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China's new scientists

The emerging leaders behind Beijing's drive for technological self-reliance

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Summary

— China's Politburo has long been dominated by economic technocrats, but a change in its overall composition confirms an important new direction in the policy intentions of the political leadership, with a much greater focus on science and technology. The appointment of five prominent scientists to the 24-member Politburo at the 20th National Congress of the Communist Party of China (CPC) in October 2022 reflects the determination of President Xi Jinping, the party's general secretary, to ensure the country's economic, scientific and technological self-reliance and boost its resilience to external shocks.

— Xi's long-held ambitions to boost China's domestic industrial base and achieve scientific self-reliance have been accelerated, at a time of intensifying geopolitical and geo-economic competition, by efforts on the part of the US and its allies to curb Chinese access to critical technologies and research partnerships.

— Beijing's priorities include strengthening China's ability to overcome 'chokepoints' in strategically critical technology sectors; fostering homegrown talent and 'reshoring' expertise to spearhead innovation; and building a resilient digital economy in line with the CPC's own governance standards. All of these agendas respond to deep anxieties about China's capacity for high-tech development, and about the vulnerabilities arising from its dependence on overseas suppliers for critical components ranging from semiconductors to aircraft engines.

— The five scientists who have now joined the Politburo all achieved significant successes in their respective fields – ranging from space to environmental and nuclear sciences – prior to embarking on their political careers. They have had experience of studying and working in advanced economies, and have built up important connections with the scientific community internationally. But they have reached high political office not just through their scientific achievements, but also because of their politically loyalty to Xi and the CPC. Indeed, it is reasonable to expect that some of the scientists featured in this paper will eventually become candidates for the future leadership. More immediately, the expectations on them to drive innovation at home and shield China's economy from external pressures are high.

— China has the ambition and enormous state-funded resources to advance its science and technology agenda, but the extent to which a deepening of the one-party state under Xi may support or impede innovation over the long term is less certain. The ability to make substantial scientific progress is equally dependent on researchers having the freedom to think critically and creatively, as well as open exchanges with peers internationally. As the space for debate within China shrinks, and relations with the West become more fractious, the country will struggle to achieve Xi's ambitious targets.

Introduction

Much of the analysis of the 20th National Congress of the Communist Party of China (CPC) in October 2022 focused on Xi Jinping securing an unprecedented third term as General Secretary, and his promotion of a new generation of loyalists to the party's Politburo – in particular the composition of the Standing Committee.[1] But, as Xi further consolidates his own power, his choice of senior leaders gives strong indications as to the direction in which he wants to take China.

Amid a domestic economic downturn and an intensification of strategic competition with the US-led West, President Xi offered the National Congress his own formula for party legitimacy and China's economic survival, calling for an accelerated effort towards economic and scientific self-reliance, and emphasizing that:

> Education, science and technology, and human resources are the foundational and strategic pillars for building a modern socialist country in all respects. We must regard science and technology as our primary productive force, talent as our primary resource, and innovation as our primary driver of growth. We will fully implement the strategy for invigorating China through science and education, the workforce development strategy, and the innovation-driven development strategy. We will open up new areas and new arenas in development and steadily foster new growth drivers and new strengths.[2]

Economic development and domestic – referred to in official documents as 'indigenous' – innovation in science and technology, in order to protect China from external shocks and sustained pressure from the US targeting Chinese technologies, is thus at the very heart of Xi's third-term political agenda.[3]

Xi's priorities in pursuit of scientific self-reliance include strengthening China's ability to overcome the so-called 'chokepoints' in strategically critical technology sectors; domestic talent-grooming and 'reshoring' of expertise to spearhead innovation; and building a digital economy in line with the CPC's own governance standards. The president's pronouncements on the ambition of self-reliance have so far been heavy on generalities but decidedly light on detail. But a set of new appointments to the party Politburo in October 2022 serves as a clear indication of how Xi intends to set about accelerating China's attainment of scientific self-reliance.

Of the 24 members of the 20th Politburo, five of the 11 newcomers elected in 2022 are prominent scientists. This represents a significant departure from the convention of the last two decades, whereby the CPC's decision-making body has been mostly dominated by economic planners.[4] The five scientists who have newly joined the Politburo are leaders in their respective fields (see Box 1), ranging from aerospace to environmental and nuclear sciences. Over the last decade, China

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1 *The Economist* (2022), 'Xi Jinping has surrounded himself with loyalists', 27 October 2022, https://www.economist.com/china/2022/10/27/xi-jinping-has-surrounded-himself-with-loyalists.
2 Xi, J. (2022), 'Full text of the report to the 20th National Congress of the Communist Party of China', 25 October 2022, https://www.fmprc.gov.cn/eng/zxxx_662805/202210/t20221025_10791908.html.
3 Zheng, W. (2023), 'Dual circulation needed to protect China economy in 'extreme' circumstances, Xi Jinping warns', South China Morning Post, 9 June 2023, https://www.scmp.com/news/china/politics/article/3223483/dual-circulation-needed-protect-china-economy-extreme-circumstances-xi-jinping-warns.
4 Yu, J. (2022), 'Xi Jinping is preparing the Communist Party to face new realities', *Nikkei Asia*, 19 October 2022, https://asia.nikkei.com/Opinion/Xi-Jinping-is-preparing-the-Communist-Party-to-face-new-realities.

has become a highly important player in these three areas, and in many respects the country is on a par with Western competitors such as the US and France. Xi's apparent aim now is to draw on the scientists' expertise to help deliver his plan to promote domestic innovation and scientific self-reliance.

Box 1. The 20th CPC Politburo's five 'new' scientists

The environmental engineer: Professor Chen Jining, party secretary of Shanghai

- Born 1964, Liaoning Province
- BSc and MSc engineering, Tsinghua University; PhD environment engineering, Imperial College London (UK)
- 1993–98, post-doctoral fellow and research assistant, Imperial College London
- 2012 professor of environmental science and president, Tsinghua University
- 2015 minister of environmental protection
- 2017 acting mayor, Beijing Municipality
- 2022– member, 20th CPC Politburo; party secretary, Shanghai Municipality
- Fluent in English

The nuclear scientist: Dr Li Ganjie, head of CPC Organization Department

- Born 1964, Hunan Province
- BSc nuclear science and MSc engineering, Tsinghua University
- 1991–93 studied in France
- 1993 senior engineer, National Nuclear Safety Administration
- 1999 first secretary, Chinese embassy in Paris (France)
- 2006 director, National Nuclear Safety Administration
- 2008 deputy minister of environmental protection
- 2017 minister of environmental protection
- 2020– governor, Shandong Province
- 2022– member, 20th CPC Politburo
- Fluent in English and French

The space scientist: Professor Ma Xingrui, party secretary of Xinjiang

- Born 1959, Heilongjiang Province
- BSc general mechanics, Liaoning University of Technology; PhD mechanics, Harbin Institute of Technology
- 1992–96 professor and vice-president, Harbin Institute of Technology
- 1996 vice-dean, Chinese Academy of Space Technology; chief engineer, Shijian-5 space programme
- 2007 general manager, China Aerospace and Technology Corporation; elected member, International Academy of Astronautics
- 2013 director, China National Space Administration; chief commander, Chang'e 3 lunar exploration programme
- 2015 party secretary, Shenzhen, Guangdong Province
- 2017 governor, Guangdong
- 2021– party secretary, Xinjiang Uygur Autonomous Region
- 2022– member, 20th CPC Politburo
- Fluent in English

