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CHINA'S MILITARY-CIVIL FUSION (MCF) STRATEGY: HOW THREATS AND THE GOVERNMENT LED THE DRIVE FOR TECHNOLOGICAL INNOVATION

by

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China's military-civil fusion (MCF) strategy has played a key role in modernizing China's economy and military from the Deng Xiaoping to Xi Jinping eras and is now being relied on even more with achieving China's national rejuvenation of establishing a fully developed country with a world-class military by 2049. This thesis seeks to examine the underlying factors driving China's MCF strategy. This research concluded that China's MCF strategy was highly reinforced by China's geostrategic security concerns, state-directed industrial policy, and foreign technology transfers. Deng's and Hu Jintao's relatively benign threat assessments allowed them to focus more on legacy domestic policies that made China prosperous, while Jiang Zemin and Xi, on the other hand, faced multiple security pressures, which drove them to seek dual-use technologies from the high-tech private sector for military applications. This thesis also conducted a case study on China's artificial intelligence (AI) development strategy, which revealed that China's AI strategy was also driven in large part by geostrategic concerns. However, an equal driving force was China's local governments as they competed against other cities in the hopes of constructing advanced cities filled with high-tech enterprises and savvy entrepreneurs.

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ABSTRACT

China's military-civil fusion (MCF) strategy has played a key role in modernizing China's economy and military from the Deng Xiaoping to Xi Jinping eras and is now being relied on even more with achieving China's national rejuvenation of establishing a fully developed country with a world-class military by 2049. This thesis seeks to examine the underlying factors driving China's MCF strategy. This research concluded that China's MCF strategy was highly reinforced by China's geostrategic security concerns, state-directed industrial policy, and foreign technology transfers. Deng's and Hu Jintao's relatively benign threat assessments allowed them to focus more on legacy domestic policies that made China prosperous, while Jiang Zemin and Xi, on the other hand, faced multiple security pressures, which drove them to seek dual-use technologies from the high-tech private sector for military applications. This thesis also conducted a case study on China's artificial intelligence (AI) development strategy, which revealed that China's AI strategy was also driven in large part by geostrategic concerns. However, an equal driving force was China's local governments as they competed against other cities in the hopes of constructing advanced cities filled with high-tech enterprises and savvy entrepreneurs.

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LIST OF ACRONYMS AND ABBREVIATIONS

AI	Artificial Intelligence
AIDP	Artificial Intelligence Development Plan
AIIA	Artificial Intelligence Industry Alliances
CCP	Chinese Communist Party
CMC	Central Military Commission
FYP	Five-Year Plan
GGF	Government Guidance Fund
GPC	Great Power Competition
IDAR	Introduce, Digest, Absorb, Re-Innovate
IP	Intellectual Property
JV	Joint Venture
MCF	Military-Civil Fusion
MIC 2025	Made in China 2025
MLP	Medium and Long-Term Plan for S&T Development
MNC	Multi-National Corporation
PLA	People's Liberation Army
R&D	Research and Development
RMB	Renminbi
S&T	Science and Technology
SOE	State-owned Enterprise

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I. INTRODUCTION

A. MAJOR RESEARCH QUESTION

China's Military-Civil Fusion (MCF) strategy has been credited with rapidly transforming China into becoming a global leader economically, technologically, and militarily over the past four decades. Theoretically, MCF is beneficial as it promotes the cross-pollination of resources, personnel, and know-how to flow seamlessly between the military and commercial sectors, thereby increasing efficiency and innovation. Previous Chinese leaders—Mao Zedong, Deng Xiaoping, Jiang Zemin, and Hu Jintao—have promoted MCF to boost military and economic modernization. China's current President and General Secretary of the Chinese Communist Party (CCP), Xi Jinping, recognized MCF's importance towards achieving China's dream of national rejuvenation, and has elevated MCF into China's upper echelons of national strategies such as Made in China 2025 (MIC 2025), the 2017 New Generation Artificial Intelligence Development Plan (AIDP), and the People's Liberation Army's (PLA) modernization plans to become a world-class military by 2049.[1]

China's MCF strategy has garnered a lot of attention from observers around the world as its economy and military have rapidly surpassed other advanced industrialized nations. From Deng's Reform and Opening in 1978 to 2013, China's economy grew from accounting for 1% of global trade, to surpassing the United States (U.S.) as the world's largest trading nation.[2] China's sustained, rapid economic growth was a welcome contribution to the global economy as many of the world's top multinational corporations (MNCs) exported most of their factories onto Chinese soil. However, what has caught the world off guard was China's military rise, where the PLA leapfrogged decades of research and innovation, and caught up with West, and in many ways superseded it with new

[1] Richard A. Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," *Asia Policy* 16, no. 1 (January 2021): 12–22.

[2] Mark Wu, "The 'China, Inc.' Challenge to Global Trade Governance," *Harvard International Law Journal* 57, no.2 (Spring 2016): 261–62, https://harvardilj.org/wp-content/uploads/sites/15/HLI210_crop.pdf.

weapons systems and equipment. Now that China has caught the world's attention, political leaders as well as commercial enterprises have found it challenging to confront China's MCF strategy as it is difficult to decipher which activities are illicit and which are not.

The research question underpinning this thesis is: What were the main drivers of China's MCF strategy that has caused it to vastly enhance its economy and military? And secondly, how effective were those drivers in sustaining growth in both domains? This thesis will begin with a comparative analysis of MCF under China's leaders—beginning with Deng, Jiang, Hu, and culminating with Xi—to provide a more nuanced understanding about the various MCF drivers throughout the different eras of China's leadership. This thesis will primarily examine three prominent MCF drivers—geostrategic competition and security concerns, the role of state intervention and domestic policy, and the reliance of foreign technology transfer. In addition, a separate case study in the following chapter will examine China's Artificial Intelligence (AI) development strategy, to figure out whether or not the three selected drivers for MCF played a prominent role towards the growth of one of the fastest growing dual-use technologies.

B. RESEARCH SIGNIFICANCE

China's MCF strategy has accelerated the development of China's defense capabilities by absorbing dual-use technologies from China's commercial and private enterprises. China's MCF strategy is not only significant for policy makers and political leaders to consider, but also for civilian organizations such as businesses and universities. China's ability to attract and pilfer foreign-based dual-use technology has contributed in large part to China's economic dominance in global markets as well as its ability to project its national interests through enhanced defense capabilities. Evron's article, "China's MCF and Military Procurement," conveys how China's MCF strategy has caused global alarm, especially within the U.S's Defense of Department wherein it included China's MCF strategy for the first time in its 2019 annual report on China's military modernization.[3] Ding, during a 2017 U.S.-China Economic and Security Review Commission testimony,

[3] Yoram Evron, "China's Military-Civil Fusion and Military Procurement," *Asia Policy* 16, no.1 (January 2021): 41, https://doi.org/10.1353/asp.2021.0002.

asserts that China's pursuit of AI "will fundamentally alter the character of warfare, ultimately resulting in a transformation from today's 'informatized' ways of warfare to future 'intelligentized' warfare"—which refers to the implementation of autonomy, machine-learning, and AI with weapon systems.[4] Therefore, in order to maintain America's dominance in military affairs and ensure China does not leapfrog the West in the development of emerging technologies, the U.S. government and its allies will have to find ways to mitigate China's attempts at obtaining its intellectual property (IP) without stoking tensions.

Protecting American technology and IP needs to be taken seriously because if not, China has shown that it has been effective at procuring proprietary information through various means—cyber-attacks, commercial joint-ventures (JV), and academic talent programs—to leapfrog years of research and development (R&D) and challenge America both economically and militarily. In *China's Quest for Foreign Technology: Beyond Espionage,* Sutter reveals "that the total theft of U.S. IP and trade secrets accounts for between $225 billion and $600 billion a year," of which many suspect China accounts a large majority of.[5] In response, Washington cautioned companies like Microsoft and Google in collaborating with their China-based counterparts, even advocating for decoupling from them.[6] Other advanced industrialized nations have experienced similar problems wherein China's commercial enterprises pilfered indigenous innovations that were later found to be reverse engineered into other commercial or defense-related products. Washington fears that the stolen IP provided to the PLA—as promoted through China's MCF strategy—will chip away at American military preponderance and have further implications as Beijing projects its newfound power further beyond its borders.

[4] Jeffrey Ding, *Deciphering China's AI Dream* (Oxford, UK: Centre for the Governance of AI, 2018): 13, https://www.fhi.ox.ac.uk/wp-content/uploads/Deciphering_Chinas_AI-Dream.pdf.

[5] Karen Sutter, "Foreign Technology Transfer Through Commerce," in *China's Quest for Foreign Technology: Beyond Espionage* ed. William Hannas and Didi Kirsten Tatlow (New York: Routledge, 2021), loc 64 of 350, Kindle.

[6] Elsa B. Kania and Lorand Laskai, "Myths and Realities of China's Military-Civil Fusion Strategy," Center for New American Security (CNAS) Reports, last modified January 28, 2021, https://www.cnas.org/publications/reports/myths-and-realities-of-chinas-military-civil-fusion-strategy.

Ever since Xi came to power in 2012, Beijing's appetite to procure dual-use advanced technology from the United States has grown increasingly aggressive despite Beijing's repeated claims of its peaceful rise. Even though MCF existed under China's previous regimes, MCF has particularly garnered more support under Xi as he hopes to achieve his grand strategy of national rejuvenation.[7] Xi's major domestic policies such as the 13th and 14th Five-Year Plans (FYP), MIC 2025, the 2017 AIDP, have pushed China's commercial and defense industries to aggressively procure technical know-how from abroad.

China's MCF strategy linked its quest to become a Science and Technology (S&T) superpower with its desire to become a modern military that can fight and win wars. In addition to China's MCF strategy, advancement in its AI capabilities have big implications towards its commercial and defense posturing for the future. China's 2017 AIDP states that, "AI has become a new focus of international competition. AI is a strategic technology that will…enhance national competitiveness and protect national security."[8] AI is believed to provide military spin-off capabilities in aerospace, missile technology, space, unmanned vehicles, and surveillance, and as well as contribute towards smart city infrastructure apparatuses, automated driving, medical diagnosis, and voice recognition.[9] China's rapid development in these emerging technologies reveals China's growing capability to wean itself off of foreign technology transfers with the enhancement of indigenous innovation, and China's desire to use of technologies to project its power domestically and internationally.

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[7] Xinhua News Agency (translated by Etcetera Language Group, Inc), "Proposal of the Central Committee of the Chinese Communist Party on Drawing Up the 14th Five-Year Plan for national Economic and Social Development and Long-Range Objectives for 2030," Center for Security and Emerging Technology (CSET), Last modified December 7, 2020, 83, https://cset.georgetown.edu/wp-content/uploads/t0237_5th_Plenum_Proposal_EN-1.pdf

[8] New America (translated by Graham Webster, Rogier Creemers, Paulo Triolo, and Elsa Kania), "Full Translation: China's 'New Generation Artificial Intelligence Development Plan' (2017)" *New America,* last modified August 1, 2017, https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/

[9] Ding, *Deciphering China's AI Dream*, 21.

C. BACKGROUND AND LITERATURE REVIEW

Selected literature will examine academic debates on the role China's MCF strategy had under previous leaders from Deng Xiaoping to Xi Jinping towards the development of China's economy, military, and emerging technologies such as AI. AI was selected as a case study because it is an emerging technology that possesses dual-use capabilities in both the commercial and defense sectors. The following literature review will help answer major research questions mentioned in this thesis by highlighting key drivers of MCF and how the strategy has paid dividends towards China's overall economic and military growth. The first MCF driver examined will revolve around geostrategic concerns—namely China's threat assessment of its security environment; the second MCF driver observes China's state intervention—in the form state-directed industrial policy; and the third MCF driver features a more global trends in foreign cooperation—measuring China's reliance of foreign technology transfer, and attracting foreign talent.

1. Deng's MCF Agenda

China's MCF efforts under Deng Xiaoping (1978–1992) was guided by the mantra of "hiding its capabilities and bide its time," as he took advantage of the relatively benign security environment—achieved through rapprochement with both the United States and Japan in the 1970s—and focused on building China's economy.[10] Deng was responsible for shifting China away from the Mae era pursuit of expensive strategic and conventional weapons systems, towards a revitalization of S&T infrastructure that was ravaged during Mao's Cultural Revolution.[11] This restructuring of the economy saw the defense industry's civilian production grow from less than 10% in 1978, to account for around 80% by the late 1990s, where according to Bitzinger, China's defense industries produced "70% of all taxicabs, 20% of all cameras, and around 65% of all motorcycles" by the mid-1990s.[12]

[10] Avery Goldstein, "China's Grand Strategy under Xi Jinping: Reassurance, Reform, and Resistance," *International Security* 45, no. 1 (2020): 165, https://doi.org/10.1162/isec_a_00383.

[11] Yifei Sun, "China's National Innovation System in Transition," *Eurasian Geography and Economics* 43, no. 6 (May 2013): 480–81, https://doi.org/10.2747/1538-7216.43.6.476.

[12] Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 13–14; and Tai Ming Cheung, *Fortifying China: The Struggle to Build a Modern Defense Economy* (Ithaca: Cornell Press University, 2013), 6, Proquest.

Following along the lines of developing China's national economy, Deng launched his signature MCF policy, the 863 Program, which sought to promote R&D in strategic S&T fields such as aerospace, lasers, opto-electronics, semiconductors, and new materials for commercial applications—as opposed to technologies solely for military application as was under Mao Zedong.[13]

As China opened itself up to the global economy—accredited to Deng's 1978 Reform and Opening—it was followed by years of rapid economic growth as more attention was given towards economic growth and away from the Cold War military build up strategy. In guiding China towards industrialization, Deng downsized the PLA and reassigned approximately 50% to 66% of the defense industry to work in the commercial sectors.[14] However, even as Deng focused more of his attention towards liberalizing China's economy, he was still able to procure critical weapon systems and equipment from the United States as it acted as a buffer against the Soviet Union's expansion. Kania and Wood explains that beginning in 1981, the Reagan Administration engaged in extensive foreign military sales to China providing "avionics packages, anti-submarine warfare (ASW) torpedoes, and gas turbine engines that were used by the PLA Navy."[15] Due to normalized U.S.-China relations and lax export controls, China was also able to acquire dual-use technologies and manufacturing techniques that played key roles in growing its defense and commercial sectors.

2. Jiang's MCF Agenda

China under Jiang Zemin's leadership (1992-2002) faced a geostrategic environment different from Deng's, fueled by growing hostilities from the West and growing challenges in Cross Strait relations. Following the Tiananmen Massacre in 1989, the West imposed strict arms and technology embargoes causing Beijing to begin looking inwardly for indigenous production of advanced technologies and modern warfare

[13] Bitzinger, 14.

[14] Cheung, *Fortifying China,* 55.

[15] Elsa Kania and Peter Wood, "The People's Liberation Army and Foreign Technology," in *China's Quest for Foreign Technology: Beyond Espionage,* ed. William Hannas and Didi Kirsten Tatlow (New York: Routledge, 2021) loc 227 of 350, Kindle.

equipment.[16] In addition, Beijing witnessed U.S. military preponderance during the First Gulf War (1991), Bosnian War (1995), Taiwan Strait Crisis (1995), and Kosovo War (1999), which galvanized China's desire to modernize the PLA with advanced weaponry.[17] China's leaders in the late 1990s focused their efforts in forming China into a global technological power as they realized the valuable spin-off capabilities S&T—particularly strategic domains such as IT, space, and cyberspace—had towards military modernization.[18] This realization prompted PLA modernization efforts to shift from mechanized to informatized warfighting capabilities.

In the early 1990s, China's defense industry and PLA were inept and inefficient, in being able to confront its geostrategic concerns. Therefore, China's central government intervened in reforming China's defense and military industrial sector. In 1998, China's military and defense industrial sectors underwent significant reforms that created a more competitive and efficient system for weapons development and procurement. The one major reform was the separation of the PLA-run General Arms Department (GAD) from the Commission of Science, Technology, Industry for National Defense (COSTIND).[19] Jiang's reforms within the PLA's leadership—such as the separation of the GAD and CONSTIND—removed institutional barriers that had previously hindered China's military modernization efforts towards informatization.[20] According to McReynolds and Mulvenon, Jiang's emphasis on informatization "took on not only programmatic but political dimensions, with major implications for the distribution of power, financial

[16] Samir Abas, "China's Military Modernization: The Growth of Domestic Defense Industries," *The Journal of Defense and Security* 5, no. 2 (2015): 146, Proquest.

[17] Alex Stone, and Peter Wood, *China's Military-Civil Fusion Strategy: A View from Chinese Strategists,* China Aerospace Studies Institute (Montgomery, AL: CASI, 2020), 22, https://www.bluepathlabs.com/uploads/1/1/9/0/119002711/chinas_military_civil_fusion_strategy-_full_final.pdf.

[18] Ryan Fedasiuk, Jennifer Melot, and Ben Murphy, *Harnessed Lighting: How the Chinese Military is Adopting Artificial Intelligence* (Washington, DC: Center for Security and Emerging Technology (CSET) 2021), 4, https://cset.georgetown.edu/wp-content/uploads/CSET-Harnessed-Lightning.pdf.

[19] James Mulvenon and Rebecca Samm Tyroler-Cooper, "China's Defense Industry on the Path of Reform*,"* (Washington, DC: U.S.-China Economic and Security Review Commission (USCC), 2009, 9.

[20] Joe McReynolds and James Mulvenon, "The Role of Informatization in the People's Liberation Army Under Hu Jintao," in *Assessing the People's Liberation Army in the Hu Jintao Era,* ed. Roy Kamphausen, David Lai, and Travis Tanner (Carlisle, PA: U.S. Army War College Press, 2014), 225.

resources, and personnel within the PLA, including for force reductions that were resisted by elements of the PLA leadership."[21]

3. Hu's MCF Agenda

China under Hu Jintao (2002-2012) continued to emphasize military technology development, but to a larger scale with the announcement of "locate military potential in civilian capabilities, and Military-Civil Fusion"—于军于民 (Yujun Yumin) and 军民融合 (Junmin Ronghe)—during his 17th Central Party Congress report in 2007.[22] The transition from Jiang to Hu saw an even deeper fusion between civilian and military sectors as Hu capitalized on China's rapid economic growth in the early 2000s. China's overall geopolitical climate was mild compared to his predecessors, as the likelihood for conflict was low. This allowed China's commercial sector, especially in the S&T industries, to take advantage of the shifts in globalization and experience accelerated growth where 55% of China's gross domestic product (GDP) in 2010 consisted of foreign trade—accounting for both imports and exports.[23] Additionally, China's dramatic economic growth during this timeframe witnessed China surpass Japan as the world's largest trading partner in 2003, and become the fourth largest economy in 2005.[24] Due to Hu's increased integration of MCF, China's defense industry was able to capitalize on the vast resources—financial funding and highly educated talent pool—from the booming commercial sector.

Hu's industrial policies—National Medium- and Long-Term Program (MLP) for Science and Technology Development (2006–2020), 10th and 11th Five-Year Plans (FYP)—cultivated deeper integration between China's military, defense, commercial

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[21] McReynolds and Mulvenon, "The Role of Informatization in the People's Liberation Army Under Hu Jintao," 225–26.

[22] Stone and Wood, *China's Military-Civil Fusion Strategy,* 23; and Daniel Alderman, Lisa Crawford, Brian Lafferty, and Aaron Shraberg, "The Rise of Chinese Civil-Military Integration," in *Forging China's Military Might*, ed. Tai-Ming Cheung (Baltimore: Johns Hopkins University Press, 2014), loc. 109 of 295, Kindle.

[23] Daniel M. Hartnett, "The 'New Historic Missions': Reflections on Hu Jintao's Military Legacy," in *Assessing The People's Liberation Army in the Hu Jintao Era,* ed. Roy Kamphausen, David Lai, and Travis Tanner (Carlisle, PA: U.S. Army War College Press, 2014), 50.

