Testimony before the U.S.-China Economic and Security Review Commission on "Current and Emerging Technologies in U.S.-China Economic and National Security Competition"

Panel III: China's Progress in Commercial Applications of Selected Emerging Technologies

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Co-Chairs Wessel and Helberg, distinguished Commissioners and staff, thank you for the opportunity to testify on China's current and emerging technologies and their implications for U.S.-China Economic and National Security Competition. It is an honor to be here alongside esteemed experts on this panel. My testimony reviews China's domestic and international efforts to ramp up the development of artificial development (AI), focusing on investment trends and key institutions driving the country's commercial development of the technology. It also assesses China's current AI governance and internal and external factors impacting the country's AI growth, including the Biden administration's 2023 executive order restricting U.S. private equity and venture capital investments in China's technologies. Finally, it concludes with recommendations based on the economic and national security implications these factors hold for the United States. These recommendations include:

- U.S. policymakers need accurate, evidence-based assessments of China's technological power.
- To restrict U.S. capital and intangible benefits from aiding the development of China's AI used for military purposes, the United States should carefully scope the outbound investment program spearheaded by the Department of Treasury.
- The United States should coordinate with its allies and partners to track the flow of venture capital and private equity investments into Chinese AI companies.

1. Domestic Support for AI

The Chinese government has consistently emphasized AI as central to China's aim to become a technology superpower. In particular, the 2017 New Generation Artificial Intelligence Development Plan (AIDP) calls for both relevant state and non-state actors to support the central government in pursuing global leadership in AI and using the technology to achieve the next phase of economic growth.[1]

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[1] "Notice of the State Council on Issuing the New Generation Artificial Intelligence Development Plan" [国务院关于发音《新一代人工智能发展规划》的通知], PRC State Council, 2017, https://perma.cc/B9ZR5LQL; English translation is available at https://www.newamerica.org/cybersecurityinitiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan2017/.

1.2. State Support for Public AI R&D

The Chinese government views basic science as key to winning the global competition for leadership in AI, and to this end is responsible for funding the bulk of basic research and development (R&D) in AI. The 2016 Innovation-Driven Development Strategy aims to reclaim control over key emerging technologies previously dominated by advanced nations like the United States.[2] China's 14th Five-Year Plan (covering 2021-2025) further specifies the need to boost spending on basic research to reduce chokepoints in areas such as AI, biotechnology, robotics, and quantum computing.[3] In 2022, the Chinese National Bureau of Statistics reported that China's R&D investment exceeded $421 billion (3 trillion RMB), a 10 percent increase from 2021.[4] This meets China's goal of increasing R&D expenditure by more than 7 percent annually, as addressed in the 14th FYP.[5]

The Chinese Academies of Science (CAS) and The National Natural Science Foundation of China (NSFC) are China's largest funders of basic research, dedicating $23.8 billion (170 billion RMB) and $6 billion (42.8 billion RMB), respectively, to basic research programs in 2023.[6] Some of the NSFC's research funding objectives for AI in 2023 included deep learning, brain-inspired AI, AI methods in biomedicine and computing.[7] In December 2023, NSFC also announced plans to fund 6 generative AI basic research projects to "enhance [China's] international competitiveness."[8]

One way the Chinese government can channel capital to AI research is through state funding mechanisms such as the National Key R&D Programs (NKPs). After the 2014 reform of the national S&T funding system, the NKPs absorbed both the 973 Program for basic research and

[2] "Outline of the National Innovation-Driven Development Strategy Issued by the CPC Central Committee and the State Council [中共中央 国务院印发《国家创新驱动发展战略纲要》]," *Xinhua*, May 19, 2016, http://www.xinhuanet.com/politics/2016-05/19/c_1118898033.htm; English translation is available at: https://cset.georgetown.edu/wp-content/uploads/t0076_innovation_driven_development_strategy_EN.pdf.

[3] "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035."

[4] "China R&D investment will exceed 3 trillion yuan in 2022," [2022 年我国研发经费投入突破 3 万亿元], *Xinhua*, September 18, 2023, https://www.gov.cn/lianbo/bumen/202309/content_6904781.htm.

[5] "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035" [中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要], *Xinhua*, March 12, 2021, 8 https://perma.cc/73AK-BUW2; English translation is available at https://cset.georgetown.edu/wp-content/uploads/t0284_14th_Five_Year_Plan_EN.pdf.

[6] "Department Budget of the Chinese Academy of Sciences 2023" [中国科学院 2023 年部门预算], CAS, https://www.cas.cn/tz/202303/P020230328780041440473.pdf; "National Natural Science Foundation of China 2023 Department Budget" [国家自然科学基金委员会 2023 年度部门预算], NSFC, https://www.nsfc.gov.cn/Portals/0/fj/fj20230330_01.pdf.

[7] Notice on the Release of the "Guide to the 2023 Annual Projects for the Major Research Program on Explainable and Generalizable Next-Generation Artificial Intelligence Methods" [关于发布可解释、可通用的下一代人工智能方法 重大研究计划 2023 年度项目指南的通告], NSFC, March 31, 2023, https://perma.cc/9C45-MK52; English translation is available at https://cset.georgetown.edu/wp-content/uploads/t0552_explainable_AI_plan_EN.pdf.

