EU-China Innovation Relations
From Zero-sum to Global Networks

by

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Abstract

- It is in the long-term interests of both the EU and China to encourage innovation collaboration. Transnational innovation networks or ecosystems can boost innovation outcomes for both sides.
- European and Chinese leaders should encourage an open mindset among policymakers, businesses, researchers and the public at large. This requires moving beyond thinking about innovation as a national or regional project and seeing it as a way to enrich the engagement of European and Chinese researchers and enterprises in global networks. Targets, such as those for local content, which encourage nationalist or protectionist mindsets should be avoided.
- The EU and China are already cooperating in science, technology and innovation and there is much potential to cooperate further in basic research; food and agriculture; manufacturing and industrial technology, such as high-speed railways and aircraft; sustainable urbanization, such as water and health; and climate change mitigation measures, such as renewable energy and green finance.
- To boost innovation cooperation further, the governments of EU member states and China should facilitate the movement of researchers, through flexible and easy-to-navigate visa regimes, student exchanges, and by encouraging researchers to collaborate and to gain global experience. They should also facilitate the cross-border registration of patents by their nationals, so that the EU and China can become effectively the world's largest single market for innovation.
- Growing industrial competition complicates potential close innovation relations. The encouragement of innovation networks needs to be balanced by risk management measures to maintain incentives for individual firms and institutions to invest in innovation, and by the further development and strengthening of intellectual property rights protection.
- Evaluating relative innovation capacity has become more complex with the rise of China, and shifts to a more diffuse and multipolar world. But developed economies are still at the forefront in innovation, and Europeans should have confidence in the strengths that mature research institutions and supportive regulatory frameworks can bring to global innovation. Innovative Chinese companies will also create new opportunities for Europe.

Introduction

Innovation is a strategic policy priority for the EU and China, seen by both as a means to further develop their economies and deal with sustainability challenges including climate change and local environmental degradation. Nurturing an efficient science and technology sector and innovation ecosystem can promote long-term economic growth – as returns diminish from physical means of production, revenues from ideas and innovation can fill the gap (see Box 1). Smart, sustainable and inclusive growth with innovation at the core has been a priority under the EU's Europe 2020 strategy and China's 12th and 13th five-year plans.[1] This paper explores the opportunities and challenges in EU–China innovation relations as a basis for policy recommendations to 2025. It was produced as part of a research project on EU–China relations carried out by Bruegel, the China Center for International Economic Exchanges (CCIEE), Chatham House and The Chinese University of Hong Kong (CUHK).[2]

The EU has described itself as facing an 'innovation emergency', with total spending on research and development (R&D) at around 2.03 per cent of GDP during 2013–15, after a rise from 1.77 to 2.01 per cent during 2007–12. However, this expenditure is, respectively, some 0.7 percentage points and 1.5 percentage points lower than in the US and in Japan, and other countries have caught up fast, including China and South Korea. In response, under the Europe 2020 strategy, the aim is to spend 3 per cent of GDP on R&D by 2020. According to the EU, more innovative products and services could help with job creation through increased output and exports that arise from greater competitiveness and productivity, and better use of resources. Innovation could also help address a range of challenges from climate change and clean energy to managing ageing populations. The EU claims the strategy could create 3.7 million jobs and increase annual GDP by €795 billion by 2025. The key EU instrument for delivering this objective is the Horizon 2020 programme, which aims to fund €80 billion of activity from 2014 to 2020, coupling research and innovation in science with industrial leadership and tackling societal challenges. The EU further aims to develop a European Research Area as 'a genuine single market for knowledge, research and innovation'.[3]

The Chinese government's 13th Five-Year Plan, which sets out strategic economic and social goals for 2016 to 2020, features innovation as one of its most important themes.[4] The target for annual R&D spending by 2020 is 2.5 per cent of GDP (compared with 2.07 per cent in 2015, below the targeted 2.2 per cent). Other major goals are enhanced internet penetration (with plans for mobile broadband to reach 85 per cent of households), a contribution of science and technology to economic growth of 60 per cent (55.3 per cent in 2015), and 12 invention patents filed annually per 10,000 head of population (compared to 6.3 in 2015).[5]

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[1] For analysis of the 12th Five-Year Plan see Ash, R., Porter, R. and Summers, T. (2014), 'Rebalancing towards a sustainable future: China's twelfth five-year programme', in Brown, K. (ed.) (2014), *China and the EU in context: insights for business and investors*, London: Palgrave Macmillan, pp. 82 and pp. 113–19. For the 13th Five-Year Plan see Kennedy S. and Johnson, C. (2016), *Perfecting China, Inc.: The 13th Five-Year Plan*, Washington, DC: Center for Strategic & International Studies, https://www.csis.org/analysis/perfecting-china-inc (accessed 23 Apr. 2018).
[2] The paper reflects more detailed research done in the preparation of a joint report by these four organizations: García-Herrero, A., Kwok, K.C., Liu, X., Summers, T. and Zhang, Y. (2017), 'EU–China Economic Relations to 2025: Building a Common Future', Chatham House Report, London: Royal Institute of International Affairs, https://www.chathamhouse.org/publication/eu-china-economic-relations-2025-building-common-future.
[3] European Commission (2017), 'Innovation Union', http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=home (accessed 8 Oct. 2017); European Commission (2017), 'Horizon 2020', https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020 (accessed 8 Oct. 2017); for a detailed earlier analysis of the challenges facing the EU, see European Commission (2012), *International Cooperation in Science, Technology and Innovation: Strategies for a Changing World*, Brussels, https://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/report-inco.pdf; Eurostat, 'EU expenditure on R&D', http://ec.europa.eu/eurostat/statistics-explained/index.php/R_per cent26_D_expenditure (accessed 8 Oct. 2017).
[4] This paragraph is primarily based on Kennedy and Johnson, *Perfecting China, Inc.;* Xinhua (2016), 'The Outline of the 13th five-year plan for national economic and social development of the People's Republic of China' (translated from the Chinese), http://news.xinhuanet.com/politics/2016lh/2016-03/17/c_1118366322.htm (accessed 23. Apr. 2018).
[5] A degree of caution should be exercised in using such data to make comparisons between economies; for example, different approaches to counting patents may be adopted in Europe and China.

The 13th Five-Year Plan also identifies 75 priority technologies and key sectors, including six strategic emerging industries. The ICT sector is the highest priority, and the Made in China 2025 plan has been developed to boost innovation in manufacturing, with the intention of 'elevat[ing] a small vanguard of Chinese manufacturers to a higher level of efficiency and productivity'.[6] This is against a background of a substantial increase in the scale and quality of China's human capital resources in recent years, notably in engineering-related disciplines. China's extensive manufacturing ecosystem has enabled it to perform well in production-related and efficiency-driven innovation. Moreover the rapid growth in its large and dynamic consumer market provides fertile ground for consumer-related innovation as 'Chinese consumers enable innovation by accepting early iterations of products and services and providing feedback for rapid refinement'.[7] Public procurement can also spur innovation by creating space to test new technologies on a large scale, though most of this is managed by the government. Furthermore, given its latecomer status, China can often leapfrog technological and market developments; when the regulatory stance has been relatively liberal (especially at local levels of government), new business models have been able to develop rapidly, for example in financial technology (FinTech) and P2P payment systems. China was the world's largest filer of patents in 2015, though most of these are domestic, while Europe was fifth in global rankings behind the US, Japan and South Korea, as well as China (the US continues to lead in the stock of patents in force).[8] Some have even suggested that the EU is 'on the sidelines of the globalization of science process'.[9] However, as discussed below, there is plenty of evidence to the contrary, and filings of triadic patents indicate that Europe remains well ahead of China in this international measure.[10]

Box 1: What is innovation?