[24] Jia Qingguo, "Close and More Balance: China-U.S. Relations in Transition," in *Rising China: Power and Reassurance,* ed. Ron Huisken (Canberra: The Australian National University Press, 2009), 26.

sectors.[25] These state-directed policies became a vital source of funding for S&T-related innovation projects. The 863 Program, under the Hu administration, was large recipient of government support, receiving 22 billion Renminbi (RMB), approximately four times the amount allocated from 1985 to 2000.[26] Along with this surge in state funding, the Hu era saw a growth of high-tech R&D laboratories, which were responsible for providing cutting-edge dual-use applications. By 2009 and 2010, China's government had created 218 state key laboratories and 232 state engineering technology research centers, which attracted 7.8 billion RMB in research funds, and employed 13,000 researchers and engineers working on over 20,000 research topics.[27] Hu's 11th FYP—from 2006 to 2010—encouraged its commercial enterprises to seek foreign technological know-how and repatriate it back home—also referred to as technology transfer.[28]

4. Xi's MCF Agenda

Just as Jiang's elevated threat perception intensified the development of strategic weapon systems, the same occurred under the Xi era (2012-present) with increased maritime and territorial disputes, along with U.S. rebalancing efforts in the Indo-Pacific.[29] In a reversal of Deng's "hiding capabilities and biding time" approach, China under Xi's leadership has pursued more aggressive foreign policies driven by China's national rejuvenation.[30] This grand strategy of national rejuvenation became central to Xi's domestic and foreign policies, wherein China wants to exert more of its influence in the international system reflective of its growing economic and military strength. Xi's attempts at reforming the existing international order culminated with the launching of his two most

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[25] Richard A Bitzinger and J.D. Kenneth Boutin, "China's Defense Industries: Change and Continuity," in *Rising China: Power and Reassurance,* ed. Ron Huisken (Canberra: The Australian National University Press, 2009), 135; and Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 16.

[26] Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 16–17.

[27] Alderman et al., "The Rise of Chinese Civil-Military Integration," loc. 119.

[28] Sutter, "Foreign Technology Transfer Through Commerce," loc 64.

[29] Tai-Ming Cheung, "Conclusions," in *Forging China's Military Might,* ed. Tai-Ming Cheung (Baltimore: Johns Hopkins University Press, 2014), loc. 275 of 295, Kindle.

[30] Aaron L. Friedberg, "The Sources of Chinese Conduct: Explaining Beijing's Assertiveness," *The Washington Quarterly* 37, no. 4 (January 2015): 143, https://doi.org/10.1080/0163660X.2014.1002160.

significant foreign policy projects—the Belt and Road Initiative (BRI) in 2013, and the Asian Infrastructure Investment Bank (AIIB) in 2016.[31]

On the domestic front, Xi elevated MCF to a national-level policy in 2015, and launched key initiatives such as MIC 2025 and the 2017 AIDP.[32] These domestic initiatives displayed Xi's strategy of implementing a whole-of-society approach that involved all branches of the PLA, defense SOEs, civilian research institutions, and commercial enterprises to promote indigenous innovation for military spin-on capabilities. While the formation of the BRI and AIIB were significant towards China's rejuvenation, further discussion about their roles within the framework of MCF are beyond the purview of this thesis, and their examples were meant to show the overarching themes of Xi's grand strategy. Xi's active participation in China's MCF strategy has had a profound impact in achieving national rejuvenation as China's commercial and defense sectors have modernized and been able to compete on the global stage.

In addition to his MCF initiatives, Xi also continued the legacy of other national strategic initiatives that began prior to his era—the 2006—2020 Medium- and Long-Term Defense Science & Technology Development Plan (MLP)—which was important in fostering innovative research at Chinese universities, and S&T parks since.[33] A deepening of MCF development withing civilian research parks and universities accelerated under Xi, whereby total government R&D expenditure grew by 350% between 2005 and 2015.[34] These investments in China's own indigenous R&D centers laid a foundation for Xi's aggressive future FYPs and MCF strategies. By 2016, Xi's 13th FYP—from 2016 to 2020—elevated MCF to be a part of the China's national strategy and influenced major military reforms. The improved synergistic relationship between the PLA, defense SOEs,

[31] Goldstein, "China's Grand Strategy under Xi Jinping," 182–87.

[32] Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 20; and Lorand Laskai, "Civil-Military Fusion: The Missing Link between China's Technological and Military Rise," Council on Foreign Relations, last modified January 29, 2018, https://www.cfr.org/blog/.

[33] Cheung, *Forging China's Military Might*, loc 4.

[34] Helena Legarda, and Meia Nouwens, "China's pursuit of advanced dual-use technologies," The International Institute for Strategic Studies, December 18, 2018, https://www.iiss.org/blogs/research-paper/2018/12/emerging-technology-dominance

commercial and civilian enterprises resulted in cost-effective and more efficient supply chains in procuring military equipment.

5. Xi's AI Agenda

When Google's intelligent computer, AlphaGo, beat two of the world's champions in a game called Go—against South Korea's Lee Sodel in 2016 and China's Ke Jie in 2017—it proved to be a turning point in CCP leadership's eyes of AI's potential dual-use capabilities on both the commercial and defense industries.[35] Hannas and Chang, point out that AI immediately became a national priority as China's State Council on November 29, 2016, released its *National Strategic Emerging Industry Development Project,* which included AI as a necessary technology for the "commercialization of neuromorphic computing chips, intelligent robots and intelligent application systems."[36] Within the following year, China invested additional financial and political support by sharply increasing the number of AI colleges and academic research institutions, and amended the 2017 National Science Technology Innovation Programs to include AI as one of the disciplines needed in order for China to reach its national development and modernization ambitions.[37]

More significantly in 2017, China's State Council issued a document titled "The New Generation AI Development Plan" (AIDP).[38] This plan signaled a national-level development plan for AI to eventually become the world's leader in AI by 2030.[39] In 2019, China's Ministry of Science and Technology (MOST) established 20 New Generation AI Innovation Development Experimental Zones, which acted as innovation

[35] Kai-Fu Lee, *AI Superpowers: China, Silicon Valley, and the New World Order* (New York: First Mariner Books, 2021), loc 8 of 354, Kindle.

[36] Hannas, and Huey-Meei Chang, "China's 'Artificial' Intelligence," in *China's Quest for Foreign Technology: Beyond Espionage,* ed. William Hannas and Didi Kirsten Tatlow (New York: Routledge, 2021) loc 187 of 350, Kindle.

[37] Hannas, and Chang, loc 188.

[38] Hannas, and Chang, loc 188.

[39] Hannas, and Chang, loc 189.

centers to recruit foreign experts, foster domestic talent, and convert S&T achievements into commercial products.[40]

a. Domestic Development Policy: Foreign Tech Transfer and JVs

Most major U.S. technology companies such as Microsoft, Apple, Google, and Amazon, have set up their AI R&D facilities in China, which have contributed to China's ability to access to foreign AI talent and resources. Microsoft stands out the most with its Microsoft Research Asia (MSRA) which hosts more than 200 scientists and 300 visiting scholars and students.[41] Additional Microsoft associated R&D centers built in China are: The National Engineering Laboratory for Brain-inspired Intelligence Technology and Application which was co-founded by China's tech firms Baidu and iFlytek; and Next Generation AI Open Research and Education Platform, which collaborates with some of China's most prestigious universities such as Beijing University.[42] Over the past two decades, these collaborative efforts have developed China's talent pool, as well as provided opportunities for them in entrepreneurial or academic pursuits.

China's military has been one of the main benefactors for MNCs conducting business in China. Hannas argues that China's Civil-Military Integration Department within the Ministry of Industry and Information Technology (MIIT), has encouraged China's defense SOEs to leverage its relationship with China's commercial sector in obtaining dual-use technologies. The close relationship between MCF affiliated state organizations and China's commercial and defense sectors indicate a clear motivation in technology transfer. According to Mulvenon and Zhang, the regulatory and commercial environment in China compels foreign companies to share their technology in JV type relationships.[43] This results in foreign companies becoming unwitting participants in the

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[40] Hannas, and Chang, loc 191.

[41] Hannas, and Chang, loc. 198.

[42] Hannas, and Chang, loc 198.

[43] James Mulvenon, and Chenny Zhang, "Targeting Defense Technologies," in *China's Quest for Foreign Technology: Beyond Espionage*, ed. William Hannas and Didi Kirsten Tatlow (New York: Routledge, 2021) loc. 96–97 of 350, Kindle.

transfer of technology, capital, and know-how to China's domestic companies that have links to the PLA.

b. AI and the Commercial Sector

In its efforts to catch up with the United States and eventually become a world leader in AI, China has encouraged JV deals wherein domestic companies sign business relationships with MNCs to obtain access to critical technologies. This type of activity has caught the attention of Western nations wherein 2017, the European Union (EU) implemented new screening measures of foreign direct investment in emerging technologies such as AI, robotics, and semiconductors, to protect its industries from China's predatory practices.[44]

Despite much of the rhetoric concluding that China has surpassed the United States in the commercial AI domain, Ding provides evidence that counters such dispositions. One of the many factors that can measure AI's development is the size of the commercial ecosystem—which is made up of the number of AI companies and total AI financing received. According to Ding's research, in 2017 there were a total of 2,542 AI companies in the world, 42% of which were U.S.-based, while China followed with 23%.[45] In the competition for access to the technology from AI start-ups, between 2012 to 2017, U.S. tech firms acquired 66 of the 79 total acquisitions during that time period, whereas China only acquired only three.[46]

c. AI and the Bureaucracy

A popular misconception about China's MCF strategy and its approach to AI is that the commercial and defense sectors adhere to the strict top-down structure from the central government. In fact, according to Ding, one notable trend that has taken place within China's AI landscape is that "bureaucratic agencies have begun to compete for authority over AI policy, a trend highlighted by the fact that the State Council has tasked 15 offices

[44] Ding, *Deciphering China's AI Dream*, 17.

[45] Ding, 27.

[46] Ding, 27.

with implementing their AI plan."[47] Ding also relayed that commercial enterprises, such as China's largest technology companies—Alibaba, Baidu, Tencent, and Huawei—have shown to sidestep such bureaucratic top-down controls and instead used market forces in guiding their decisions of how and when to recruit foreign talent. Kania expresses concern that despite the CCP's and PLA's commitment towards developing emerging technologies, their top-down approach and high degree of centralized power—which is typically characteristic of authoritarian regimes—could impede the ability to innovate.[48] Mulvenon and Zhang on the other hand highlight that the close symbiotic relationship between the commercial and defense sectors allows for "the defense sector to leverage spin-on benefits from synergies with the commercial sector."[49]

d. Foreign Cooperation: Recruiting Overseas Talent

Not only has China's domestic policies played a vital role for AI's development, but access to foreign AI resources—such as U.S. universities and corporations—has proven highly beneficial as well. China's state-sponsored activities to exploit the collaboration between China's domestic AI enterprises and foreign-based AI entities, has put international researchers and institutions at risk of being unwitting contributors towards China's MCF strategy. China's 2017 AIDP encourages foreign talent programs—such as the Thousand Talents Plan—to foster relationships with leading overseas AI universities and research institutes, as well as welcomes foreign experts to set up R&D centers in China.[50] The growth in talent program participants and domestic innovation centers has increased dramatically. Overseas participants in China's talent programs—Thousand Talents, Changjiang Scholars, Chunhui Plan—have largely been selected from the United States and Europe, whereby more than 100 program participants have been identified as

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[47] Ding, 10.

[48] Elsa B. Kania, "Artificial Intelligence in China's Revolution in Military Affairs," *Journal of Strategic Studies* 44, no. 4 (May 2021): 536, https://doi.org/10.1080/01402390.2021.1894136.

[49] Mulvenon and Zhang, "Targeting Defense Technologies," 96.

[50] Hannas, and Chang, "China's Artificial Intelligence," loc 189.

U.S. government employees, some of whom held security clearances, while others held dual positions at U.S.-based and Chinese universities.[51]

China has placed a high priority in being able to attract and recruit high-end AI talent through its scholarship programs. However, China's efforts to attract foreign talent has not had the results as expected. Ding observes that "multiple empirical studies and interviews with recruiters for the talent programs [reveals] that these programs have not managed to attract the 'best and brightest' Chinese scientists to return."[52] Factors that prevent overseas Chinese nationals from returning back to China are: a research-culture that prioritizes quick results over quality, a lack of understanding towards China's work culture, and the lack of opportunities in China to meet their children's needs.[53] However, China has experienced some success in attracting AI-talent in the commercial industry. China's top AI companies—Baidu, Alibaba, and Tencent—now offer salaries that range up to 70%-150% of what is offered in America.[54]

In addition to offering above average salaries, China has also established its own AI research institutes located at America's technology hubs—namely Silicon Valley, Los Angeles, and Boston—as well as sent head-hunters targeting international scholars and engineers at universities worldwide to convince them to return back to China. Despite China producing more Science, Technology, Engineering, Math (STEM) degrees graduates than the United States, the U.S's AI talent pool dwarfs that of China's in terms of quantity and quality, wherein the United States has over 78,000 AI researchers, half of which have more than 10 years of work experience, while China has half the amount of AI researchers, 25% of which have more than 10 years of work experience in the field.[55] This talent deficit drives both the Chinese government and commercial enterprises to recruit and attract overseas talent.

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[51] Hannas, and Chang, loc 193.

[52] Ding, *Deciphering China's AI Dream,* 20.

[53] Ding, 20.

[54] Ding, 20.

[55] Ding, 26.

e. China Trails the United States

Hannas and Chang acknowledge that even though China has made vast investments in attracting foreign talent and building its own indigenous innovation research centers, it still falls in comparison to the United States. Hannas and Chang's research on China's AI environment reveals that China still lags in the theory and mathematics that support AI. According to a former head of the Chinese Academy of Engineering (CAE), "the cornerstone of artificial intelligence is mathematics, and the key element is algorithms. But China's investment in this field is far behind the United States."[56] Although some Chinese officials acknowledge this sentiment, most in China and internationally believe that China will overtake the United States in AI capabilities in five to ten years.[57]

Ding offers a pessimistic view of China's AI development, one that is hindered by the limited access to the global supply chain of semiconductors, and relies on state-directed theft of IP.[58] Despite China in 2014 surpassing the United States in terms of volume of AI research—which is measured by AI patent registrations and articles on deep learning—China still lags behind the United States and United Kingdom in AI research.[59] China's AI Potential Index (AIPI)—an assessment used to measure a country's overall AI capabilities as a proportion of the global total showing a score between 0 and 100—score was 17, which was about half of the U.S.'s AIPI score of 33.[60]

f. GPC and AI

According to Kania, China's impetus to become a world leader in AI is directly related to its rising external threats such as the U.S.-China strategic competition and other contentious regional security dilemmas. In response to these security threats and under the direction of Xi, the PLA has shifted away from informatized warfare towards intelligentized warfare, by leveraging the rapid advances in newly emerging technologies

56 Hannas, and Chang, "China's Artificial Intelligence," loc 200.

57 Hannas, and Chang, loc 200.

58 Ding, *Deciphering China's AI Dream,* 24–25.

59 Ding, 26.

60 Ding, 5.

such as AI.[61] This concept fully materialized in China's 2017 AIDP, which labelled AI as a core priority in strengthening military applications, such as command decision-making, military deductions (e.g., wargaming), and defense equipment.[62]

China's installment of the Strategic Support Force (SSF) in 2015, coupled with the PLA's Academy of Military Science (AMS) prioritization of S&T development in 2018, were clear indicators of China's commitment of integrating the PLA's defense capabilities with emerging technologies and technological innovation.[63] Chinese military officials believe that AI and other emerging technologies are critical to winning future wars, wherein AI capabilities would be able to assist in "remote, precise, miniaturized, large-scale unmanned attacks."[64] In addition to warfighting capabilities, AI is believed to also contribute to the cognitive and information domains by assisting in command decision-making, as well as providing intelligentized logistic support, education, and training.[65]

D. POTENTIAL EXPLANATIONS AND HYPOTHESES

Analysis of the Deng era revealed that after the reform and opening of China in 1978, Deng favored a MCF strategy that focused on economic growth by liberalizing China's markets and exposing it to foreign competition. Therefore, economic development became the main driver of China's MCF policies, as Deng launched programs to kick start development in the S&T industry. Deng's Four Modernizations also highlighted his emphasis on developing the economy as modernizing the industrial base was prioritized ahead of agriculture, technology, and national defense.[66]

The Jiang era implemented a MCF strategy geared towards military modernization and attracting overseas talent. China's geostrategic security issues such as the Taiwan Strait

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[61] Kania, "Artificial Intelligence in China's Revolution in Military Affairs," 522 -24.

[62] Kania, 525.

[63] Kania, 526–27.

[64] Kania, 533.

[65] Kania, 534.

[66] Nan Li, introduction to *Chinese Civil-Military Relations: The Transformation of the People's Liberation Army*, ed. Nan Li (New York: Routledge, 2006), 1.

Crisis of 1995–96, and the accidental U.S. bombing of the Chinese embassy in Belgrade drove the CCP to seek technological advancement within its security and military apparatuses. Due to China's technological and military lag, Jiang began a strong push for attracting and developing China's talent base. In 1994, Jiang oversaw the creation of Overseas Chinese Scholar (OCS) returnee parks, where ideas and innovation obtained by Chinese scientists could return back to China and used towards modernizing China's backward commercial sector.[67] However, despite China's S&T base needing foreign experts and foreign technology transfer to drive innovation, China's constant facing of geostrategic concerns drive Jiang to integrate an even greater relationship between the defense and commercial sectors.

China's economy during the Hu era, experienced an average annual growth rate that superseded his predecessors, which allowed him to focus on a MCF strategy geared more towards economic development. Despite not facing many serious external security threats, American military dominance in the Middle East most likely convinced Hu of the importance of developing military capabilities that could capitalize on information technology (IT). In 2003, Hu emphasized the importance of developing both foreign and domestic talent resources, "paying equal attention to the independent cultivation and development of talent and to the introduction of overseas talent."[68] This may have signaled Hu's MCF efforts to acquire foreign technology transfers. However, Hu's Outline for the National Medium and Long-term Talent Development Plan (2010-2020) also signaled the importance of developing China's domestic talent pool, rather than solely focusing on the procurement of high tech hardware and equipment.[69]

One of the main drivers for China's MCF strategy is its growing external threat environment, as defined in Great Power Competition (GPC). According to Lafferty, "the many U.S. military engagements since 1991 have only reinforced for Chinese strategist

[67] Hannas and Chang, "Chinese Technology Transfer," loc 5.

[68] Hannas and Chang, loc 13.

[69] Jeffrey Stoff, "China's Talent Programs," in *China's Quest for Foreign Technology: Beyond Espionage,* ed. William Hannas and Didi Kirsten Tatlow (New York: Routledge, 2021) loc 40 of 350, Kindle.

that modern warfare has transitioned from the mechanized warfare to the informatized warfare."[70] China's negative threat assessment has caused it to explore incorporating dual-use technologies, such as AI, to enhance its economy and security apparatus. Since Xi came to power, MCF has played an even larger role in building China into an economic, technological, and military superpower. Xi's emphasis on MCF potentially was predicated on the growing trend of unstable domestic and external security dilemmas. However, Xi remained popular within the CCP and PLA, more so than his predecessors, which may have been an important factor in pushing through policies, such as the BRI, MIC 2025, 2017 AIDP and the like.

E. RESEARCH DESIGN

This thesis is divided into 3 chapters. The second chapter, which contains the bulk of the thesis, examines the drivers of China's MCF strategy under Deng, Jiang, Hu, and Xi, and its impact on China's economic and military development. This chapter will look into both the internal and external factors that significantly impacted and directed the course of China's MCF strategy. Government spending, state-directed industrial policy, and significant military and commercial developments will be highlighted in this chapter for each Chinese administration.