[8] "Application Guideline for the Special Project 'Basic Research on Generative Artificial Intelligence'" ["生成式人工智能基础研究"专项项目申请指南], NSFC, December 13, 2023, https://www.nsfc.gov.cn/publish/portal0/tab434/info91118.htm.

the 863 Program for high-tech development.[9] This integration of different R&D programs serves as a means to link basic research to the development of applied technology.[10] Another way is through the "2030 Science and Technology Innovation—'New Generation Artificial Intelligence' Megaproject" (科技创新 2030—'新一代人工智能'重大项目), which was launched in 2018 to ramp up AI development among a wide array of Chinese universities, companies, and research labs.

On the receiving end of some of these funds are State Key Labs (SKLs). These labs secure a steady stream of funding from the government to drive China's strategic basic research in S&T in the military and commercial spaces. In 2019, for instance, SKLs received a total of $925 million from China's Ministry of Education, Ministry of Science and Technology, and CAS.[11]

SKLs also sit at the intersection of public- and private-operated labs. The Chinese government establishes enterprise-based SKLs hosted within firms to link basic research to advanced technology applications. As of July 2022, nearly 40 percent of the 469 known SKLs were managed by government-designated AI national champions such as iFlytek and other conglomerates like Huawei and ZTE.[12]

1.3 State Support for China's Commercial AI Development

In the commercial sector, the government also plays a role in aligning public and private interests around strategic technologies like AI. As stipulated in the 14th Five-Year Plan, the Chinese government aims to "deepen the reform of investment and financing systems, exploit the leveraging role of government investment, stimulate private investment activity, and form endogenous growth mechanisms based on market-led investment."[13] To identify key commercial actors in China's AI innovation system, it is important to examine different means by which the state finances AI development in the commercial sector.

1.3.1. State financing for commercial AI

One of China's traditional industrial policy mechanisms to boost strategic industries is subsidies. In recent years, the state has identified and supported the "Little Giants," which are small and medium-sized companies with significant responsibilities for China's economic growth. Launched by the Ministry of Industry and Information Technology (MIIT) in 2018, the nationwide Little Giant initiative seeks to promote innovation while insulating the country from

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[9] "Press Conference on the 'Launch and Implementation of the National Key R&D Program': Summary Transcript [国家重点研发计划启动实施"新闻发布会：文字摘要]," PRC Ministry of Science and Technology, February 16, 2016, https://perma.cc/XFZ3-3AMX; English translation is available at: https://cset.georgetown.edu/publication/press-conference-on-the-launch-and-implementation-of-the-national-key-rd-program-summary-transcript.

[10] Ibid, 2-3.

[11] Emily S. Weinstein, et al., "China's State Key Laboratory System: A View into China's Innovation System," Center for Security and Emerging Technology, June 2022, https://cset.georgetown.edu/publication/chinas-state-key-laboratory-system/.

[12] Author's calculation of the numbers provided in Ibid.

[13] "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035 [中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要]," Xinhua, March 12, 2021, https://perma.cc/73AK-BUW2; English translation is available at: https://cset.georgetown.edu/wp-content/uploads/t0284_14th_Five_Year_Plan_EN.pdf.

supply-chain vulnerabilities and other external shocks by supporting companies in strategically important sectors such as manufacturing, hardware, and software.

As of July 2023, there are 12,756 Little Giant companies, although it is difficult to tell exactly whether all of them have received public and private funding.[14] In 2021, the MOF and MIIT issued a notice to support the first three batches (out of five total) of the Little Giants, offering more than $1.4 billion (10 billion RMB) in grants and subsidies between 2021 and 2025.[15] From 2020-2022 more than 1,500 Little Giants also received other forms of funding by winning major national S&T projects.[16] Given the government's interests in these companies, they are also popular among venture capital (VC) firms, having received nearly $224 billion (1,597 billion RMB) in funding since 2018.[17]

In the public equity investment realm, the Chinese state has emphasized the importance of tech-focused stock exchanges such as the Shanghai-based STAR Market and Shenzhen-based ChiNext board on China's tech industry. Tech companies listed on the STAR Market align closely with China's industrial policy goals. According to the 14th Five-Year Plan, China "will open up domestic IPO financing channels for S&T enterprises, enhance the 'key and core technology' characteristics of the STAR Market…to serve growing innovative and entrepreneurial enterprises."[18] The exchange market aims to fast-track IPOs for Chinese tech firms in key sectors like AI, semiconductors, and biotechnology by relaxing regulations and restrictions on IPO pricing.

Meanwhile, in China's private equity market, the government uses a public-private funding mechanism, known as government guidance funds (GGF), to steer capital into strategic industries like AI.[19] The government is involved across the different stages of the funding process, from fundraising to investment to operation. A 2021 CSET report found that the government sets up the fund's target size and allocates 20–30 percent of the total funding target to attract private investors who may have too little appetite for the risk of investing in high-risk, high-reward sectors like emerging technologies.[20] Often, these private investors are state-owned enterprises and state-run banks. Finally, government-affiliated entities, such as management

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[14] "2023 National "Specialized, Specialized, New" Little Giant Research Report" released: These companies may become the stars of tomorrow" [《2023 全国"专精特新"小巨人研究报告》发布：这些企业或成为明日之星], *21st Century Business Herald*, December 06, 2023, https://www.stcn.com/article/detail/1056972.html.

