

**CHINA'S SPACE INDUSTRY:
BACKGROUND, RECENT
DEVELOPMENTS AND
CHALLENGES**

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Executive Summary

1. US-China technology competition has gone to the space. In general, the space industry's development has military and economic ramifications, benefitting many sectors of the economy and society.
2. China began to lead the world in terms of orbital launches in 2018 and continued to do so in 2019. By March 2020, China ranked second in the world after the United States in the total number of operating satellites. In June 2020, China completed its Beidou Positioning and Navigation System (BDS), an alternative to the US government-owned Global Positioning System (GPS).
3. China has promoted the building of space power and promulgated several policies and regulations to encourage the development of commercial space programmes in recent years.
4. The United States on the other hand is encouraging space marketisation, planning a commercial model and promoting the private sector's entry into space. China has also leveraged on the private sector to initiate commercial space programmes since 2015.
5. Big state-owned enterprises, including China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC), are playing an essential role in commercial space programmes.
6. Since the end of 2014, China has lifted numerous restrictions against private companies' involvement in the space industry.
7. Commercial space launch has taken off in China since 2014. CASC launched Jielong-1 rocket in August 2019. iSpace, a startup in China, launched Hyperbola-1 from Jiuquan Satellite Launch Centre in July 2019.

8. The satellite internet, which provides internet access globally, is another hotly pursued commercial space programmes. The satellite internet is part of China's "new types" of infrastructure.
9. China still faces many challenges in the development of commercial space programmes. First is the poor coordination between public and private sectors in commercial space programmes.
10. Second is the underdevelopment of the financial capabilities of private space companies. Third is the lack of adequate legal and policy support for China's private aerospace companies.

CHINA'S SPACE INDUSTRY: BACKGROUND, RECENT DEVELOPMENTS AND CHALLENGES

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Global Space Competition

- 1.1 Space is one of the significant dimensions of the US-China technology competition. In June 2020, China launched the final satellite to complete its Beidou Positioning and Navigation System (BDS), an alternative to the US government-owned Global Positioning System (GPS).¹ China, following the United States, has begun to explore Mars. In July 2020, a Long March 5 rocket launched the Tianwen-1 orbiter for Mars exploration.²
- 1.2 As an indicator of international status, space technology has become a factor in shaping world space competition,³ with the United States, Russia and China competing for a dominant position in the first echelon of space exploration and the European Union, Japan, India and Brazil competing in the second echelon; the third echelon incorporates other countries with independent satellite launching capabilities, including Israel, Iran, North Korea, South Korea, South Africa and Pakistan.⁴

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¹ BBC, "BeiDou: China launches final satellite in challenge to GPS", 23 June 2020, BBC News website, available at <https://www.bbc.com/news/business-53132957> (accessed 6 October 2020).

² Andrew Jones, "Tianwen-1 launches for Mars, marking dawn of Chinese interplanetary exploration", 23 July 2020, Space News website, available at <https://spacenews.com/tianwen-1-launches-for-mars-marking-dawn-of-chinese-interplanetary-exploration/> (accessed 5 October 2020).

³ John Agnew and Stuart Crobridge (2002). *Mastering space: hegemony, territory and international political economy*. London, New York: Routledge.

⁴ Before successfully launching Long March 5B rocket in 2020, China was considered a part of the second echelon in the competition of space technology. See China Pictorial, "Chinese Manned Space Projects Move to the Third Step: The Success of Long March 5B Rocket", 11 August 2020, the website of China Pictorial, available at http://www.rmhb.com.cn/yxsj/zttp/202008/t20200811_800217294.html (accessed 1 November 2020).

- 1.3 Generally, the space industry's development has military and economic ramifications, benefitting many sectors of the economy and society.⁵ A recent OECD research listed overall gross domestic product (GDP) growth, environmental management, transport and urban planning, research and development and science, climate monitoring and meteorology as the industry's beneficiaries.⁶
- 1.4 The benefits also include productivity and efficiency gains and cost saving at the firm level, human capital accumulation for workers, and improved coordination and co-operation at the organisation level.⁷
- 1.5 Ten years ago, only around 50 countries had enough funds for developing the space industry,⁸ while in 2018, Greece, Australia, Zimbabwe, Turkey and Luxembourg, for example had newly established space agencies, an indication of the recognition of aerospace's critical role in supporting national socio-economic, strategic and technological development.
- 1.6 In 2018, the total global government aerospace budget reached US\$70.9 billion, at a compound annual growth rate of 5.75% in the past five years.⁹ Countries investing in aerospace continues to increase, registering 88 countries with aerospace budgets, a record high.
- 1.7 The United States is planning to hold its leadership position in the space industry. In March 2018, the Trump administration promulgated the National Space Strategy. The strategy highlights the "America First" principle and emphasises America's