Chapter 1 will provide a summary of MCF and why it is a significant topic for research. This portion will also explain why this topic is important to both China and the United States, provide overview of scholarly literature, and lay out plan for answering research question. Some of the questions considered will be:

Chapter 2 will examine MCF's drivers of under China's different leaders from Deng Xiaoping to Xi Jinping. The varying hypotheses such as the role of state-directed policies, acquiring foreign technology transfers, and geostrategic security concerns will be analyzed as to whether they had a significant role towards influencing China's MCF strategy.

[70] Brian Lafferty, "Civil-Military Integration and PLA Reforms," in *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms,* ed. Phillip C. Saunders, Arthur S. Ding, Andrew Scobell, Andrew N.D. Yang, and Joel Wuthnow (Washington, D.C.: National Defense University Press, 2019), 629, https://ndupress.ndu.edu/Portals/68/Documents/Books/Chairman-Xi/Chairman-Xi.pdf.

Chapter 3 will also examine the drivers for China's AI development plans. AI was chosen as a case study because it is considered as one of the emerging technologies that had dual-use capabilities in both the defense and commercial sectors. In addition, both China's MCF and AI policies were elevated to national importance after Xi came to power. This case study will investigate whether or not China's MCF and AI strategies took on similar pathways towards development. It will be important to see if China's AI policy was influenced by the same drives as China's MCF strategy, and whether or not China uses the same mechanisms towards developing this emerging technology.

Chapter 4 will provide a summary of findings, the weaknesses of China's MCF strategy, and policy recommendations for the United States in how to confront China's MCF-related activities.

For sources, this thesis will draw upon a variety of academic journals, translated Chinese government policy papers, and analysis provided by varying Western China-focused think tanks. These sources of information will be used to extract data points from previous Chinese administrations to provide a comparative analysis with the current Chinese administration on MCF policy. Many of the academic journals and literature will focus on the progress of China's military modernization, developments within China's commercial industry that have military applications, and China's response to geostrategic threats stemming from the United States, and within the Asia region. Likewise, these documents sources will examine the effectiveness of China's MCF strategy on the development of AI.

II. CHINA'S MCF STRATEGY

China's economic growth has been impressive since its Reform and Opening Policy began in 1978, boasting an annual growth rate of around 10% from 1979 to 2010, and a GDP expanding from $191 billion in 1980 to $14 trillion by 2020.[71] In 1980, China was barely a contributor to the global economy, making up only 1% of global GDP, however by 2010, it grew to 9.1%.[72] What shocked observers even more was that China before the turn of the 21st century China's was known as the manufacturer of low-end and labor-intensive products, however by 2010, China moved up the value-added supply chain and supplanted Germany as the largest exporter of manufactured goods and replaced Japan as the world's second largest economy.[73] China's military modernization has been even more impressive, where it has achieved a worrying level of technological advancement on par with the West, where its defense industrial base fielded its first indigenously designed stealth jet fighter, the J-20, in 2018, operationalized hypersonic weapons in 2020, and produced its first indigenously designed aircraft carrier, the Fujian, in 2022.[74] What enabled China to simultaneously develop its economy and modernize its military to a level where it has leapfrogged ahead of other Western economies and militaries? The answer that many observers point to is the implementation of China's MCF strategy.

If China's MCF strategy played a leading role into China's economic development and military modernization, then what were the drivers that led to its implementation? Did all the MCF drivers play an equitable role during China's industrialization under China's various leaders? Did those MCF drivers achieve the same positive results? This chapter

71 World Bank GDP (current US$ China and United States; accessed July 29, 2022), https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=CN-US; and Alvin Y. So and Yin-wah Chu, *The Global Rise of China (*Malden, MA: Polity Press, 2016) loc. 406 of 6236, Kindle.

72 So and Chu, *The Global Rise of China*, loc. 393.

73 So and Chu, 420.

74 Patrick M. Cronin, "The Significance of China's Fujian Aircraft Carrier," The Hudson Institute, last modified July 5, 2022, https://www.hudson.org/research/17936-the-significance-of-china-s-fujian-aircraft-carrier; China Power Team, "Does China's J-20 Rival Other Stealth Fighters?" China Power, last modified August 26, 2020, https://chinapower.csis.org/china-chengdu-j-20/; and "Hypersonic Weapon Basics," Missile Defense Advocacy Alliance (MDAA), last modified May 30, 2018, https://missiledefenseadvocacy.org/missile-threat-and-proliferation/missile-basics/hypersonic-missiles/.

will argue that the main drivers for MCF's strategic implementation during the post-Mao era were impacted, in large part, by the Chinese leaders' threat assessments of their security environment. Equally as important, but highly dependent upon the first driver, was China's central government. The degree of China's state support was the second most important driver as it played a vital role implementing favorable industrial policies and state funding mechanisms that stimulated S&T innovation in both the defense and commercial industrial bases. And lastly, China's acquisition for foreign technology transfers via talent programs, commercial JVs, and civilian research labs was an enduring factor that inherently drove China towards achieving indigenous innovation and a high level of self-sufficiency.[75] These three drivers culminated under the Xi era and was able to intensify MCF efforts due to China's already modernized defense and commercial industrial base. However, the strongest driver that drove MCF efforts throughout the post-Mao era was the overarching geostrategic concerns, causing the defense and military sectors to increasingly rely upon the civilian and commercial sectors to help them modernize.

China's post-Mao leaders—Deng Xiaoping, Jiang Zemin, Hu Jintao, and Xi Jinping—were faced with the challenges of being undeveloped and left behind, and displayed a strong sense of urgency in implementing a MCF strategy that would integrate the S&T talent and resources of the fast growing civilian and commercial sectors with the personnel and equipment from the defense industrial sector. Now, two decades into the 21st century, China has become America's chief strategic competitor in the global arena on both the economic and military fronts, spearheaded by some of the China's leading technology companies such as Baidu, Alibaba, Tencent, and Huawei—a group of China's most successful high-tech companies known as China's national champions—and a modernized PLA.[76] China's ability to tap into the technical know-how and financial resources of the commercial sectors, and integrate it with the PLA, has allowed China's

[75] Marcel Angliviel et al., *Open Arms: Evaluating Global Exposure to China's Defense-Industrial Base (*Washington, DC: Center for Advanced Defense (C4ADS), 2019), 3, https://static1.squarespace.com/static/566ef8b4d8af107232d5358a/t/5d95fb48a0bfc672d825e346/1570110297719/Open+Arms.pdf.

[76] Evan Medeiros, Roger Cliff, Keith Crane, and James Mulvenon, *A New Direction for China's Defense Industry (*Santa Monica, CA: RAND Corporation, 2005), 215–18.

defense industrial base to create asymmetric cutting-edge technologies capable of altering the balance of power in the region.

This chapter will provide a nuanced overview of each post-Mao leaders' MCF drivers—geostrategic concerns, state intervention and domestic policies, and the dependency on foreign technology transfers—highlighting which policies, programs, and strategies were effective towards China's dual goals of economic development and military modernization. China's geostrategic concerns provided the overall driving impetus that galvanized a strict top-down state planning system that implemented policies favoring the cultivation of domestic talent as well as the procurement of foreign technology transfers with the goal of becoming increasingly self-sufficient in the production of strategic emerging technologies.

A. DENG'S DRIVER #1: GEOSTRATEGIC CONCERNS

The guiding terminology used during the Deng era to promote MCF was "Junmin Jiehe" (军民结合)—Civil-Military Integration—to emphasize the conversion of the defense industries towards civilian production as China's threat assessment abated and economic reforms took the forefront.[77] China under Deng was not faced with the same security dilemmas as Mao, and therefore switched from having a confrontational Cold War mentality to a policy of engagement. This significantly diminished China's pursuit of strategic high-tech weaponry. According to Feigenbaum, "after rapprochement with the United States and Japan in the early 1970s, China cleared away two potential threats while checking Soviet pressure through new strategic partnerships."[78] National defense was still a priority, but due to China's relatively benign geostrategic environment, national defense

[77] Alex Stone, "Military-Civil Fusion Terminology: A Reference Guide," China Aerospace Studies Institute (CASI), last modified February 2021, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/CASI%20Articles/2021-03-15%20MCF%20Lexicon.pdf?ver=ERteHVCsjK2IBa6__DAldw%3d%3d; and Alderman et al., "The Rise of Chinese Civil-Military Integration," loc. 110.

[78] Evan Feigenbaum, "Who's Behind China's High-Technology 'Revolution'?: How Bomb Makers Remade Beijing's Priorities, Policies, and Institutions," *International Security* 24, no. 1 (Summer 1999): 98–99, https://www.jstor.org./stable/2539349.

was demoted to the last rung in Deng's 1978 "Four Modernizations," prioritized below the industrial, agricultural, and S&T sectors.[79]

Acquiring high-end dual-use technologies from the West followed under Deng's 1982 frequently quoted 16-character mantra of "civil-military integration, peacetime and wartime integration, give priority to military products, using the civil support the military" (军民结合，平战结合，以军为主，以民养军).[80] This concept of peacetime war preparation—"peacetime and wartime integration" (平战结合)—did not mean to halt all military development, but rather to continue modernizing the military even when not faced with external threats. While the focus of Deng's Reform and Opening strategy focused on transitioning the defense industry to civilian production, China's defense industry was actively receiving arm sales from the United States.

Although China's security environment was relatively peaceful during the early years of Deng's rule, it benefited greatly from the U.S.-Soviet standoff. In the 1980s, U.S. technology transfers as well as military sales increased extensively between the United States and China, as the Reagan administration looked for a counterbalance to the Soviet Union.[81] The growing U.S.-China relationship played a critical role in establishing China's commercial industrial base with the co-production of the McDonnell Douglas MD-82 and MD-90 passenger jets, along with various other sub-components being sourced from foreign companies such as Boeing, Airbus, Sikorsky, Pratt & Whitney, and Bombardier.[82] Pollack asserts that by 1987, foreign military sales from the United States included programs such as "avionics packages for Chinese combat aircraft, sales of anti-submarine warfare torpedoes and gas turbine engines for the Chinese navy (the latter still in use on

[79] Nicholas M. Trebat and Carlos Aguiar De Medeiros, "Military Modernization in Chinese Technical Progress and Industrial Innovation," *Review of Political Economy* 26, no. 2 (Routledge, 2014), 303–324, http://dx.doi.org/10.1080/09538259.2014.890461.

[80] Daniel Alderman, "An Introduction to China's Strategic Military-Civilian Fusion," in *China's Evolving Military Strategy*, ed. Joe McReynolds (Washington, DC: Brookings Institution Press, 2016), loc. 5305–09 of 7444, Kindle.

[81] Kania, and Wood, "The People's Liberation Army and Foreign Technology," loc. 227.

[82] Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 13.

Chinese destroyers), sales of artillery-locating radar and the upgrading of artillery production capabilities."[83]

B. DENG'S DRIVER #2: STATE INTERVENTION AND DOMESTIC POLICIES

Deng's most significant industrial policy was his shift of focus from the defense industries development of strategic weapon systems to commercial production. In the early 1980s, the defense sector's S&T capabilities were more advanced than the private sector, and Deng wanted to leverage those strengths by integrating the defense state-owned enterprises (SOE) into the civilian economy. In reference to Figure 1*, Civilian Production from China's Defense Sector*, the defense industry's conversion away from military-related production towards civilian production continued into the Jiang-era where according to statistics, by the early 1990s, around 80% of the production output value of the defense industry were civilian goods, compared to less than 10% in 1978.[84]

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[83] Jonathan D. Pollack, "The Cox Report's 'Dirty Little Secret'," Arms Control Association, last modified July 1, 2020, https://www.armscontrol.org/act/1999-04/cox-reports-dirty-little-secret.

[84] Cheung, *Fortifying China*, 54.

Table 3.2. Changing ratios of military-civilian production in the Chinese defense economy, 1978–1997

Year	*Military production as a percentage of total annual output of the defense economy*	*Civilian production as a percentage of total annual output of the defense economy*
1978	92%	8%
1979	84	16
1980	78	22
1981	72	22
1982	66	34
1983	60	40
1984	54	46
1985	48	52
1986	38	62
1987	37	63
1988	28	72
1989	26	74
1990	26	74
1991	23	77
1992	20	80
1993	19	81
1994	15.5	84.5
1995	17	83
1996	15.5	84.5
1997	15.5	84.5

Source: Zhongguo Junzhuanmin Dashiji Bianxiezu [Chronicle of China's Defense Conversion Editorial Writing Group], *Zhongguo Junzhuanmin Dashiji, 1978–1998* [Chronicle of China's Defense Conversion, 1978–1998] (Beijing: Guofang Gongye Chubanshe, 1999), 206.

Figure 1. Civilian Production from China's Defense Sector[85]

Even though Deng's economic reforms boosted economic output, his efforts to revitalize the S&T sector was not as successful. Knowing that S&T innovation will help drive productivity and economic growth, Deng in 1985, initiated large-scale S&T reform with the release of one of his most important memorandums on S&T, the "Decision on Reforms of the Science and Technology System."[86] The purpose of this S&T reform was to integrate China's private sector R&D labs with the industrial sector in hopes of allowing the technology market drive innovation, and force the R&D labs to become less reliant on government funding. However, Sun points out that, "the technology market approach failed to achieve the expected results. As late as 1999, two decades after the reforms began, the

85 Source: In Cheung, *Fortifying China*, 76.

86 Sun, "China's National Innovation System in Transition," 481.

government still provided 62.9% of the funding for governmental laboratories and 47.5% of that for universities."[87] Many factors contributed towards this failure in trying to stand up the S&T sector, one of which was because of the technology gap within China's R&D infrastructure that was not able to produce the quality and type of technologies that the commercial sectors needed. In order to ameliorate the failures of his initial economic reforms, Deng launched the National High-Tech Development Plan—more famously known as the 863 Program.

Launched in 1986, the 863 Program was a long-term plan to invest in the R&D of seven emerging technologies such as biotechnology, IT, aerospace, lasers, automation technology, energy technology, and new materials.[88] Following along the lines of Deng's focus on the civilian economy, the 863 Program's R&D projects focused on commercial applications, as opposed to overly favoring military development. One of the main reasons why the 863 Program was successful, as opposed to previous attempts at revitalizing the S&T sector, was due in large part of the program's shift away from a consignment system to a bidding system in determining who receives funding. Sun asserts that "competition was introduced into the process, in sharp contrast to the previous [approaches] which allocated research funding according to the number of employees in the institutes."[89]

Even though the Reagan administration's Strategic Defense Initiative was meant as a deterrent against nuclear war with the Soviet Union, it inadvertently galvanized China to invest more into its civilian and defense aerospace and space capabilities.[90] Although it did not come to fruition until 2003, China's space program was initiated in large part by the 863 Program in hopes developing a dual-use technology not only capable of projecting its political, economic, and military power, but also to compete with the Soviets and United

[87] Sun, 482.

[88] William C. Hannas, James Mulvenon, and Anna B. Puglisi, "China's History of Relying on Western Technology," in *Chinese Industrial Espionage: Technology Acquisition and Military Modernization* (New York: Routledge, 2013) loc. 12 of 297, Kindle.

[89] Sun, "China's National Innovation System in Transition," 483.

[90] James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests, 3rd Ed. (*California: Stanford University Press, 2019) loc. 176 of 388, Kindle; and Trebat and Aguiar De Medeiros, "Military Modernization in Chinese Technical Progress and Industrial Innovation," 307–308.

States who had already built their space stations.[91] Another one of the 863 Program's successful byproducts was the computer-integrated manufacturing system (CIMS) project, which was designed to overcome production delays when manufacturing weapons systems.[92] Trebat and Aguiar de Medeiros asserts that China's Chengdu Aircraft Corp's (CAC) FC-1 fighter jet "depended on 863 funds promoting research into the military application of computer-aided design and computer aided manufacturing. This research reduced the research and design period by 50%."[93]

C. DENG'S DRIVER #3: FOREIGN TECH TRANSFER

During the Deng era, China was heavily reliant upon international trade as it was trying to recover from the devasting Mao era isolationist policies of the Cultural Revolution. Deng wanted to obtain technologies from the West in order to gain the technical capabilities that would boost commercial production. Cheung points out that the PLA in the 1980s and 1990s became acutely aware of the low-grade quality of its domestic arms production and became increasingly reliant upon Russia and other militarily advanced countries to provide the necessary weapons systems.[94] The end of the Cold War opened up arm sales which allowed China to make two key naval purchases—Russia's sale of Sovremenny destroyers and Kilo SSKs—that not only boosted China's defense S&T capabilities, but also provided a framework of how to design future naval innovations."[95] The collapse of the Soviet Union was a pivotal event as it provided China access to the former Soviet bloc's defense industrial facilities and recruitment of their scientists and

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[91] Kevin Pollpeter, "Organization as Innovation: Instilling a Quality Management System in China's Human Spaceflight Program," in *Forging China's Military Might,* ed. Tai-Ming Cheung (Baltimore: Johns Hopkins University Press, 2014), loc. 223 of 295, Kindle.

[92] Cheung, *Fortifying China,* 162.

[93] Trebat and Aguiar De Medeiros, "Military Modernization in Chinese Technical Progress and Industrial Innovation," 318.

[94] Cheung, *Fortifying China*, 169.

[95] Richard A. Bitzinger, Michael Raska, Collin Koh Swee Lean, and Kelvin Wong Ka Weng, "Locating China's Place in the Global Defense Economy," in *Forging China's Military Might,* ed. Tai-Ming Cheung (Baltimore: Johns Hopkins University Press, 2014), loc. 181 of 295, Kindle.

engineers.[96] According to Bitzinger and Boutin, most of the Deng era technology transfers from Russia did not fully come to fruition until the end of the Jiang era, when in 2000, China began "construction of at least of at least six new destroyers, seven frigates and eight diesel-powered submarines."[97]

In addition to receiving technology transfers from Russia, China's defense industrial base was also the recipient of technology transfers from the United States as the Reagan administration sought to find a partner against the Soviet Union starting in 1981.[98] According to Kania and Wood, arms sales to China during the early 1980s included, "avionics packages, anti-submarine warfare (ASW) torpedoes, and gas turbine engines."[99] More importantly, the increase of exchanges during the Reagan administration with China's defense industrial base included the collaboration in the largest bilateral aviation project where McDonnell-Douglas defense contractors provided the technological support and training to its Chinese counterparts in co-producing the MD-82.[100]

Another key part of Deng's Reform and Opening policy was the promotion of academic exchange. Deng's push to increase the number of its domestic talent to study at advanced Western countries, particularly the United States, was based on the premise of developing a S&T workforce capable of contributing towards China's modernization efforts. Hannas, Mulvenon, and Puglisi point out that from the start of Deng's era to the end of Hu's, "more than 2.24 million Chinese have studied overseas for advanced degrees…and 818,400, or more than one-third, have returned to China after completing their studies."[101] The United States became the most popular destination of Chinese college and graduate students, wherein an overwhelming majority from 1978 to 1984,

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96 Tai-Ming Cheung, *Innovate to Dominate: The Rise of the Chinese Techno-Security State* (Ithaca: Cornell University Press, 2022), loc. 218 of 400, Kindle.