[15] "The central government's financial incentives and subsidies support the development of 'specialized, special and innovative' small and medium-sized enterprises - 10 billion yuan in red envelopes invested in 'little giant' firms" [中央财政奖补资金支持"专精特新"中小企业发展——100 亿元红包投向"小巨人"企业], *People's Daily*, February 6, 2021, https://perma.cc/RPY3-9ZLT.

[16] "The Report on the Development of Specialized, New Small and Medium Enterprises was Released [《专精特新中小企业发展报告》发布]," Zhongguancun Hi-Tech Technology Enterprise Association, September 19, 2022, http://www.cecc.org.cn/news/202209/569205.html.

[17] https://www.stcn.com/article/detail/1056972.html

[18] "Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035."

[19] Ngor Luong, Zachary Arnold, and Ben Murphy, "Understanding Chinese Government Guidance Funds," Center for Security and Emerging Technology, March 2021, https://cset.georgetown.edu/publication/understanding-chinese-government-guidance-funds/.

[20] Luong et al.,, "Understanding Chinese Government Guidance Funds."

institutions established by government agencies or state-owned investment firms, can also be found among the general partners who handle the day-to-day operations of the GGFs.

1.3.2. State Control and Influence over Non-state Firms

Within China's tech ecosystem, the state maintains close linkages between different military, public, and private actors, including under its military-civil fusion (MCF) policy. The Chinese government can assert control in and influence non-state firms by acquiring controlling stakes, directly subsidizing AI companies, establishing contract relationships with firms, and guiding private action by signaling its interests in specific industries of strategic importance.

The state can appear in Chinese non-state AI firms' ownership structure via investment common in the equity finance world. One way the state can take up shares in a non-state AI company is through its GGF investments. For instance, Chinese AI and facial recognition company iFlytek received a $2.9 million (18.5 million RMB) investment from Hefei Venture Capital Guidance Fund (合肥市创业投资引导基金), which accounted for nearly 8 percent of the company's equity shares in 2021.[21] Another way is through its state-owned companies. According to the financial database Refinitiv, AI and facial recognition company Hikvision, is 36 percent owned by CETHIK Group Co., Ltd., a subsidiary of SOE China Electronics Technology.

Beyond direct funding, the state can maintain close ties with non-state firms through contract relationships. China's MCF strategy has increasingly muddled the distinction between technologies developed in the military and civilian realm, or public sectors and private ones. In the implementation of MCF, the Chinese government's emphasis on developing AI systems for both military and civilian applications aligns with the dual-use nature of AI. Most AI systems are designed to have flexible models and customizable uses where users can fine-tune the model to their needs. There is evidence that AI systems developed by commercial entities can be adapted for military purposes to meet the needs of a government client. For instance, the People's Liberation Army (PLA) awarded 4Paradigm, a Chinese AI company, a contract to deliver decision-making and human-machine-teaming software in 2020.[22] According to its website, 4Paradigm offers products and services such as generative AI and decision-making AI that can be used in both civilian and military settings.[23]

To a lesser extent, the Chinese government sometimes relies on signaling to influence private capital flows in the commercial sector to serve the state's interests. The China Banking and Insurance Regulatory Commission plans to set up a "traffic light" system meant to guide private capital toward what the government deems as productive sectors, making clear the areas in which private investors can invest, while urging "firms to obey the Party's leadership."[24] For

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[21] "关于科大讯飞股份有限公司非公开发行股票申请文件反馈意见回复报告" (About 'Report on Feedback of Application Documents for Non-Public Offering of iFlytek Co., Ltd.'), April 1, 2021, https://q.stock.sohu.com/cn,gg,002230,7014689930.shtml.
[22] Ryan Fedasiuk, Jennifer Melot, and Ben Murphy "Harnessed Lightning" (Center for Security and Emerging Technology, October 2021), https://cset.georgetown.edu/publication/harnessed-lightning/.
[23] "4Paradigm," 4Paradigm, https://www.4paradigm.com/.
[24] "Correctly Understand and Grasp the Characteristics of the Rules of Capital (People's Viewpoint) [正确认识和把握资本的特性和行为规律（人民观点）]," *People's Daily*, February 8, 2022, http://qh.people.com.cn/n2/2022/0208/c401598-35125876.html; Ella Cao And Kevin Yao, "China to increase

many Chinese VC or PE investors, following government signals when making investment decisions is likely their best bet. This is especially true as the Chinese government pushes for greater control of what it has referred to as a "disorderly expansion of capital."[25]

1.3.3. Funding Limitations

The Chinese government's efforts to control, influence, and support the development of AI in the commercial sector through the aforementioned range of funding mechanisms face a number of limitations. First, traditional industrial policy mechanisms like subsidies and emerging ones like GGFs are often plagued with corruption, inefficiencies, waste, and lack of coordination.[26] For example, one independent market research firm reporting on the implementation of GGFs found that "many regions have jumped on the bandwagon of establishing AI industry development funds, even though there are few local companies in the AI field."[27]

Second, there is tension between Beijing's expectations and market realities concerning public equity flows into Chinese companies. Despite financial incentives for localization, as of 2023, there were 252 Chinese companies listed on the New York Stock Exchange (NYSE), Nasdaq, and NYSE American, which are the three largest US stock exchanges.[28] A number of these companies have also opted for dual listing, which allows US investors to convert their shares into securities listed in Hong Kong to hedge against the uncertainty caused by heightened tensions between the United States and China.