The rocket scientist: Dr Yuan Jiajun, party secretary of Chongqing

- Born 1962, Jilin Province
- BSc and PhD aircraft design and mechanics, Beijing Institute of Aeronautics and Astronautics
- 1988–90 visiting research fellow, German Aerospace Centre
- 2000 commander, Shenzhou manned spaceflight programme; elected member of International Academy of Astronautics
- 2007 deputy general manager, China Aerospace and Technology Corporation; deputy chief commander, Chang'e 3 lunar exploration programme
- 2013 deputy governor, Ningxia Hui Autonomous Region
- 2014 deputy governor, Zhejiang Province
- 2017 governor, Zhejiang
- 2020 party secretary, Zhejiang
- 2022– member, 20th CPC Politburo; party secretary, Chongqing Municipality
- Fluent in English

The military-industrial expert: Zhang Guoqing, vice-premier, with focus on trade, technology and state-owned enterprises

- Born 1964, Henan Province
- BSc electric engineering, Changchun University of Science and Technology
- 1987 project manager for Middle East region, China North Industries Group Corporation
- 1999 vice-president, China North Industries Group Corporation
- 2004 CEO, China North Industries Group Corporation
- 2013, deputy party secretary, Chongqing Municipality
- 2017–18 deputy party secretary and mayor, Tianjin Municipality
- 2020 party secretary, Liaoning Province
- 2022– member, 20th CPC Politburo
- 2023– No. 3 vice-premier, State Council of the People's Republic of China, trade and technology portfolio
- Fluent in English

Sources: Xinhua (2022), 'CPC 20th Central Leadership', https://www.xinhuanet.com/politics/leaders; Evans, J. G. and Wang, Y. (2022), 'Infographic: China's New Leaders after the 20th Party Congress', Fairbank Center for Chinese Studies, Harvard University, 6 November 2022, https://fairbank.fas.harvard.edu/research/blog/infographic-chinas-new-leaders-after-the-20th-party-congress.

The five scientists featured in this paper are undoubtedly Xi's political protégés; they have worked with him closely in the past, and their loyalty and successful track records as, variously, heads of state-owned enterprises (SOEs), president of a top university and provincial party secretaries – all with a strong focus on scientific innovation – are now being rewarded with political influence. While Xi has successfully managed to eliminate political rivals and consolidate his paramount authority over the past decade, he also needs to have experienced

'enablers' to ensure his political and economic mandate is fulfilled.[5] Xi is therefore likely to have high expectations that the scientist members of the Politburo will deliver his highly ambitious agenda to boost China's innovation capabilities.

For the 20th Politburo, the scale of the domestic innovation and self-reliance challenge is vast. To start with, there has been a structural shift in how innovation policies and talent-reshoring programmes are decided and delivered. The centrality of the CPC under Xi's leadership has blurred the line between policies run by government departments, both at national and provincial level, and the policies overseen by the party. This has been reflected in an unprecedented level of political intervention in science policies and research programmes – in contrast to the 1990s and early 2000s, when scientists worked in a more politically neutral environment.

The centralization of party authority under Xi Jinping may have the effect of discouraging homegrown innovation as well as critical thinking that challenges conventional theory and practice.

The unintended consequences of this shift in the relationship between party, state and science reach far beyond the scientific community, as young Chinese STEM (science, technology, engineering and mathematics) graduates have increasingly begun to favour jobs in the civil service, seeing these as the best route to lifelong financial security, rather than work for research institutes or small start-up companies. Furthermore, small and medium-sized tech companies are concerned about policy uncertainties and inconsistencies arising from political intervention from ideologically focused party officials. This centralization of party authority may have the effect of discouraging homegrown innovation as well as critical thinking that challenges conventional theory and practice.

Although Xi has made clear his ambition for China to find its way to scientific self-reliance, in reality the country's successes thus far in science and technology are – as for its peers and competitors – a direct result of frequent exchanges and connectivity with the scientific community globally. Each of the newly appointed scientist members of the Politburo has substantial experience of either studying or working abroad, and is fluent in one or more foreign languages. Their time spent overseas has certainly helped them rise to prominence in their specialist field before entering politics and in time reaching high office within the CPC. But the challenge for Xi and the scientists within the Politburo now is how far the drive for 'self-reliance' can go in delivering China's desired scientific breakthrough by overcoming the country's reliance on imports of critical technology components.

While the new scientist members of the Politburo have mostly come with strong domestic political experience, they have also contributed to China's external engagement through their various professional roles and experience

5 White, E. (2023), 'China's Palace Politics: Xi Jinping loyalists compete for power', *Financial Times*, 25 January 2023, https://www.ft.com/content/f1ddaaa1-7077-4e0a-bdc4-55205e4d2657.

in their earlier careers as scientists. Some have, in the past, either worked with or directly competed against peers and counterparts in the US and Europe. As such, it may appear reasonable to speculate as to whether these new entrants to the Politburo may favour a diplomatic 'reset' with Western advanced economies. It would be a mistake to conclude that fluency in foreign languages or time spent abroad has shaped their fundamental ideological beliefs and political preferences. But one thing that is certain is that their overseas experience, whether positive or negative, will ultimately be reflected in their policy decisions for China's domestic scientific innovation, as well as in Beijing's wider foreign policymaking, over the coming decades.

This research paper addresses the question of how the make-up of the 20th CPC Politburo, with a particular focus on the new scientist appointees, sheds light on Xi's stated ambition to prioritize innovation in pursuit of China's scientific and technological self-reliance. The analysis draws on publicly available secondary sources, records of speeches made by Xi and the newly appointed Politburo members, and policy documents published by the Chinese government. An examination of the wider composition of the current Politburo is followed by a discussion of the scientific chokepoints for China. The paper then goes on to assess the politics associated with scientific self-reliance; the context for talent-grooming and reshoring; and the politics of building a digital economy in line with the party's preferences. In the concluding section, the paper reflects on the significance of the new appointments to the Politburo and the wider implications for China's political economy.

What's different about the 20th CPC Politburo?

The 20th CPC Politburo (including the seven members of the Standing Committee – the party's supreme decision-making body) is made up of 13 returnees from the previous iteration, along with 11 new entrants. The newcomers' published biographies confirm that each has been closely associated with Xi through various stints in senior provincial and/or municipal political roles. The 24 Politburo members carry critical weight in policymaking processes, ranging from economics to external affairs, at the central level, as well as managing some of China's most important economic powerhouses at the provincial level.[6]

The senior leadership of the CPC selects Politburo members based on three guiding principles: loyalty, competence and professional experience at grassroots level. Over the last four decades, beginning with the 12th CPC National Congress in 1982, new members have often been chosen for their strong professional experience in economic planning.[7] Looking at the composition of politburos

6 Yu, J. (2022), 'A guide to the Chinese Communist Party's National Congress', *The World Today*, 21 September 2022, https://www.chathamhouse.org/publications/the-world-today/2022-08/guide-chinese-communist-partys-national-congress.
7 Mirsky, J. (1982), 'China's 12th Party Congress', *The World Today*, 38(12), pp. 471–77, https://www.jstor.org/stable/40395342.

between 1982 and 2017, a notable number of members have had substantial experience in macroeconomic planning, which served as a key criterion for selection.[8]

The appointment of the 20th Politburo has prioritized members with competence in science and SOE executive management, marking a fundamental shift in policy focus within the party leadership from maintaining double-digit economic growth to building economic resilience against external shocks. Reflecting Beijing's deep anxieties about the country's capacity for high-tech development and the vulnerabilities arising from its dependence on overseas suppliers for critical components from semiconductors to aircraft engines, Xi has for some years underscored the importance of a 'holistic view of national security' with scientific self-reliance as a core element.[9] The make-up of the 20th Politburo – in which just one member, He Lifeng, has a strong background in macroeconomic planning, compared with three in the 19th Politburo – reflects this shift in political priorities.

China's leadership is aiming to foster a new cohort of technocrats, with strong professional experience in homegrown scientific innovation, to help drive progress towards achieving Xi's ambition of self-reliance in strategically critical sectors such as AI, quantum computing and semiconductors.