⁵ OECD 2019, The Space Economy in Figures How Space Contributes to the Global Economy, available at https://www.oecd-ilibrary.org/sites/c5996201-en/1/2/2/index.html?itemId=/content/publication/c5996201-en&_csp_=ffe5a6bbc1382ae4f0ead9dd2da73ff4&itemIGO=oecd&itemContentType=book (accessed 20 October 2020).

⁶ <https://www.oecd.org/innovation/the-space-economy-in-figures-c5996201-en.htm> (accessed 22 October 2020).

⁷ Ibid.

⁸ *Xinhua News Agency*, "International Observation: Will the launch of Shenzhou 5 successfully transform global order of space exploration?" 16 October 2003, available at http://www.cas.cn/zt/jzt/kpzt/szwhzj/jwzy/200310/t20031016_2667303.shtml (accessed 12 September 2020).

⁹ Simon Seminari, "Global government space budgets continues multiyear rebound", 24 November 2019, *Space News*, available at <https://spacenews.com/op-ed-global-government-space-budgets-continues-multiyear-rebound/> (accessed 10 September 2020).

leading position in space. To implement Trump's space strategy, the United States reestablished the National Space Council (NSC), set up the Space Development Agency (SDA), a space combat force and the US Space Command (USSPACECOM),¹⁰ which has the potential of almost reshaping the entire space.

- 1.8 Since the strategy was announced, it has brought responses from many major powers. Russia, Germany, France, Canada, Japan, and South Korea have also formulated or issued space strategies, guidelines, frameworks, basic laws and plans. France approved the establishment of a space commander, while Japan proposed establishing a space security force and India set up the National Defence and Space Agency to improve its space capabilities and protect the security of its own space assets.
- 1.9 Russia is deepening aerospace industry management reform and stimulating aerospace vitality through various measures such as formulating laws and regulations, increasing skilled human resources, and optimising financial management.¹¹
- 1.10 The United States' "National Defence Authorisation Act for Fiscal Year 2020" officially came into effect, authorising the formation of a space army under the Air Force and building the sixth service of the US military; the Department of Defence issued the "Indo-Pacific Strategic Report", clarifying US strategic plan in the Asia-Pacific region.
- 1.11 The report's basic proposition is a cooperation between the National Aeronautics and Space Administration (NASA) and other parties in commercial space programmes, a military-civilian integration with particular emphasis on maintaining the superiority of American companies in the space industry.

¹⁰ Sandra Erwin, "Trump formally reestablishes U.S. Space Command at White House ceremony", 29 August 2019, *Space News*, available at <https://spacenews.com/usspacecom-officially-re-established-with-a-focus-on-defending-satellites-and-deterring-conflict/> (accessed 19 September 2020).

¹¹ Xinhua Net, "Russian Space Industry: Stepping out of history and heading to future", 2 August 2019, the website of Xinhua Net, available at http://www.xinhuanet.com/mil/2019-08/02/c_1210225577.htm (accessed 1 November 2020).

- 1.12 The role of the private sector has been highlighted. The main strategies include encouraging space marketisation; planning a commercial model landing on the moon; allowing private companies to undertake the “International Space Station”; and encouraging public-private partnerships to accelerate the transfer of related technologies from NASA and the military to private enterprises.¹²
- 1.13 In 2017, the NASA Transition and Authorisation Act left low Earth orbit (between 160km and 2,000km of altitude) to commercial providers and this opened a huge opportunity to the private sector. US private companies such as SpaceX have managed to launch rockets to deploy hundreds of satellites in low Earth orbit (e.g. “Starlink” developed by SpaceX, Orbcomm under Amazon).¹³