2. Chinese AI Companies and the World

Over the past decades, the Chinese leadership has amassed the country's resources to improve its technology innovation system to compete globally. It has emphasized the ability to build indigenous capacity at home to gain a first-mover advantage and according to the AIDP, become the global center for AI by 2030.[29] Although it is difficult to compare the innovativeness of Chinese non-state AI firms to that of U.S. firms, it is clear that China has become a leader in AI research, based on metrics such as the number of research publications, citation counts, and participation in top AI conferences.[30] China also tops the list of global AI-related patent producers, which can be a useful (albeit imperfect) indicator of technological advancement and a linkage between science, technology, and commercial activity. As Chinese firms are ramping up their ability to compete globally, further monitoring of their activities and indicators of success can help improve our understanding of China's innovativeness.

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support for private firms to bolster recovery," *Reuters*, July 19, 2023, https://www.reuters.com/markets/asia/china-increase-support-private-companies-bolster-economy-2023-07-19/.

[25] "Correctly Understand and Grasp the Characteristics of the Rules of Capital (People's Viewpoint)."

[26] Luong et al., "Understanding Government Guidance Funds."

[27] Luong et al., "Understanding Government Guidance Funds."

[28] "Chinese Companies Listed on Major U.S. Stock Exchanges," USCC, January 9, 2023, https://www.uscc.gov/research/chinese-companies-listed-major-us-stock-exchanges.

[29] Hannas, William, and Huey-Meei Chang. Chinese Power and Artificial Intelligence. 1st ed. Taylor and Francis, 2022; "Notice of the State Council on Issuing the New Generation Artificial Intelligence Development Plan."

[30] Such indicators and measures can be found on CSET's Emerging Technology Observatory (ETO)'s Country Activity Tracker (CAT): Artificial Intelligence, https://cat.eto.tech/?countries=China+%28mainland%29%2CHong+Kong&countryGroups=.

2.1. Chinese AI Firms' Investment and Research Ties to Other Countries

In addition to supporting Chinese non-state AI companies at home, the Chinese government also encourages them to seek opportunities abroad. The New Generation AI Development plan frames AI as "a new focus of international competition" and urges Chinese firms to "go out" into the global economy—namely, to invest and expand overseas.

In the investment world, Chinese AI companies, like others, often make strategic investments to benefit themselves, including gaining insights into the portfolio company's technology, establishing partnerships, or locking out a competitor. In the past 5 years, a number of leading Chinese AI companies, including tech giants like Baidu, Alibaba, and Tencent (BAT) as well as AI unicorns such as SenseTime, have been "going out" to invest in companies based in other countries (Appendix, Figure 1). For these companies, the top investment destinations include the United States and, to a lesser extent, the United Kingdom and Singapore. Tencent is slightly more active outside the Chinese border. It's important to note that investment is a two-way street. China, deeply connected to the global economy, sees companies like Tencent expanding their global financial footprints to fund and reap the benefits of technologies in other countries. At the same time, companies on the receiving end are also benefiting from Chinese AI companies' investments, especially when they can develop, scale, and commercialize their products.

Another way in which Chinese AI companies are establishing and deepening ties with the broader, global AI community is through collaborative research. For instance, according to CSET's merged corpus of scholarly articles, over the past five years, about half the English-language research papers published by some of China's leading tech companies, including BAT, SenseTime, ByteDance, and Yitu, were co-authored with foreign researchers (Appendix, Figure 2).[31] Such extensive collaboration between top Chinese AI firms and foreign researchers shows how much progress China has made in becoming a vital part of and a leader in the global research community.

2.2. China's Reliance on Foreign Tech

A 2022 CSET report by Ben Murphy on 35 Chinese tech chokepoints, namely, China's strategic technology import dependencies, found that the Chinese tech market, particularly in strategic areas such as photolithography machines and aviation design software heavily relies on foreign products. Take for example the aviation design software area. A Chinese scholar notes that "if foreign companies stop providing China with the software, the PRC aviation industry will be 'paralyzed.'"[32]

One of the explanations behind China's dependency, as the report points out, is that Chinese universities and labs struggle to link basic research with commercial applications.[33] While

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[31] The AI papers analyzed here exclude a very high proportion of Chinese-language-only publications, so we are likely overestimating the percentages of collaborations. However, analysis of papers published in English-language publications, indicating prestige and a certain level of paper quality, still offers meaningful results.
[32] Ben Murphy, "Chokepoints: China's Self-Identified Strategic Technology Import Dependencies" (Center for Security and Emerging Technology, May 2022), https://cset.georgetown.edu/publication/chokepoints/.
[33] Murphy, "Chokepoints: China's Self-Identified Strategic Technology Import Dependencies."

Chinese universities and research institutes are not solely responsible for commercializing products, the Chinese government emphasizes the importance of translating AI research into practical applications. In 2021, Xi Jinping said, "Our capacity to convert S&T achievements [into practical applications] is weak" and declared that the country must accelerate the "application of independent innovation achievements."[34]

To address this dependence on foreign technologies and materials, the Chinese government has focused on policies aimed at achieving self-sufficiency such as the investment efforts discussed above. Through such investments and other political and financial support mechanisms, the Chinese government is consolidating its influence in both the domestic market and across the overseas markets where it has encouraged Chinese firms to "go out." Taken together, this combination of public, private, and public-private investment vehicles is meant to advance China's goal of becoming a self-sufficient technological power within the next decade.