This is not to suggest that appointing accomplished scientists to Beijing's senior leadership is a new phenomenon. Indeed, long-time China analysts might contend that appointing technocrats to high office has been a characteristic of Chinese elite politics for the last 50 years. Xi Jinping's two immediate predecessors, Jiang Zemin and Hu Jintao, had professional backgrounds in electrical engineering and hydroengineering respectively; while former premiers Li Peng and Wen Jiabao had early careers in, respectively, civil engineering and geology. Many distinguished scientists have also at various points led ministries or government agencies with science portfolios, among them the British-educated geologist Li Siguang (who headed the country's geology ministry from 1952) and the MIT-educated and later California Institute of Technology professor Qian Xuesen (who headed China's Fifth Academy of the national defence ministry).[10] Qian, who was deported from the US in 1955 in a move eventually described by one senior US official as 'the stupidest thing this country ever did', went on to oversee China's first successful space satellite launch, 15 years after his return to China.[11] As well as leading China's missile programme, Qian also had a critical role in grooming some of the new intake of Politburo members, including fellow rocket scientists Yuan Jiajun and Ma Xingrui.[12]

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8 The CPC National Congress convenes every five years to decide on the membership of the Politiburo; the 19th Politburo was appointed in October 2017.
9 Xi, J. (2014), 'A Holistic View of National Security', 15 April 2014, *Qiushi*, http://en.qstheory.cn/2020-12/04/c_607611.htm.
10 BBC News (2020), 'Qian Xuesen: The man the US deported – who then helped China into space', 27 October 2020, https://www.bbc.co.uk/news/stories-54695598; University of Birmingham (2016), 'University of Birmingham marks birthday of influential Chinese alumnus', 26 October 2016, https://www.birmingham.ac.uk/news-archive/2016/university-of-birmingham-marks-birthday-of-influential-chinese-alumnus-1.
11 BBC News (2020), 'Qian Xuesen: The man the US deported – who then helped China into space'.
12 Yi Dan Yuan (2021), '钱学森身边的两位航天少帅，如今都成为省委书记｜纪念钱学森110周年诞辰' [Commemoration of 110-year anniversary of Qian Xuesen: Qian's mentees who became party secretaries of provinces], 12 December 2021, https://c.m.163.com/news/a/GR0UNN8Q053579XX.html.

However, what distinguishes the present generation of scientist technocrats, as a collective, from their predecessors is the scale and level of seniority they now represent in the Chinese political apparatus. Before entering politics, all five of the scientists featured in this paper had played a key role in leading advance scientific research sectors such as aerospace, missiles and nuclear technology. They are now sitting at the second-highest tier of the CPC leadership, with significant responsibilities. Zhang Guoqing, for instance, one of the State Council's vice-premiers, has oversight of China's national scientific programmes as part of his portfolio; Chen Jining has the task of running Shanghai, China's economic powerhouse; and Ma Xingrui is party secretary of the remote but politically and strategically important Xinjiang region.

What distinguishes the present generation of scientist technocrats, as a collective, from their predecessors is the scale and level of seniority they now represent in the Chinese political apparatus.

From a political perspective, by shifting from an earlier emphasis on appointments from among local officials, or party cadres, in the two previous politburos to prominent scientists in the 20th Politburo, Xi has broadened the profile of the party's elite. The five newcomers featured in this paper have spent most of their careers in science sectors, with relatively brief stints in recent years as provincial governors. It is thus reasonable to assume they are more inclined to align themselves with the party and national leadership, and less with vested interests at the local level, which is likely to help Xi further consolidate his own authority. The scientist members of the Politburo can thus be regarded as 'outsiders', undermining the so-called 'dukedom economies' or locality-based political factions.[13]

As has previously been pointed out by another China analyst, the nature of aerospace engineers' work means they have often operated in an environment that brings relatively little interaction with local officials and interest groups.[14] In addition, their extensive professional exposure in managing SOEs also brings practical experience that can apply to managing economic priorities at the provincial level. Among the five new scientist entrants to the Politburo, three are also former senior executives of SOEs, reflecting Xi's focus on improving economic efficiency and sharpening the country's international competitiveness.

Whatever its members' professional backgrounds and past experience, the 20th Politburo will be expected to come up with detailed measures to manage the financial risks emerging from downsizing and addressing the debt crisis

13 Breslin, S. (2000), 'Decentralisation, Globalisation and China's Partial Re-engagement with the Global Economy', *New Political Economy*, 5(2), https://warwick.ac.uk/fac/soc/pais/people/breslin/research/decentralisation.pdf.
14 Clay, M. (2022), 'The Re-emergence of an 'Aerospace Clique' in Chinese Politics?', 19 February 2022, *The Diplomat*, https://thediplomat.com/2022/02/the-re-emergence-of-an-aerospace-clique-in-chinese-politics.

in China's property sector, at the same time as channelling more money – both public and private – into scientific research and grooming the talent needed to spur innovation. It will also have to find ways to promote job creation and more equitable growth to support the country's post-COVID recovery, in parallel with steps to enhance the country's security in line with Xi's 'holistic' approach.

Breaking China's technological chokepoints

On several public occasions prior to the 20th National Congress, Xi Jinping warned that China is at the mercy of advanced economies regarding several 'chokepoint' technologies, and that 'key core technologies are controlled by others'.[15]

The term technological chokepoints is often used in reference to critical technologies, components or resources that are essential to the functioning of key industries, economies or military capabilities. In this context, chokepoints can be used to limit a country's access to critical technologies or to gain leverage over other countries or companies.

For China, the most acute chokepoints are high-end components including advanced semiconductors, along with aircraft engines and specialized steel alloy, the production of which is dominated by one or very few companies based in the US or other advanced economies.[16] And, in the context of deepening rivalry between Beijing and Washington, China's leaders are acutely aware of the massive disruption to supply chains likely to arise in the event of military escalation over Taiwan, which accounts for some 60 per cent of the world's semiconductor production.[17] Given China's current dependence on imported semiconductors, it faces a pertinent challenge in balancing a pragmatic need to secure its supply needs with its pursuit of a 'reunification' strategy.

A series of newspaper articles published by the state-run *Science and Technology Daily* newspaper in 2018 indicated that China is dependent on imports of around 35 technologies and key components[18] that are currently overwhelmingly produced in the EU, Japan, South Korea and the US. Of these 35 items, or chokepoints, very few Chinese companies, either state-owned or private, can design and manufacture Chinese versions of these products, let alone compete with overseas counterparts.

As a number of international technology specialists have pointed out, China's universities and research institutes frequently have a good record of achieving scientific breakthroughs but are rarely able to commercialize the products of their research, leaving the domestic market dependent on imports of similar

15 Xi, J. (2021), '努力成为世界主要科学中心和创新高地' [Strive hard to become the world's major science centre and innovation hub], *Qiushi*, 15 March 2021, http://www.qstheory.cn/dukan/qs/2021-03/15/c_1127209130.htm.
16 Murphy, B. (2022), *Chokepoints: China's Self-Identified Strategic Technology Import Dependencies*, Issue Brief, Center for Security and Emerging Technology, https://cset.georgetown.edu/publication/chokepoints.
17 *The Economist* (2023), 'Taiwan's dominance of the chip industry makes it more important', 6 March 2023, https://www.economist.com/special-report/2023/03/06/taiwans-dominance-of-the-chip-industry-makes-it-more-important.
18 *Science and Technology Daily* (2018), '这些“细节”让中国难望顶级光刻机项背' [China does not own those technologies in lithography, and cannot compete with its peers], http://scitech.people.com.cn/n1/2018/0419/c1007-29936207.html.

technologies.[19] Moreover, Chinese companies often have serious doubts regarding the quality of domestically sourced goods, preferring instead to use trusted foreign suppliers for high-end products.