China’s Response to the Global Space Competition

- 2.1 Like the United States, China has started to leverage on the private sector to initiate commercial space programmes since 2014. Commercial space programmes are expected to channel more resources to the space industry and, more importantly, to promote innovation and enhance efficiency.
- 2.2 Similar to leading countries in the sector, China has a long history in space exploration. It launched its first satellite with the Long March rocket in 1970.¹⁴ In the 1980s, the development of space programmes was included in the National High-Tech R&D programme (“863” programme) in response to the Star War programme initiated by the United States.¹⁵

¹² Lambright, W H (2019). Administrative Leadership and Long-Term Technology: NASA and the International Space Station. *Space Policy*, 47, 85-93 and Heracleous, L, Terrier, D and Gonzalez, S (2019). NASA's Capability Evolution Toward Commercial Space. *Space Policy*, 50, 101330.

¹³ Stephen Clark, “SpaceX closes out busy week with launch of more Starlink satellites”, 7 August 2020, Spaceflight Now Website, available at <https://spaceflightnow.com/2020/08/07/spacex-closes-out-busy-week-with-launch-of-more-starlink-satellites/> (accessed 10 September 2020).

¹⁴ Tariq Malik, “China Launched Its 300th Long March Rocket This Month”, 17 March 2019, Space.com Website, available at <https://www.space.com/china-launches-300th-long-march-rocket.html> (accessed 10 September 2020).

¹⁵ Ke, W (2012). Exploring work: the interaction between scientists and policy-makers. Case study of 863 Plan of China. *Journal of Science Communication*, 11(3), C04.

- 2.3 In 2003, China's human space programmes bore fruit when it launched Shenzhou 5 spacecraft, sending her first human traveller to space.¹⁶ China also sent its Chang'e Three lander making the first soft landing on the moon in December 2013.¹⁷
- 2.4 China led the world in terms of orbital launches (35) in 2018¹⁸ and in 2019 (34).¹⁹ As of 31 March 2020, China (363) ranked second in the world after the United States (1,327) in terms of the total number of operating satellites.²⁰
- 2.5 The Long March rockets completed 300 launches by 2019. It took 37 years for Long March rockets to complete the first 100 launches, while it only took four years to complete its final 100 launches.²¹
- 2.6 As indicated in the report of the 19th National Congress of the Communist Party of China, China set the strategic goal of becoming a space power and elevated this as one of the major national strategies.
- 2.7 In recent years, China has continued to promote its objective of becoming a space power, promulgated several policies and regulations to encourage the development of commercial launch vehicles, promoted the application of civilian remote sensing data, and deepened the integration of Beidou navigation, satellite communications and digital transportation, ports and civil aviation.

¹⁶ Space.com Staff, "Making History: China's First Human Spaceflight", 28 September 2005, Space.com Website, available at <https://www.space.com/1616-making-history-china-human-spaceflight.html> (accessed 10 September 2020).

¹⁷ Rui C Barbosa, "China's Chang'e-3 and Jade Rabbit duo land on the Moon", 14 December 2013, NASA Spaceflight Website, available at <https://www.nasaspaceflight.com/2013/12/china-jade-rabbit-lunar-arrival/> (accessed 10 September 2020).

¹⁸ Joan Johnson-Freese, "China launched more rockets into orbit in 2018 than any other country", 19 December 2018, *MIT Technology Review*, available at <https://www.technologyreview.com/2018/12/19/66274/china-launched-more-rockets-into-orbit-in-2018-than-any-other-country/> (accessed 10 September 2020).

¹⁹ *Xinhua News Agency*, "China reveals space plan for 2020", 17 January 2020, available at http://www.xinhuanet.com/english/2020-01/17/c_138713906.htm (accessed 10 September 2020).

²⁰ UCS Satellite Database, "In-depth details on the 2,666 satellites currently orbiting Earth, including their country of origin, purpose, and other operational details", 1 April 2020, *Union of Concerned Scientists*, available at <https://www.ucsusa.org/resources/satellite-database> (accessed 10 September 2020).

²¹ Xinhua Net, "China Focus: China's Long March rockets complete 300 launches", 10 March 2019, Xinhua Net website, available at http://www.xinhuanet.com/english/2019-03/10/c_137883742.htm (accessed 2 October 2020).