97 Bitzinger and Boutin, "China's Defense Industries," 139.

98 Pollack, "The Cox Report's 'Dirty Little Secret'."

99 Kania and Wood, "The People's Liberation Army and Foreign Technology," loc. 227.

100 Pollack, "The Cox Report's 'Dirty Little Secret'."

101 William C. Hannas, James Mulvenon, and Anna B. Puglisi, "Chinese Foreign Students in the United States," in *Chinese Industrial Espionage: Technology Acquisition and Military Modernization (*New York: Routledge, 2013) loc. 137 of 297, Kindle.

studied in S&T-related fields: physical sciences (31%), engineering (23%), life sciences (8%), mathematics (7%), and computer science (4%).[102]

D. JIANG'S DRIVER #1: GEOSTRATEGIC CONCERNS

Jiang's era began on the cusps of retaliatory efforts by the West in response to Beijing's harsh crackdown on protesters at Tiananmen in June 1989. The United States and its European allies sanctioned the sale of defense-related weapons and services to China causing Beijing to begin looking inwardly for indigenous production of advanced technologies and modern warfare equipment.[103] China's experience of being denied access to foreign arms and technology reignited the pains it experienced during its Century of Humiliation—an era from 1839 to 1949 where China lost a series of wars and was mistreated with Unequal Treaties imposed by foreign powers—which galvanized China's efforts to upgrade its domestic arms production.[104] The United States and European Union imposed sanctions that proved to be a major inflection point for Jiang and PLA leaders causing them to believe that self-sufficiency should be a major priority.

The next event that elevated Jiang's security concerns was America's Operation Desert Storm in Iraq in the early 1990s. This event galvanized PLA leaders to pursue modernization efforts with high-tech weaponry and air superiority. China believed they were falling behind technologically, and that future conflicts would shift away from conventional mechanized warfighting, towards one utilizing informatized capabilities—military capabilities that incorporate IT and advanced communication network systems. In Hagt's point of view, "China saw the Gulf War in 1991 as the 'the first modern information

[102] Hannas et al., loc. 140.

[103] Abas, "China's Military Modernization," 146.

[104] Bernard D. Cole, "Right-Sizing the Navy: How Much Naval Force Will Beijing Deploy," in *Right Sizing the People's Liberation Army: Exploring the Contours of China's Military,* ed. Roy Kamphausen and Andrew Scobell (Pennsylvania: U.S. Army War College, 2007), 528; and Michael McDevitt, "The Strategic and Operational Context Driving PLA Navy Building," in *Right Sizing the People's Liberation Army: Exploring the Contours of China's Military,* ed. Roy Kamphausen and Andrew Scobell (Pennsylvania: U.S. Army War College, 2007), 484–85.

war,' a war waged and won on the strength of U.S. technological superiority." [105] Highly influenced by the aftermath of the Gulf War, Jiang's 1993 speech to the Central Military Commission (CMC) promoted a new military strategic guideline in preparation for future military conflicts, stating that China must prioritize fighting to "[win] a local war under modern technological, especially high-tech conditions."[106]

U.S. military intervention in the 1995–96 Taiwan Strait incident inflamed Jiang's threat perceptions and played a defining moment in accelerating the PLA's drive towards modernization efforts. In Beijing's view, Taiwan is still a lingering unsettled territorial issue originating from its Century of Humiliation. U.S. military interventions in the Taiwan Strait during the mid-1990s not only deteriorated cross-strait relations, but also exposed the PLA's deterrence capabilities. This led to CMC executive vice-chairman General Liu Huaqing stressing the importance of rebuilding China's defense capabilities by utilizing the strengths of China's growing civilian economy.[107] The development of China's anti-ship ballistic missile (ASBM) technology was directly linked to the 1996 Taiwan Strait Crisis, as Jiang and his PLA leaders sought to deter the United States and Taiwan in future crises.[108] Chang asserts that the anti-satellite (ASAT) technology was also developed in response to the 1996 Taiwan Incident since "the United States would rely heavily on satellite intelligence and communications in the event of any Taiwan Strait contingency operations."[109] Weapons systems that began development during the Jiang era— such as the Yuan-class attack submarine, the SC-19 ASAT system, Dongfeng-21D (DF-21D)

[105] Eric Hagt, "Emerging Grand Strategy for China's Defense Industry Reform," in *The PLA at Home and Abroad: Assessing the Operational Capabilities of China's Military,* ed. Roy Kamphausen, David Lai, and Andrew Scobell (Carlisle, PA: Strategic Studies Institute, 2010), 484–85.

[106] David M. Finkelstein, "China's National Military Strategy: An Overview of the 'Military Strategic Guidelines'," in *Right Sizing the People's Liberation Army: Exploring the Contours of China's Military,* ed. Roy Kamphausen and Andrew Scobell (Pennsylvania: U.S. Army War College, 2007), 69–140.

[107] Cheung, *Innovate to Dominate*, loc. 207.

[108] Trebat and Aguiar De Medeiros, "Military Modernization in Chinese Technical Progress and Industrial Innovation," 320.

[109] Amy Chang and John Dotson, *Indigenous Weapons Development in China's Military Modernization* (Washington, DC: U.S.-China Economic and Security Review Commission (USCC), 2012), 27, https://www.uscc.gov/sites/default/files/Research/China-Indigenous-Military-Developments-Final-Draft-03-April2012.pdf.

ASBM, and the Chengdu Jian-20 (J-20) stealth fighter aircraft —utilizing a high degree of China's nascent MCF ecosystem.[110]

The next key event that spurred Jiang to modernize the PLA's fighting capabilities was the 1999 accidental bombing of the Chinese embassy in Belgrade.[111] This incident led to the creation of China's most important and least known about defense projects called the 995 New High-Technology Project—named in memorial of the bombing incident in May 1999.[112] The 995 Project helped China's defense and S&T entities to engage in developing asymmetric capabilities that could specifically target U.S. vulnerabilities. The impact of the 995 Project was significant for the PLA's modernization wherein China's defense R&D spending between 1999 to 2009—the first ten years of the 995 program—accounted for more than China's defense spending on R&D the previous 50 years.[113] This investment in the 995 Project, according to former Major General Yao Youzhi, was responsible for the design and production of approximately 40 new types of weapons systems.[114]

1999 proved to be another low point in U.S.-China relations, wherein the U.S. Cox Report essentially accused the Chinese of procuring space-related technologies—specifically regarding rockets and satellites—from U.S. companies and ended any future space-related cooperation due to strict export controls.[115] This report further convinced China's leadership that it needed to accelerate the development of its S&T capabilities in emerging technologies such space, especially since both the Soviet Union and the United States had already launched their space stations decades earlier. Although the launch of China's first manned spaceflight occurred in 2003 under the Hu administration, the

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[110] Chang and Dotson, *Indigenous Weapons Development in China's Military Modernization*, 6–34.

[111] Tai-Ming Cheung, "Conclusions," in *Forging China's Military Might,* ed. Tai-Ming Cheung (Baltimore: Johns Hopkins University Press, 2014), loc. 275 of 295, Kindle.

[112] Cheung, *Innovate to Dominate*, loc. 181.

[113] Cheung, loc. 183.

[114] Cheung, loc. 182.

[115] Tim Hwang and Emily S. Weinstein, *Decoupling in Strategic Technologies: From Satellites to Artificial Intelligence* (Washington, DC: Center for Security and Emerging Technology, 2022) 4–5, https://cset.georgetown.edu/publication/decoupling-in-strategic-technologies/.

development phase is accredited to the Jiang era wherein a large-scale whole-of-society approach took place with the involvement of 300,000 personnel from various industries such as aviation, shipbuilding, electronics, and armaments.[116]

E. JIANG'S DRIVER #2: STATE INTERVENTION AND DOMESTIC POLICIES

An overlooked driver during the Jiang era was the central government's support for R&D within China's education and S&T-related research infrastructure. Not only was the Chinese government's role vital for China's defense industries drive to procure and develop advanced weapons systems, but it also was the primary source of funding for government R&D labs, and S&T programs within China's universities. Under Jiang, China's high-tech industry's contribution towards national economic growth expanded from 446 billion RMB in 1993 to 1.1 trillion RMB by 1998.[117]

Jiang, in the 1990s, boosted investment in China's top universities in hopes of bolstering China's academic institutions becoming a valuable source of S&T talent for the defense industry. The first of these academic initiatives became known as the 211 Project—launched by the State Education Commission in 1995—which allocated 18 billion RMB to approximately one hundred universities between 1996 and 2010.[118] In 1998, Jiang followed that up with another initiative called the 985 Project, which provided additional investment to approximately 40 universities.[119] The 211 and 985 Projects further integrated China's academic institutions and defense industries, namely amongst China's seven elite defense-related universities known as the "Seven Sons of National Defense"—Beijing Institute of Technology, Beijing University of Aeronautics and Astronautics, Harbin Engineering University, Harbin Institute of Technology, Northwestern Polytechnical University, Nanjing Aeronautics and Astronautics University, and Nanjing

[116] Pollpeter, "Organization as Innovation," loc. 225.

[117] Sun, "China's National Innovation System in Transition," 487.

[118] Alderman et al., "The Rise of Chinese Civil-Military Integration," loc. 119.

[119] Alderman et al., loc. 119.

University of S&T.[120] Graduates from the Seven Sons of National Defense made up approximately 90% of China's space industry and were responsible for designing the Long March 2F (LM-2F), which was the rocket used in China's first manned spaceflight mission (Shenzhou).[121]

Jiang's increased investments in education increased the number of graduates by 86% between 1999 and 2005.[122] This growing domestic talent-pool filled China's defense S&T laboratories which were responsible for producing cutting-edge technologies. Jiang's investments into the education system paid dividends extending into the Xi era, where the number of college graduates increased from one million in 2000 to more than 8 million by 2018—5 million of which consisted of STEM degrees, more than India, Japan, Germany, France, Italy, Canada, the United Kingdom, and United States combined.[123] By 2010, China had enough S&T talent to fill its 218 state key laboratories and 232 state engineering technology research centers, which acted as the primary focal points in conducting R&D in critical technologies.[124] This integration between China's elite S&T universities and the defense industry helped pave the way for more ambitious MCF strategies for the Hu and Xi eras.

One of the most important reforms from the 1998 People's Congress was the establishment of a new General Armaments Department (GAD)—which was later reorganized into the Equipment Development Department (EDD) in 2016 during the Xi era—to act as the sole overseer of defense R&D and procurement for the PLA.[125] The GAD's function was to ensure that local arms producers complied with PLA standards of capabilities, quality, and costs. Mulvenon and Tyroler-Cooper argue that the significance

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120 Mulvenon and Zhang, "Targeting Defense Technologies," loc. 99.

121 Pollpeter, "Organization as Innovation," loc. 226–27.

122 Cheung, *Fortifying China*, 156.

123 J. Stewart Black and Allen J. Morrison, "The Strategic Challenges of Decoupling," *Harvard Business Review (*May-June 2021), https://hbr.org/2021/05/the-strategic-challenges-of-decoupling.

124 Alderman et al., "The Rise of Chinese Civil-Military Integration," loc. 119.

125 Bitzinger and Boutin, "China's Defense Industries," 133.

of Jiang's 1998 defense industry reforms made the PLA's procurement processes more efficient and eliminated corruption by separating the producers from the purchasers."[126]

Another key bureaucratic structural change came as a result of the strict sanctions imposed by the West after the Tiananmen Incident in 1989, a key government entity—the Central Special Committee (CSC)—was reestablished to oversee the development of strategic S&T programs.[127] The CSC was the forerunner to the Central Military-Civilian Fusion Development Commission (CMCFDC)—a key MCF entity created under Xi Jinping in 2017 to oversee all MCF functions—as it harnessed military and civilian capabilities to develop strategic and defense S&T programs.[128] The CSC had the political clout and organizational expertise to guide large projects through bureaucratic hurdles that other government entities such as The Commission of Science, Technology, and Industry for National Defense (COSTIND) and the Ministry of S&T (MOST) could not do.[129] The CSC was an influential MCF organization during the Jiang era as it fell directly under the joint leadership of the State Council and the CMC, and because its leadership structure was made up of civilian and military officials of high importance, headed by China's Premier.[130]

F. JIANG'S DRIVER #3: FOREIGN TECH TRANSFER

China's ascension to the World Trade Organization (WTO) expedited the transfer of foreign technologies into its own domestic industrial base as multinational corporations (MNC) moved their production facilities to China.[131] Absorbing foreign technologies in order to bring about re-innovation was a mainstay throughout the Jiang era, which was exposed in the 1999 U.S. Congress Cox Report, as technology transfers from U.S.-based companies accelerated the development of the PLA's capabilities, especially in regards to

[126] Mulvenon and Tyroler-Cooper, *China's Defense Industry on the Path of Reform,* 9.

[127] Cheung, *Innovate to Dominate*, loc. 208.

[128] Cheung, loc. 105.

[129] Cheung, loc. 208.

[130] Cheung, loc. 209.

[131] Medeiros et al., *A New Direction for China's Defense Industry*, 214.

space and nuclear technology.[132] Following this 1999 report, the United States imposed strict export controls—with the passage of its 1999 National Defense Authorization Act—related to advanced space technologies such as satellites, which eliminated any further collaboration in space research or satellite launches with China.[133] However, China was able to receive critical support from Russia towards its nascent spaceflight program in the form of hardware and design.[134] Despite the decoupling from the United States in the space industry, China during the Jiang era was responsible for approving and developing the space program, which eventually led to its first manned flight in 2003.[135]

In the early 1990s, re-innovation became a popular practice wherein China would acquire foreign technologies and then wholly modify them using domestically designed specifications.[136] The practice was then developed into a multistep strategy of introduce, digest, absorb, re-innovate (IDAR), which resulted in concrete gains for the PLA and was seen as a critical process towards pursuing indigenous innovation.[137] The PLA Air Force's (PLAAF) J-10 and J-11 fighter jets—which were China's first domestically produced fourth-generation aircraft—were prime examples of the IDAR model, which were derived from Israeli's Lavi and Russia's Su-27 in the early 1990s.[138] Other PLA weapons systems that were successfully adopted from foreign sources were: Chengdu J-20 stealth fighter jet, the Yuan-class diesel attack submarine, and the second-generation Sovremenny II 956E class destroyer and the Frigate M2EM 3D.[139] Although the Yuan-class submarine was

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[132] Moltz, *The Politics of Space Security,* loc. 276.

[133] Hwang and Weinstein, *Decoupling in Strategic Technologies*, 4–5.

[134] Moltz, *The Politics of Space Security,* loc. 260; and Pollpeter, "Organization as Innovation," loc. 235.

[135] Pollpeter, "Organization as Innovation," loc. 213–225.

[136] Cheung, *Innovate to Dominate*, loc. 214.

[137] Angliviel et al., *Open Arms*, 3.

[138] Phillip C. Saunders and Erik Quam, "Future Force Structure of the Chinese Air Force," in *Right Sizing the People's Liberation Army: Exploring the Contours of China's Military,* ed. Roy Kamphausen and Andrew Scobell (Pennsylvania: U.S. Army War College, 2007), 393–94.

[139] Tai Ming Cheung, "Dragon on the Horizon: China's Defense Industrial Renaissance," *The Journal of Strategic Studies* 32, no. 1 (February 2009): 47–48, https://doi.org/10/1080/01402390802407418; and Trebat and Aguiar De Medeiros, "Military Modernization in Chinese Technical Progress and Industrial Innovation," 319.

unveiled in 2004, China's ASAT successfully destroyed a satellite 530 miles above the Earth in 2007, and the J-20 conducted its first test flight in 2011, all three weapon systems were credited with being developed by the PLA in the 1990s.[140]

Converting foreign technology transfers into indigenous innovations relies on capabilities of China's domestic talent-pool working in the civilian and defense R&D labs. China's universities were an important MCF vehicle for acquiring the foreign technology transfers and cultivating indigenous talent. China's universities have produced a growing talent pool of science and engineering (S&E) specialists. The number of bachelor degrees in S&E have grown substantially from 250,000 in 1998 to 1.7 million by 2015, and PhD degrees from 1,900 in 1993 to 34,000 in 2018.[141] MCF-related activities within the civilian academic institutions have been spearheaded by the Seven Sons of National Defense. These are some of China's best funded universities, where approximately half of the allocated monies for each school goes towards defense research.[142]

Although a lot of credit is attributed to the Hu-era Thousand Talents Program, it was Jiang who in 1994 initiated China's first efforts to recruit foreign experts through the Hundred Talents Plan.[143] After witnessing the significant contributions the Hundred Talent Program made towards the development of China's S&T sector with over 1,500 participants, China then launched additional talent programs like the Changjiang Scholars Award Program in 1998.[144] Stoff asserts that China's many state-sponsored talent recruitment programs "play a critical role in transferring intellectual capital and property to China."[145] However, despite the rapid growth of its talent programs, and large-scale investments into its universities and R&D infrastructure, China's technological output—

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140 Chang and Dotson, *Indigenous Weapons Development in China's Military Modernization*, 12–15.

141 Cheung, *Innovate to Dominate*, loc. 220.

142 Alex Joske, *The China Defense Universities Tracker: Exploring the Military and Security Link of China's Universities*, Policy Brief Report no. 23/2019 (Australia: Australian Strategic Policy Institute (ASPI), 2019), 7, https://www.aspi.org.au/report/china-defence-universities-tracker.

143 Stoff, "China's Talent Programs, loc. 39; Hannas and Chang, "China's 'Artificial' Intelligence," loc. 193.

144 Stoff, loc. 39.

145 Stoff, loc. 49.

innovation coming from China's commercial industries, government research labs, and universities—remained small, wherein China's industrial enterprises purchased domestic technologies amounting to only 1.38 billion RMB in 1999, compared to purchases of foreign technologies worth 20.8 billion RMB.[146]

G. HU'S DRIVER #1: GEOSTRATEGIC CONCERNS

In the early 2000s, Hu's MCF strategy was driven less by geostrategic concerns, and more on taking advantage of the S&T boom. According to Scissors, China experienced high economic growth "between June 2002 and June 2008, [wherein] China's GDP more than tripled and its exports more than quadrupled."[147] Hannas, Mulvenon and Puglisi also highlight that China's S&T boom which began in 2002, was fueled in large part by foreign direct investment (FDI) from hundreds of the world's largest MNCs totaling "$46.4 billion in actual FDI and $76.5 billion in contracted FDI, [both] increases of 20% and 35%" from 2001.[148] This created a "Malacca Dilemma"—a phrase made popular by Hu in 2003—in response to the growing fear that other foreign powers would take advantage of this maritime chokepoint where 80% of China's imports flowed through.[149]

In addition, Hu wanted to continue carrying on the doctrine from the Jiang era of "China's peaceful rise," to placate global concerns of a rising revisionist power bent on changing the current international order. Hu also was motivated to avoid any large-scale international confrontations as China was going to host two highly visible global events: the 2008 Olympics and the 2010 Shanghai Expo.[150] Hu therefore took advantage of this lowered threat assessment and wave of economic growth to further increase cooperation

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[146] Sun, "China's National Innovation System in Transition, 488.

[147] Derek Scissors, "Deng Undone: The Costs of Halting Market Reform in China," *Foreign Affairs* 88, no.3 (May/June 2009): 34, https://www.jstor.org/stable/20699561.

[148] Hannas, Mulvenon, and Puglisi, "Chinese Foreign Students in the United States," loc. 149.

[149] Emily de La Bruyere, "Beijing's Innovation Strategy: Threat-informed Acquisition for an Era of Great Power Competition" (Acquisition Research Symposium, Naval Postgraduate School, 2020), 15, https://calhoun.nps.edu/bitstream/handle/10945/66005/Beijings_Innovation_Strategy_SYM-AM-20-091_Panel.pdf?sequence=1&isAllowed=y.