Beijing is proud of China's technological prowess, and is explicit about its ambition for the country to become self-reliant in critical sectors. The need for self-sufficiency is all the more urgent in the face of US sanctions and efforts, initiated under the Trump administration, to block the work of a handful of Chinese tech companies.[20] The country's technological strengths are apparent in the form of a huge talent pool of STEM students and generous public grants to fund research, but so too are its weaknesses in terms of its current capacity to overcome technological chokepoints.

Xi's elevation to the Politburo of the five scientists featured in this paper can be seen not only as a reward for their political loyalty; their appointment is also in recognition of some of the breakthroughs these scientists have been involved in during their past careers, in areas ranging from space science to missile and nuclear technologies.

Of the five 'new' scientists, Yuan Jiajun and Ma Xingrui were highly prominent in China's space industry; Li Ganjie and his colleagues developed China's advanced pressurized nuclear reactor programme; Chen Jining pioneered interdisciplinary research on environmental science; and Zhang Guoqing's work advanced military technology for civilian use.[21] For any country to have this level of scientific expertise within its senior political leadership is extremely unusual, and the expectations for these figures to drive new technological breakthroughs in China are clearly high.

In line with Xi's focus on science and technology, in March 2023 the annual National People's Congress endorsed the establishment of a new Central Science and Technology Commission.[22] The commission, which sits directly under the CPC Politburo, and which has authority over the Ministry of Science and Technology, is intended to accelerate progress towards China's goal of scientific self-reliance and to ease China's technological chokepoints. As at mid-2023, it remains unclear who will head this new body, and who will be on it, as few details have been made public. Meanwhile, its establishment is seen as a direct response to the tough measures adopted by the US designed to dent China's ambitions of technology supremacy.[23]

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19 Cortese, A. J. (2023), 'The Chinese Talent Behind Your Favorite Generative AI Product', Macro Polo, 4 April 2023, https://macropolo.org/chinese-talent-generative-ai/?rp=m; Wang, D. (2022), 'Better Manufacturing Through Science', Gavekal Dragonomics, 31 March 2022, https://research.gavekal.com/teaser/better-manufacturing-through-science.
20 Weinland, D. (2022), 'The tech war between America and China is just getting started', *The Economist*, 18 November 2022, https://www.economist.com/the-world-ahead/2022/11/18/the-tech-war-between-america-and-china-is-just-getting-started.
21 Zheng, W. (2023), 'China's Vice-Premier Zhang Guoqing, a one-time weapons executive, targets country's manufacturing sector', *South China Morning Post*, 7 June 2023, https://www.scmp.com/news/china/politics/article/3223239/one-time-weapons-executive-and-now-vice-premier-zhang-guoqing-targets-chinas-manufacturing-sector.
22 Bapista, E. (2023), 'China to restructure sci-tech ministry to achieve self-reliance faster, Reuters, 7 March 2023, https://www.reuters.com/world/china/china-restructure-sci-tech-ministry-reach-self-reliance-faster-state-media-2023-03-07.
23 The White House (2022), 'CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China', 9 August 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china.

The politics of scientific self-reliance

The current state of deep tensions between China and the US – the world's two largest economies – goes well beyond ideology and a political war of words. The underlying driver of their rivalry is a race for global technological supremacy, as part of which each country is looking to target the other's supply-chain vulnerabilities.

In this context, Xi and other members of China's senior political leadership have publicly emphasized the need for the country to have ownership of critical technologies, and for supply chains for these to be 'self-determined' and 'self-controlled'. It is clearly a source of frustration that those elements of the Chinese tech sector with the highest value added remain dependent on overseas suppliers and are thus vulnerable to geopolitical tensions. But China's concern to have control over its technological future far predates the rhetoric of the 20th party congress. Indeed, it lies in the institutional memory of senior party members who are well aware of the impact of the schism between China and the post-Stalinist USSR of the 1950s, at which time Soviet leader Nikita Khrushchev severed Beijing's access to critical technologies for both civilian and military purposes.[24]

The 'Made in China 2025' policy is among several crucial steps taken by the Chinese government in recent years to strengthen the country's scientific innovation capacity.

The 'Made in China 2025' policy is among several crucial steps taken by the Chinese government in recent years to strengthen the country's scientific innovation capacity.[25] Introduced in 2015, the aim of the initiative is to achieve a mass-scale upgrade of China's manufacturing capabilities, over a 10-year period, by reducing the production of consumer basics to increase its export of high-end tech components. As part of this, a key goal is to ensure the country is a self-reliant global leader in 10 core strategic innovation sectors. The initiative caused some consternation in both the US and the EU, and marked a beginning of a 'tech war' between China and the US and its allies.

As already noted, several members of the 20th Politburo have made significant contributions to China's advances in science and technology. Among the newcomers, for example, Yuan Jiajun, a fluent English-speaker and a senior visiting fellow at the German Aerospace Centre DLR, was just 33 when he was appointed deputy commander of the Shenzhou manned spaceship project.[26]

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24 Radchenko, S (2020), 'The Sino–Russian relationship in the mirror of the Cold War', *China International Strategy Review*, 1, pp. 269–82, https://doi.org/10.1007/s42533-019-00030-x.
25 State Council of the People's Republic of China (2016), 'Quality revolution needed for 'Made in China'', 29 August 2016, https://english.www.gov.cn/policies/policy_watch/2016/08/26/content_281475426397196.htm.
26 *China Youth Daily* (2002), '他们把杰出演绎地如此精彩' [An Interview with three architects of China's Shenzhou Space Programme], 30 December 2002, http://zqb.cyol.com/content/2002-12/30/content_588963.htm.

His work accelerated China's space programme, with the first Chinese astronauts going into space under his supervision, and he ultimately oversaw five Shenzhou missions – all of them successful. Through his career, Yuan has published numerous peer-reviewed papers and articles arguing that China must achieve self-reliance in space science.[27]

Yuan's technocrat background proved extremely useful when he formally entered politics to become deputy party secretary of the hydrocarbon-rich Ningxia Hui Autonomous Region, in northwest China. There, he oversaw one of the country's most ambitious energy projects – the ultra-high-voltage line taking coal-fired energy from Ningxia to the coastal manufacturing base of Zhejiang, home to many private Chinese business headquarters and Xi's political power base before he became CPC leader.

Another new member of the Politburo, nuclear scientist Li Ganjie, led the development of China's civil nuclear sector. A fluent French-speaker, he worked at China's embassy in France to facilitate Sino-French civil nuclear cooperation in the late 1990s. As director of China's National Nuclear Safety Administration and deputy minister for environmental protection, Li frequently advocated for China's civil nuclear programme to achieve the 'highest safety standard and technological self-reliance'.[28] While working on safety standards for nuclear technology, he also campaigned for China to export its civil nuclear technologies as part of wider diplomatic engagements with countries across Asia and Africa.

Notably, both Yuan and Li were beneficiaries of international scientific exchanges through visiting fellowships and publishing peer-reviewed articles in prestigious international academic journals in their early careers. Their career histories show that external connections and frequent exchanges with the global scientific community are a key factor in China's technological progress thus far. Xi is now pushing for greater self-sufficiency in strategic sectors. But, given that China has long relied on connectivity with the rest of the world to support innovation, the limits of this self-sufficiency drive are likely to be tested.

Talent-reshoring and self-reliance

For any country, the ability to make substantial scientific progress is dependent on having both 'infrastructure', in the form of financial resources and physical institutions, and 'space', which for individual researchers means academic freedom as well as opportunities for critical and creative thinking and frequent exchanges with peers internationally. In the case of China, the state-sponsored 'infrastructure' is well in place and has rapidly expanded to include all sectors of scientific research in recent years.