- 2.8 For example, on 27 November 2014, China's State Council issued "Guiding Opinions of the State Council on Innovating Investment and Financing Mechanisms in Key Fields to Encourage Social Investment".²² In 2019, "The notice given by two institutions about promoting the development of commercial rockets" has been initiated to regulate commercial rocket programmes.²³
- 2.9 In July 2019, the State Council Information Office of the People's Republic of China released the white paper "China's National Defence in the New Era".²⁴ The white paper points out that space is the commanding international strategic competition.
- 2.10 Big state-owned enterprises play an essential role in the commercial space programme. Two major state-owned companies of the aerospace industry, namely, the China Aerospace Science and Technology Corporation (CASC) and the China Aerospace Science and Industry Corporation (CASIC), were set up in 1999. The two had established commercial spinoffs to compete in commercial space programmes (e.g, ExPac under CASIS and China Rocket under CASC).²⁵
- 2.11 Some top research universities in China that are contributing to research and training talents for developing space technologies include Beihang University, Harbin Institute Of Technology, Northwestern Polytechnical University, Beijing Institute of Technology, Nanjing University of Aeronautics and Astronautics, Nanjing University of Science and Technology, Shenyang Aerospace University and Nanchang Hangkong University, where most founders of China's leading private space companies graduated from.

²² State Council, "The guidance of encouraging social financing of building innovative mechanism of financing in key fields", 26 November 2014, available at http://www.gov.cn/zhengce/content/2014-11/26/content_9260.htm (accessed 22 October 2020).

²³ The central government of China, "Made by State Administration of Science, Technology and Industry for National Defence and Logistic Support Department of Central Military Commission", 17 June 2019, available at http://www.gov.cn/xinwen/2019-06/17/content_5400951.htm (accessed 23 October 2020).

²⁴ Ministry of National Defence of The People's Republic of China, "The White Paper of China's National Defense in the New Era", 24 July 2019, Ministry of National Defence of The People's Republic of China Website, available at http://www.mod.gov.cn/regulatory/2019-07/24/content_4846424.htm (accessed 25 October 2020).

²⁵ CASC primarily focuses on space launch vehicles, while CASIC designs and builds satellites as well as guidance systems.

- 2.12 Private firms have been involved in the development of commercial space programmes since 2014. At present, China's private aerospace companies are mainly focused on the research and development of launch vehicles, the cornerstone of commercial aerospace. They are primarily to meet two types of market needs: one is the launch of small commercial satellites and the other is human space travel, which requires a leapfrog in the rocket's carrying capacity and a significant reduction in launching cost.

Why the Fostering of Commercial Space Programmes in China Recently?

- 3.1 Commercial aerospace is considered to be a necessary stage of becoming an aerospace power. Space technology has strong military and civilian use, and commercialisation is the primary strategy to promote space strategy's sustainable development. By facilitating civilian use of space technology, aerospace development can be profitable, thereby significantly reducing government's fiscal burden.
- 3.2 Commercial aerospace focuses on the market demand for low-cost, fast and flexible access to space. It uses small launching vehicles to carry out research and development work in order to provide commercial launching services for the microsatellite market. Compared with state-run aerospace industries, it relies more on capital market and technologies sharing through open market, while traditional state-run counterparts are less flexible and less willing to share experiences with partners especially from the private sector.
- 3.3 For China, commercial space programme development is to first help improve the resilience of a state's overall capability in space. For example, satellites owned by the government and military can quickly become targets of potential enemies, but commercial satellites are less likely to be threatened by attacks. Therefore, in certain extreme cases, private companies' civilian satellites can still provide a minimum level of services.
- 3.4 Second, to strengthen international collaborations in recognition of the space arena as a global public good that serves the wellbeing of all humankind.

- 3.5 Third, to improve efficiency, as China had learned the lesson of NASA's experience. NASA was the primary contractor and has long-term exclusive partnership with customers from the private sector. It owned the technology and was granted the privilege of selecting contractors. While the space shuttle was the flagship project of NASA, the NASA-centred system is considered to be less efficient and not innovative enough.²⁶ After the participation of the private sector, efficiency has been improved. All-in cost to deliver a kilogram of cargo to the international space station was about \$89,000 for SpaceX, one of the most valuable private companies in the United States,²⁷ while the cost was \$272,000 under the space shuttle.²⁸
- 3.6 Finally, to promote the development of space technology-related industries to increase employment and enhance macroeconomic growth have always been a fundamental goal of the space strategy of countries and organisations in the European Union, South Korea and Japan, to name a few.
- 3.7 For the EU, space exploration is not plagued by security concerns, while economic or commercial purposes are highlighted more frequently. In particular, the massive amount of data and signals from satellites can be beneficial to the data-driven innovative activities in the digital economy.