Innovation in economic growth and sustainable development depends on the relationship between long-term economic development, productivity growth and endogenous innovation. Efficient allocation of the scarce physical means of production will lead to diminishing returns as the marginal benefits of adding more factors of production decline over time, leading economic growth to slow. However, economic growth theories argue that new technologies and ideas can turn diminishing returns into increasing returns. Given the non-zero-sum nature of ideas, greater innovation can lead to more productive and faster growth. Economic policy can promote this significantly by nurturing an efficient science and technology and innovation ecosystem (thus facilitating endogenous innovation and technological development). A diverse range of players (universities, science institutes, large corporations, small and medium-sized enterprises (SMEs), startups etc.) with different strengths can all contribute to a strong innovation ecosystem. The effective integration of different levels and players in the field of innovation is therefore important.

A distinction can be drawn between three levels of innovation: theoretical, production and consumer.[11] Enabling innovative products or services to have an impact on the economy typically involves high-level conceptual or theoretical knowledge or inventions; mid-level innovations related to production and industrial design that

[6] Wübbeke, J., Meissner, M., Zenglein, M. J., Ives, J. and Conrad, B. (2016), *Made in China 2025: the making of a high-tech superpower and consequences for industrial countries*, Berlin: Merics, https://www.merics.org/en/papers-on-china/made-china-2025 (accessed 9 May 2018).
[7] McKinsey Global Institute (2015), 'The China Effect on Global Innovation', http://mckinseychina.com/the-china-effect-on-global-innovation/ (accessed 8 Oct. 2017).
[8] World Intellectual Property Organization (2016), 'Global Patent Applications Rose to 2.9 Million in 2015 on Strong Growth From China; Demand Also Increased for Other Intellectual Property Rights', http://www.wipo.int/pressroom/en/articles/2016/article_0017.html#marks (accessed 20 Apr. 2018).
[9] Veugelers, R. (2011), cited in Serger, S. S. (2014), 'Sino-Swedish Science and Technology Relations – the Bigger Picture from a Strategic Perspective', Swedish Governmental Agency for Innovation (VINNOVA), www.stint.se/8bf3-21285b3be2-0a30ccde96d8137a (accessed 23 Apr. 2018).
[10] Using data from national patent offices to measure innovation may not differentiate between inventions of minor and substantial economic potential. Inventions for which patent protection is sought in three of the world's largest markets – the US, Europe and Japan – are likely to be viewed by their owners as justifying the high costs of filing and maintaining these patents in three markets. These *triadic patents* serve as an indicator of higher-value inventions. These data show that the US, Europe and Japan are still far ahead of China in innovation in high-tech industries.
[11] Bhidé, A. (2008), *The Venturesome Economy: How Innovation Sustains Prosperity in a More Connected World*, Princeton University Press.

turn these into quality products and services; and, in turn, lower-level, consumer-related innovations (market analyses, marketing, logistics etc.) to make these products and services a success. These often include feedback loops that lead to the adaptation or modification of the inventions and industrial designs. The importance of this third level of innovation is demonstrated by the fact that many innovative startup firms are concerned more with the speed and effectiveness of their efforts to bring innovative products and ideas to the market, rather than with the science and technology involved.

The OECD also notes that innovation goes far beyond R&D.[12] This approach to innovation is illustrated by the Oslo Manual published by the OECD and Eurostat, which provides guidance on how innovation could be measured. It identifies four types of innovations at the level of the firm:

- Product innovations that produce entirely new or significantly improved products and services;
- Process innovations that significantly change production and delivery methods;
- Organizational innovations that involve changes in business practices, in workplace organization or in the firm's external relations; and
- Marketing innovations that lead to changes in product design and packaging, in product promotion and placement, and in methods for pricing goods and services.[13]

Innovation has also been identified by the EU and China as an area for collaboration, though more work is needed to judge the effectiveness of this cooperation.[14] The EU–China 2020 Strategic Agenda for Cooperation affirms the relationship between EU–China trade and investment and innovation, and the role of innovation in promoting sustainable development. It envisages cooperation in innovation in the fields of food, agriculture and biotechnology, and lists five initiatives for science, technology and innovation cooperation under the agenda's third theme of sustainable development. These range from sustainable growth and urbanization to new and renewable energy and nuclear energy (see Annex).[15] The European Commission's more recent Elements for a new EU strategy on China suggests that 'the EU's economic strengths are complementary to the priorities of China's 13th Five-Year Plan, such as innovation, services, green growth and balancing urban and rural development'.[16] These issues were themes of a series of meetings of the EU–China Innovation Cooperation Dialogue (ICD).[17]

At the same time, in both the EU and China, some voices in policy and business circles see retaining the fruits of innovation as an essential part of their competitiveness. Such a mindset militates against cooperation in innovation. Many Chinese see risks of greater protectionism in the business environment in Europe, while European governments and businesses in China have become more concerned that Chinese policy is moving (backwards) towards 'indigenous innovation' and away from openness, reflecting an underlying strand of Chinese policymaking that seeks to maximize 'self-sufficiency'. A couple of recent high-profile Chinese investments in Europe have been a focal

[12] OECD, 'OECD Innovation Strategy: Defining Innovation', https://www.oecd.org/site/innovationstrategy/defininginnovation.htm (accessed 23 Apr. 2018).
[13] OECD and Eurostat (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3rd edn, Paris: OECD Publishing, http://dx.doi.org/10.1787/9789264013100-en (accessed 23 Apr. 2018).
[14] For a recent discussion of this see Farnell, J. and Irwin Crookes, P. (2016), *The Politics of EU-China Economic Relations: An Uneasy Partnership*, London: Palgrave Macmillan, Chapter 6: 'Innovation and Research'.
[15] European Union (2013), EU–China 2020 Strategic Agenda for Cooperation, http://eeas.europa.eu/archives/docs/china/docs/eu-china_2020_strategic_agenda_en.pdf (accessed 23 Apr. 2018).
[16] European Commission, Joint communication to the European Parliament and the Council, 'Elements for a new EU strategy on China', 22 June 2016, p. 6, http://eeas.europa.eu/archives/docs/china/docs/joint_communication_to_the_european_parliament_and_the_council_-_elements_for_a_new_eu_strategy_on_china.pdf (accessed 23 Apr. 2018).
[17] The conclusions of the third ICD are summarized in the EU's 2 June 2017 News Alert on 'EU-China Summit: new flagship initiatives in research and innovation', http://ec.europa.eu/research/index.cfm?pg=newsalert&year=2017&na=na-020617 (accessed 23. Apr. 2018).

point for European concerns (see discussion of European debates, below). There are also arguments that the earlier complementarity between the two economies has given way to a more complex relationship as a result of China's growing economic influence and technological strength. Dealing with the tensions between cooperation and competition in innovation is therefore part of a wider challenge facing EU–China economic and commercial relations. Different perceptions on issues such as intellectual property protection, indigenous innovation and market access have made it difficult for the two sides to agree on a comprehensive investment agreement.