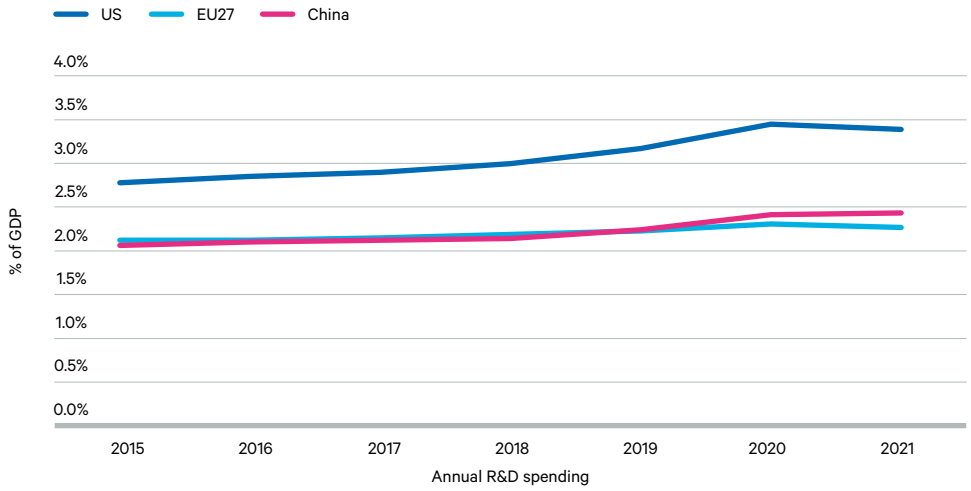
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27 Yuan, J. (2011), 'An Overview in Detailed and Qualitative Management in Aerospace', Engineering Sciences, Vol 13, Issue 8, 23 August 2011, https://www.engineering.org.cn/ch/article/20110627007.
28 Li, G. et al. (2006), *Nuclear Safety Regulations and Review of New Nuclear Power Plants in China*, International Atomic Energy Agency, pp.256–58, https://www-pub.iaea.org/MTCD/publications/PDF/Pub1272_web.pdf; The Paper (2016), '李干杰会见西屋电气公司代理全球总裁兼首席执行官' [Li Ganjie met acting CEO of Westinghouse Electric Group], https://www.thepaper.cn/newsDetail_forward_1523130.

In particular, Beijing places particular emphasis on the value of 'basic research' – also termed fundamental research or pure research – meaning scientific investigations conducted to expand knowledge and understanding in a particular field without any immediate or specific application in mind. Although basic research may not have immediate practical applications, it serves as the foundation for applied research and technological advancements. Many significant discoveries and breakthroughs in science and technology (for example the discovery of penicillin, leading to the wider development of antibiotic drugs) have emerged.

As shown in Figure 1, China's spending on basic science research, as a share of GDP, has grown rapidly since 2015, particularly in contrast to US R&D spending. The key word for Chinese leaders now is 'talent', and an underlying concern is the extent to which China is seen as an attractive option for homegrown as well as foreign talent.[29]

Figure 1. R&D intensity as a percentage of GDP, China, EU and US, 2015–21



Sources: Compiled from National Bureau of Statistics of China (2023), '2022年我国R&D经费突破3万亿元 与GDP之比达2.55%' [In 2022, China's R&D expenditure will exceed 3 trillion yuan and the ratio to GDP will reach 2.55%', 20 January 2023, https://www.gov.cn/xinwen/2023-01/20/content_5738199.htm; World Bank (2023) 'Research and development expenditure (% of GDP) – China', https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=CN (accessed 18 Jul. 2023); National Center for Science and Engineering Statistics (2023), 'U.S. R&D Increased by $51 Billion in 2020 to $717 Billion; Estimate for 2021 Indicates Further Increase to $792 Billion', 4 January 2023, https://ncses.nsf.gov/pubs/nsf23320/figure/2; National Center for Science and Engineering Statistics (2023), 'Federally Funded R&D Declines as a Share of GDP and Total R&D', 13 June 2023, https://ncses.nsf.gov/pubs/nsf23339; Eurostat (2022), 'R&D expenditure', https://ec.europa.eu/eurostat/statistics-explained/index.php?title=R%26D_expenditure#Gross_domestic_expenditure_on_R.26D.

29 Zhang, Z. (2022), 'Nurturing talent seen as priority: Interview with Minister of Education', *China Daily*, 3 November 2022, https://www.chinadaily.com.cn/a/202211/03/WS63630195a310fd2b29e7ff82.html.

Well before the 20th party congress, and in line with China's 14th Five-Year Plan (covering the period 2021–25), Xi Jinping has on a number of occasions emphasized the need for China to ensure it has the talent and the human capital to support Beijing's drive for scientific self-reliance. Strikingly, in a major speech in late 2021, Xi urged the country to 'exhaust all means to lure global talent'.[30]

Under the current iteration of the socialist market economy, the Chinese government makes clear that the state will richly reward people who can create jobs in the innovation sector and will protect their patent rights. A standard salary offered to a natural sciences researcher returning from overseas is around $150,000, and seed funding for eligible start-ups is between $300,000 and $600,000.[31] Such incentives represent an open call to tens of thousands of Chinese who have been studying and working in Silicon Valley and other tech hubs to come home.

Until very recently, China has long been a net exporter of talent in the fields of science and technology. Latterly, too, growing tensions with the West, Beijing's increasing political scrutiny of the work of foreign researchers and border closures in the context of the COVID-19 pandemic have combined to undermine Beijing's efforts to foster more Chinese homegrown and foreign talent in the tech sectors.

Beijing's talent-reshoring effort has been inadvertently boosted by the US's suspicion of Chinese students and academics.

But Beijing's talent-reshoring effort has been inadvertently boosted by the US's suspicion of Chinese students and academics. For example, between 2018 and 2022, the US Department of Justice's controversial China Initiative focused on preventing economic and scientific espionage within America's elite universities.[32] The initiative ultimately resulted in the arrest of a very small number of scientists, but it has created a strong sense of fear among the scientific community.[33] Other G7 countries such as the UK and Canada have also devised schemes to restrict the work of Chinese students and academics in strategically important sectors such as AI and quantum computing.[34] OECD data show that

30 Xi, J. (2021), '深入实施新时代人才强国战略　加快建设世界重要人才中心和创新高地' [Implementing a talent strategy to strengthen the country in a new era through the rapid establishment of a world-class talent and innovation centre], *Qiushi*, 27 September 2021, http://www.qstheory.cn/dukan/qs/2021-12/15/c_1128161060.htm; Sun, L., 'China will 'exhaust all means' to lure global talent, despite push for tech self-sufficiency, Xi Jinping says', *South China Morning Post*, 16 December 2021, https://www.scmp.com/economy/china-economy/article/3159975/xi-jinping-says-china-will-exhaust-all-means-lure-global.
31 Chik, H. (2023), 'China's return incentive scheme lures young scientists – superstars not so much', *South China Morning Post*, 6 January 2023, https://www.scmp.com/news/china/science/article/3205715/chinas-return-incentive-scheme-lures-young-scientists-superstars-not-so-much.
32 United States Department of Justice (2021, archived), 'Information About the Department of Justice's China Initiative and a Compilation of China-related Prosecutions Since 2018', https://www.justice.gov/archives/nsd/information-about-department-justice-s-china-initiative-and-compilation-china-related.
33 Reuters (2019), 'U.S. charges Chinese professor in latest shot at Huawei', 9 September 2019, https://www.reuters.com/article/us-huawei-tech-usa-idUSKCN1VU0J5; United States Attorney's Office, Eastern District of Pennsylvania (2015), 'University Professor Charged In Wire Fraud Scheme', press release, 21 May 2015, https://www.justice.gov/usao-edpa/pr/university-professor-charged-wire-fraud-scheme.
34 Reuters (2020), 'UK to exclude Chinese students from sensitive subjects', 1 October 2020, https://www.reuters.com/article/uk-britain-china-students-idUSKBN26M5YY.