The Recent Development of Commercial Space Programmes in China

- 4.1 China's commercial aerospace covers satellite manufacturing, launch vehicle launches, satellite operations and services, and ground equipment manufacturing.
- 4.2 China National Space Administration (CNSA) is the national agency to coordinate space activities among different players, including the private sector. It is also the major regulatory agency for commercial space programmes.²⁹

²⁶ Weinzierl, M (2018). Space, the final economic frontier. *Journal of Economic Perspectives*, 32(2), 173-92.

²⁷ Sissi Cao, "As SpaceX Reaches \$36 Billion Valuation, Elon Musk Clarifies Starlink IPO Rumors", 3 October 2020, Observer website, available at <https://observer.com/2020/03/spacex-elon-musk-clarify-starlink-ipo-plan/> (accessed 5 October 2020).

²⁸ Weinzierl, M (2018). Space, the final economic frontier.

²⁹ See the section of "Institutional Function" on the website of China National Space Administration,

- 4.3 Since end-2014, China has lifted numerous restrictions against private companies' involvement in the space industry.³⁰ The year 2015 was regarded as the genesis of the entry of the private sector into the space industry when several major private companies were created; the old system that was previously dominated entirely by state-owned companies has been somewhat updated.³¹
- 4.4 There was also an uptick in state-owned enterprises' investment in commercial space programmes. In August 2019, Jielong-1 rocket developed by China Rocket Co Ltd, a commercial spinoff under CASC, was launched for the first time.³²
- 4.5 Private firms in the industry include iSpace, a startup in China, which launched Hyperbola-1 from Jiuquan Satellite Launch Centre in July 2019.³³ It is the first startup in China that launched a rocket into the orbit. In November 2020, Galactic Energy, another private firm, launched Ceres-1 rocket, which sent a satellite to a 500-kilometre Sun-synchronous orbit.³⁴
- 4.6 In general, there are two echelons of private aerospace companies in China. The first echelon comprises Onespace, Landspace and i-Space, which have been approved to launch rockets by governments; the second echelon comprises various smaller companies, such as Tianyi Research Institute, Jiuzhou Yunjian (Beijing) Space

available at http://www.cnsa.gov.cn/n6758821/index.html#w_two (accessed 16 November 2020).

³⁰ On 27 November 2014, China's State Council issued "Guiding Opinions of the State Council on Innovating Investment and Financing Mechanisms in Key Fields to Encourage Social Investment".

³¹ For a long time, China's aerospace industry has been dominated by big state-owned enterprises such as CASC. The operation business of CASIC is less clear and less important than CASC because CASIC is the main contractor of China's aerospace defence programme and is more focused on short- and medium- range launching vehicles.

³² Andrew Jones, "Chinese commercial rocket Smart Dragon-1 reaches orbit with first launch", *Space News*, 19 August 2019, <https://spacenews.com/chinese-commercial-rocket-smart-dragon-1-reaches-orbit-with-first-launch/> (accessed 10 July 2020).

³³ Yiwei Hu, "Graphics: 2019, a crucial year for China's space launch vehicles", 27 December 2019, China Global Television Network, available at <https://news.cgtn.com/news/2019-12-27/Graphics-2019-a-crucial-year-for-China-s-space-launch-vehicles-MLwIKh1lQc/index.html> (accessed 19 September 2020).

³⁴ Andrew Jones, "Chinese rocket firm Galactic Energy succeeds with first orbital launch, secures funding", *Space News*, 7 November 2020, available at <https://spacenews.com/chinese-rocket-firm-galactic-energy-succeeds-with-first-orbital-launch-secures-funding/> (accessed 2 December 2020).

Technology Co Ltd, Beijing Lingdong Feitian Power Technology Co Ltd, Shenzhen LinkSpace Aerospace Technology Co Ltd and so on.