3. China's AI Regulatory Environment

In recent years, the Chinese government has put forth a number of regulatory frameworks to govern the development and deployment of AI. These regulations focus on recommendation algorithms, synthetically generated content, and generative AI. These regulations highlight the Chinese state's focus on steering AI development to align with its interests and priorities, particularly in areas of information control for political, economic, and social stability. In doing so, Beijing is grappling with challenges in balancing between state control and state support for AI development.

Several of the Chinese government's policy documents since the launch of the AIDP in 2017 discuss general guidance for AI regulations and the layout of relevant issues.[35] However, three policy documents are key drivers behind the country's attempt at shaping the regulatory environment for AI development.

In 2021, four Chinese ministries jointly related the "Provisions on the Management of Algorithmic Recommendations in Internet Information Services."[36] This document emphasizes the role of the state in planning and coordinating the governance of algorithmic recommendation services. It prohibits algorithm recommendation companies from engaging in services that "endanger national security or the societal public interest, disrupt economic and social order, or harm the lawful rights and interests of others."[37] One provision is worth highlighting; article 13

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[34] "Xi Jinping: Strive to Become the World's Primary Center for Science and High Ground for Innovation," translated by Ben Murphy, Rogier Creemers, Elsa Kania, Paul Triolo, and Kevin Neville, DigiChina, March 18, 2021, https://digichina.stanford.edu/work/xi-jinping-strive-to-become-the-worlds-primary-center-for-scienceand-high-ground-for-innovation/.

[35] Matt Sheehan, "China's AI Regulations and How They Get Made," Carnegie Endowment for International Peace, July 10, 2023, https://carnegieendowment.org/2023/07/10/china-s-ai-regulations-and-how-they-get-made-pub-90117.

[36] "Provisions on the Management of Algorithmic Recommendations in Internet Information Services," [国家互联网信息办公室、中华人民共和国工业和信息化部、中华人民共和国公安部、国家市场监督管理总局], CAC, December 31, 2021, http://www.cac.gov.cn/2022-01/04/c_1642894606364259.htm; English translation is available at https://www.chinalawtranslate.com/en/algorithms/.

[37] "Provisions on the Management of Algorithmic Recommendations in Internet Information Services."

restricts synthetically generated fake news information, underscoring the state's interest in controlling online news content.

Given the Chinese government's concern over artificially generated content, the Cyber Administration of China (CAC) released the "Provisions on the Administration of Deep Synthesis Internet Information Services" in 2022.[38] Through this document, the state articulated that deep synthesis (or deepfake) technology threatens China's information security, and therefore, activities that "endanger the national security and interests, harm the image of the nation, harm the societal public interest, disturb economic or social order, or harm the lawful rights and interests of others" are prohibited.[39] This regulation tracks with Beijing's efforts to prevent what it considers political and social disruption and enforce censorship and content regulations more broadly.

In 2023, CAC, the National Development and Reform Commission (NDRC), the Ministry of Education (MOE), the Ministry of Science and Technology (MST), the MIIT, and the Ministry of Public Security (MPS) issued "Interim Measures for the Management of Generative Artificial Intelligence Services."[40] These measures focus on text, image, audio, and video generated by large language models (LLMs) like OpenAI's ChatGPT, as well as on training data. Previously discussed documents on recommendation algorithms and deepfakes had laid the groundwork for content generation regulation. What's new in this document is the inclusion of measures to govern the data used to train generative AI systems. The quality and quantity of data is an important component that makes training deep learning models possible.[41]

As such, the Chinese National Information Security Standardization Technical Committee put together a draft for feedback, "Basic Safety Requirements for Generative Artificial Intelligence Services," addressing specific requirements for Chinese AI companies.[42] With respect to training data, the draft notes the use of a blacklist; data that contains over 5 percent of what is referred to as "illegal and unhealthy information" is deemed unsafe for training. From the compliance perspective, companies that build AI software will likely opt in for state-approved content, for instance from state-run media sources, to meet the threshold.

Based on the three AI regulatory frameworks, it is clear that the Chinese government aims to shape the development of AI to serve its interests, especially in the realm of information control

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[38] "Provisions on the Administration of Deep Synthesis Internet Information Services" [国家互联网信息办公室 工业和信息化部 公安部], CAC, November 25, 2022, http://www.cac.gov.cn/2022-12/11/c_1672221949354811.htm; English translation is available at https://www.chinalawtranslate.com/en/deep-synthesis/.

[39] "Provisions on the Administration of Deep Synthesis Internet Information Services."

[40] "Interim Measures for the Management of Generative Artificial Intelligence Services" [国家互联网信息办公室 国家发展和改革委员会 教育部等], CAC, July 10, 2023, http://www.cac.gov.cn/2023-07/13/c_1690898327029107.htm; English translation is available at https://www.chinalawtranslate.com/en/generative-ai-interim/.