[150] Julie Makinen, "Shanghai Expo 2010 Turns Spotlight on Nations," New York Times, last modified May 30, 2010, https://www.nytimes.com/2010/05/31/business/global/31expo.html.

between the defense and civilian sectors. One significant way Hu did this was by allocating approximately 22 million RMB towards the 863 Program—an amount that was four times more than was allocated to the program between 1985 to 2000.[151]

China's security concerns shifted away from the United States as the U.S. military got caught up in anti-terrorism and counter-insurgency efforts in the Middle East after the 9/11 attack. Hu's focus centered on the South China and East China Seas, where both seas were primary maritime trade routes in and out of China and hosted abundant resources such as oil reserves and fisheries. However, the area holds high geostrategic value for Beijing with many unresolved territorial disputes such as the Spratly Islands, Diaoyu/Senkaku Islands, Paracel Islands, and Taiwan. However, Hu's concerns over Taiwan were significantly less than Jiang's as Taiwan's newly elected president in 2008, Ma Ying-jeou, had less inclinations for stirring up independence movement than his predecessors.[152] However, according to Goldstein, "after 2008, observers discerned a change in China's behavior in East Asia that was inconsistent with its emphasis since the mid-1990s on fostering cooperation. Most notably, China again began more actively to challenge neighbors with which it had maritime territorial disputes in the East China and South China Sea."[153]

U.S. military operations in the Middle East, namely Iraq and Afghanistan, during the first decade of the 21st had an impact on China's modernizing efforts within the defense industry.[154] On a strategic level, U.S. military air superiority forced Hu to transition away from Jiang's focus of "winning local wars under high-tech conditions," to developing "informatized" warfighting capabilities.[155] On the bureaucratic level, Hu in 2004,

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[151] Toby Warden, "A Revolutionary Evolution: Civil-Military Integration in China," Australian Institute of International Affairs, last modified October 1, 2019, https://www.internationalaffairs.org.au/australianoutlook/a-revolutionary-evolution-civil-military-integration-in-china/.

[152] Nan Li, "China's Evolving Naval Strategy and Capabilities in the Hu Jintao Era," in *Assessing the People's Liberation Army in the Hu Jintao Era,* ed. Roy Kamphausen, David Lai, and Travis Tanner (Carlisle, PA: U.S. Army War College Press, 2014), 262.

[153] Goldstein, "China's Grand Strategy under Xi Jinping," 176.

[154] Hagt, "Emerging Grand Strategy for China's Defense Industry Reform," 12–13.

[155] Joe McReynolds, "Preface," in *China's Evolving Military Strategy*, ed. Joe McReynolds (Washington, DC: Brookings Institution Press, 2016) loc. 76 of 7444, Kindle.

promoted the PLAAF to having a seat within the CMC, joining the PLA Navy (PLAN) and the PLA Rocket Force (PLARF).[156] This elevation of status signified the PLAAF's growing importance in China's military modernization plans, and the recognition that aerospace was becoming increasingly vital towards the PLA's modernization efforts. On a commercial level, Hu's 2008 SOE reforms combined the defense SOEs of the China Aviation Industry Corporation I and China Aviation Industry Corporation II, to form the Aviation Industry Corporation of China (AVIC), which reduced production redundancy by becoming the main supplier for aviation weapons systems and commercial aircraft.[157]

The development of China's space program during the Hu era was accelerated in part by a few significant international events. In 2007, China successfully launched its first ASAT test. Although China's ASAT program was initiated during the Jiang era in response to the first Taiwan Strait incident in 1995, many observers point out that it was in direct retaliation to former President Bush's bold statement that America had the right to deny space to any hostile adversary.[158] In 2011, China experienced two significant events in its burgeoning space industry that drove it to decouple itself from the United States and to further enhance its capabilities. They were the exclusion from the U. S's International Space Station and the creation of the U.S. government's Wolf Amendment.[159] This amendment essentially restricted NASA and other U.S. government agencies from collaborating.

H. HU'S DRIVER #2: STATE INTERVENTION AND DOMESTIC POLICIES

The Hu administration's state-directed industrial policies to promote MCF, focused on encouraging the cross-pollination of China's commercial-sector technology, talent pool,

[156] Cristina L. Garafola, "The Evolution of PLAAF Mission, Roles and Requirements," in *China's Evolving Military Strategy*, ed. Joe McReynolds (Washington, DC: Brookings Institution Press, 2016) loc. 1288 of 7444, Kindle.

[157] James Mulvenon, "Economic Espionage and Trade Secret Theft Cases in the U.S.," in *China's Quest for Foreign Technology: Beyond Espionage,* ed. William C. Hannas and Didi Dirsten Tatlow (New York: Routledge, 2021) loc. 302 of 350, Kindle.

[158] Suzanne Goldenberg, "Bush Issues Doctrine for U.S. Control of Space," *The Guardian,* October 19, 2006, https://www.theguardian.com/science/2006/oct/19/spaceexploration.usnews.

[159] Hwang and Weinstein, *Decoupling in Strategic Technologies*, 5.

and financial resources with the defense industry. In the early 2000s, China's economy experienced a boom as global markets vied for cheap Chinese electronics and IT products. In order leverage the growth of the civilian S&T sector of the early 2000s, Hu issued a new MCF principle of *Yujun Yumin*—locate military potential in civilian capabilities—which was announced during the 16th Party Congress in 2003.[160] In addition to Jiang's efforts in dismantling the barriers between China's defense industry and its resource-rich civilian S&T institutions, Hu continued to push for reforms in China's national defense S&T industrial system stating in 2007, at the 17th Central Party Congress that China "will establish and perfect a weapons and equipment research and manufacturing system that 'combines the military and civilian sectors' and 'locates military potential in civilian capabilities.'"[161]

When Hu and his premier, Wen Jiabao, took over leadership in 2002, they immediately implemented large-scale policies to stimulate growth in the country's S&T industries, especially in strategic emerging technologies. One key plan was the 2006–2020 MLP. According to Hagt, the 2006–2020 MLP stressed MCF as a primary goal, where approximately half of the prioritized 16 items had clear civil-military dual-use features.[162] Those deemed to have been for defense or dual-use projects were China's space program, high-resolution earth observation system, integrated electronic components, high-end semiconductors and computer machine tools, and large commercial airliner projects.[163]

An overlooked MCF success during the Hu era was China's first manned space flight in 2003. China's top-level political leaders proved essential in achieving this feat, as Pollpeter reveals, that due to the nature of any space program's large-scale budgets, "top-level political support is required for the success of a space program."[164] The 1999 Cox report also played a big role in boosting China's manned space aspirations as the strict

[160] Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 16.

[161] Alderman et al., "The Rise of Chinese Civil-Military Integration," loc. 109.

[162] Hagt, "Emerging Grand Strategy for China's Defense Industry Reform," 481; and Mulvenon and Zhang, "Targeting Defense Technologies," loc. 94.

[163] Cheung, *Innovate to Dominate*, loc. 205.

[164] Pollpeter, "Organization as Innovation," loc. 214.

export controls meant to thwart China's space industry. By 2003, Hu increased China's space budget to 18 billion RMB as China's space industry proved increasingly successful.[165]

A similar plan was launched at the same time—the 2006–2020 Medium-and Long-Term Defense S&T Development Plan (MLDP)—which focused on defense-related R&D.[166] According to Cheung, one of the main goals of the MLDP was to remove the "barriers that have kept the defense R&D system separate from the rest of the national R&D base and [encourage] the forging of close links with universities and civilian research institutes."[167] The MLDP built upon the established links between the defense research labs and the academic institutions from the Jiang-era 863 and 973 programs. The MLDP, and its civilian counterpart, the MLP, provided a 15-year roadmap towards improving indigenous innovation in emerging technologies, and highlighted the importance of transferring commercial technologies to the military.[168]

The beginning of the Hu era not only saw the launching of long-term S&T initiatives such as the MLP and MLDP, but also the funding of legacy programs such as Deng's 863 Program. During the first 14 years 863 Program, it only received a total of 5 billion RMB, compared to an increase of 22 billion RMB under Hu's 10th FYP (2001-2005).[169] The sustained and increased funding towards high-tech R&D projects and civilian institutions revealed that Hu was focused on closing the technological gap with the West and ensuring China's long-term industrial competitiveness. The 863 program sought to accomplish those goals by bolstering civil-military research cooperation into several targeted areas such as "biotechnology, energy, IT, spaceflight, new materials, and oceanography."[170] In reference to Figure 2, *China's High-Tech Funding Programs 2001–*

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[165] Pollpeter, loc. 225.

[166] Tai-Ming Cheung, "Introduction," in *Forging China's Military Might* (Baltimore: Johns Hopkins University Press, 2014), loc. 10 of 295, Kindle.

[167] Cheung, loc. 12–13.

[168] Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 16.

[169] Warden, "A Revolutionary Evolution: Civil-Military Integration in China."

[170] Warden.

08, 863 funding significantly increased during the Hu administration dwarfing other high-tech programs such as the 973 and other key technology programs.

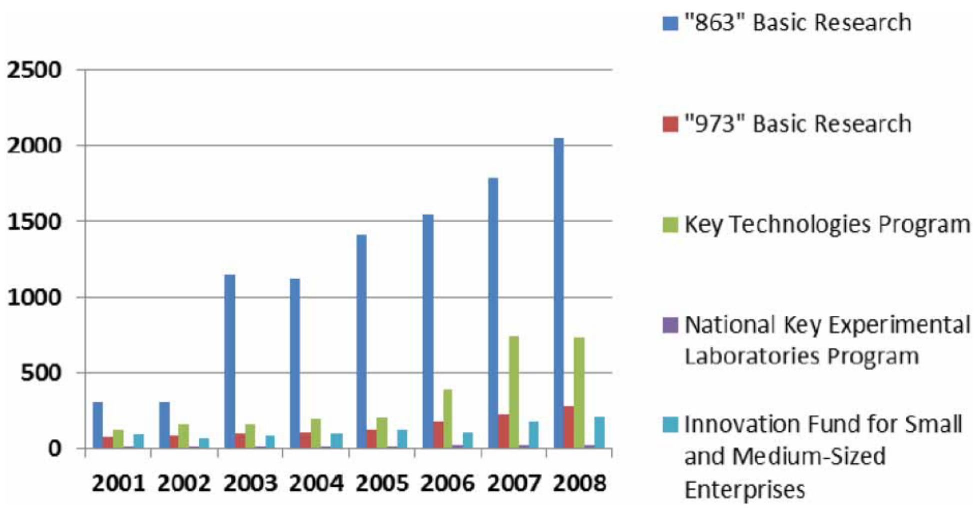

Figure 2. Funding for China's High-Tech Research Programs, 2001–2008 (Rmb Millions)
Source: Liu & Cheng (2011) and authors' estimates.
Notes: Data for 863 program for 2006–2008 estimated by applying an annual growth rate of 10%, which roughly corresponds to China's GDP growth in the period. This is a conservative estimate: the average annual growth rate between 2006 and 2008 of the other programs in Figure 2 was about 60%.

Figure 2. China's High-Tech Funding Programs 2001–08[171]

I. HU'S DRIVER #3: FOREIGN TECH TRANSFER

Hu understood that in order to help China's defense and commercial industries achieve self-sufficiency and indigenous innovation, China first had to acquire and adopt foreign technologies. According to Cheung, this is where the "absorption" process of the IDAR model became vital as it cultivated the process of "reverse engineering, [the] acquisition of advanced automation machine-building equipment, and the encouragement of foreign firms to establish engineering and manufacturing outputs in China."[172] Angliviel's research provides an in-depth description of how China South Rail (CSR) Locomotive & Rolling Stock Corporation Limited was able to produce a military weapons

[171] Source: Trebat and Aguiar De Medeiros, "Military Modernization in Chinese Technical Progress and Industrial Innovation," 308.

[172] Cheung, *Innovate to Dominate*, loc. 221.

system for the PLA utilizing the co-optation of commercial technologies.[173] In 2008, CSR, a state-owned company that specialized in producing high speed trains, purchased United Kingdom (UK)-based Dynex Semiconductor.[174] With the newly acquired technologies, CSR, along with PLA scientists and engineers, were able to "absorb" Dynex's insulated-gate bipolar transistors (IGBT) to "re-innovate" an Electromagnetic Aircraft Launch System (EMALS)—an advanced aircraft catapult system used to assist launching aircraft aboard aircraft carriers.[175]

Re-innovating technologies based upon foreign technology transfers have been a mainstay within China's MCF strategy as it simply required the transferring of copied or imported technologies to be locally modified with wholly domestic parts. There were many examples, especially within the aerospace sector, where China used advanced imitation methods on foreign-derived technologies to domestically produce a similar technology with slight modifications. Prime examples of this were: the Chengdu J-10 multirole fighter jet, which originated from Israel's Lavi fighter jet, and China's J-15 and J-16 fighter jets, which were based off of Russia's Sukoi-33 and Sukoi-30 respectively.[176]

Foreign technology transfers have made China's military industries produce state-of-the-art weapon systems and have allowed China's commercial sector to be more competitive on a global scale. The lure of China's vast domestic market, especially in the IT industry, has led MNCs to collaborate with Chinese firms to facilitate market access. Some observers argue that China leverages its vast domestic market by compelling foreign high-tech companies seeking market access to transfer technology and invest in Chinese JV labs.[177] Some foreign companies have tacitly complied with Chinese demands to hand over IP to ensure market access. For example, Ericsson—a multinational

[173] Angliviel et al., *Open Arms*, 47–50.

[174] Angliviel et al., 47–50.

[175] Angliviel et al., 47–50.

[176] John A. Tirpak, "The Chinese Air Force's Great Leap Forward," Air Force Magazine, last modified May 29, 2018, https://www.airforcemag.com/article/The-Chinese-Air-Forces-Great-Leap-Forward/; Bitzinger et al., "Locating China's Place in the Global Defense Economy," loc. 187; and Cheung, *Innovate to Dominate*, loc. 226.

[177] Bitzinger, "China's Shift from Civil Military Integration to Military Civil Fusion," 16–17.

telecommunications company—turned over the source code to its CDMA cellular technology to its commercial Chinese counterpart, as did Microsoft with the source code to Windows.[178]

Talent recruitment was a significant source of foreign technology transfer during the Hu era. In 2008, the Hu administration established the Global Experts Recruitment Program, more commonly known as the Thousand Talents Program (TTP).[179] In 2011, the TTP launched its own venture capital fund, The Thousand Talents Venture Capital Center, which was responsible for launching the first promotional event in Silicon Valley to attract high-level talent to start businesses in China.[180] Between 2008 and 2018, it is estimated that the TTP was responsible for approximately half of the returning Chinese scientists and high-tech entrepreneurs from the United States and Europe who had repatriated back to China.[181] Regarding overseas scholars being recruited to come to China to start businesses or take part in JVs, Stoff quantifies the amount to be around 3,000.[182] The GAD launched its own talent programs—the Military High-Level Personnel in Science and Technology Innovation Project in 2009, and the Talent Development 2020 Plan in 2012—in which hundreds of promising civilian and military personnel with S&T backgrounds were selected for specialized training, which included the opportunity to be mentored by some of the best experts in the field. In a review of these talent programs, impressive progress was made wherein those associated with these talent programs ended up participating in vital dual-use S&T projects such as the Shenzhou space program, Tianhe high-performance computer project, and other important national S&T projects under the 863, 973, and 995 programs.[183]

Just as China's talent pool was cultivated domestically, a large percentage of bachelor and graduate students were still vying for opportunities to study overseas,

[178] Mulvenon and Zhang, "Targeting Defense Technologies," loc. 97.

[179] Stoff, "China's Talent Programs," loc. 39.

[180] Stoff, loc. 45.

[181] Cheung, *Innovate to Dominate*, loc. 242.

[182] Stoff, "China's Talent Programs," loc. 47.

[183] Cheung, *Innovate to Dominate*, loc. 42–43.

especially in the United States. In reference to Figure 3, *Hu-era Students Going to U.S. Universities (2001 to 2011)*, the growth in Chinese students enrolled at U.S. universities from 2002 to 2001 almost tripled from about 64,000 to 194,000 respectively. When including all of China's overseas students in 2011, the total grows to about 339,700, which was ten times more than the amount of Chinese overseas students in 2000.[184] To a smaller scale, the PLA, more specifically the PLAAF through its PLAAF Command College, launched foreign military exchanges with its officers and pilots to study abroad to promote the exchange with other countries concerning a wide range of issues such as strategic dialogue, security, and combined exercises.[185] This exchange of military delegations was an international initiative directly attributed to Hu, as he wanted to improve China's soft power and military modernization efforts. Some of the destinations Chinese military officers were sent to were India, Russia, Italy, France, and the United Kingdom.[186]

TABLE 6.1 Chinese Students in the United States, 2001–2012 (thousands)[13]

	2001	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
US	63.2	64.7	61.8	62.5	62.5	67.7	81.1	98.2	127.6	157.6	194
%Δ	15.5	2.4	-4.6	1.2	0.1	8.2	19.8	21.1	29.9	23.5	23.1

Figure 3. Hu Era Students Going to U.S. Universities (2001–2011)[187]

J. XI'S DRIVER 1: GEOSTRATEGIC CONCERNS

Although various version of a MCF strategy were implemented under all the post-Mao regimes, none can be credited more than Xi in elevating MCF to a level of national prominence. As Xi took over the leadership of China in 2012, Xi pursued deeper

[184] Hannas, Mulvenon, and Puglisi, "Chinese Foreign Students in the United States," loc. 138.

[185] Kenneth Allen, "Trends in People's Liberation Army International Initiatives Under Hu Jintao," in in *Assessing the People's Liberation Army in the Hu Jintao Era,* ed. Roy Kamphausen, David Lai, and Travis Tanner (Carlisle, PA: U.S. Army War College Press, 2014), 489–93. Proquest.

[186] Allen, 493.

[187] Source: Hannas et al., loc. 139.

integration between the commercial, civilian, and defense sectors as part of his grand strategy of achieving national rejuvenation.[188] Just as Jiang's elevated threat perceptions intensified the development of strategic weapons systems, the same occurred under the Xi era where China's security environment was challenged with increased maritime and territorial disputes, and a rebalancing of U.S. priorities towards the Asia Pacific.[189] Xi was driven to regain China's status as the preeminent global political and economic superpower, and viewed China's MCF strategy as a key element towards achieving both technological superiority and economic self-sufficiency.

The Xi era was immediately faced with escalations in the East China and South China Seas, prompting him to equip China with a technologically advanced military that can protect its interests. In 2012, two diplomatic standoffs highlighted the need for the PLA to further modernize its defense capabilities: the confrontation between Manila's navy frigates and Beijing's maritime patrol vessels at Scarborough Shoal, and the Japanese government's purchase of three out of the five disputed Senkaku/Diaoyu Islands.[190] In addition to the heightened contentiousness over disputed territorial claims, North Korea resumed its nuclear tests despite U.S. objection, all of which indirectly contributed towards an escalation within China's security environment. These factors prompted the Obama administration to shift more diplomatic, economic, and military efforts towards the Pacific in 2011, leading Chinese leaders to grow suspicious of America's intentions and therefore reciprocate by modernizing both its economic and national defense capabilities even more.[191]

As Xi witnessed the U.S. military exhibit advanced technologies in its war against terrorism in the Middle East, Xi guided the PLA away from the mechanization of warfare towards informatized and intelligentized capabilities, especially in the sea, space, and cyber

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[188] Aaron L. Friedberg, "The Sources of Chinese Conduct: Explaining Beijing's Assertiveness," *The Washington Quarterly* 37, no. 4 (January 2015): 143, https://doi.org/10.1080/0163660X.2014.1002160.

[189] Cheung, "Conclusions," loc. 275.

[190] Friedberg, "The Sources of Chinese Conduct,"135.

[191] Goldstein, "China's Grand Strategy under Xi Jinping," 176–77.

domains.[192] China's growth in the commercial S&T industry has benefitted the modern military warfighting capability with spin-on technologies. In trying to keep up with the fast-changing S&T environment and seeing the vast benefits emerging technologies like Artificial Intelligence (AI) can have on the battlefield, Xi launched the 2017 AIDP.[193] Another large-scale MCF initiative was the MIC 2025 plan, which promoted the transition to high end manufacturing in areas of dual-use technologies. Together with the 2017 AIDP, Xi hope to bring technological innovation within both of China's commercial and defense industrial bases, especially in areas of artificial intelligence, high-performance computing, and robotics.[194]

U.S.-China relations soured exponentially under the Trump administration (2016-2020) which imposed sanctions on vital high-end technologies needed for China's defense industrial base. The Trump administration's strict export limits had a dual-purpose: 1.) to lessen the trade surplus China had with the United States; and 2.) to slow down the PLA's modernization efforts. China's increasingly hostile geopolitical environment threatened to siphon it [China] off from crucial technologies causing Xi in 2020 to point out the need to indigenously develop dual-use technologies.[195] It is unknown as to how much of a negative impact the Trump imposed trade barriers had on Chinese commercial entities, but the export restrictions on high-end technologies such as semiconductors provided an impetus to speed up indigenous innovation of the much-needed technology, of which China was highly reliant upon.

