult for institutions and researchers to understand the nature and scope of this specific challenge.

The hypothesis that the levels of awareness of risks posed by cooperation with Chinese individuals and entities is low has been confirmed by the survey conducted among Central European researchers. Furthermore, interviews with Czech and Slovak members of the academia uncovered a widely shared perception that China may not be interested in research cooperation due to the perceived superiority of its own research. Contrary to this assumption, there are actually areas where Central European HEIs and research centres produce world-class outputs. This fact, downplayed by the local researchers, has not gone unnoticed in China. As a result, since

2006 Chinese PhD students in STEM areas started enrolling to Central European universities and research centres, though not evenly distributed.

The number of PhD students from China has been the highest and rather constant in Austria, continuously growing in the Czech Republic and rather low in Slovakia. Also different are the cross-country perceptions of the Chinese students. Results from qualitative research, conducted specifically for this study, indicate that students from China tend to be viewed highly positively in the Czech Republic, with the researchers mentioning their greater dedication, a more active approach and better study results compared to local students. Data from Austria show a more polarised view with several researchers sharing the Czech researchers' views, whereas others cited problems with the language barrier, or a need for more guidance.

Interestingly, the number of outputs which were published by local researchers in areas defined as priority by Chinese strategic documents and which received Chinese (co)funding have also risen over time. In Austria, the authors identified 685 research outputs in key scientific areas declaring exclusive funding from Chinese sources and over 200 outputs funded on a bilateral basis. In the Czech Republic, it was 203 research outputs that declared funding solely from Chinese sources, while in Slovakia, 41 projects acknowledged only funding from Chinese sources and 54 were funded on a bilateral basis. Research cooperation has been constantly increasing, especially in recent years.

Concerning research areas, in the Czech Republic, most research cooperation has been identified in the fields of the development of new materials, agriculture and smart manufacturing and robotics. In Austria, there is a more diversified distribution of research cooperation in various fields, ranging from agricultural equipment, smart manufacturing and robotics to new materials.

Dozens of Chinese funding agencies on both the national and provincial level provide funding for scientific research in Central Europe. Several research projects under scrutiny were also financed by the Thousand Talents Programme, China's scheme to identify and recruit foreign researchers, which has been connected to proven breaches of research integrity. Interestingly, one of the research papers included in the dataset also declared funding from the Central Military Commission, the highest national defence organisation in China (operating under both the state and the Chinese Communist Party system), which is in charge of the overall administration of China's armed forces and is chaired by Xi Jinping.

The survey conducted among Central European researchers who cooperated with China revealed that researchers did not report any negative experience connected to cooperation with China which also correlates with the positive perception of Chinese funding. Unsurprisingly therefore, the research cooperation with Chinese counterparts was not perceived as a potential risk by 65 percent of the respondents who filled in the questionnaires.

Regarding the motivation driving researchers into cooperation with China, the respondents predominantly underlined the importance of previous positive experience with a Chinese partner and personal contacts or experience gained in China. Despite a relatively low response rate - possibly caused by a widespread aversion to responding to questions connected to China for fear of featuring in a 'naming and

shaming' campaign - the survey revealed that it has mainly been Chinese partners who initiated the research cooperation.

Perhaps most importantly, the survey results showed a lack of knowledge regarding existing mitigation strategies for safeguarding research cooperation and significant gaps in the implementation of such strategies at HEIs or research centres. Over half of the respondents did not know whether their institution had any specific internal mechanisms in place to be followed in the case of concerns about the motivation or the actions of an international partner. An additional quarter affirmed that no such mechanisms existed. Moreover, 40 percent of those surveyed claimed they did not know whom they would consult in the case of any concerns related to risks of possible cooperation with a foreign partner. Similarly, half of the respondents did not know whether their institution organised dedicated training or seminars for staff in the area of trusted research. A further 21 percent stated that training on these topics is not under consideration.

Alarmingly, low awareness of potential risks can also be identified in terms of access to laboratories or research data by Chinese PhD students or researchers. 89 percent of respondents claimed access to venues or data is not limited. Additionally, the survey results showed a considerable lack of precautions employed when travelling to China. From those attending an in-person conference in China, only 16 percent of the respondents took any precautions and only 25 percent reached out to someone in order to get advice on security prior to the conference.

As for expectations from the national government, 44 percent of the participating researchers do not know whether they would welcome more government support in terms of trusted research. An additional 30 percent of respondents would not wish to see any measures introduced by the state. Only a quarter of respondents were open to governmental support which, based on their opinions, should ideally consist of providing systematic information on potential risks, the organisation of seminars on trusted research and potentially the sharing of examples of bad and good practice and creating 'red lines' (e.g. a blacklist of foreign HEIs and research centres). Several respondents suggested the establishment of a contact point or a help desk which would help institutions and individual researchers to evaluate security risks.

Based on the aforementioned analytical findings, the authors designed actor-specific guidelines in order to narrow down the knowledge gap and complement the existing actor-agnostic recommendations:

→ **Address the elephant in the room.** Adopting actor-agnostic regulations for safeguarding trusted research and knowledge security should not obscure the specific challenges connected with China's activities. Its global reach, far-reaching goals, increasingly revisionist agenda and the nature of its political regime make China a risk and a challenge like no other, one that deserves special attention reflected in an actor-specific approach. While China's characteristics do not disqualify the existing general measures, they warrant specific adaptation for the Chinese case.