European debates on EU–China innovation relations

There is an ongoing debate in Europe over China's innovation capacity, which ranges across a spectrum from those who see China as a potential threat based on a view of innovation as a kind of zero-sum game between countries, to those who argue that China lags a long way behind, often for cultural or political reasons. In a report published in 2013, the UK-based non-profit organization Nesta identified five broad narratives about China's innovation capacity:[18]

- A potential science and innovation superpower, pulling ahead of the EU and US, as seen in the resources spent on innovation and indicators such as numbers of researchers or papers produced;
- A fast follower, which does not need to operate at innovation frontiers but can grow and innovate as a follower, while finding it difficult to escape dependence on others' know-how;
- A giant with an Achilles' heel, lacking the 'open interaction' needed for innovation and the legal backing for the protection of intellectual property rights, owing to an untransparent and authoritarian state;
- A techno-nationalist China, which engages in forced transfer of intellectual property, manipulates standards and regulations, favours its own state-owned companies, and as a result constitutes a threat to the EU and US; and
- A low-carbon pioneer, which targets investment in innovation in areas where global growth potential is strong (such as solar energy).

The conclusion reached by Nesta is a nuanced one: China excels at adopting technology and is a fast follower rather than a leader; Chinese research is at the frontier in some areas;[19] but in general it remains much more dependent on connections to those elsewhere and lower down value chains than the country's leadership would like. The report also emphasizes the role of 'innovation in design, processes and organizational models in manufacturing and services which isn't captured by the traditional measures of R&D'.[20] This point aligns with the analysis on industrial innovation networks in a later section of this paper.

Over the past couple of years, however, there have been some shifts in mainstream European views of innovation in China. Most significantly, the assessment among the European business community there has become more critical, describing the current climate as somewhat in line with the 'techno-

[18] Nesta (2013), *China's Absorptive State: Innovation and research in China,* London: Nesta, http://www.nesta.org.uk/publications/chinas-absorptive-state-innovation-and-research-china (accessed 20 Apr. 2018).
[19] This is also a finding of Frietsch, R. and Tagscherer, U. (2014), 'German-Sino collaboration in science, technology and innovation', Fraunhofer ISI Discussion Papers *Innovation Systems and Policy Analysis* 43, p. 11, http://www.isi.fraunhofer.de/isi-wAssets/docs/p/de/diskpap_innosysteme_policyanalyse/discussionpaper_43_2014.pdf (accessed 23 Apr. 2018).
[20] Nesta, *China's Absorptive State*, p. 4.

nationalist' narrative identified by Nesta. This is demonstrated, for example, in the 2016/2017 position paper on European business in China by the European Union Chamber of Commerce in China (EUCCC).[21] In the context of questioning the commitment of the Chinese government to deliver the market-oriented reforms set out at the third plenary meeting of the 18th Central Committee of the Communist Party in November 2013, discussion of innovation is a major theme of the report. It recognizes that innovation is 'a top government priority', reflected in a 42 per cent increase in R&D spending between 2012 and 2015. But it contrasts the Chinese approach, which 'prescribes specific technological pathways through which innovations should be attained', with that in Europe, where governments facilitate, but the lead is taken by the private sector and universities, and key programmes such as Horizon 2020 are 'open to participants from around the world'. The report reflects concern among European businesses in China that the direction of Chinese policy is towards a less open approach to innovation, noting that the term 'indigenous innovation' – largely avoided after 2012 – reappears six times in the 13th Five-Year Plan; the EUCCC argues instead that innovation 'requires full connectivity with one's industry globally and unfettered access to information regarding the latest developments within it'.[22]

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The EUCCC's report reiterates some of these concerns in discussion of the Made in China 2025 initiative. It comments that 'although technological neutrality is key to encouraging innovation, the government has actually prescribed technological pathways, which significantly hinders companies' ability to innovate', and expresses concerns that subsidies under the initiative will lead to overcapacity, while noting that the Chinese government has said that implementation will be left to the market. The EUCCC is further concerned that European and other non-Chinese businesses – which have a 'deep understanding of the industries covered [by the initiative]' – are not able to participate in technical committees that assist in the formulation of standards. It argues for equality in treatment, including inclusion in the National Innovation System. It further supports OECD advice that the 'R&D driven by the private sector tends to have better innovation outcomes', and argues for more encouragement for 'entrepreneurial Chinese enterprises' and SMEs. In support of its concerns, the report notes a decline in the number of European businesses with an R&D centre in mainland China that are planning to expand their operations.[23] Chinese approaches that target sectors and technologies differ from, for example, German targeting of innovation solutions such as improved processes.[24] Similar themes appear in the most recent EUCCC report.[25]

Some recent planned or actual Chinese investments in Europe have come under the spotlight in some European countries. The €4.5 billion acquisition of German robotics manufacturer Kuka by Chinese white-goods manufacturer Midea attracted substantial media coverage because of the perceived threat to Germany's Industry 4.0 strategy, itself a partial inspiration for the Made in China 2025

[21] European Union Chamber of Commerce in China (2016), *European Business in China: Position Paper 2016/2017*, September 2016, http://www.europeanchamber.com.cn/en/publications-archive/459/Executive_Position_Paper_2016_2017 (accessed 23 Apr. 2018).
[22] Ibid., pp. 12–18.
[23] Ibid., p. 11 notes that SMEs 'are often technological leaders in their field, [and] not allowing them to fully participate in the market directly impacts China's ability to innovate'.
[24] Frietsch and Tagscherer (2014), 'German-Sino collaboration', p. 1.
[25] European Union Chamber of Commerce in China (2017), *European Business in China Position Paper 2017/2018*, September, http://www.europeanchamber.com.cn/en/publications-archive/560/European_Business_in_China_Position_Paper_2017_2018 (accessed 9 May 2018).

initiative (though in different industrial and economic contexts).[26] There is also growing sensitivity in the US and Europe about Chinese ambitions in the semi-conductor industry; the US administration rejected a Chinese company's bid for chip equipment maker Aixtron in late 2016. Given the role of technology acquisition through outward investment in Made in China 2025, these developments have sparked debate in Europe about additional screening mechanisms for inward foreign direct investment (FDI).[27] In his State of the Union 2017 address, EU Commission President Jean-Claude Juncker proposed a new EU framework for investment screening.[28]

At the same time, other examples show the positive potential for jobs and investment in Europe by innovative Chinese companies. Huawei's investments in the UK include cooperation with the University of Surrey on a 5G innovation centre (£5 million), projects with the University of Cambridge and other ICT partners, the creation of 130 jobs in a Global Finance Centre of Excellence, and £1.3 billion for investment and public procurement over 2013–17.[29] Other innovative Chinese companies have also expanded in Europe, such as ZTE, Haier and Sany.