- 4.7 In 2019, China was ranked first in the world for completing 34 space launches, and second for the number of spacecraft launched. China Aerospace Science and Technology Corporation's (hereinafter referred to as Aerospace Science and Technology Group) Long March series and Jielong 1 carrier rockets completed a total of 27 launches. The total mass and total quantity of developed and launched spacecraft were ranked first and second among global spacecraft manufacturers, respectively.
- 4.8 The privatisation of the space industry is also beneficial for China's ongoing economic upgrade. China has accelerated its pace of building the Internet of Things (IoT).³⁵ For example, in 2018, Beidou, China's navigation satellite system, has developed IoT models tailored for smart automobiles in China.³⁶
- 4.9 Satellite data-related services will contribute to civilian economic activities. Gaofen-7 satellite under high-definition Earth observation project was launched in November 2019 to improve orbital imaging capabilities. It is China's first civil-use satellite which can detect objects less than a metre away.³⁷
- 4.10 In April 2020, the satellite internet was named by the NDRC as part of the "new types" of infrastructure.³⁸ The satellite internet can provide internet access anywhere on the surface of the planet and significantly improve internet access in China's hinterland.

³⁵ China is leading in the development and application of 5G network, artificial intelligence and big data, all of which are regarded as crucial foundations for successfully developing IoT.

³⁶ *Xinhua News Agency*, "Models of Beidou for Internet of Things are released in Chongqing", 11 January 2018, *Xinhua News Agency* website, available at http://www.xinhuanet.com/fortune/2018-01/11/c_1122245752.htm (accessed 18 August 2020).

³⁷ CGTN, "China's Gaofen-7 satellite officially put into use", the website of CGTN, 20 August 2020, available at <https://news.cgtn.com/news/2020-08-20/China-s-Gaofen-7-satellite-officially-put-into-use-T6tUXnj09q/index.html> (accessed 26 October 2020).

³⁸ *Xinhua News Agency*, "News infrastructure building in satellite internet should well design top-down institutions", 29 April 2020, *Xinhua News Agency* website, available at http://www.xinhuanet.com/2020-04/29/c_1125920571.htm (accessed 25 August 2020).

Challenges Faced

- 5.1 Although the Chinese government has incorporated the satellite internet as part of the recent initiatives of the “New Types of Infrastructure” and supported the ongoing development of industrial internet, commercial aerospace is still new for China; it is unclear how it could profit from commercial aerospace activities.
- 5.2 Compared to US space technology, China is still lagging far behind. An indicator of the firms’ competitiveness in the commercial space programme is the cost level of space programmes.
- 5.3 For example, the payload cost of US’ SpaceX Falcon 9 is as low as US\$2,700 per kilogram,³⁹ while that for Kuaizhou-1A developed by China’s leading state player CASIC is now quoted as US\$20,000 per kilogram. The payload cost for Kuaizhou 11, a follow-up model, is quoted as US\$10,000 per kilogram.⁴⁰
- 5.4 Besides cost level, another indicator is the success rate of launching. The only two private space companies in China that have relatively successful rocket launches are i-Space and Galactic Energy. Other private companies such as Landspace and OneSpace had failed launches from 2019 to 2020. The first launch of Kuaizhou-11 rocket did not succeed either in 2020.⁴¹
- 5.5 Coordination between the public and private sectors in commercial space programmes is a significant concern. In principle, a high degree of competition should be supported by contractors and a coordinating space agency. The stiff competition for contracts from the space agency is a stimulator for individual firms to improve efficiency and be more innovative.

³⁹ Wendy Whitman Cobb, “How SpaceX lowered costs and reduced barriers to space”, 1 March 2019, The Conversation Website, available at <https://theconversation.com/how-spacex-lowered-costs-and-reduced-barriers-to-space-112586> (accessed 19 September 2020).

⁴⁰ Andrew Jones, “Chinese state-owned firms preparing to launch new commercial rockets”, 26 February 2019, Space News website, available at <https://spacenews.com/chinese-state-owned-firms-preparing-to-launch-new-commercial-rockets/> (accessed 19 September 2020).

⁴¹ Andrew Jones, “First Launch of Chinese Kuaizhou-11 rocket ends in failure”, 10 July 2020, Space News website (accessed 30 September 2020), available at <https://spacenews.com/first-launch-of-chinese-kuaizhou-11-rocket-ends-in-failure/> (accessed 30 September 2020).