China achieved a net inflow of scientists by 2021, as a significant number of Chinese scholars in scientific disciplines who had been working in G7 countries returned home (see Table 1).[35]

Table 1. Net flows of scientific authors, top publishing countries, '000, 2015 and 2021

	2015	2021
US	2,920.4	−896.0
China	**−336.1**	**3,108.8**
EU27	−4,101.8	2,256.3
Canada	64.0	559.0
Germany	−52.4	616.2
Australia	773.4	5.7
Spain	−1,608.2	−318.5
Russia	162.3	−424.4
Japan	−534.0	−255.0
South Korea	102.7	−177.5
Italy	−1,274.5	−450.5
France	−563.0	−538.8
Brazil	−253.2	−1,216.5
UK	91.5	−1,658.0
India	−1,314.1	−1,831.4

Source: OECD calculations, based on Scopus Custom Data, Elsevier, Version 6.2022, September 2022, https://stat.link/0akyvp.

The career path of another of the new appointees to the Politburo, the environmental scientist Chen Jining, is an example of successful talent-reshoring in the past. Like many of his colleagues in the Politburo, Chen took his bachelor's degree at the prestigious Tsinghua University and subsequently continued his studies in the UK, graduating three decades ago with a PhD in environmental engineering from Imperial College London.[36] He later returned to work as an academic at Tsinghua, eventually rising to the position of president of the university. His championing of interdisciplinary research at Tsinghua was popular with students and academics alike.

In common with several of his peers within the Politburo, Chen went on to combine his technical expertise and professional experience to launch a political career. He was awarded the position of environment and ecology minister in 2015.

35 Organisation for Economic Co-operation and Development (2023), *OECD Science, Technology and Innovation Outlook 2023: Enabling Transitions in Times of Disruption*, Paris: OECD Publishing, https://doi.org/10.1787/0b55736e-en.
36 Imperial College London (2013), 'PhD graduate 1993 – Chen Jining', https://www.imperial.ac.uk/civil-engineering/alumni/alumni-profiles/phd-graduate-1993---chen-jining.

His success in introducing several radical environmental protection measures – a task requiring considerable agility in balancing vested interests – earned him the reputation of someone able to 'get the job done'. As such, Chen's trajectory is emblematic of Xi's agenda to bring into senior positions cadres who combine expert technical knowledge with proven political loyalty.

Along with his track record in delivering the national government's environment agenda, Chen also gained substantial experience in finding and mentoring emerging talent during his academic career at Tsinghua. In a speech to scholars and senior staff members there in 2014, he emphasized that: '[W]e must not only produce students who behave like high-performing robots without individual character and creative thinking, or students who are not ready to rise to the challenges of geopolitical volatility.'[37] Such a direct message from the president of this prestigious university pointed to deep anxiety about the direction of the talent-grooming drive, as well as concerns about China's ability to attract the best talent to support the country's ambitions to achieve true breakthroughs in its critical science and technology sectors.

Latterly, as CPC secretary in Shanghai (a crucial stepping stone for a party high-flyer expected to ultimately win a position on the Politburo's Standing Committee), Chen has continued to advocate for talent to be attracted to and nurtured in this megacity, with an particular emphasis on talent-reshoring from centres of excellence worldwide.[38]

Chen's fellow scientist members of the 20th Politiburo, Yuan Jiajun, Li Ganjie, Ma Xingrui and Zhang Guoqing, have similarly, in their past provincial and regional party roles, called for the reshoring of talent in the aerospace, civil nuclear and digital economy sectors.[39] Generous packages are often available for the people each province is looking to attract, in the form of accommodation in desirable neighbourhoods, subsidies for school fees, high salaries, and seed funding for start-ups. While party secretary of Shangdong, Li notably gave officials the task of devising quantitative targets for talent-reshoring, with a particular emphasis on AI and biochemistry.[40] Achieving the set targets became one of the criteria for determining staff promotions during annual appraisals.

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37 Chen, J. (2014), '全面深化教育教学改革 大力提升人才培养质量' [Deepening education reform and improving talent-grooming quality], Tsinghua University, 16 October 2014, https://www.tsinghua.edu.cn/info/1793/72603.htm.
38 Shanghai Government (2023), '聚焦高水平人才高地建设: 上海市人才工作领导小组会议明确工作重点' [Focusing on building a talent hub: published meeting brief of talent steering group for Shanghai Municipality], March 2023, https://tyjr.sh.gov.cn/shtyjrswj/sjxx/20230329/d06ce1d11029429292cf3ff453a5e4a8.html.
39 Ma, X. (2016), '在建设世界科技强国中勇当先锋' [Being in the vanguard of world-leading science power], *People's Daily*, 12 August 2016, http://opinion.people.com.cn/n1/2016/0812/c1003-28630324.html; Yuan, J. (2019), '袁家军在杭州调研时强调 强化高质量发展的人才支撑' [Interview with Yuan Jiajun: strengthening talent development to support qualitative growth], The Paper, 21 November 2019, https://m.thepaper.cn/newsDetail_forward_5040261; Zhang, G (2017), '改革创新发力 转型升级加速——访重庆市市长张国清' [Interview with Zhang Quoqing: Accelerating economic upgrade through empowering innovation', *People's Daily*, 4 September 2017, http://cpc.people.com.cn/n1/2017/0904/c64102-29512036.html.
40 Li, G. (2022), '积极探索有效路径 主动服务和融入新发展格局' [Seeking an effective path to better serve the new development model], *Qiushi*, 1 September 2022, http://www.qstheory.cn/dukan/qs/2022-09/01/c_1128959856.htm.

Considering China's current domestic policy trajectory and the present global geopolitical context, it appears that Beijing remains committed to further strengthening the 'infrastructure' for innovation, but the 'space' that is equally required to drive Xi's ambition for self-reliance in science and technology has diminished rapidly – for both external and internal reasons.

From the perspective of many researchers in advanced economies, a strong capacity for technological innovation tends to go hand in hand with respect for individual political freedoms. A key question, therefore, is the extent to which a deepening of the one-party state under Xi may support or impede innovation over the long term. China may have the ambition and enormous state-funded resources to advance its science and technology agenda, but what is now lacking is the political will to nurture critical thinking and to allow a new generation of researchers to challenge conventional wisdom and existing authority.

China's advantage in terms of the sheer number of its STEM graduates gives it a solid foundation on which to pursue its ambitions to become a world leader in science and technology.

In 2020, Chinese universities awarded some 1.4 million engineering degrees at bachelor's level, compared with roughly one-seventh of this number in the US.[41] China's advantage in terms of the sheer number of its STEM graduates thus already gives it a solid foundation on which to pursue its ambitions to become a world leader in science and technology. At the same time, however, a shrinking of the space for individual freedoms and creativity within the country's institutions has discouraged potential global partners from working with China's scientists in recent years.[42]

From the 1980s until very recently in China, the steady rise in status of the private business and entrepreneurial classes led many talented young people to want to become the next Jack Ma, or China's Elon Musk, rather than settling for less 'fashionable' work as a civil servant in local government. But under Xi Jinping's leadership, there has been a marked shift in the political environment, with the CPC returning to the centre of all policymaking and almost all aspects of Chinese society. As a result, working for the party and government institutions has now regained popularity among young graduates in China.