[41] Ben Buchanan, "The AI Triad and What It Means for National Security Strategy" (Center for Security and Emerging Technology, August 2020), https://cset.georgetown.edu/publication/the-ai-triad-and-what-it-means-for-national-security-strategy./

[42] "Basic Safety Requirements for Generative Artificial Intelligence Services (Draft for Feedback)" [生成式人工智能服务安全基本要求（征求意见稿）], Chinese National Information Security Standardization Technical Committee, October 11, 2023, https://cset.georgetown.edu/wp-content/uploads/t0574_generative_AI_safety_EN.pdf.

for political, economic, and social stability. The proposed regulations largely deal with the current and potential social, ethical, and economic impacts of AI on Chinese citizens, and the decision to focus early regulatory efforts on these areas reflects the state's desire to solidify its political legitimacy amid rapid technological changes. Finally, China wants the world to see itself as a leader in AI governance and is creating a regulatory environment domestically to shape an international one. Shan Zhiguang (单志广), director of the State Information Center of China's Information and Industrial Development Department, takes pride in China leading the release of measures to regulate generative AI and suggests inserting China's practices into the international framework.[43]

3.1. Domestic Factors Impacting China's AI Growth

China's efforts to regulate AI can provide firms with some degree of predictability and articulate government expectations in rapidly evolving and dynamic AI markets. As Carnegie Endowment's Matt Sheehan pointed out, China's AI regulatory frameworks will help shape the parameters for the future development of AI in the country.[44] For companies, regulations offer some assurance that the systems they develop will have a receptive market if they abide by the rules. Indeed, there is already some evidence that Chinese AI companies are developing technologies to adapt to the new rules. For instance, SenseTime is developing a "deepfake detection + digital watermark" ("深伪检测+数字水印") technology to prevent AI models from generating false content.[45]

At the same time, excessive regulation can stifle innovation and impose prohibitive compliance costs, especially on new and small companies. It is still too early to assess the actual impact of China's AI regulations on innovation in the country, but there is some evidence that Chinese AI companies are concerned about the costs of complying with expanding regulations. For instance, at a Chinese AI forum hosted by the Institute of Law of the Chinese Academy of Social Sciences and attended by key industry leaders, participants expressed concerns that AI companies will require not only technical teams for developing large models but also risk assessment teams to ensure compliance with the rules. They are also concerned that the overlapping rules and unclear bureaucratic authorities will add more pressure on companies developing and deploying AI across China.[46]

Other internal factors including economic slowdown and demographic changes are also impacting China's AI ecosystem. China's economy is expected to see an annual growth average of just 4.5 percent, with no signs of potential recovery to the 10 percent growth rate numbers that turned China into an economic powerhouse more than a decade ago.[47] The continuation of slow

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[43] "Promoting the safe development of AI" [推动人工智能安全发展], *Xinhua*, January 3, 2024, http://www.news.cn/tech/20240103/da71ac3a00a34af588b9b515084d6739/c.html.

[44] Sheehan, "China's AI Regulations and How They Get Made."

[45] "Promoting the safe development of AI."

[46] "How can risk governance take into account innovation and safety when artificial intelligence legislation is being carried out?" [人工智能立法进行时 风险治理如何兼顾创新与安全？], *21st Century Business Herald,* December 19, 2023, https://www.21jingji.com/article/20231219/herald/70fc4a20d58e447ac91a6a590d10bff9.html.

[47] Greg IP, "Why Xi Can No Longer Brag About the Chinese Economy," *Wall Street Journal*, November 14, 2023, https://archive.is/L6bBJ.

and stagnant growth may impact the country's ability to finance major investments in emerging technologies. Local governments, which are important players in setting up and contributing initial capital to government guidance funds, are also facing financial pressures. With more local debt burdens, these guidance funds often struggle to meet their fundraising goals. Fundraising amounts saw a 35 percent drop in 2022 from the previous year.[48]

China's ability to innovate and its population problems are intertwined. Innovation needs talent. The current supply of AI workers is estimated to only meet 10 percent of the demand in the workforce.[49] The geographic distribution of available opportunities in the AI sector is another question. A 2023 CSET report assessing China's AI workforce found that in some provinces such as Shangdong and Henan, AI professionals who graduated from AI programs locally may struggle to find employment given the relatively low level of AI job demand in the area.[50]

Despite these challenges, the Chinese government continues to view technology as crucial for China's economic development, societal well-being, and geostrategic and military goals. Xi Jinping in 2018 said that "key technologies are the most important weapons of the country to promote high-quality economic development and guarantee our national security."[51] This political declaration is not a new phenomenon. Xi's predecessors have also stressed the idea of self-sufficiency to better guard against both domestic and global volatility. The high-level ambitions are clear but how the Chinese leadership will cope with these domestic challenges remains to be seen.

3.2. External Factors Impacting China's AI Growth

There are a number of external factors impacting China's ability to meet its AI goals, including U.S. export controls on advanced computing chips and related semiconductor manufacturing equipment. Access to advanced chips is critical in researching and developing advanced AI systems like LLMs, which often demand extensive computing power, and some evidence suggests that Chinese companies developing LLMs use Nvidia's chips more often than Chinese-made chips.[52] At least in the short term, U.S. export controls on advanced semiconductors will likely undercut China's AI advancement, including by forcing Chinese companies to use stockpiles of less advanced Chinese-made chips, which are not optimal for training LLMs.[53]

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[48] Author's calculation from "Zero2IPO 2022 annual review: 120 new government guidance funds were established, and integration and optimization became the norm" [清科 2022 年度盘点：新设立政府引导基金 120 支，整合优化成常态], Zero2IPO, https://pdf.dfcfw.com/pdf/H3_AP202302151583167286_1.pdf?1676457061000.pdf.