Innovation relations between EU member states and China

More generally, innovation has become an important component of bilateral relations with China for several EU member states, which is reflected in the organic growth of innovation networks between universities and other research bodies. For example, innovation was a feature of President Xi Jinping's 2015 state visit to the UK: Xi visited the national graphene institute in Manchester, as well as Huawei; and an agreement between Oxford University and China Construction Bank International on regenerative medicine and tissue engineering research, a memorandum of understanding on a 'garden of ideas', an agreement between the UK's then Department for Business, Innovation & Skills and the Chinese National Development and Reform Commission to cooperate in strategic emerging industries, as well as a range of technology-linked investment projects – such as the investment in Hinkley Point C nuclear facility by China General Nuclear Power Corporation (CGN) – were all signed during the visit.[30] Behind these initiatives lies a growing non-official science and innovation relationship: the UK is China's second-largest science partner by co-publications, over £200 million of joint funding has been committed since 2014 under the UK–China Research and Innovation Partnership Fund (part of the Newton Fund), and outside the Newton Fund there have been £146 million of co-funded programmes since 2007. These are underpinned by a government-to-government Joint Commission for Science and Technology, and effective liaison work in China by the Research Council's UK office in Beijing, and the embassy and consulates.[31]

Collaboration in science, technology and innovation has also been a long-standing part of Sino–German relations, involving public research bodies, industry and support from both governments. Bilateral agreements and a joint committee for science and technology demonstrate this government

[26] Wübbeke, Meissner, Zenglein, Ives and Conrad (2016), *Made in China 2025*, p. 6, describes the Made in China 2025 strategy to promote and disseminate smart technology as 'borrowing from the German concept of Industry 4.0 and the Industrial Internet formulated in the United States'.
[27] Chazan, G. and Wagstyl, S. (2016), 'Berlin pushes for EU-wide rules to block Chinese takeovers', *Financial Times*, 28 October 2016, https://www.ft.com/content/1b892ae4-9cd6-11e6-8324-be63473ce146 (accessed 23 Apr. 2018).
[28] European Commission (2017), 'State of the Union 2017 – Trade Package: European Commission proposes framework for screening of foreign direct investments', press release, http://europa.eu/rapid/press-release_IP-17-3183_en.htm (accessed 23 Apr. 2018).
[29] Oxford Economics (2015), *The Economic Impact of Huawei in the UK*, June 2015, Oxford: Oxford Economics, www.huawei.com/ilink/uk/download/HW_441177 (accessed 14 May 2018).
[30] UK Trade and Investment (2016), 'Chinese state visit: up to £40 billion deals agreed', 23 October 2015, https://www.gov.uk/government/news/chinese-state-visit-up-to-40-billion-deals-agreed (accessed 23 Apr. 2018).
[31] Foreign and Commonwealth Office (2016), 'UK Science and Innovation Network country snapshot: China', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/550314/China_Snapshot_2016.pdf (accessed 23 Apr. 2018).

support and institutionalize the relationships. Collaboration is indicated by a growth in the number of co-publications (rising from 700 in 2000 to over 3,500 in 2012), mainly in areas of 'relative strength of intensive research activity in China'. However, in relative terms, Germany has declined in China's portfolio of international collaborations, while China has grown in relative importance from a German perspective. Throughout most of this collaboration to date there has been a strong degree of complementarity between German and Chinese strengths, reflected in patent filings and high-tech exports.[32]

It is worth noting that Germany's expenditure on R&D is among the highest in the EU, at close to 3 per cent of GDP. However, this figure is exceeded in north Europe, with Denmark, Finland and Sweden all spending over 3 per cent of GDP, which has made them attractive research partners for China, particularly in areas relating to sustainable development. For example, energy-saving technologies and ideas from many north European countries will find a big market in China, where energy efficiency in building designs or electrical equipment is generally low. In terms of co-publications, Sweden ranked fourth among European countries between 2005 and 2010, and the Swedish government has been active in strengthening research and innovation cooperation with China. Swedish firms have a relatively strong presence in R&D activities in China.[33]

The complexity of these competing dynamics and debates in innovation relations is reflected in the European Commission's Elements for a New EU Strategy on China. This asserts that a 'top EU priority is to promote reform and innovation in support of transforming China's growth model into a more sustainable one, based on greater domestic consumption, an expanded service sector, and openness to foreign investment, products and services'.[34] The document identifies particular opportunities for cooperation on the digital economy (reflected in the Made in China 2025 and Internet Plus initiatives), while noting – in line with business concerns – that 'Chinese policy and regulation have increasingly been marked by protectionism'. It calls for further protection and enforcement of intellectual property rights (IPR), and a 'political agreement … on combatting cyber-enabled theft of IPR and trade secrets'.[35] In addition it calls for enhanced cooperation in research and innovation through 'tapping into China's talent pool, promoting the EU as an attractive location for research and innovation, and finding solutions to shared social and environmental challenges'. Key to all this is a 'level playing field for research and innovation', and reciprocal access to programmes and resources.

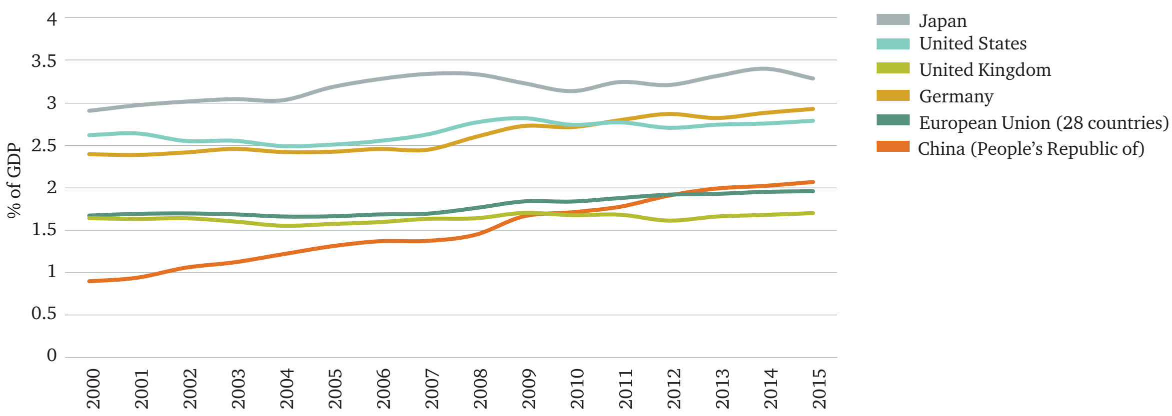
Innovation networks in an era of globalization

The discussion so far reflects a common approach to examining the state of innovation by developing comparative methodologies that rank countries in terms of their innovative capability. This approach is particularly dominant in Western writing about innovation in China: for example, one recent report concludes that China is a 'fat tech dragon', where much greater innovation inputs have not been translated into effective high-tech outputs.[36] Analysis of indicators such as spending on R&D as a percentage of GDP (Figure 1) and total researchers in employment per thousand total employment (Figure 2) tends to suggest that China still lags considerably behind major research-heavy economies.

[32] See Frietsch and Tagscherer (2014), 'German-Sino collaboration', p. 13.
[33] Serger (2014), 'Sino-Swedish Science and Technology Relations'.
[34] European Commission, 'Elements for a new EU strategy on China', p. 6.
[35] Ibid., p. 9.
[36] Kennedy, S. (2017), 'The Fat Tech Dragon: Benchmarking China's Innovation Drive', Washington, DC: Center for Strategic and International Studies, https://www.csis.org/analysis/fat-tech-dragon (accessed 23. Apr. 2018).