While Xi and his Politburo may well be pleased to see young talent now keen to win party or government positions, they should also be wary of the potential negative consequences for innovation as political institutions attract the best and brightest at the expense of China's small and medium-sized private tech companies. For Chinese graduates – whether educated at home or returning

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41 Jones, H. and Goldman, D. P. (2022), 'US-China AI rivalry a tale of two talents', *Asia Times*, 2 July 2022, https://asiatimes.com/2022/07/a-tale-of-two-talents.
42 Burke, M. (2022), 'What next for scientific collaboration as stand-off between China and the west heats up?', *Chemistry World*, 18 October 2022, https://www.chemistryworld.com/news/what-next-for-scientific-collaboration-as-stand-off-between-china-and-the-west-heats-up/4016361.article.

from abroad – the choices they make between working in party/government posts or for SOEs will become another important factor shaping China's economic development. As Xi has sharpened his ideological focus on managing the Chinese economy through a security lens, and many young engineering graduates now expect to compete for government jobs rather than solve the riddle of producing semiconductors for an 'iron rice bowl', the implications for the success of the drive for scientific self-reliance are far from clear.[43]

Pioneering a digital economy and governance with Chinese characteristics

Stemming from his drive for China's scientific self-reliance and talent-reshoring, Xi Jinping has also prioritized the building of a robust and expansive digital economy as one of the key elements of the pathway to economic resilience. China is an important player in digital technology and cyberspace, and has pioneered a range of initiatives aimed at harnessing the power of emerging technologies as catalysts for socio-economic development, innovation and competitiveness. China has long recognized the power of digital and cyber governance to achieve its strategic ambitions and improve the lives and livelihoods of its citizens.[44]

However, Beijing has different approaches to digital and cyber governance compared with Western norms. These differences are rooted in political ideology, the roles of central and provincial governments, and precarious geopolitical realities. The application of technology in building a digital economy cannot exist in a political vacuum: it carries values, along with differences in governing ideologies and sources of power. Political considerations of technology are never far from the centre of the wider debate between technology and governance.

A new National Data Bureau was established in March 2023 within the National Development and Reform Commission (NDRC), China's powerful economic planning agency, while the Cyberspace Administration of China (CAC) was brought under the party's direct control.[45] The CAC's function as an enforcer of data governance in China is increasingly prominent, and its role extends far beyond that of a policy adviser to the State Council.

These shifts underscore Beijing's determination to promote the development of the country's digital economy, and to address digital vulnerabilities that might threaten China's national security. The new National Data Bureau will be responsible for regulating China's digital economy and implementing a national big data strategy, including digital infrastructure and public cloud infrastructure.

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43 The 'iron rice bowl' is term commonly used in China to refer to 'jobs for life' with good social welfare provisions, funded by the state or state-owned enterprises.
44 Cai, C. H. (2018), 'Global Cyber Governance: China's Contribution and Approach', *China Quarterly of International Strategic Studies*, 4(1), pp. 55–76, https://doi.org/10.1142/S2377740018500069; Segal, A. (2020), 'China's Vision for Cyber Sovereignty and the Global Governance of Cyberspace', in Rolland, N. (ed.) (2020), *An Emerging China-centric Order: China's Vision for a New World Order in Practice*, Special Report, Seattle, WA: National Bureau of Asian Research, https://www.nbr.org/publication/chinas-vision-for-cyber-sovereignty-and-the-global-governance-of-cyberspace.
45 Reuters (2023), 'China to form a national bureau to manage its troves of data, 7 March 2023, https://www.reuters.com/world/china/china-form-national-data-bureau-2023-03-07.

The creation of the National Data Bureau also serves as a further mechanism to support Beijing's efforts to control and use certain data for state-led development initiatives, in line with central government oversight of other economic inputs like land, capital and labour.

In terms of China's digital economy and cyber governance, a trend has been emerging whereby the central government and legal authority issue relevant legal documents and executive orders; individual provinces and municipalities then adapt these to local governance rules and regulations, and put them into practice. As with many evolving policy initiatives in China, the central government issues overall policy guidance while giving some autonomy to allow various provinces to tailor implementation. This often starts with local pilot studies and then is later expanded across the country. Digital and cyber governance also follows this trend, most notably in China's most economic vibrant areas.

Two of the new scientist members of the Politburo members, Ma Xingrui and Yuan Jiajun, were pioneers in building a digital economy with Chinese technologies during their respective tenures as provincial party secretaries in Guangdong and Zhejiang.

Ma, like Yuan, is another space scientist who notably led Chang'e 3, China's first lunar mission. He became party secretary of the tech and innovation hub of Shenzhen in 2015, and was promoted to the position of governor of Guangdong, one of the country's major economic and export hubs, in 2017.[46]

Ma's distinguished academic background – he has published a large number of articles in peer-reviewed journals in the fields of aerospace and astronomy – and professional track record have been very helpful to him as a provincial leader in one of the country's richest provinces. In Guangdong, his influence was a critical factor in the establishment of an international science and technology innovation centre in the Greater Bay Area, in response to escalating trade frictions and technological competition with the US.[47]

During Ma's tenure as governor of Guangdong, a number of new laboratories were established within the province, contributing to China's work in the fields of digital economy, 5G, 4K/8K ultra-high-definition video, new-energy vehicles, and industrial robots.[48] Previously, in Shenzhen, he had championed use of digital currency for businesses and consumers, and had the ambition for the province to be an early adopter of digital initiatives developed by the central government, just as Shenzhen had earlier been a pioneer in the reform and opening up of China after 1978.[49]

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46 China Internet News Center (2018), 'Ma Xingrui official biography', http://guoqing.china.com.cn/zy/2018-02/28/content_50607232.htm.
47 China Net Finance (2019), '马兴瑞：加快粤港澳大湾区国际科技创新中心建' [Ma: Accelerate the establishment of an international science and technology innovation centre in Greater Bay Area], http://finance.china.com.cn/news/20190603/4996825.shtml.
48 *Southern Daily* (2019), '马兴瑞接受访谈：推动广东高质量发展走在全国前列' [Interview with Ma Xingrui: Spearhead Guangdong's high qualitative growth and innovation to be the lead country], 13 March 2019, http://zfsg.gd.gov.cn/xxfb/ywsd/content/post_2222415.html.
49 *Shenzhen Daily* via Shenzen Government Online (2021), 'GD supports SZ to pilot digital money use: Ma', 25 January 2021, http://www.sz.gov.cn/en_szgov/business/news/content/post_8514859.html.

Since 2021, Ma has been party secretary of Xinjiang. His appointment to this highly politically sensitive position suggests Xi places significant trust in him. The key challenge facing Ma is whether he will be able to apply his pro-business attitude and tech innovation advocacy in a region like Xinjiang, which has an entirely different economic structure from southern China and where social and ethnic tensions are prevalent.

In the eastern province of Zhejiang, Yuan Jiajun won respect among private business and small to-medium sized tech companies by encouraging innovation in grassroots digital economy initiatives. Zhejiang has long been one of the main drivers of China's economy and has become a cluster for emerging tech sectors.

As party secretary in Zhejiang, Yuan championed efforts to find market-oriented ways to access data and empower the local economy with data-driven activities, including through building an advanced public cloud system. He encouraged collaboration between Zhejiang University, one of the leading academic centres for science and innovation, and several private tech companies to provide datasets for export manufacturers, another core element of the local economy.[50]

Not least from his background as a rocket scientist and experience in managing space competition with his NASA counterparts, Yuan is acutely aware of China's long-term competition with the US in areas of critical technology. In line with this, he urged Zhejiang's 'little giant' tech companies to focus on this strategically important sector, in line with Xi's ambitions for China's technological self-reliance.[51]

Now, as party secretary of Chongqing, a politically critical megacity with a population of some 32 million, it is reasonable to assume that Yuan will continue to advocate for the rapid development of the digital economy in southwest China. It is to be expected, too, that he is well placed to draw on his professional background in the vanguard of China's space industry to respond to Xi's ambitions to build self-sufficiency in science and technology. His successes now may help him build unique political capital to help him rise even higher in China's party leadership.