→ **(Re)define "sensitive".** The majority of currently published guidelines use the term "sensitive research" which generally concerns dual-use and military material.

Recently, in the European Union, the discussion on the ethical use of research findings commenced, for example, in the context of the use of artificial intelligence for facial recognition. However, none of these categories encompass emerging technologies which may be the target of foreign efforts to acquire research results. While the identification of such "crown jewels" is difficult, it is indispensable in mitigating potential risks arising from research cooperation with China. Moreover, the definition of potentially risky areas is a continuous process due to rapid technological developments. It is therefore important to create flexible, responsive mechanisms designed to adapt to and keep up with the pace of technological development, unlike export controls which are burdened by lengthy and rigid legislative procedures. Crucially, the list of potentially vulnerable research areas should not be viewed as a 'no-go zone' but rather as a motivation to conduct more careful due diligence and adopt more efficient preventive measures.

→ **Draw 'red lines'.** Creating a set of detailed questions and a checklist covering all potentially risky areas is a practical tool to ensure that all potential problems are considered. For instance, the German guidelines, created by the German Rectors' Conference mentioned in the section of this report describing the various guidelines, provide an exhaustive list of questions to take into account. While such guidelines define due diligence in great detail, referring to all potential data that could indicate warning signs, they typically do not conclude which results of due diligence are still acceptable ('go') and which already denote a significant threat ('no go'). In short, even this detailed approach does not draw a red line. A particularly useful mechanism to evaluate the potential risks to research integrity might be a "risk matrix" that would complement the list of questions. A combination of the detailed questions and the matrix could then determine possible mitigation measures for the concerned research project or activity.

→ **Don't delegate, assist.** Measures targeting higher education institutions and research centres have to be designed with the aim of bringing research institutions on board as collaborative partners and stakeholders. While it is in the interest of HEIs and research centres to act responsibly, credibly and transparently, they quite often lack the experience and human and financial resources to identify and safeguard their "crown jewels." In all processes, HEIs and research centres should be supported by national administrations financially and legally.

→ **Create a national contact point.** The assessment of foreign interference represents a complex and demanding cross-disciplinary issue. The guidelines usually delegate a huge portion of (often newly defined) responsibility to universities which are e.g. asked to appoint a new professional responsible for risk mitigation and framework establishment. This typically requires additional funding which could otherwise be used in research or elsewhere in the institutions' activities. Since the guidelines serve as recommendations, some universities may opt not to adopt the suggested measures at all. The states could meet the academic institutions halfway by establishing an independent point of contact that could provide advice and recommendations to all universities in such need. Such a centre could help

identify the key aspects to consider while conducting due diligence and draw the 'red lines'. It could also be in charge of organising training and mentoring to raise awareness of the risks related to international research cooperation for all concerned actors. Ideally, the trainings would include also a simulation exercise with various scenarios to gain practical experience which would show how to work with the guidelines, help identify the risks in advance but also indicate potential solution for dealing with various obstacles. Another role would be to serve as an intermediary between universities and the government. Alternatively, it may also serve as a contact point providing advice to companies, start-ups and spin-offs, especially those conducting research, which may struggle with the legislation or may not realise the potential security implications of their research or products. Importantly, it could gradually evolve into a trusted centre for sharing best practice and lessons learned concerning foreign cooperation among universities, disseminating information of detected risks, and even communicating with similar centres located in other countries. An example of such a centre can already be found in the Netherlands, where the National Contact Point for Knowledge Security is available to answer questions about both opportunities and risks arising from international collaboration. Crucially, the contact point would need to bridge the gap between the academia and state institutions and devote efforts to gaining trust among researchers as they are often worried about excessive state intervention to academia.

→ **Stay competitive.** In designing and reevaluating research funding schemes, European countries and their national agencies should not take for granted that European (or their allies') financial resources are the only game in town. Especially in the field of emerging technologies, research funding needs to ensure that the most promising activities stay European. For instance, there should be an acknowledgement of the risks associated with groundbreaking research by an accommodation and an acceptance of the uncertainty of such endeavour in the evaluation process. A failure to reach a declared result does not necessarily indicate a failed scientific effort. A promising European scientist turned disgruntled researcher may present an opportunity for China.

→ **Embrace the proactive approach.** An awareness of the importance of protection of STI should not only be based on passive responses to ever-evolving threats, but should also include active endeavour on the part of the state and the research institutions to identify the most promising research fields which deserve special attention. Research institutions should not be primarily discouraged by being presented with the repercussions of not meeting the existing legal criteria for the protection of STI. Instead, they should be motivated to develop and nurture an environment for trusted research as a key advantage in terms of attracting scientific talent, securing funding, and developing mutually beneficial relationships with other research institutions as well as private actors. An ideal system would thus create incentives for institutions to foster trusted research on their own initiative.

→ **Expand the scope.** Logically, most of the potentially sensitive research areas lie within the natural sciences and technologies. However, existing cases suggest that research conducted in humanities or social sciences may also be subject to foreign interference. Additionally, due to the growing importance of interdisciplinary research, it would seem beneficial to raise awareness across various disciplines, including those which currently seem the least vulnerable or not a source of risk. The same logic applies to the general tendency to view applied research as more vulnerable, potentially omitting the risks in basic or even highly theoretical research, which is excluded from most export controls regulations. However, it is in this area where China is found to be most lacking and thus hugely interested in utilising international cooperation to make progress.

Authors

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Footnotes

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