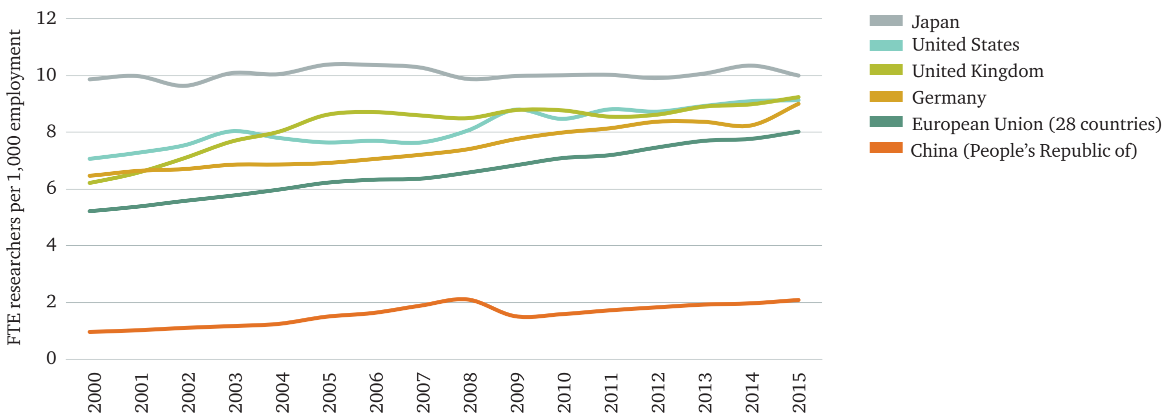
On the other hand, the country performs well in outputs of technical and scientific papers, and patent applications and grants (figures 3 and 4). Moreover, senior US officials have increasingly talked about Chinese innovation and industrial capacity in terms of 'threats' to the US, particularly given a shift to the 'America First' policy under President Trump.[37]

Figure 1: Gross expenditure R&D as a percentage of GDP



Source: OECD, 'Main Science and Technology Indicators', http://www.oecd.org/sti/msti.htm.

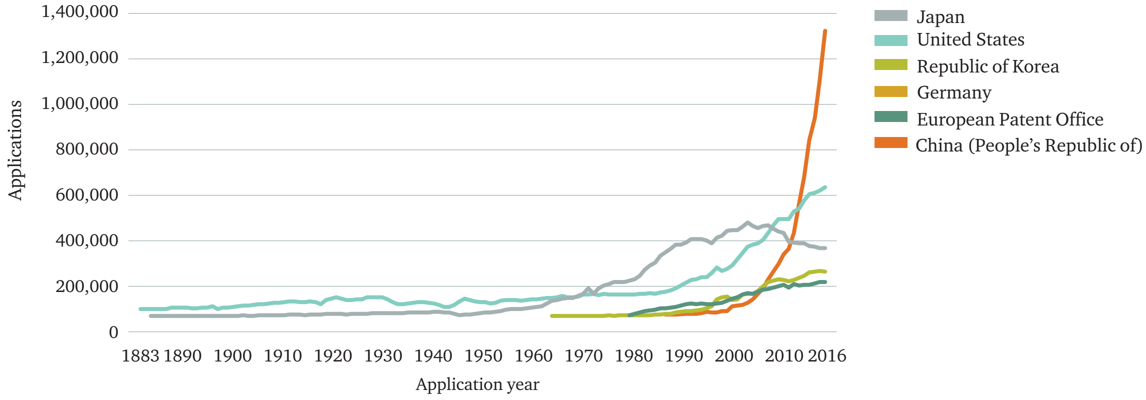
Figure 2: Total researchers in Full Time Equivalent (FTE) per thousand total employment



Source: OECD, Main Science and Technology Indicators, http://www.oecd.org/sti/msti.htm.

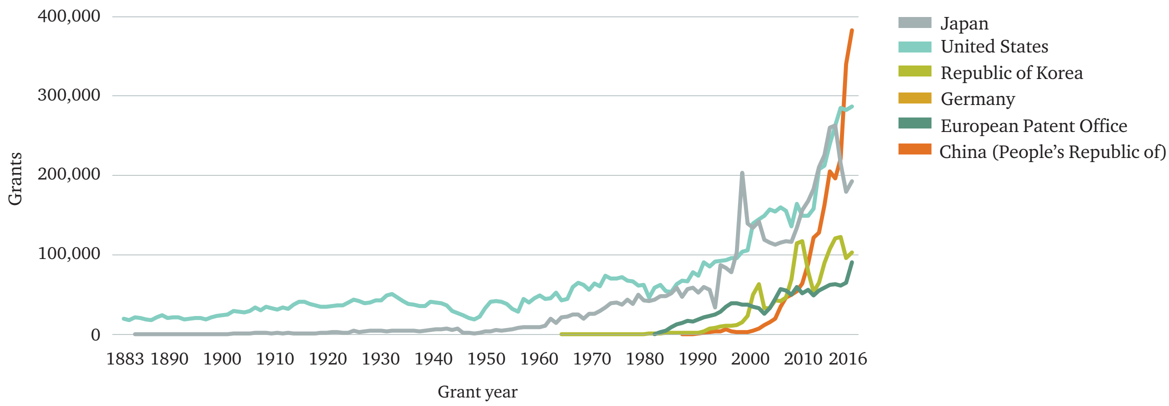
[37] See, for example, Bland, B. (2017), 'Wilbur Ross warns China's drive for industrial automation is a threat to US', *Financial Times*, 27 September 2017, https://www.ft.com/content/f7b46dc6-d8ba-3acc-8d73-12bef4911074 (accessed 23 April 2018).

Figure 3: Trend in patent applications for the top five offices



Source: WIPO (2017), World Intellectual Property Indicators 2017, Geneva: World Intellectual Property Organization, http://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2017.pdf.

Figure 4: Trend in patent grants for the top five offices



Source: WIPO (2017), World Intellectual Property Indicators 2017, Geneva: World Intellectual Property Organization, http://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2017.pdf.

What these approaches do not take account of is the transborder nature of innovation in an era of globalization. This needs to be understood in order to evaluate further the current state of innovation connectivity between the EU and China, and the future prospects of this relationship. The fundamental concept here is networks, namely the idea that innovation is achieved most effectively and efficiently when those engaged in innovation are connected not just within national borders but across them. As President Xi said in 2012, the 'development of science and technology requires extensive international cooperation. Science and technology have no nationality.'[38] Or as stated in the 2012 science, technology and innovation (STI) strategy report produced for the EU, 'the overall principle should be to allow and encourage "the best and brightest" to participate in projects, regardless of their geographical location.'[39]

[38] Cited in Nesta, *China's Absorptive State*, p. 61.
[39] European Commission (2012), 'International Cooperation in Science, Technology and Innovation', p. 12.