China has yet to find a workable balance between delivering economic benefits and exerting control when it comes to the digital economy and digital governance. Given the greater emphasis on ideological control across all aspects of Chinese society under Xi's leadership, it is inevitable that there will be blurred lines between commercial opportunities and national security concerns. This is clearly seen, for example, with the Chinese government's regulation of ChatGPT and other generative AI with general application to ensure these embody 'socialist values'.[52]

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50 Zhejiang Lab (2022), 'YUAN Jiajun Inspects Zhejiang Lab', 7 September 2022, https://en.zhejianglab.com/newsevents/news/202209/t20220919_3313.shtml.
51 Sohu.com (2022), '浙江省委书记袁家军：数字经济是主战场 要进一步加强产业大脑建设' [Yuan: Digital economy is the main battlefield and strengthening industrial brains is the key], 16 September 2022, https://www.sohu.com/a/585494848_120988576; Kynge, J., Yu, S. and Lewis, L. (2022), 'Fortress China: Xi Jinping's plan for economic independence', *Financial Times*, 15 September 2022, https://www.ft.com/content/0496b125-7760-41ba-8895-8358a7f24685. The term 'little giants' refers to China's smaller but influential tech companies with rapid growth and significant impacts in specific sectors.
52 McMorrow, R. and Liu, N. (2023), 'China slaps security reviews on AI products as Alibaba unveils ChatGPT challengers', *Financial Times*, 11 April 2023, https://www.ft.com/content/755cc5dd-e6ce-4139-9110-0877f2b90072.

The real challenge for the new scientist members of the Politburo is whether they can use a tried and tested formula to roll out digital governance for their respective economically vibrant regions that can apply for the rest of the country. Equally, demonstrating political loyalty to Xi will require them to follow ideological over pragmatic lines, as these often contradict each other. Having reached the Politburo, all five prominent scientists will be expected to both toe the party line and deliver on an ambitious policy agenda.

Conclusion

The elevation of prominent scientists to the 20th CPC Politburo has been an active response to Beijing's overall concern regarding China's difficulties in achieving scientific self-reliance in the context of a deteriorating geopolitical environment, including deepening rivalry with the US, and a slowing Chinese economy.

The appointment of Ma, Li, Yuan, Chen and Zhang also underscores Xi Jinping's preference for senior party technocrats or cadres with a combination of long-term political loyalty, strong professional experience and a track record of successful delivery of his political priorities. All five, judging from their careers so far, seem to fit this model well. But what is yet to be seen is the extent to which these scientists can draw on their past expertise to advance China's desired breakthrough in science and technology.

It is undeniable that these scientists reached high office within China's political establishment because of their excellence in managing scientific and innovation programmes in the past. However, to engineer genuine innovation across the Chinese economy is an entirely different matter. As policymakers in Beijing well understand, vast expenditure on a domestic semiconductor programme in the past decade has not yet been able to close the development gap in the industry between China and the US.[53]

Achieving the innovation necessary to fulfil Xi's ambition of self-reliance in science and technology will demand not just the 'infrastructure' afforded by financial resources and a policy toolbox, but equally importantly the 'space' that comes from allowing critical thinking, less political intervention, greater individual freedom and general acceptance of challenges to the status quo. Ensuring all these factors are in place could attract a steady inflow of talent both within China and from abroad. Homegrown innovation cannot be achieved only by appointing scientists to the Politburo, or by creating a new central science commission directly controlled by the party.[54]

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53 Yang, Z. (2022), 'Corruption is sending shock waves through China's chipmaking industry', *MIT Technology Review*, 5 August 2022, https://www.technologyreview.com/2022/08/05/1056975/corruption-chinas-chipmaking-industry.
54 Mallapaty, S. (2023), 'China is mobilizing science to spur development – and self-reliance', *Nature*, 14 March 2023, https://www.nature.com/articles/d41586-023-00744-4; Yu, J. (2023), 'Beijing briefing: China aims for tech self-reliance', *The World Today*, 31 March 2023, https://www.chathamhouse.org/publications/the-world-today/2023-04/beijing-briefing-china-aims-tech-self-reliance.

The appointment of this group of scientists to the Politburo also sheds some light on the next generation of Chinese leaders likely to follow Xi. China's president is reinforcing the shaping of China in his image. He has picked both loyalists and scientists to engineer and deliver the fruits of what he calls 'a pathway to Chinese modernization'.[55] Their task now is vast, requiring the country to sustain a high level of economic prosperity, reach global technology supremacy and retain ideological purity, ever more independent of Western capitalism.

It can be expected that many of the new Politburo members will be among the candidates for the future leadership, given their past and current professional experience and their accumulated political capital of trust from Xi. The five scientists featured in this paper have far less deeply entrenched political and social networks than the longer-serving members who have risen from traditional local bureaucracy or from the People's Liberation Army with vested interest groups behind them. So far, it is unclear whether any existing or future rivalries among the 24 Politburo members could disrupt policymaking, particularly on key questions such as Taiwan and the trajectory of the Chinese economy, and ultimately a leadership transition plan.

China's leadership has vowed to double down on its policy instruments to accelerate indigenous innovation, yet the financial resources earmarked for science will most certainly fall short as the post-pandemic economic rebound requires public finance to be channelled to other sectors.

Xi has left no doubt as to the importance of China's self-reliance in science and technology, and has called for a 'whole-nation approach' to dealing with technological chokepoints including the semiconductor industry. But the country's recent technological advances have been made through connectivity and globalization. All five of the new scientist members of the Politburo have studied and/or worked in advanced economies for a substantial period of time, and have benefited from frequent exchanges with the expert community internationally. It is reasonable to wonder how far the pursuit of self-reliance can go in the absence of continued opportunities for such exchanges with foreign peers. Achieving self-reliance, moreover, is not only dependent on China's own willingness and resources. It will also be determined by other countries' shifts in other policy direction towards China – particularly on the part of the US and its allies.

55 *People's Daily* (2023), 'Chinese path to modernization: Characteristics and global significance', 31 March 2023, http://en.people.cn/n3/2022/0331/c90000-10078510.html.

Some in the West might think that China's scientists-turned-politicians may be easier to work with than traditional bureaucrats, given their overseas experience and their ease in dealing with their counterparts overseas. Others might hope that at least a temporary diplomatic reset with advanced economies might be on the way.

However, both at home and abroad, the real influence of the new scientists will be judged on their results. In President Xi's third term, he has appointed technocrats in the Politburo to find ways of attracting and retaining talent to ensure scientific self-reliance and build a digital economy and society in line with CPC principles, and to promote China's domestic norms and practices internationally.

Despite and also because of an even more precarious geopolitical environment, Beijing's ambitions to achieve technological self-reliance remain undented. China's leadership has vowed to double down on its policy instruments to accelerate indigenous innovation, yet the financial resources earmarked for science will most certainly fall short as the post-pandemic economic rebound requires public finance to be channelled to other sectors. Innovation takes time to bear fruit, and is a risky business that will require the party leadership to loosen some control. This is yet another 'principal contradiction' that Xi and the CPC must now work to resolve.[56]

56 'Principal contradiction' is a term first attributed to Mao Zedong, referring to the most pressing issues to be dealt with in governing China.

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Dr Yu Jie is the senior research fellow on China in the Asia-Pacific Programme at Chatham House, focusing on the decision-making process of Chinese foreign policy as well as China's economic diplomacy. She frequently comments in major media outlets such as BBC News and the *Financial Times*, and regularly briefs senior policy practitioners from G7 member governments as well as major intergovernmental organizations. She also advises major FTSE 100 corporates and leading European financial institutions on China's political landscape.

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Cover image: Gui Haichao, Zhu Yangzhu and Jing Haipeng of China's Shenzhou 16 space mission wave to well-wishers at a pre-launch departure ceremony on 30 May 2023 at the Jiuquan satellite launch centre.
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