[49] TAKASHI KAWAKAMI, "China's shortfall in AI tech talent estimated in the millions," *Nikkei Asia*, September 14, 2023, https://asia.nikkei.com/Business/China-tech/China-s-shortfall-in-AI-tech-talent-estimated-in-the-millions.

[50] Dahlia Peterson, Ngor Luong, and Jacob Feldgoise, "Assessing China's AI Workforce: Regional, Military, and Surveillance Geographic Job Clusters" (Center for Security and Emerging Technology, November 2023), https://cset.georgetown.edu/wp-content/uploads/CSET-Assessing-Chinas-AI-Workforce.pdf.

[51] "Xi Jinping: Core Technology is the Most Important Weapon of the Country [习近平：关键核心技术是国之重器]," Xinhua, July 15, 2018, https://perma.cc/3XVT-U6C2.

[52] Helen Toner, Jenny Xiao, and Jeffrey Ding, "The Illusion of China's AI Prowess," *Foreign Affairs, June 2, 2023,* https://archive.is/hfgV8.

[53] Hanna Dohmen Jacob Feldgoise, "A Bigger Yard, A Higher Fence: Understanding BIS's Expanded Controls on Advanced Computing Exports," CSET, December 4, 2023, https://cset.georgetown.edu/article/bis-2023-update-explainer/.

Second, the U.S.'s 2023 outbound investment executive order (EO) restricting venture capital and private equity (VC/PE) investment in China could also impact the country's AI development. Although the EO narrowly scopes the restriction to companies working on military applications of AI, its impact may extend beyond that. In recent years, the Chinese VC/PE market has been maturing thanks to government support and foreign capital and networks, including those from the United States.[54] If U.S. VC firms become reluctant to continue investing in China, they will also be denying the investment expertise and networks that benefit the Chinese VC players. Investments from big VC firms, especially those in the United States, may convey a credible signal of a firm's quality to other parties. For example, Intel Capital's investment in Chinese Easy Tech raised the profile of this AI chip company, resulting in more investment from state-backed Zhuhai S&T VC firm.[55] It is possible that with more limited access to U.S. expertise and networks, Chinese AI companies may face challenges in finding investors to fund their prototypes and products.

U.S. restrictions on tech export and investment could also add to the pessimism about the economic and technological outlook in China. In response to these restrictive measures, Chinese AI companies and investors may look to grow their financial and technology footprint in regions like Southeast Asia with its growing tech base, potentially at the expense of investment in the domestic AI ecosystem.[56] There is evidence that Chinese entrepreneurs and wealthy individuals who could be funders are leaving China, especially for Singapore.[57] That said, external factors such as restrictive U.S. measures on semiconductor exports and AI investment screening are also adding more pressure on Beijing to push forward with its self-sufficiency policies in order to guard against these external changes.

4. Economic and national security implications for the United States

China's rapid advancement in AI, fueled by significant state support, can pose economic and security challenges to the United States. In particular, China's progress in commercial AI applications can also support its military modernization efforts in a way that threatens U.S. national security. The United States has implemented measures to restrict Chinese access to U.S. technologies and know-how, capital, and markets. To ensure current and future U.S. policies toward China meet their goals, it is crucial to regularly assess China's AI capabilities and their impact on U.S. competitiveness. I recommend the following actions for U.S. policy:

1) **U.S. policymakers need accurate, evidence-based assessments of China's technological power.** Open-source intelligence (OSINT) collection and analysis, for instance, can help augment our understanding of China's science and technology capabilities, including in emerging technology areas such as AI. CSET experts have recommended establishing a center, outside of the intelligence community, to collect

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[54] Emily S. Weinstein and Ngor Luong, "U.S. Outbound Investment into Chinese AI Companies" (Center for Security and Emerging Technology, February 2023), https://cset.georgetown.edu/wp-content/uploads/CSET-U.S.-Outbound-Investment-into-Chinese-AI-Companies.pdf.

[55] Weinstein and Luong, "U.S. Outbound Investment into Chinese AI Companies."

[56] Ngor Luong Margarita Konaev, "In & Out of China: Financial Support for AI Development," CSET, August 10, 2023, https://cset.georgetown.edu/article/in-out-of-china-financial-support-for-ai-development/.

[57] Jason Douglas , Keith Zhai and Stella Yifan Xie, "As China Reopens, Flight of Wealthy Chinese to Singapore Set to Accelerate," *Wall Street Journal,* February 27, 2023, https://archive.is/6lGIp.

open-source intelligence, monitor, analyze, and share information with allies and partners on China's S&T capabilities.[58]

2) **To restrict U.S. capital and intangible benefits from aiding the development of China's AI used for military purposes, the United States should carefully scope the outbound investment program spearheaded by the Department of Treasury.**
According to the Treasury's accompanying advanced notice of proposed rulemaking (ANPRM), prohibited transactions currently cover investments in companies that are engaged "in the development of software that incorporates an AI system and is designed to be exclusively used for military, government intelligence, or mass-surveillance end uses." In a public comment in response to the Treasury's ANPRM, CSET, the Center for New American Security (CNAS), and the Atlantic Council recommend a revision to the scope of end use-based prohibited transactions to reflect the dual-use nature of AI systems, replacing "exclusively used" with "intended, entirely or in part, for use in military, government intelligence, or mass-surveillance end uses."[59] While there are AI systems designed specifically for military purposes, most are designed to have flexible models and customizable uses where users can fine-tune the model to their needs. There is evidence that Chinese military entities have acquired AI systems that are not exclusively designed for military uses. For instance, in 2020, 4Paradigm secured a contract to provide intelligent algorithm models, metadata classification software, and knowledge discovery software.[60] 4Paradigm is not exclusively a military AI company, but its products are nonetheless being sold to the Chinese military.