One of the consequences of the recent phase of globalization has been the geographical fragmentation of production to incorporate multiple locations across many different countries, a process that has been facilitated by the digitization and modularity of production processes. These production networks have enabled the proliferation of specialized firms and accelerated product cycles, permitted flows within and among firms and across geographical boundaries, and facilitated disruptive innovation.[40] China has played an important role in these processes of globalization: following the launch of 'reform and opening up' by Deng Xiaoping in December 1978, parts of China and some Chinese firms gradually became incorporated into regional and global production networks or value chains; this process accelerated from 1992, and again with the country's entry into the World Trade Organization in 2001. The result has been China's integration into much of globalized production, and the development of an extensive manufacturing ecosystem, which – as noted above – has enabled it to perform well in production-related and efficiency-driven innovation.

There have been some similar structural trends in the globalization of industrial innovation. As with manufacturing, industrial innovation has become geographically dispersed, but there are important differences. Unlike in manufacturing, where supply chains feature firms with multiple ownership brought together by 'system integrator' firms at the top,[41] ownership of innovation networks has remained concentrated. The role of multinational corporations (MNCs) has been central to this, as they manage 'highly diversified, highly internationalized research networks which they … own'.[42]

In areas of innovation that take place outside corporate structures, transborder networks are also important, and university research is increasingly based on collaboration between experts based in different parts of the world. Again, there are concentrations in particular institutes, especially in capital-intensive areas of research, and in many cases established research institutes or universities in developed economies continue to occupy leading positions in these innovation networks. In most fields, for example in Sino–German innovation relations, 'the scientific gap between Chinese and German companies is still large. So effectively, it is German (or foreign) companies who are responsible for the majority of co-invented patents of Chinese and German inventors.'[43] One estimate shows that in 2005 European firms conducted over 40 per cent of their R&D overseas.[44] As the authors of that study put it, challenging though this may be:

> In this interconnected world, the incentives to engage in international knowledge exchange are aligned in mature industrialized countries and emerging market countries despite their different levels of development and their differing degrees of sophistication of their stocks of scientific and technological knowledge. Each country has its own specific types of differentiated expertise and forms of knowledge. Many innovation opportunities now depend on moving new applications across both industries and markets, including between markets with different proportions of high-income and low-income consumers, and with different challenges for innovation. Therefore the policy agenda must be to move away from the inward-looking approach of techno-nationalism towards a philosophy of mutual or shared interest in protecting and sustaining the entire international ecosystem of technological knowledge, which reaches well beyond any individual country or place.[45]

[40] Steinfeld, E. (2010), *Playing Our Game: Why China's Rise Doesn't Threaten the West*, Oxford University Press.
[41] Nolan, P. (2012), *Is China buying the world?*, Cambridge: Polity, p. 17.
[42] Steinfeld (2010), *Playing Our Game*, p. 148.
[43] Frietsch and Tagscherer (2014), 'German-Sino collaboration', p. 17.
[44] Athreye, S. and Cantwell, J. (2016), 'A Bigger Bang for the Buck: Trends, Causes and Implications of the Globalization of Science and Technology', in Dutta, S., Lanvin, B. and Wunsch-Vincent, S. (eds) (2016), *The Global Innovation Index 2016: Winning with Global Innovation*, http://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2016-chapter2.pdf (accessed 20 Apr. 2018).
[45] Ibid.

Global innovation networks have also been driven by the need to tap into cross-disciplinary knowledge. First of all, products and services are integrating more technology from multiple sectors. Car manufacture, for example, no longer primarily depends on mechanical engineering techniques, but also includes electronics, computer-control, audio-visual systems, network linked intelligence, and other designs and facilities to enhance user experience. The mobile phone is today much more a multi-purpose computer than just a telephone. Secondly, there is increasing scope for knowledge disciplines to learn from one another. For example, analyses[46] of backward citations of patents (which indicate where the knowledge of the relevant patent comes from) across a wide range of technological areas show that a growing number come from other fields of knowledge.

> As technology and innovation become ever more globally networked, involving a diverse range of players, the innovation capabilities of MNCs in many sectors have also evolved.

Global innovation networks therefore more often engage a diversity of technology and innovation players. In the past, MNCs undertook most of their R&D in-house, often in their headquarters. But given the need to tap into new sources of knowledge and ideas from different disciplines and in different markets, it is proving more effective for them to collaborate with a variety of players, including customers, suppliers, SMEs, research institutes and, increasingly, start-ups. MNCs' subsidiaries around the world, having access to different external knowledge networks as well as internal knowledge networks within their parent MNCs, could also specialize in different ways of accumulating and exploring various categories of knowledge. For example, a study of MNC subsidiaries in the pharmaceutical industry in Germany showed that, given the expanding complexity of knowledge, MNCs are more frequently using the international internal knowledge networks of subsidiaries for incremental knowledge-building within the same field, and their subsidiaries' local external knowledge networks for transferring more technologically complex knowledge.[47]

As technology and innovation become ever more globally networked, involving a diverse range of players, the innovation capabilities of MNCs in many sectors have also evolved. They have to become more effective integrators of multi-sector, multi-level technologies, ideas and innovations across different parts of the world. The ability to integrate hardware, software and services is also important and highlights an important dimension of the competitive edge of MNCs in a world of globalized innovation.

The rapid rise of China's innovation capabilities and the evolution of EU–China innovation relations

From a rather low base, China has made tremendous strides in the past few decades in science, technology and innovation. In the process it has become deeply tied into global innovation networks. China's role in these networks varies across different types of R&D (namely research in fundamental new technologies, as well as for new product platforms, and to adapt existing products):[48]

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[46] Ibid.
[47] Cantwell J. and Zhang, F. (2011), 'Technological Complexity and the Evolving Structure of MNC Subsidiary Knowledge Accumulation', *Journal of Industrial and Business Economics*, 38(4): pp. 5–33.
[48] Steinfeld (2010), *Playing Our Game*, Chapter 6.

- Fundamental new technologies remain (on the whole) the domain of developed economy firms.
- New product platforms have often resulted from cooperation and networks, and here China has been an important location for MNCs to develop product adaptation, integrating with global R&D networks; this has been helped by more productive and lower-cost Chinese engineers.
- Product adaptation has generally been localized by MNCs in their largest markets, including in China; this helps with business development but says little about knowledge transfer.

This means that knowledge flows from Chinese consumers and engineers to MNCs, as the latter make use of indigenous talent. It also means that foreign R&D centres make up a significant part of the Chinese innovation system,[49] and highlights differences between innovation in China and a previous phase of East Asian development in Japan and subsequently South Korea, where ownership was local and innovation and production tended to be vertically managed within single firms. Another difference in China has been the emphasis on 'forward engineering' (the role of university spin-off firms) in contrast to the 'reverse engineering' of South Korea and Taiwan (whereby indigenous enterprises could learn modern technologies and designs through the use, maintenance or breaking down into individual components of complex machines, in the process introducing improvements or adaptations for the local market and then export – that is, imitation, improvement, innovation and internationalization). It has also focused on the acquisition of technology and brands through international mergers and acquisitions; and parallel learning from FDI firms to promote indigenous companies.