The Department of Commerce Entity List is a tool that the U.S. government has used to prevent the proliferation of critical technologies that may threaten U.S. national security to unfriendly foreign individuals and entities. Chinese firms accounted for only

[192] Lafferty, "Civil-Military Integration and PLA Reforms," 641.

[193] Fedasiuk et al., *Harnessed Lighting*, 4.

[194] Tai-Ming Cheung and Eric Hagt, "China's Efforts in Civil-Military Integration, Its Impact on the Development of China's Acquisition System, and Implications for the United States" (master's thesis, Naval Postgraduate School, 2019), 151, http://hdl.handle.net/10945/63022.

[195] Justin Feng, "Technological Decoupling: The Newest Phase of U.S.-China Competition," *The International Affairs Review* (January 2022), https://www.iar-gwu.org/blog/iar-web/technological-decoupling-the.

7% of the total listed entities from 1998 to 2008, but grew to 10% in 2019, 17% in 2020, and 24% by 2021.[196] Xi's MCF drive has also been influenced by concerns about resource restraints that would deeply impact China's national security. A case in point being in May 2018 when the U.S. government banned the export of U.S. technology to ZTE, one of China's national champions, in response to China's continuous trade relations with North Korea and Iran.[197]

In response to what Beijing perceived to be decoupling and deglobalizing efforts—such as the case of the United States placing an export ban on ZTE and Huawei—Xi Jinping and top-level CCP officials initiated a "dual circulation" strategy in 2020.[198] The purpose of the dual circulation was to circumvent international disruptions to the supply chains of important and critical resources such as semiconductors and other advanced technologies. This dual circulation approach to China's economy was first announced by Xi at an April 2020 Central Financial and Economic Commission meeting, wherein Cheung points out that Xi wanted to "establish a complete system of domestic demand that would have a crucial bearing on China's long-term development and stability."[199] China's Vice-premier, Liu He, echoed similar sentiments shortly after in November 2020 that China's domestic manufacturing capabilities could sustain economic growth as the threats to China's global supply chains have increased.[200]

China's MCF strategy inextricably links its drive to becoming a modern military by 2035 and a world-class military by 2049, with becoming a global leader in technological innovation.[201] As highlighted in the previous chapters, China's geostrategic concerns have increased over issues such as Taiwan, territorial disputes in the East China and South China Seas, and a decoupling of international trade relations with the West. These security

[196] Cheung, *Innovate to Dominate,* loc. 280–81.

[197] Cheung, loc. 231.

[198] Feng, "Technological Decoupling: The Newest Phase of U.S.-China Competition."

[199] Cheung, *Innovate to Dominate,* loc. 300.

[200] Cheung, loc. 301.

[201] Peter Cowhey, Susan Shirk, and Orville Schell, *Meeting the China Challenge: A New American Strategy for Technology Competition (*San Diego, CA: 21st Century China Center, 2020), 2, https://asiasociety.org/sites/default/files/inline-files/report_meeting-the-china-challenge_2020.pdf.

challenges have not only impacted China's drive for talent cultivation, and development of high-tech weaponry, but also the strategies of China's commercial enterprises. In 2022, China's commercial enterprises have experienced significant increases in orders from within China's military industrial supply chain. For instance, Guide Infrared Group in March 2022 signed a $40.28 million contract to supply thermal imaging devices; Sinofibers Technology, also in March 2022, signed a contract for $24.82 million; and Kuang-Chi Technologies signed a contract for $297.57 million to supply stealth materials for China's aviation industry.[202] Between 2012 to 2018, China's commercial UAV industry experienced a tenfold increase in drone sales, from 120 to more than 1,200 drones sold.[203]

Chinese companies like Kuang-Chi highlight a growing and concerning trend for the U.S. government. Even though Kuang-Chi was founded in 2010 and has focused its efforts mainly on researching metamaterials to be used with space, engine, and satellite technologies, it was not until 2019 when it won its first military contract to supply the PLA with stealth technology for vessels.[204] In addition to its activities of supplying the military with stealth weapon systems, Kuang-Chi managed two venture capital funds, and invested in foreign technology firms that focus on emerging technologies such robotics, aviation, and telecommunications.[205] One such foreign firm was HyalRoute Communications Group, a Singaporean company that builds fiber-optic network cables throughout Southeast Asia, which has collaborating projects in China's BRI.[206] Kuang-Chi's significance reveals the growing integration between China's civilian and commercial enterprises with China's military and economic strategies.

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[202] Barry van Wyk, "China's Military Industry is Booming with Huge Demand for Combat Equipment," SupChina, last modified June 3, 2022, https://supchina.com/2022/06/03/chinas-military-industry-is-booming-with-huge-demand-for-combat-equipment/.

[203] Cheung, *Innovate to Dominate,* loc. 135.

[204] Levesque, "Military-Civil Fusion: Beijing's 'Guns AND Butter' Strategy to Become a Technological Superpower;" and Tang Shihua, "Chinese Future Tech Firm Wins First Military Order to Make Ships Invisible," *Yicai Global*, January 15, 2019, https://www.yicaiglobal.com/news/chinese-future-tech-firm-wins-first-military-order-to-make-ships-invisible.

[205] Levesque, "Military-Civil Fusion: Beijing's 'Guns AND Butter' Strategy to Become a Technological Superpower."

[206] Kirk Lan, "KuangChi Science Announces Singapore-Based Innovation HQ," *PRNewswire,* May 31, 2016, https://www.prnewswire.com/news-releases/kuangchi-science-announces-singapore-based-innovation-hq-300276731.html.

K. XI'S DRIVER #2: STATE INTERVENTION AND DOMESTIC POLICIES

When he came to power, Xi noticed a wasteful and inefficient MCF strategy that produced underwhelming results from a large amount of investment. China's MCF strategy under previous leaders had bureaucratic and structural obstacles that impeded the synergies between the defense and commercial industrial bases. In a 2014 speech, Xi echoed that sentiment by stating "China's foundation for S&T innovation is still not firm. China's capability for indigenous innovation, and especially original innovation, is still weak."[207] As a solution to this problem, Xi placed indigenous S&T innovation at the core of his MCF development plans, such as his 14th FYP (2021-2025), and utilized state interventionist policies to resolve the systemic and bureaucratic issues constraining the full implementation of MCF.

Xi launched two significant events to ensure the success of his future MCF policies. The first was his March 2015 announcement which elevated MCF into a national-level development strategy. This put MCF on par with other national strategic priorities such as economic development, S&T indigenous innovation, and military modernization.[208] Under previous Chinese leaders, China's MCF strategy did not receive the high-level attention attained under the Xi era because it was previously managed by mid-level government and military officials who lacked the technical understanding of MCF's impactful nature.[209]

The second major policy change was the establishment of the Central Military-Civilian Fusion Development Commission (CMCFDC) in 2017.[210] The creation of the CMCFDC was unprecedented not only because it consolidated one organization to oversee all MCF efforts—whereby Xi placed himself as its head to ensure successful implementation—but it also elevated the organization to be on par with the State Council

[207] Cheung, *Innovate to Dominate,* loc. 229.

[208] Stone and Wood, *China's Military-Civil Fusion Strategy,* 7–23.

[209] Stone and Wood, *China's Military-Civil Fusion Strategy,* 24.

[210] Greg Levesque, "Military-Civil Fusion: Beijing's 'Guns AND Butter' Strategy to Become a Technological Superpower," *The Jamestown Foundation*, last modified October 8, 2019, https://jamestown.org/program/military-civil-fusion-beijings-guns-and-butter-strategy-to-become-a-technological-superpower/.

and CMC, reporting directly to the Politburo Standing Committee.[211] As Xi elevated MCF strategy's political and bureaucratic status, it brought with it benefits such as having the backing and attention of China's highest leadership which it had lacked under previous leaders. Since 2017, the CMFCDC has implemented at least 11 MCF priorities such as having provincial and local governments forming their own MCF industrial development plans and constructed 36 national-level MCF industrial zones that host commercial, academic, and military organizations.[212]

Xi's signature policies and development projects mirrored the benchmarks set forth in China's Dream of becoming a "moderately well-off society" by 2021—the centennial of the CCP—and becoming a fully developed country by 2049—the centennial of China's founding.[213] Xi's 13th FYP (2016-2020) prioritized S&T innovation with the launching of Internet Plus Action Plan and MIC 2025 wherein both plans increased funding for emerging technologies such as advanced computers, autonomous robots, and the Internet of Things.[214] In addition, Xi's 13th FYP stressed a deeper integration of the military and civilian industries, and a significant shift from the IDAR model within the defense industry towards indigenous innovation.[215] Likewise, Xi's 2017 AIDP sought to put China on par with other Western industrialized nations in AI capabilities by 2020, and by 2030, become the world's premier AI innovation center.[216]

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211 Cheung, *Innovate to Dominate*, loc. 101.

212 Levesque, "Military-Civil Fusion: Beijing's 'Guns AND Butter' Strategy to Become a Technological Superpower."

213 Gill, "China's Future Under Xi Jinping," 4.

214 Sutter, "Foreign Technology Transfer Through Commerce," loc. 59; and Katherine Koleski, *The 13th Five-Year Plan* (Washington, DC: U.S.-China Economic and Security Review Commission, 2017), 12–13, https://www.uscc.gov/sites/default/files/Research/The%2013th%20Five-Year%20Plan_Final_2.14.17_Updated%20%28002%29.pdf.

215 Koleski, *The 13th Five-Year Plan*, 7.

216 New America (translated by Rogier Creemers, Leiden Asia Centre; Graham Webster, Yale Law School Paul Tsai China Center; Paul Triolo, Eurasia Group; and Elsa Kania), "State Council Notice on the Issuance of the Next Generation Artificial Intelligence Development Plan," New America, Last modified August 1, 2017, 6, https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/

Since this new modern warfighting environment shifted its focus towards technology and innovation, Xi acknowledged that, "quantity should be reduced and quality improved to build capable and efficient military forces."[217] Modern warfare's shift to informatized and intelligentized capabilities made China's leadership think about reforming its military forces to be S&T oriented and less reliant on labor intensive manpower. This led to Xi's 2016 announcement to reduce the PLA's manpower by 300,000—from 2.3 million to 2 million—and to involve the PLA's noncombat organizations and personnel with civilian counterparts.[218] The PLA's troop reduction was unprecedented and revealed that the PLA was moving toward a smaller, adaptable, and more technically oriented fighting organization that will be increasingly more reliant upon the civilian and private sectors to meet certain noncombat roles and responsibilities.[219] Xi has increasingly relied on integrating civilian resources and capabilities to fill the gaps within the PLA, as such the case with Xi's creation of the Strategic Support Force (SSF). The SSF's mission is to enhance China's fighting capabilities in space and cyberspace domains. Civilian information systems became increasingly important towards advancing military modernization towards cyber warfare.[220]

Despite references to MIC 2025 having stopped in 2018 after attracting too much criticism from the U.S. government for its predatory efforts on monopolizing global supply chains and state-directed IP theft, Xi's 14th FYP (2021-2025) continued MIC 2025's focus towards developing advanced technologies, and acquiring foreign expertise.[221] In reference to Figure 4, *14th FYP Priorities*, the largest sections—measured by the number of chapters dedicated to them—were "innovation and industrial modernization," and

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217 Lafferty, "Civil-Military Integration and PLA Reforms," 637.

218 Joel Wuthnow and Phillip Saunders, "Introduction: Chairman Xi Remakes the PLA," in *Chairman Xi Remakes the PLA: Assessing Chinese Military Reforms* (Washington, D.C.: National Defense University Press, 2019), 2–9, https://ndupress.ndu.edu/Portals/68/Documents/Books/Chairman-Xi/Chairman-Xi.pdf.

219 Lafferty, "Civil-Military Integration and PLA Reforms," 637.

220 Elsa Kania, "China's Strategic Support Force: A Force for Innovation?" The Diplomat, last modified February 18, 2017, https://thediplomat.com/2017/02/chinas-strategic-support-force-a-force-for-innovation/

221 Karen M. Sutter, *Made in China 2025 Industrial Policies: Issues for Congress,* CRS Report No. IF10964 (Washington, DC: Congressional Research Service, 2020), https://crsreports.congress.gov/product/pdf/IF/IF10964.

"economic system and market reforms," both of which Xi devoted 14% of his FYP to.[222] Grunberg and Brussee also note in their research that despite "innovation" having more chapters dedicated to it, the word "security" barely out mentioned "innovation" 177 to 164 respectively.[223] The 14th FYP endorsed Xi's "dual circulation" strategy as the FYP elevated China's technological development on par with China's national security.[224] According to Feng's analysis, "spending on research and development [increased] by over 7% annually for the next five years, an astonishing figure that [surpassed] the military budget's 6.8% increase."[225] The 14 FYP mirrors Xi's MCF strategy with a focus on S&T innovation, especially in strategic emerging industries, and strengthening the domestic manufacturing capability to end China's reliance on importing essential resources.

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222 Nis Grunberg and Vincent Brussee, "China's 14th Five-Year Plan—Strengthening the Domestic Base to Become a Superpower," MERICS, last modified April 9, 2021, https://merics.org/en/short-analysis/chinas-14th-five-year-plan-strengthening-domestic-base-become-superpower.

223 Grunberg and Brussee, "China's 14th Five-Year Plan."

224 Feng, "Technological Decoupling: The Newest Phase of U.S.-China Competition."

225 Feng, "Technological Decoupling: The Newest Phase of U.S.-China Competition."

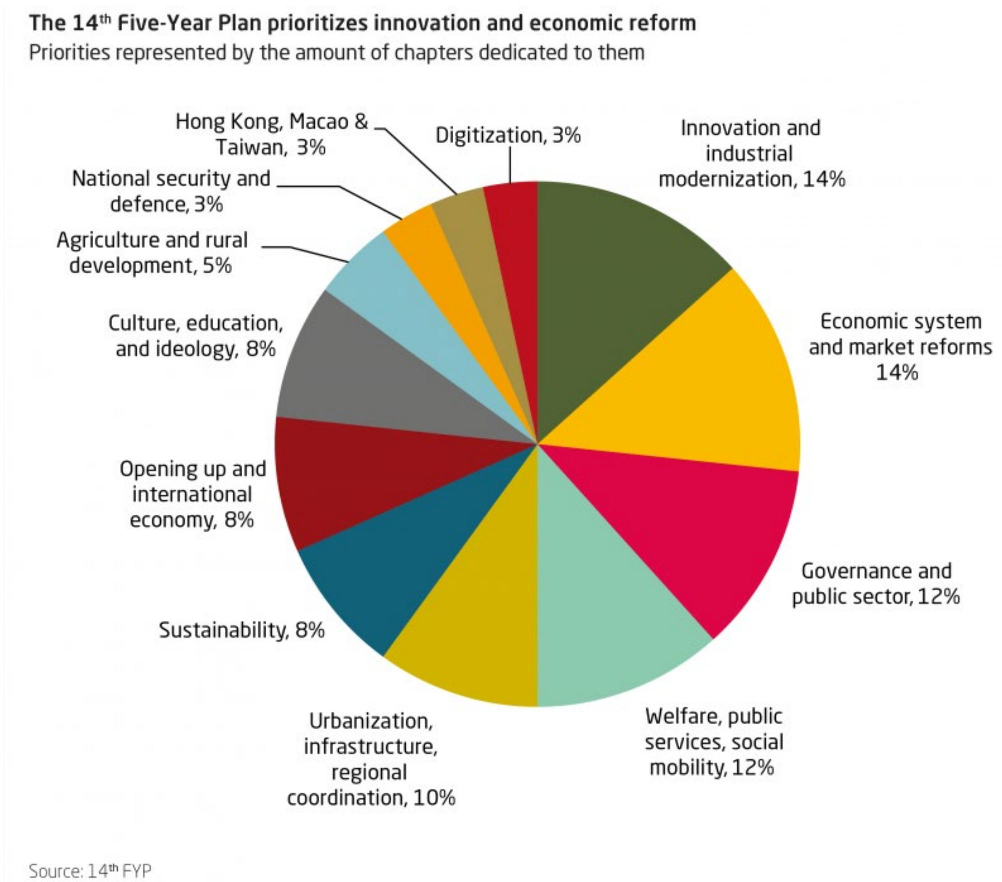

Figure 4. 14th FYP Priorities[226]

MCF's role under the Xi has also experienced increased activity and profitability within the defense SOEs. In reference to Figure 5, *China Defense SOEs Financial Performance (2009-2019),* China's defense industry started to become profitable around the time Xi came to power, averaging around 5% of annual profits.[227] Xi's 2020 SOE reforms have eased capital investment restrictions between private and foreign sources, provided more autonomy for SOE executives in decision-making processes, and encouraged the merging of state and non-state enterprises.[228] For example in May 2022, two large Chinese defense enterprises—China Avionics Systems and AVIC

226 Source: Grunberg and Brussee, "China's 14th Five-Year Plan."

227 Cheung, *Innovate to Dominate,* loc. 170.

228 Cheung, *Innovate to Dominate,* loc. 119.

Electromechanical Systems—merged to form the largest domestic producer of airborne systems.[229] In addition to the consolidation of defense SOEs, and increased investment capital flows from the private sector, China's defense SOEs have been active investors in the commercial sector, becoming shareholders in more than 6,000 Chinese commercial enterprises.[230] Xi's 2020 SOE reform efforts have rapidly taken root in making China's SOEs more competitive in the global market, avoiding inefficient resource dispersion, and reducing manufacturing redundancy.

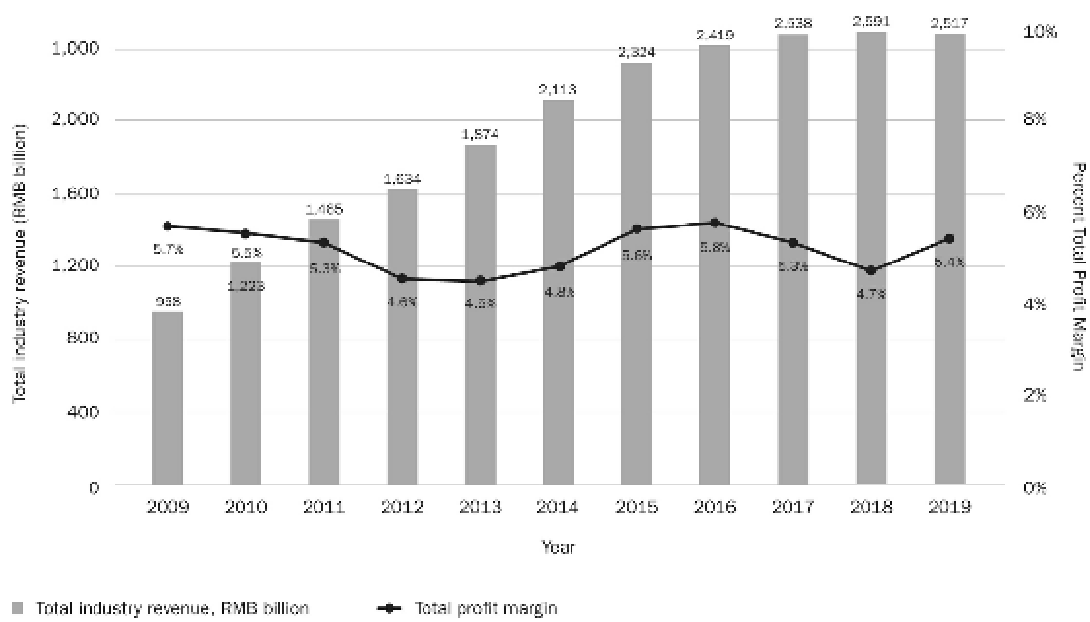

Figure 5. China Defense SOEs Financial Performance (2009–2019)[231]

L. XI'S DRIVER #3: FOREIGN TECH TRANSFER

Xi's MCF reforms did not only have an impact on a political and bureaucratic level, but also on the commercial sector as he promoted indigenous innovation. Since China's

229 van Wyk, "China's Military Industry is Booming with Huge Demand for Combat Equipment."