I also recommend an entity-based approach to prohibit U.S. investments in AI for military purposes. This approach would prevent the U.S. government from having to determine which AI systems are designed for military purposes. It accounts for the fact that AI systems are made more harmful based on the entity developing or using such systems. An entity-based approach can also offer a tool that is similar to the Bureau of Industry and Security (BIS)'s "know your customer" guidance.[61] A list of problematic entities may also make compliance easier for the industry since it would not be left up to interpretation on a company-by-company basis. Without such guidance, one firm could decide that a transaction should be prohibited on the basis of end use restrictions, while another may disagree and choose to pursue the transaction, which could put the companies that conduct extensive due diligence at a competitive disadvantage.

[58] Owen J. Daniels, "CSET Analyses of China's Technology Policies and Ecosystem: The PRC's Efforts Abroad" (Center for Security and Emerging Technology, September 2023), https://cset.georgetown.edu/wp-content/uploads/20230036_The-PRCs-Efforts-Abroad_FINAL9.20.2023.pdf; Dewey Murdick, Ph.D., "Testimony before the Senate Select Committee on Intelligence: Countering the People's Republic of China's Economic and Technological Plan for Dominance," Center for Security and Emerging Technology, May 11, 2022, https://cset.georgetown.edu/wp-content/uploads/2022.05.11-Testimony-before-theSenate-Select-Committee-on-Intelligence.pdf.

[59] Emily Kilcrease, Tim Fist, Sarah Bauerle Danzman, Ngor Luong, and Emily Weinstein, Comments on Provisions Pertaining to U.S. Investments in Certain National Security Technologies and Products in Countries of Concern (September 29, 2023), https://www.regulations.gov/comment/TREAS-DO-2023-0009- 0049.

[60] Fedasiuk et al., "Harnessed Lightning."

[61] "Supplement No. 3 to Part 732—BIS's "Know Your Customer" Guidance and Red Flags," Code of Federal Regulations, accessed on November 25, 2023, https://www.ecfr.gov/current/title-15/subtitle-B/chapter-VII/subchapter-C/part-732/appendix-Supplement%20No.%203%20to%20Part%20732.

3) **The United States should coordinate with its allies and partners to track the flow of venture capital and private equity investments into Chinese AI companies.**
   To increase the effectiveness of U.S. outbound investment restrictions on certain technologies in China, there is a need to coordinate with allies and partners that also have investments in China's AI ecosystem. CSET research found that Chinese AI companies also attract investment from foreign investors other than the United States. Any unilateral U.S. action will be weaker without the help of U.S. allies and partners.

   Since the launch of the 2023 EO restricting U.S. capital into China's technologies, the United States has made some progress with U.S. allies and partners at the strategic level, but specific coordinated actions on how to develop and implement this outbound investment screening are further needed. We see the Group of Seven (G7) releasing a statement noting the importance of forming appropriate measures to address outbound investment concerns related to emerging technologies.[62] In a joint declaration, the United States and the United Kingdom also agreed to address their concerns over capital flow into China's technologies.[63] But additional information sharing between key U.S. allies, such as on transactions of concern, can make coordination efforts more effective, avoid overextending U.S. jurisdiction, and help countries learn from each other's experiences.[64]

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[62] "G7 Leaders' Statement," White House, December 6, 2023, https://www.whitehouse.gov/briefing-room/statements-releases/2023/12/06/g7-leaders-statement-6/#:~:text=We%20recognize%20that%20appropriate%20measures,that%20threaten%20international%20peace%20and.

[63] "Addressing the national security risks posed by certain types of outbound investment," United Kingdom Government, June 21, 2023, https://www.gov.uk/government/publications/the-atlantic-declaration/addressing-the-national-security-risks-posed-by-certain-types-of-outbound-investmen.

[64] Ngor Luong Emily S. Weinstein, "A Guide to the Proposed Outbound Investment Regulations," CSET, October 6, 2023, https://cset.georgetown.edu/article/a-guide-to-the-proposed-outbound-investment-regulations/.

5. Appendix

Figure 1: Select Chinese AI companies' investments outside of China (2019-2023)

AI company	Investment transactions outside of China	All investment transactions	Percentage of investment transactions outside of China
Tencent	222	407	54.6%
Alibaba	37	98	37.8%
ByteDance	8	52	15.4%
Baidu	4	24	16.7%
SenseTime	1	12	8.3%

Source: CSET analysis of Crunchbase

Figure 2: Select Chinese AI companies' AI collaboration with foreign researchers (2019-2023)

AI company	AI papers in collabation with foreign researchers	All AI papers	Percentage of AI papers in collaboration with foreign researchers
Alibaba	2,379	2,732	87%
Tencent	1,287	3,083	42%
Baidu	631	1,460	43%
ByteDance	208	349	60%
Sensetime	117	256	46%
iFlytek	52	167	31%
MEGVII	40	168	24%
Yitu Technology	28	45	62%
Horizon Robotics	17	44	39%
CloudWalk Technology	4	11	36%

Source: CSET's Merged Academic Corpus