This relates to a second feature, the 'structural uncertainty' in China's political economy, under which the approach of a complex bureaucratic matrix at the level of firms or institutes is difficult to predict. As a result, China has not come up with radical breakthroughs in innovation, but has thrived in 'second-generation innovations, including organization innovation and process innovation'.[50] In the global innovation context, therefore, China – at an aggregate level – has to run to stand still.[51] Two other reasons may be identified for the scarcity of breakthrough innovation in China, at least at present. The first is the relatively low percentage (around 5 per cent) of its total R&D expenditure devoted to basic research. The second is more cultural (and one can say is a broadly East Asian trait): there is too much respect for established scholarly authority. China is unlikely to be hospitable to an Einstein-like figure that demolishes the theories of Newton.

But this assessment of China's innovation capabilities should be understood in the context of the country's rapidly changing state of development. When it was still going through the early stage of modernization during the 1980s and 1990s, China clearly found it much more effective to adopt and adapt proven technologies and ideas from the developed world. In engineering and machine-related technologies, it has also been seen to be very effective in reverse engineering. The large and rapidly growing domestic market has meant that, for many Chinese enterprises, the fastest way to capture a share is to acquire the necessary technologies and ideas from the outside world and adapt such innovations in the local market. Indeed, some of the ongoing overseas acquisitions by Chinese enterprises are still driven mainly by this motivation of leveraging on overseas expertise to rapidly capture the local market, rather than to capture overseas markets.

[49] Ibid., p. 172.
[50] So, A.Y. and Chu, Y. W. (2015), *The Global Rise of China*, Cambridge: Polity, p. 136 (italics removed).
[51] This is the *Run of the Red Queen* explanation (after the 2011 book of that title by D. Breznitz and M. Murphree), summarized by So and Chu, *The Global Rise of China*, pp. 130–38.

But as its economy continues to grow and modernize, China is gradually evolving from an adopter and adapter in most technologies and innovations to a global leader in selected areas such as mobile technologies, P2P payment and internet commerce. The ability of the state to mobilize resources and put the best and brightest engineers into specific sectors has also enabled China to achieve breakthroughs and become a global leader in strategically chosen sectors, such as supercomputers, rockets, and nuclear and satellite technology.

At the same time, China is contributing to changes in the global geography of innovation. While developed economies remain the most significant players in terms of both inputs and outputs, their shares of innovation are beginning to decline, and emerging markets are playing a more prominent role, as shown by the data on patent filings cited above. For Europe, the challenges brought by these changes have been intensified by growing fiscal and economic pressures since the 2008 crisis. In sum, the innovation landscape is not just becoming more networked, but also more spread out and increasingly 'multipolar'.[52]

China is not the only relative newcomer to these networks. For 200 years, global innovation has been mostly dominated by the developed world, which – with less than 20 per cent of the world's population – has been home to most of the world's human capital in innovation.[53] However, the amount of human capital in emerging economies has been increasing rapidly. The quality was initially weaker, as many graduates were still relatively young and inexperienced, but has been catching up with the developed economies. Exploiting this human capital is an important means of delivering ongoing innovation. China has also engaged more in South–South investment in technology-related industries and sectors. An increasing variety of actors in emerging economies are contributing to enrich the global innovation landscape. As these economies become important production bases and markets for developed-world MNCs, their R&D activities are needed to support local production, product localization and adaptation, and local market development. But there are often feedback loops that help MNCs to improve their innovative capabilities back home or in other markets (reverse innovation). Some emerging markets have evolved beyond being local market subsidiaries, attaining a regional or global remit for the MNCs concerned.

The 'indigenous' mindset and the way forward

There is a need to address the potential contradiction between the idea that global networks are the best way of promoting innovation and the continued pull of national politics and regulation. Particularly in the current context where globalization is being questioned, and with some degree of nationalist political pressure in both Europe and China, it is not going to be possible – or politically desirable – to do away with national borders when it comes to innovation. There will always be a tendency for politics to push to protect or enhance 'local innovation'. At the same time, it is in the longer-term interests of both the EU and China to encourage innovation collaboration, not least because transnational innovation networks provide the most effective outputs. Effective innovation

[52] Innovation is rarely spread evenly in countries – indeed, innovation strengths vary substantially across both Europe and China. In the EU, there are particular strengths in the south of England, Germany, the areas around Paris, and parts of Scandinavia. In China, a small number of coastal cities dominate in terms of expenditure on innovation, patent applications, number of top research institutes, etc. Guangdong has a much higher pattern of private-sector investment in innovation, while Beijing and to a lesser extent Shanghai tend to rely more on state-linked funds (see maps from Nesta report, cited earlier); European Commission (2012), 'International Cooperation in Science, Technology and Innovation'; uneven development and multipolarity are more general features of contemporary global political economy, see Castells, M. (2010), *The Rise of the Network Society,* Oxford: Wiley-Blackwell, 2nd edn.
[53] Total OECD population in 2014 was 1.26 billion. OECD (2018), 'Population', https://data.oecd.org/pop/population.htm (accessed 26 Apr. 2018).

cuts across national boundaries, and in an era of globalization fully 'indigenous' innovation is not possible, even if it were politically desirable. In any case, the ability to integrate a diverse range of technological and innovation capabilities across different parts of the world will be more important for MNCs in the future. Adoption of an 'indigenous' mindset could only succeed in the short term in selected specific areas (though in the long term its chances are better in larger and more diverse economies such as the US and China).

Moreover, both the EU and China are large markets in themselves. Together, they constitute an even larger one. It is well known that the economic returns to innovation increase disproportionately to the size of the market, because once the fixed costs of innovation are recouped, the additional sales generate pure profits. Thus the Chinese market may be worth much more to Apple because the iPhone development costs have already been amortized in the US market. The EU and China, through appropriate reciprocal or expedited cross-patent registration and greater IPR enforcement, can boost returns significantly for all their innovators.

EU and Chinese leaders should therefore encourage an open mindset among policymakers, businesses and researchers, and move beyond thinking about innovation as a national or regional project towards measures that enrich the engagement of all their researchers and enterprises in global networks, taking advantage of their vast combined market, as well as the rest of the world. The statement at the second EU–China innovation cooperation dialogue in 2015 of the benefits of 'a global open innovation ecosystem without unnecessary obstacles to innovation and cooperation across borders' is welcome in this regard.[54]

The EU and China, through appropriate reciprocal or expedited cross-patent registration and greater IPR enforcement, can boost returns significantly for all their innovators.

Achieving this would be helped by avoiding government targets that encourage the indigenous mindset, such as a focus on market shares in particular technologies, and by facilitating cross-border patenting between EU states and China. This will be challenging, as the nation state is firmly embedded in global evaluations of innovation capacity.[55] However, increased use of measures of innovation that reflected the 'global value chain' approach to measuring trade would help to move policy towards enriching global innovation networks.

Another important perspective in considering how to promote network innovation is to distinguish between public-sector and private-sector collaboration. The former involves government and other public bodies and is driven by non-market-based public need, whereas the latter happens when profit-making enterprises work together to increase competitiveness and profits.

Basic research is an area in which EU–China collaboration could be promoted. As there is not much conflict of commercial or other interests, the results of such cooperation can be jointly owned or be put into the public domain. CERN, the European Organization for Nuclear Research, is a successful example of international cooperation and collaboration in R&D in basic research. The assignment and ownership of the IPR arising from discoveries at CERN are not contentious as the research results could not directly be exploited for commercial profits.