230 van Wyk, "China's Military Industry is Booming with Huge Demand for Combat Equipment."

231 Source: Cheung, *Innovate to Dominate,* loc. 170.

commercial and defense sectors were still widely nascent in their technological development, and not fully prepared for indigenous innovation, they had to utilize simpler modified forms of innovation, one of which Stone and Wood refer to as "integrated innovation" (集成创新)—the practice of locally producing newer and modified versions of acquired foreign technologies.[232] Another model that was popularized amongst China's commercial enterprises to promote innovation was IDAR—Introduction, Digestion, Absorption, and Re-Innovation.[233] IDAR, much like integrated innovation, required the importation of foreign technologies, which was then used to re-innovate using Chinese specifications. A C4ADS report reveals that between 2014 and 2019, there were 1,665 Chinese commercial entities that partook in foreign technology transfers with Western counterparts, wherein the acquired foreign technologies were re-innovated to products for PLA use.[234] Although not all foreign acquired technologies get converted to military application, the research provides anecdotal evidence to show that some form of integrated innovation or IDAR is still prevalent throughout China.

China's C919 passenger jetliner is widely recognized as one of China's MCF success stories. Although many may laud the C919 as a domestically designed and manufactured product, the manufacturer of the C919—a civilian aviation SOE named Commercial Aircraft Corporation of China (COMAC)—utilized illicit means of foreign technology transfer via Intellectual Property (IP) theft and cyberattacks to obtain technologies for the engine, cockpit, flight control system, weather radar, and much more.[235] According to Sutter, Turbine Panda—a cyber threat actor with ties to the Ministry of State Security's Jiangsu Bureau—"targeted multiple foreign aerospace suppliers

232 Stone and Wood, *China's Military-Civil Fusion Strategy*, 74.

233 Chriss Street, "Chinese Army Employs Military-Civil Fusion to Weaponize Industrial Base," The Epoch Times, last modified September 30, 2019, https://www.theepochtimes.com/chinese-army-employs-military-civil-fusion-to-weaponize-industrial-base_3101117.html?welcomeuser=1.

234 Angliviel et al., *Open Arms*, 7–19.

235 Sutter, "Foreign Technology Transfer Through Commerce," loc. 64.

between 2010 through 2015," some of which were Ametek, Honeywell, Safran, Capstone Turbine, and GE Aviation, for technologies tied to a turbine jet engine co-produced by GE and French aerospace firm Safran.[236]

In addition to commercial enterprises, the Chinese government utilized its top academic institutions to acquire foreign tech transfers. Chinese leaders believed that the West would view collaboration with Chinese civilian entities on S&T-related topics as less ominous, than compared to an SOE or large commercial enterprise. China's top defense-related S&T universities—also known as the "Seven Sons of National Defense"—have been important mechanisms for producing research and converting acquired foreign technologies directly into weapons systems.[237] According to an Australian Strategic Policy Institute report, these national defense universities are some of China's most financially-supported universities, wherein 2016 they altogether spent 13.79 billion RMB on defense research, and have faculty, scientists, and graduates that participate in a wide variety of MCF activities such as PLA expert advisory committees and major military projects.[238] The research produced from each of the Seven Sons of National Defense key state laboratories transcend beyond defense-related contributions, but also have civilian subsidiaries with a total of 191 companies. The dual-use contributions of China's research laboratories and universities have directly improved China's civilian and defense engineering and manufacturing output.

Talent recruitment programs during the Xi era have intensified as it strived to obtain knowledge from foreign-based experts in advanced technology fields. From 2013 to 2018, the TTP under the Xi administration recruited 4,700 participants, a 41% increase compared to the 3,320 TTP participants recruited under the Hu administration from 2008 to 2012.[239] One such example involved, Wang Chunzai, who simultaneously worked as a research

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[236] Sutter, loc. 65; and Catalin Cimpanu, "Building China's COMAC C919 Airplane Involved a lot of Hacking," last modified October 14, 2019, https://www.zdnet.com/article/building-chinas-comac-c919-airplane-involved-a-lot-of-hacking-report-says/.

[237] Joske, *The China Defense Universities Tracker*, 6–7.

[238] Joske, 7.

[239] Cheung, *Innovate to Dominate*, loc. 242.

scientists at the National Oceanic and Atmospheric Administration (NOAA), and was under contract with the Chinese government through the TTP and the Changjiang Scholarship, was convicted in 2018 and indicted on five counts of defrauding the U.S. government as he simultaneously was.[240] There were many more Chinese overseas like Wang Chunzai, who returned back to China to work via China's state-sponsored talent recruitment programs. Tatlow, Feldwisch-Drentrup and Fedasiuk point out that Europe has been a hotbed of Chinese participants under the Haizhi Plan, wherein 2017, the program "organized a total of 8,651 trips by scientist back to China from overseas (including Europe), yielding 1,267 projects."[241]

M. CONCLUSION

Every Chinese leader from Mao Zedong to Xi Jinping has pursued some form of a MCF strategy. However, each leader's MCF strategy was strongly influenced by external factors, such as geostrategic and security concerns, which varied in breadth and scale under each Chinese leader. Although his era was not analyzed, Mao faced a significantly unstable security environment as the U.S. military intervened in conflicts on the Korean Peninsula in the 1950s, and Indochina throughout the 1960s and 1970s. In addition, as Sino-Soviet relations declined throughout most parts of the 1960s and 1970s, Mao decided to focus heavily on developing the defense industry. Facing a highly unfavorable geostrategic environment, China was able to develop its own nuclear bomb and long-range ballistic missile by the 1960s, and a satellite by 1970—which provided an inspiration for future Chinese generations to pursue defense-related S&T programs.

Deng on the other hand broke from the Mao era practices and instead focused on initiatives that redistributed manpower and facilities from the defense economy to serve the country's economic development. Deng's lowered threat assessment of China's security environment allowed him to launch his Reform and Opening policy. The lowered threat assessment prompted Deng to push forward important MCF initiatives that lasted for

240 Stoff, "China's Talent Programs," loc. 43.

241 Didi Kirsten Tatlow, Hinnerk Feldwisch-Drentrup, and Ryan Fedasiuk, "Europe: A Technology Transfer Mosaic," in *China's Quest for Foreign Technology: Beyond Espionage,* ed. William C. Hannas and Didi Dirsten Tatlow (New York: Routledge, 2021) loc. 115 of 350, Kindle.

many decades. Deng's most significant MCF initiative—the 863 High Technology Research Program—extended into the Jiang and Hu eras with implications to make China become globally competitive in strategic technologies. During the U.S.-Soviet Cold War confrontation, Deng was able to leverage its relationship with the United States by acting as a buffer against the Soviet threat, and in return accepted valuable technology transfers that contributed greatly to China's aviation industry. After the Soviet breakup after the Cold War, China took advantage of Russia's instability and recruited its scientists and engineers, as well as purchased its military assets for reverse engineering projects. Regardless of these foreign tech transfers, Deng's focus on developing the commercial sector left the defense industries ill-equipped to meet future conflicts during the Jiang era.

Faced with rising geostrategic concerns, Jiang was forced to resurrect important features of the Mao era, such as a renewed focus in China's defense S&T sector. In the 1990s, U.S. military interventions in the Taiwan Strait, and the accidental bombing of the Chinese embassy in Belgrade, in addition to the display of U.S. technological superiority during the Iraq and Kosovo wars, provided Jiang a large impetus to upgrade the PLA from having a mechanized warfighting capability to one of informatization. Due to the wide technological gap between China and West, Jiang launched his 995 Project to develop high-tech asymmetric warfighting capabilities. Jiang's legacy of ushering China into the WTO exposed China's nascent markets to foreign competition, however, China's commercial enterprises were able to leverage the situation by acquiring foreign technology transfers which China was able to absorb and reverse engineer.

The Hu era experienced high economic growth supported by a boom in its commercial S&T sector. Hu maintained Jiang's narrative of China's "peaceful rise" as China prepared to demonstrate on the global stage—the 2008 Beijing Olympics, and the 2010 Shanghai Expo—how modern and technologically advanced of a society it was. Hu took advantage of a relatively benign geostrategic environment in the early 2000s to focus on developing strategic emerging technologies with the launch of the 2006–2020 MLP. To leverage the growth of the commercial S&T sector, Hu in 2007, initiated a more integrated approach to MCF by utilizing China's civilian and commercial S&T entities as the locus for R&D efforts, as opposed to solely allocating R&D efforts to the defense sector, as was done with his predecessors. In further support of China's civilian commercial S&T enterprises, Hu provided funds for the 863 Program more than Jiang and Deng eras combined. Towards the end of Hu's leadership, concerns over China's security environment began to rise as Hu was faced with maritime disputes further away from China's borders. China's maritime conflicts, along with its strong economic growth, laid the groundwork for the Xi era to continue pursuing MCF efforts in leveraging the resources of the civilian sector to enhance the PLA's warfighting capabilities.

While Xi's MCF strategy was larger in terms of breadth and scale than his predecessors, he could not have implemented his MCF initiatives without the foundations that they laid. Xi recognized the importance of MCF in relation to China's economic competitiveness and national defense and implemented two significant policy changes: the first in 2015, when he elevated MCF to a national-level policy; and secondly in 2017, when he elevated the CMCFDC to a level on par with the CMC and State Council. However, the increasingly hostile security environment during the Xi era has been the largest driver for China's MCF-related activities. Maritime territorial disputes have risen in the East China and South China Seas, trade disputes have also grown exponentially, and U.S.-China relations have significantly degraded over topics such as Taiwan, unfair trade practices, and the pilfering of IP through cyberattacks. China is feeling more and more isolated and is looking to bolster its drive for self-sufficiency through indigenous innovation. China is not shy about its actions either as it shifts from Deng's "hide and bide," towards a more aggressive policy to achieve China's national rejuvenation.

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III. CHINA'S DRIVE TOWARDS AI SUPERIORITY

What were the main drivers of China's Artificial Intelligence (AI) policy? CCP leaders viewed developing AI capabilities as vital towards enhancing both its national security and economic competitiveness. To achieve this ambition, China implemented a whole-of-society approach to become the premier AI superpower by 2030. Beijing initiated national guidelines in its 2017 AIDP following a "Sputnik-like" moment wherein Google's AI AlphaGo computer program defeated two masterminds in a complex Chinese board game called Go.[242] This pivotal event caused China's leaders to realize AI's sheer potential towards national defense and economic development which spurred the central and local governments into action, creating a flurry of domestic AI-friendly policies and funding initiatives. AI has continued to be a core priority from within the highest levels of China's leadership, driven in large part by the growing strategic competition with the West, strong state support, and an educated talent pool.[243]

China's AI "Sputnik" moment raised CCP leaders' concerns about how far behind they were compared to their Western counterparts integrating emerging technologies with defense capabilities. However, despite these fears, Chinese military leaders were optimistic that AI could contribute greatly by lowering the costs of military conflict through the use of intelligent munitions, Unmanned Aerial Vehicles (UAV), and Intelligence, Surveillance, and Reconnaissance (ISR) software.[244] China's national champions—such as Huawei, Baidu, Alibaba, Tencent, and iFlytek—along with the PLA, have successfully fused their technological capabilities with weapon systems to enhance China's warfighting

[242] Kai-Fu Lee, *AI Superpowers: China, Silicon Valley, and the New World Order* (New York: First Mariner Books, 2021), loc 8 of 354, Kindle; and Ding, *Deciphering China's AI Dream*, 13.

[243] Lee, *AI Superpowers*, loc 10; and Ngor Luong and Zachary Arnold, *China's Artificial Intelligence Industry Alliance: Understanding China's AI Strategy Through Industry Alliance* (Washington, D.C.: Center for Security and Emerging Technology (CSET), May 2021), 3, https://cset.georgetown.edu/wp-content/uploads/CSET-Chinas-Artificial-Intelligence-Industry-Alliance-1.pdf.

[244] Ryan Fedasiuk, "Chinese Perspectives on AI and Future Military Capabilities," *Center for Security and Emerging Technology* (CSET), last modified August 2020, pg. 15-25, https://doi.org/10.51593/20200022.

capability.[245] Some of these technological upgrades have resulted in the creation of new asymmetric weapon systems that have severely impacted the balance of power within the U.S.-China relationship.

China's state and local governments have been instrumental in implementing AI-friendly policies to encourage AI development in both its academic and commercial startup domains. In 2017, China's State Council adopted its signature national policy, the 2017 AIDP, which initiated a wave of investment towards technological innovation and entrepreneurship. The 2017 AIDP outlined a two-pronged approach of gathering foreign talent and technical know-how using its commercial national champions, and training local talent using its AI academic programs and technology research centers.[246] This national policy reinvigorated China's commercial and private sectors, elevating AI investment and startup levels to new heights, reaching up to $15 billion in some provincial AI innovation hubs.[247] China's cities have been fundamental towards creating AI ecosystems responsible for accelerating indigenous S&T innovation.

China's rapid rise in AI innovation can be attributed to the highly trained talent pool researching at some of the world's largest AI research labs. To leapfrog the West in AI capability, China's governments, and commercial enterprises, have launched programs to lure top talent. China's growth in its domestic talent pools is fueled by China's universities, which have produced an abundance of graduates with degrees in computer science, integrated circuits, and microelectronics. In addition, China's private sector research labs have also been involved in the fostering of local talent. China's SenseTime has one of the largest AI research facilities, housing over 600 full-time researchers creating cutting-edge computer vision AI.[248] Although China's talent pool may not have reached

[245] Eric Schmidt et al., *Final Report: National Security Commission on Artificial Intelligence* (The United States of America: National Security Commission on Artificial Intelligence, 2021), 25, https://assets.foleon.com/eu-west-2/uploads-7e3kk3/48187/nscai_full_report_digital.04d6b124173c.pdf.

[246] Ding, *Deciphering China's AI Dream*, 5.

[247] Gregory C. Allen, "Understanding China's AI Strategy: Clues to Chinese Strategic Thinking on Artificial Intelligence and National Security," *Center for New American Security (CNAS) (*February 2019): 3, https://www.cnas.org/publications/reports/understanding-chinas-ai-strategy.

[248] Allen, "Understanding China's AI Strategy," 9.

the elite level of the United States yet—where U.S.'s 5,518 top-rated AI-scientists dwarfs China's 977—China's AI talent pool have launched startups that are beginning to expand and compete into global markets.[249]

This chapter will assess key elements within each main driver for China's AI development. The biggest factors driving China's AI development—strategic competition and security concerns—was significantly influenced by the challenges from the West as America imposed strict export limits on advanced semiconductors and possessed the most capable means of intelligentized defense capabilities. However, China's geostrategic concerns alone were not able to accelerate AI's development to its current level. Metaphorically speaking, if China's security concerns were the keys in the ignition to start the car, then China's central and local governments were the oil and gas that kept the car running. The central government was essential in implementing and executing AI national-level plans—2017 AIDP and MIC 2025. Under these priorities, China experienced a growth of AI startups, AI special economic zones (SEZ), and smart cities. Lastly, China's talent recruitment programs played a minor role in driving AI innovation as China's domestic talent pool has displayed an entrepreneurial and innovative spirit that rivals the West.

A. AI DRIVER #1: GEOSTRATEGIC COMPETITION AND SECURITY

The CCP, especially while under Xi's leadership, has placed modernizing the PLA, in addition to increasing China's economic strength, as a top priority. According to a U.S. 2021 report from the National Security Commission on Artificial Intelligence (NSCAI), "China sees AI as the path to offset U.S. conventional military superiority by 'leapfrogging' to a new generation of technology. Its military has embraced 'intelligentized war'—for example, swarming drones to contest U.S. air and naval supremacy."[250] China's shift towards intelligentized warfighting capabilities was predicated with the mission to offset U.S. military superiority by relying more on intelligence analysis, information

[249] Allen, 10.

[250] Eric Schmidt et al., *Final Report*, 22–23.

warfare, target recognition, and warfare algorithms.[251] Since 2016, China has also witnessed an upsurge in AI funding initiatives and policies amongst 40 other nations, stoking concerns within China as the growing trend might pose potential challenges to China's defense and commercial AI ambitions.[252]

1. International Security Concerns

China's leaders believed that AI technology could further enhance its warfighting capabilities and help counter challenges posed by the United States during an era of GPC. Kania refers to this phenomenon as "creative security," wherein external threats, such as the United States, provides China an impetus for rapid AI development.[253] One area that the PLA has observed the U.S. defense apparatus use AI, and seeks to emulate, is the implementation of ISR capabilities that can analyze foreign media and geospatial imagery.[254]

Even though China looks to the United States as a model to implement AI within its security apparatus, China also harbors many concerns about how the United States can use AI applications towards its warfighting capabilities. For example, multiple Chinese papers point to a 2018 U.S. Congressional hearing which relayed Department of Defense (DOD) AI developments to include 592 AI projects.[255] Chinese experts worry that some of these AI-enabled weapon systems will exceed their own, such as the MQ-25 Stingray Carrier-Based Aerial Refueling System UAV, AGM-158C Long Range Anti-Ship Missile (LRASM), and the ALPHA air combat simulation software.[256] However, Chinese military experts have also overstated U.S. AI defense capabilities without citing sources of the

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[251] Fedasiuk et al., *Harnessed Lighting*, 3–4.

[252] China Academy of Information and Communications Technology (CAICT) (translated by Etcetera Language Group, Inc.), "Artificial Intelligence White Paper 2022," Center for Security and Emerging Technology (CSET), Last modified June 6, 2022, 1–2, https://cset.georgetown.edu/publication/artificial-intelligence-white-paper-2022/.

[253] Kania, "Artificial Intelligence in China's Revolution in Military Affairs," 517–18.

[254] Fedasiuk et al., *Harnessed Lighting*, 17.

[255] Fedasiuk, "Chinese Perspectives on AI and Future Military Capabilities," 18.

[256] Fedasiuk, 16.

information, for example, claiming that in 2017, the DOD spent between $12-$15 billion on AI R&D, and by 2025, 90% of U.S. military's fighter aircraft will be drone-operated.[257]

Fedasiuk's research of PLA contracts between March 30 and December 1, 2020, reveals strong signals of both intent and capability behind its goals for AI and military modernization. Within this small sample size case study, Fedasiuk highlights "seven primary application areas for which the Chinese military is awarding AI-related equipment contracts: autonomous vehicles, intelligence analysis, information warfare, logistics, training, command and control, and target recognition."[258] The case study also revealed that in addition the PLA, some of China's largest defense SOEs and subsidiaries under the CMC such as the Aviation Industry Corporation of China (AVIC), the Academy of Military Sciences (AMS) and the National University of Defense Technology (NUDT), were also large benefactors of AI-related procurement contracts.[259]

The PLA's AI developments in unmanned systems for defense purposes has caught the U.S.'s attention as Beijing projects its power into its near seas and oceans. According to Kania, each branch of the PLA has made advancements in AI weaponry such as the PLA's robotics and unmanned ground vehicles; the PLA Navy's (PLAN) unmanned surface vessels and submarines; the PLA Air Force's (PLAAF) advanced unmanned systems; the PLA Rocket Force's (PLARF) remote sensing and targeting; and the PLA Strategic Support Force's (PLASSF) cyber and electronic warfare.[260] In 2017, the PLAN tested an unmanned underwater vehicle (UUV), called the HN-1, that had the stealth and movement capabilities of a real fish.[261] Due to the underwater drone's success, upgraded versions—the HN-2 and HN-3—have already been in works that are larger and faster. The

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[257] Fedasiuk, 19.