- 5.6 In the United States, NASA has played an essential role in supporting commercial companies. Private firms share both the risks and returns of investment in space.⁴² NASA started a public-private partnership scheme, Commercial Orbital Transportation Services (COTS), in the early 2000s⁴³ and set the objectives while leaving the operational details to the commercial partners.
- 5.7 In the case of SpaceX, NASA has sponsored SpaceX under COTS since the early 2000s. NASA also procured services from SpaceX. In 2012, SpaceX won a contract worth US\$1.6 billion from NASA after SpaceX launched the dragon.⁴⁴ In 2014, SpaceX was awarded another US\$2.6 billion contract under Commercial Crew Development from NASA.⁴⁵
- 5.8 This kind of public-private partnership via service procurement has yet to be fully established in China. There are however indications that a public-private partnership is in the offing. In 2019, a government document issued by the State Administration of Science, Technology, and Industry for National Defence and the Equipment Development Department of the Central Military Commission⁴⁶ allowed some collaboration between state-owned enterprises and private enterprises in the areas of commercial space programmes.⁴⁷

⁴² Weinzierl, M (2018). Space, the final economic frontier. *Journal of Economic Perspectives*, 32(2), 173-92.

⁴³ Lambright, W H (2016). Leadership, Change, and Public-private Partnerships: A Case Study of NASA and the Transition from Space Shuttle to Commercial Space Flight. IBM Centre for the Business of Government.

⁴⁴ Ibid.

⁴⁵ Ibid.

⁴⁶ The Equipment Development Department of the Central Military Commission is mainly responsible for setting the criteria for defining the technologies or equipment that are allowed to be commercialised. See the Circular About Fostering Legal and Orderly Development of Commercial Rockets issued jointly by the State Administration of Science, Technology and Industry for National Defence and the Equipment Development Department of the Central Military Commission, 30 May 2019, the website of China's government, available at http://www.gov.cn/zhengce/zhengceku/2020-03/24/content_5494956.htm (accessed 11 November 2020).

⁴⁷ China National Space Administration, "The notice given by two institutions about promoting development of commercial rockets", 17 June 2019, China's Central Government website, available at http://www.gov.cn/xinwen/2019-06/17/content_5400951.htm (accessed 5 October 2020).

- 5.9 According to this document, with some contractual arrangements, private enterprises can access state-owned enterprises' infrastructure and other resources. For example, spaceports, owned by the state, are open to private companies for commercial rocket launches.
- 5.10 As state-owned enterprises are considered “national champions” or leading companies in strategic emerging industries⁴⁸ such as the aerospace industry,⁴⁹ there is a conflict of interest in policies encouraging entry of the private sector and policies in supporting leading firms, most likely policy-supported state-owned firms, in the aerospace industry.
- 5.11 With the private sector's entry, state-owned and private firms will have to compete for human resources as evidenced by the nationally controversial occupational move of Zhang Xiaoping, a rocket scientist from a research institute under CASC, to the private aerospace firm Landspace Tech in 2018 for the much higher compensation package offered.⁵⁰
- 5.12 Another major problem is on the financing part. The investment and financing of private aerospace companies in China reflect the massive enthusiasm in the commercial aerospace market, but it also reflects that the scale of financing cannot be compared with the business environment of its counterparts in the West.
- 5.13 China's private aerospace companies generally have weak financing capabilities. The financing channels are limited to only a few types of venture capitals which could rarely secure the financial backing of banks.

⁴⁸ See a recent report on the policies from State-owned Assets Supervision and Administration Commission of the State Council (SASAC), Keyu Li, “State-owned Assets Supervision and Administration Commission of the State Council is facilitating developing strategic new industries”, *nbd.com.cn*, 22 July 2020, available at <http://www.nbd.com.cn/articles/2020-07-22/1466173.html> (accessed 26 October 2020).

⁴⁹ See a recent document from National Bureau of Statistics, “the categories of strategic new industries (2018)”, the website of National Bureau of Statistics, available at http://www.stats.gov.cn/tjgz/tzgb/201811/t20181126_1635848.html (accessed 29 October 2020).