[54] ICD Joint Statement (2017), 'EU-China Summit: new flagship initiatives in research and innovation'.
[55] The WIPO statistics cited in footnote 10 are a good example of this, though WIPO does also record transnational patents.

Space exploration that is unrelated to military use is another possible area for EU–China collaboration and would avoid duplicating efforts. China will become the only country with a working space station in the not-too-distant future. It has a leading edge in research in selected areas such as quantum communication, genomics and supercomputers, which means that collaboration with the EU in these areas could be very promising.

Mitigation of climate change (and decarbonization) is another promising area for close collaboration as both parties are committed to full implementation of the Paris Agreement. China would benefit from the EU's extensive experience on carbon trading and carbon tax. Joint research could be conducted on subjects such as nuclear power (including fusion power), new battery technology, promotion of the use of heat pumps (of which the EU is the leader), lowering the cost of long-distance transmission of electricity, and the phasing out of coal and the possibility of its alternative uses. There could also be collaboration in setting standards for electric cars, and agreeing the standardization of the terms and conditions of long-term social financing to encourage efficient substitution by capital costs for operating costs so as to achieve the goal of reducing carbon emissions.[56]

One important precondition for collaboration in R&D is to facilitate the convenient and frequent movement of the people involved in research and innovation. Flexible and easy-to-navigate visa regimes should be introduced. Encouraging and supporting student exchanges, including gaining overseas work experience after the completion of studies, are also important. It has been noted that Chinese researchers who have studied overseas and returned to China are particularly valuable for the development of collaboration with other countries,[57] and attempts should be made on both sides to develop similar networks of European researchers with research experience in China.[58] Within the EU, there is probably a need to encourage greater geographical diversity: for example, given the strengths of their research base, the Nordic countries are relatively weak in the exchange of researchers.[59]

One challenge is finding the optimal balance between high-level coordination and the organic development of bottom-up links between individuals, institutes and enterprises: it is clear from both official statements and other materials that the scope of research relationships between the EU and China is increasingly broad, and even mapping this thoroughly is probably not a feasible exercise. On the European side, the 2012 report of the STI expert group recommended a smarter, more focused and better-coordinated EU strategy. This may not be possible owing to the varying degrees of devolution between and within member states,[60] but the arguments on how such a strategy should be developed are relevant to considering innovation relations between the EU and China. There is a need to combine top-down and bottom-up identification of priorities for international collaboration, based on identifying gaps, bottlenecks and areas where market conditions outside Europe can stimulate innovation. In this regard, features of China's markets discussed above, such as growing consumption and effective engineering talent, offer opportunities for European companies to develop their products and services. These should be complemented by developing platforms that coordinate across innovation, research, business and education, and by making use of flexible models of cooperation genuinely led by businesses and researchers.

[56] Discussions on these potential areas for EU–China collaboration in R&D are primarily based on Lau, L. J. (2017), 'Comments on Industrial Cooperation and Innovation', Brussels, 13 September 2017, http://www.igef.cuhk.edu.hk/igef_media/people/lawrencelau/presentations/english/170913R.pdf (accessed 23 Apr. 2018).
[57] Frietsch and Tagscherer (2014), 'German-Sino collaboration', p. 16.
[58] García-Herrero et al. (2017), *EU–China Economic Relations to 2025*.
[59] Serger (2014), 'Sino-Swedish Science and Technology Relations'.
[60] In Germany, for example, 'it is not possible to find a general overview of where the German universities [which are under the responsibility of regional governments] collaborate with China': Frietsch and Tagscherer (2014), 'German-Sino collaboration', p. 11. Coordinating information and approaches among EU member states is itself a substantial challenge.

It is in areas of industrial competition that innovation relations are most difficult to manage, and these 'overlaps' between Europe and China may increase over the next decade (already since 2010, China has been the largest exporter of high-tech final goods by value, though many are designed in the US or Europe[61]). The political challenges this will bring should not be underestimated. Proper risk management to maintain individual firms' incentives to invest in innovation should be given due regard in the process of developing innovation networks. Transnational firms have already established such risk management measures, such as ring-fencing parts of their product R&D processes. Governments should continue to upgrade intellectual property protection regimes. This is an area in which the Chinese government has been focusing resources over recent years, for example through the establishment of specialized IPR courts. However, much more needs to be done to build institutional capacity and business culture.[62]

Sensitivity to politics also brings to the fore the varying degrees of innovation capability, which in turn reflect and feed hierarchies of global political economy. Evaluating this has become more complex with the rise of China, and shifts to a more diffuse and multipolar world. But as argued in this paper, in general terms the greatest strengths in innovation still lie in developed economies (including in Europe), which are also home to most of the corporations that dominate research-intensive industries (these often tend to be capital-intensive sectors). In a small number of areas, Chinese companies are beginning to break through into these areas, and are enhancing their capability through international acquisitions, although the stock of such investment remains small in global terms. The determination and creativity of these companies should not be underestimated, but at the same time EU policymakers and companies should have confidence in the strengths that mature research institutions and supportive regulatory frameworks can bring to innovation on a global canvas.

[61] Frietsch and Tagscherer (2014), 'German-Sino collaboration', p. 1.
[62] García-Herrero et al. (2017), *EU–China Economic Relations to 2025*.

Annex: Selected text on innovation cooperation from the EU–China 2020 Strategic Agenda for Cooperation[63]

Cooperation in science, technology and innovation (section III.I.1–5)

1. Reinforce cooperation on science, technology and innovation, involving industry, universities and research institutes, so as to tackle common challenges; complement mutual strengths and deliver win-win results in the areas of human resources, skills, technology, research infrastructure, financing of innovation, exploitation of research findings, entrepreneurship and framework conditions for innovation within the framework of the EU–China Agreement for Scientific and Technological Cooperation. Employ the EU–China Steering Committee and the EU–China Innovation Cooperation Dialogue to this end.

2. Establish an EU–China cluster cooperation initiative to strengthen collaboration in fields of strategic interest such as sustainable growth and urbanisation.

3. Joint research and innovation initiatives will be further explored, in particular in the areas of food, agriculture and biotechnology, sustainable urbanisation, aviation, water, health and ICT, by developing joint funding programmes and promoting enhanced mutual participation of Chinese and EU researchers and innovators into respective programmes.

4. Continue the implementation of the Joint Statement on cooperation in new and renewable and energy efficient technologies on the basis of common interest and mutual benefit and with special focus on participation of SMEs where appropriate.

5. Strengthen cooperation in the multilateral framework of the ITER [International Thermonuclear Experimental Reactor] project and build a strategic bilateral partnership on fusion energy research. Strengthen exchanges and cooperation on nuclear safety, nuclear fuel cycle, nuclear emergency response, nuclear waste management and nuclear security.

Cooperation in agriculture (section II.III.3)

6. With the view to enhance win-win research and innovation cooperation in the field of food, agriculture and biotechnology, the EU and China will collaborate closely using their respective research and innovation programmes to develop joint initiatives of common interest, including potential joint calls for proposals, twinning activities, joint labs, researchers' exchanges and seminars.

[63] European Union (2013), *EU-China 2020 Strategic Agenda for Cooperation*, http://eeas.europa.eu/archives/docs/china/docs/eu-china_2020_strategic_agenda_en.pdf (accessed 23 Apr. 2018).

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