⁵⁰ *Beijing Youth Daily*, “The resigning of ZHANG Xiaoping will impact China's moon landing? A response of a research institute's dean”, 27 September 2018, *Beijing Youth Daily*, available at <https://tech.sina.com.cn/d/s/2018-09-27/doc-ifxeuwwr8750337.shtml> (accessed 5 October 2020).

- 5.14 Operating aerospace requires huge investments as the risk of space activities is exceptionally high and it takes an enormously long period to generate profits.
- 5.15 The profitability of private companies in China's space industry is not promising to most investors. China's newly established Sci-Tech innovative board of the Shanghai Stock Exchange (SSE STAR Market) seems far less welcoming than the Nasdaq Stock Market of the United States. However, in the long run, it might be gradually easier for China's private aerospace companies to seek financing through the STAR market in Shanghai.
- 5.16 According to the financing information publicly disclosed by domestic private aerospace companies, 17 companies obtained over RMB2.1 billion in the fields of launch vehicle development, satellite manufacturing and operation, remote sensing services, and data analysis in 2017.⁵¹ Although many well-known venture capital institutions have also begun to invest in commercial aerospace companies in 2018, according to information disclosed by about 15 private aerospace companies, the financing scale is close to that in 2017.⁵²
- 5.17 China's private aerospace companies also lack adequate support from national laws and policies in the current economic environment. In the United States, NASA has set technical standards and has the resources to transfer technology to private aerospace companies to support their development. In China, there is a huge overlap in the R&D of most private companies and their intellectual properties are far less clearly defined or protected than those in the United States.
- 5.18 The support of startups in China is also lagging. The survival and development of private aerospace enterprises in the United States are guaranteed through government contract projects. The US Department of Defence stipulates that a certain proportion of defence contract must be subcontracted to small and medium-

⁵¹ *Xinhua News Agency*, "An Analysis of China's Commercial Space Market: Rocket Companies Cost Less than Shared Bicycles", 27 November 2018, website of *Xinhua News Agency*, available at http://www.xinhuanet.com/finance/2018-11/27/c_1210003050.htm (accessed 22 October 2020).

⁵² Ru Qin, "Competition from Funding to Services, The birth of Chinese Commercial Space Industry Facing Bright", 3 February 2020, website of 36Kr, available at <https://36kr.com/p/1725028532225> (accessed 22 October 2020).

sized enterprises (SMEs) for defence contracting projects. The National Defence Authorisation Act promulgated in 2013 requires SMEs to undertake 23% to 25% of the principal contract amount and to more than 40% for sub-contracts.⁵³

5.19 As there is a rising desire among EU countries to independently deal with China's cooperation, the EU position in space development might be increasingly crucial to China in view of the United States' technological distrust of China. For example, China and Europe had established a de facto partnership in developing the Galileo project⁵⁴ and Europe has approved the launch of the Solar wind Magnetosphere Ionosphere Link Explorer (SMILE) together with China.⁵⁵

5.20 In Asia, facing competition from emerging private aerospace companies in Japan⁵⁶ and India,⁵⁷ China might need to make more effort to lower cost and improve the reliability of launching satellites meeting both domestic and international markets.

⁵³ The United States Congress, Part II-Goals For Procurement Contracts Awarded to Small Business Concerns in The National Defence Authorisation Act for Fiscal Year 2013, available at <https://www.congress.gov/112/plaws/publ239/PLAW-112publ239.pdf> (accessed 22 October 2020).

⁵⁴ Joan Johnson-Freese and Andrew S Erickson. "The emerging China-EU space partnership: A geotechnological balancer", *Space Policy* 22 (2006): 12-22.

⁵⁵ The European Space Agency, "ESA gives go-ahead for Smile mission with China", 5 March 2019, The European Space Agency website, available at https://www.esa.int/Science_Exploration/Space_Science/ESA_gives_go-ahead_for_Smile_mission_with_China (accessed 30 September 2020).

⁵⁶ Muchen Xiao, "Sharing market, Japanese private aerospace is taking off", 19 June 2019, 81.com website, available at http://www.81.cn/hkht/2019-06/19/content_9544798.htm (accessed 19 September 2020).

⁵⁷ FE Online, "India opens space sector to private players: What it means for ISRO", 26 June 2020, Financial Express website, available at <https://www.financialexpress.com/lifestyle/science/india-opens-space-sector-to-private-players-what-it-means-for-isro/2005105/> (accessed 19 September 2020).