[258] Fedasiuk et al., *Harnessed Lighting*, 2.

[259] Fedasiuk et al., 8.

[260] Elsa B. Kania, *"AI Weapons" in China's Military Innovation (*Washington, D.C., Global China in partnership with CSET, 2020), 3, https://www.brookings.edu/wp-content/uploads/2020/04/FP_20200427_ai_weapons_kania_v2.pdf.

[261] Lyle J. Goldstein, "Meet the HN-1, China's New AI-Powered Underwater Drone," *The National Interest*, last modified July 15, 2018, https://nationalinterest.org/feature/meet-hn-1-chinas-new-ai-powered-underwater-drone-25706.

PLAN also developed a similar device called the Sea Iguana—an unmanned surface vehicle (USV)—which can be used for amphibious operations.[262] In May 2022, China unveiled the world's first intelligent unmanned system warship capable of launching drones.[263] This unmanned warship poses many security challenges to the West as the PLAN continues to project its power into the East China and South China Seas.

2. Great Power Competition

The buildup of AI-related funding initiatives and domestic policies by both China and other major economies has created a technological arms race to stake their claim as a global leader in AI. According to the China Academy of Information and Communications Technology (CAICT)—a think tank under China's Ministry of Industry and Information Technology (MIIT)—the United States, Japan, the European Union, and United Kingdom upgraded new initiatives to enhance their industrial competitiveness. For instance, in March 2021, the European Union released its 2030 Digital Compass, which targeted specific industries—quantum computing, digital innovation hubs, and AI—to further enhance its collective security and commercial competitiveness.[264] Also in 2021, both Japan and the United Kingdom each issued new AI strategies, with Tokyo calling for increased measures in R&D towards developing quantum computing and AI, and London aiming to stake its claim in the global AI race pushing forward norms and ethics for global AI governance.[265] However, mostly on Beijing's radar has been Washington's passing of the 2021 Innovation and Competition Act, which has prioritized AI and quantum computing, as well as expanded security efforts against China's aggressive economic and influence activities.[266]

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[262] Kania, "AI Weapons," 4.

[263] Alia Shoaib, "China Launch the World's First AI-Operated 'Mother Ship,' an Unmanned Carrier Capable of Launching Dozens of Drones," Insider Intelligence, last modified June 11, 2022, https://www.businessinsider.com/china-launches-worlds-first-ai-unmanned-drone-aircraft-carrier-2022-6.

[264] CAICT, "AI White Paper 2022," 1–2.

[265] CAICT, 1–2, 19.

[266] Jake Harrington and Riley McCabe, "What the U.S. Innovation and Competition Act Gets Right (and What It Gets Wrong)," CSIS, July 1, 2021, https://www.csis.org/analysis/what-us-innovation-and-competition-act-gets-right-and-what-it-gets-wrong.; CAICT, "AI White Paper 2022," 2.

3. Commercial Competition

The United States and China are vying for AI supremacy due to the advanced technology's growing economic benefits. Experts project that by 2030, China will account for 50% of the $15.7 trillion global AI industry, far surpassing that of U.S.'s projected share.[267] The U.S. Department of Commerce has taken notice of the rise of incidences involving technology transfers and has blacklisted an already growing number of overseas academic and commercial institutions. The Chinese government encourages the forging of closer working relationships with multinational corporations (MNC) in the high technology sectors to facilitate access to strategic technologies such as high-quality semiconductors and supercomputers.[268] China's 2017 AIDP supports "domestic AI enterprises to cooperate with international leading AI schools, scientific research institutes and team."[269]

An area where China has leveraged collaboration in multinational research teams and companies to its advantage was in the drone industry. According to a Center for New American Security report, even though DJI—China's leading drone manufacturer—is based in Shenzhen, "all of DJI's drone flight software development is performed at DJI's American office in Palo Alto, which predominantly employs U.S. citizens as staff. Additionally, nearly 35% of the bill of materials in each of DJI's products are from the United States."[270] Fusing the capabilities and resources from both AI powerhouses had resulted in DJI dominating 50% of the North American and 74% of the global drone markets.[271]

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[267] Ryan Sullivan, *The U.S., China, and Artificial Intelligence Competition Factors* (Montgomery, AL: China Aerospace Studies Institute, Oct 2021), 9, https://www.airuniversity.af.edu/CASI/Display/Article/2793710/the-us-china-and-artificial-intelligence-competition-factors/.

[268] Ding, *Deciphering China's AI Dream*, 16–17.

[269] New America (translated by Rogier Creemers, Leiden Asia Centre; Graham Webster, Yale Law School Paul Tsai China Center; Paul Triolo, Eurasia Group; and Elsa Kania), "State Council Notice on the Issuance of the Next Generation Artificial Intelligence Development Plan," New America, Last modified August 1, 2017, 24, https://www.newamerica.org/cybersecurity-initiative/digichina/blog/full-translation-chinas-new-generation-artificial-intelligence-development-plan-2017/

[270] Allen, "Understanding China's AI Strategy," 10.

[271] Lee, *AI Superpowers,* loc 166; and Allen, "Understanding China's AI Strategy," 9.

But competition for tech supremacy between the United States and China has grown increasingly contentious over one vital AI component—semiconductors. The United States has been the dominant leader in the manufacturing of this vital high technology, controlling 48% of the market which rakes in $193 billion annually, while China remains heavily reliant, purchasing $350 billion of the product in 2020.[272] China has invested heavily in development of AI semiconductors, especially after the United States implemented stricter export and licensing controls under the Obama and Trump administrations.[273] Additionally, in 2020, Taiwan Semiconductor Manufacturing Corporation (TSMC), manufacturers the most cutting-edge semiconductors in the world, controlling 51.5% of the global market, has also discontinued supplying Chinese companies over security concerns.[274]

Due to China's current situation of not being able to produce the advanced-level semiconductors needed for high performance mechanisms—in 2019 China was only capable manufacturing 14 nanometer semiconductors, which the United States was able to accomplish by 2014—it will likely pursue talent recruitment and cyber or industrial espionage to obtain the technological know-how. In 2021, due to expanding business, more than two-thirds of China's 3,000 semiconductor companies experienced sharp increases in demand for Chinese graduates with backgrounds in integrated circuits, microelectronics, and computer science, areas of expertise needed to develop advanced semiconductors.[275]

The United States may be ahead of China in the AI semiconductor development race; however, the Chinese government and its savvy entrepreneurial base are quickly closing the gap. So far, Nvidia has taken the lead in the AI semiconductor market, but traditionally software and digital-focused tech companies such as Google, Microsoft, and

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272 "Semiconductors and the U.S.-China Innovation Race," Foreign Policy, February 16, 2021, https://foreignpolicy.com/2021/02/16/semiconductors-us-china-taiwan-technology-innovation-competition/.

273 Foreign Policy, "Semiconductors and the U.S.-China Innovation Race,"; and Allen, "Understanding China's AI Strategy," 19.

274 Foreign Policy, "Semiconductors and the U.S.-China Innovation Race."

275 Che Pan, "China Chip Makers Scramble for Semiconductor Talent," South China Morning Post, June 10, 2022, https://www.scmp.com/tech/big-tech/article/3181209/china-chip-makers-scramble-semiconductor-talent-showering-fresh.

Facebook have also joined in on the competition for AI semiconductors.[276] For China, Cambricon, a state-sponsored startup valued at $1 billion, has recently developed semiconductors for Graphics Processing Units (GPU)—GPUs are the computing technology responsible for a wide range of applications such as visual effects in gaming and AI—that operates six times faster and consume less energy compared to standard GPUs.[277] In 2019, Huawei launched its own AI processor—Ascend 90—which is arguably the world's most powerful AI processor, overtaking Apple in the mobile AI semiconductor industry.[278] According to Ding, in October 2017, "China's Ministry of Science and Technology (MOST) announced a project to invest in semiconductors that run artificial neural networks as one of 13 'transformative' technology projects with a delivery date of 2021."[279] This AI semiconductor project specifically targets Nvidia's M40 semiconductor, hoping to outperform the M40 in terms of energy and operating efficiency by 20 times.

4. Domestic Security Concerns

AI capabilities also enable the CCP to strengthen its hold onto power through the monitoring and surveilling of targeted populations. AI has many civilian uses for the commercial sectors, which has stoked fear amongst many Chinese citizens concerning how China will use AI to monitor and suppress dissent. A 2021 U.S. National Security Commission on AI report reveals, "China's use of AI-powered surveillance technologies to repress its Uyghur minority and monitor all of its citizens foreshadows how authoritarian regimes will use AI systems to facilitate censorship, track the physical movements and digital activities of their citizens, and stifle dissent"[280]

Xiang, in her book, *Red AI,* admits that it is difficult to assess China's domestic security budget, but estimates that the Chinese government has spent approximately $197

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276 Lee, *AI Superpowers,* loc. 124.

277 Ding, *Deciphering China's AI Dream*, 18.

278 Ding, 18.

279 Ding, 16–17.

280 Schmidt et al., *Final Report: National Security Commission on Artificial Intelligence*, 27.

billion in 2017.[281] Although it was not clear how much of that budget was spent on AI-related technologies, recent trends reveal that AI has taken on a growing part of its security apparatus with improvements in facial recognition. According to China's 2018 Ministry of Finance database, the Xueliang Gongcheng (Bright Project)—a government crime prevention program utilizing surveillance cameras—reported over 10 billion RMB ($1.4 billion) in government procurement contracts as more cities and towns request for the implementation of the AI security apparatus.[282] In addition to the Bright Project, the Chinese government has initiated other domestic security AI programs such as Tianwang Gongcheng (Sky Net Program) and Pingan Chengshi (Safe Cities), which have generated tens of thousands of government procurement contracts as provincial and municipal governments rapidly implemented these programs to enhance facial recognition surveillance, public security, traffic management and emergency response.[283]

B. AI DRIVER #2: STATE INTERVENTION AND DOMESTIC POLICIES

AI posed strategic security and commercial concerns that drove CCP leaders to implement policies to counter the West. Beijing provided authoritative guidance for its provincial, municipal, and county level governments to execute, which in turn created the necessary support to attract talent inflows and venture capital. In July 2017, Beijing launched its first systematic and strategic national-level AI plan, the 2017 AIDP.[284] This policy set the direction for the rest of the country to follow—setting a benchmark for China to become the world's leading AI innovation center by 2030—by impacting local officials vying for talent and investment, in hopes of turning their localities into AI innovation hubs.[285] Kai-Fu Lee mentions that thousands of local level officials began offering "subsides for research, directing venture-capital 'guiding funds' toward AI, purchasing the

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[281] Nina Xiang, *Red AI: Victories and Warnings from China's Rise in Artificial Intelligence (*Amazon Digital Services LLC, 2019), loc 42 of 108, Kindle.

[282] Xiang, *Red AI,* loc 42.

[283] Xiang, loc 43.

[284] Fei Wu et al., "Towards a New Generation of Artificial Intelligence in China," *Nature Machine Intelligence* 2 (June 2020): 312, https://doi.org/10.1038/s42256-020-0183-4.

[285] Fei Wu et al., "Towards a New Generation of Artificial Intelligence in China," 312; and Lee, *AI Superpowers,* loc. 125.

products and services of local AI startups, and setting up dozens of special development zones and incubators."[286]

1. The New Generation AI Development Plan (2017)

The 2017 AIDP—the State Council's key AI guideline—incentivized local government officials to turn their cities into hubs for AI innovation. This signaled a national-level focus on AI and provided three-step approach towards AI development wherein China will be on par with the most advanced countries by 2020, reach a world-leading level in some AI fields by 2025, and become the global leader in AI by 2030.[287] China's whole-of-society approach towards AI development has led to a rapid rise in training and funding across both defense and private sectors. By 2018, Chinese companies already accounted for 48% of the world's total start-up funding for AI, and 15 out of the 31 provincial governments had AI plans for incentivizing innovation and entrepreneurship.[288] The 2017 AIDP also prioritized AI's contribution towards the PLA's modernization. According to Kania, the 2017 AIDP was used to "strengthen the use of AI in military applications that include command decision-making, military deductions, and defense equipment."[289]

2. Made in China 2025

MIC 2025 is one of the most important national policies aimed at reducing China's reliance of foreign supply chains and ultimately dominating global production in strategic technologies in ten sectors—information technology, robotics, aerospace, maritime equipment and ships, high-speed railways, new energy-saving vehicles, energy equipment,

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[286] Lee, *AI Superpowers,* loc. 126.

[287] Jeffrey Ding, "China's Current Capabilities, Policies, and Industrial Ecosystem in AI" before the U.S.-China Economic and Security Review Commission Hearing on Technology, Trade, and Military-Civil Fusion: China's Pursuit of Artificial Intelligence, 116th Cong., 1st sess., June 7, 2019, 20–21.

[288] Ding, "China's Current Capabilities, Policies, and Industrial Ecosystem in AI," 21–22; and Legarda and Nouwens, "China's Pursuit of Advanced Dual-Use Technologies."

[289] Kania, "AI Weapons," 3.

agriculture, metamaterials, and high-tech medical devices.[290] Although AI was not included amongst the list, the MIC 2025 and the 2017 AIDP formed the core of China's AI strategy.[291] China hopes to achieve 70% self-sufficiency in high-tech industries deemed critical to national security like aerospace and telecommunications.[292] MIC 2025 set benchmarks to expand China's semiconductor manufacturing output as a share of domestic consumption from 29% in 2014 to 80% by 2030.[293] In order to achieve this benchmark, along with other MIC 2025-related projects, China established 1,800 GGFs valued at $426 billion in 2018.[294]

When the MIIT and other government organizations designed MIC 2025 in 2014, it also promoted forced technology transfers, and the practice of mergers and acquisitions of foreign companies. Chinese investment into advanced Western nations skyrocketed after 2015.[295] According to a Harvard Business Review article, in 2016 "Chinese acquisitions of U.S. firms grew 376%, to about $55 billion…[and] venture capital deals in the U.S. with at least one Chinese investor soared 700% from 2014–2015, to $8 billion, and stayed at that level until reaching a record $11 billion in 2018."[296]

3. Local Governments

The 2017 AIDP had the biggest impact on local governments officials. Xiang reveals that the municipal and provincial level governments competed "to attract AI companies to their regions, luring top talent with the offer of subsides, free office space, favorable loans, and seed capital."[297] Direct government support in the form of funding,

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290 Thomas Orlik, *China: The Bubble That Never Pops (*New York: Oxford University Press, 2020), loc. 139 of 228, Kindle.

291 Allen, "Understanding China's AI Strategy," 3.

292 Lorand Laskai, "Why Does Everyone Hate Made in China 2025?" Council on Foreign Relations, last modified March 28, 2018, https://www.cfr.org/blog/why-does-everyone-hate-made-china-2025.

293 Allen, "Understanding China's AI Strategy," 18.

294 Sutter, *"Made in China 2025,"* 2.

295 Laskai, "Why Does Everyone Hate Made in China 2025?"

296 Black and Morrison, "The Strategic Challenges of Decoupling."

297 Xiang, *Red AI*, loc. 11.

subsidies, and lucrative contracts has accelerated the cultivation for AI startups in cities large and small. For example, between 2017 and 2020, the city of Nanjing via its Economic and Technological Development Zone, allocated around three billion RMB ($450 million) towards AI development in order to challenge other top tier AI hubs such as Beijing, Shenzhen, and Hangzhou.[298] According to Kai-Fu Lee, this fund provided incentives such as "grants of 1 million RMB per company to attract talent, rebates on research expenses of up to 5 million RMB, creation of an AI training institute, government contracts for facial recognition and autonomous robot technology…[and even] coveted spots at local schools for the children of company executives."[299]

4. Smart Cities

Another avenue that is gaining traction to deploy China's tech companies and talent to other less densely population areas is the development of smart cities. In 2017, Xi Jinping embarked on a large-scale project to build a new high technology SEZ, similar to that of Shenzhen and Shanghai, in a rural area about 130 kilometers (80 miles) south of Beijing called Xiong'an New Area.[300] The Chinese central government has taken the lead in creating a model for future smart cities utilizing AI technologies. Kai-Fu Lee mentions that Beijing has placed a high priority on this project and has invested about $583 billion towards intelligent infrastructure projects, in addition to the $91 billion allocated by the local Hebei provincial authorities to build transportation routes specifically for autonomous vehicles.[301] Autonomous driving vehicles are expected to improve vehicle traffic efficiency by 9.25%, a welcome benefit as China has estimated to have around 260,000 road fatalities annually.[302]

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[298] Lee, *AI Superpowers,* loc. 126–127.

[299] Lee, loc. 127.

[300] Frank Ka-Ho Wong, "Xiong'an New Area: President Xi's Dream City," China Briefing, last modified March 26, 2019, https://www.china-briefing.com/news/xiongan-new-area-beijing-tianjin-hebei/.

[301] Lee, *AI Superpowers,* loc. 169.

[302] Lee, loc. 129–68.

The Xiong'an New Area project is only a small part of the central government's larger plans to create smart cities where AI-related technologies will be used to manage traffic and reduce fatalities. Xiong'an New Area is expected to derive 80% of its economic growth from high technology industries such as Baidu, Alibaba, and Tencent, and other energy conservation and environmental protection companies.[303] If successful, Beijing will implement similar models in China's countryside to showcase its technological advancements that have been slow to implement in other advanced Western countries. By 2019, China's Ministry of Housing and Urban-Rural Development—the largest state-sponsor for such projects—embarked on 800 smart city pilot programs spread along China's coast, where total government investment for smart city initiatives has been estimated upwards of up to $139.9 billion.[304]

5. AI Industry Alliances (AIIA)

The 2017 AIDP encouraged the formation of AIIAs, which have played a key role in promoting collaboration and innovation between local governments, academic institutions, and the private industry. In 2017, the National Development and Reform Commission (NDRC), the MOST, the MIIT, and the Cyberspace Administration of China, created the AIIA with the aim of implementing national policies such as the 2017 AIDP.[305] Industry alliances are typically utilized to provide financial support—such as government subsides—and incorporate local government officials into the governance structures of private-sector enterprises to supervise decision-making processes. AIIA's purpose was exemplified when the Chinese government issued rewards—in the form of venture capital financing, tax benefits, and other startup services—to the winners of an AIIA hosted national technology competition. In 2018, iDeepWise—a company specializing in brain-inspired AI and deep learning—won AIIA's 2018 medical AI competition and received a

303 Wong, "Xiong'an New Area: President Xi's Dream City."

304 James Mulvenon et al., *China's Smart Cities Development (*Vienna, VA: SOS International LLC, 2020), 24–25, https://www.uscc.gov/sites/default/files/China_Smart_Cities_Development.pdf.

305 Luong and Arnold, *China's Artificial Intelligence Industry Alliance*, 5.

500,000 RMB cash reward, 6 million RMB of R&D subsidies, as well as 20 million RMB of investment.[306]

The AIIA has ambitious plans to spread beyond China's large coastal cities. Although a majority of AIIA's presence is in major cities, however, a growing number are spreading to second-tier cities. A case in point being Hefei, wherein the Anhui provincial government and the MIIT cultivated an AI ecosystem developing intelligent speech and other AI capabilities.[307] In addition, by 2023, China has planned to construct an additional 20 new AI Development Experimental Zones, in addition to the ones already in Beijing, Shanghai, Hefei, Hangzhou, Shenzhen, Tianjin, Chong Qing, Chengdu, Xi'an, and Jinan.[308] These developmental zones have been instrumental for allowing AI startups in geographically disadvantage locations to have access to state-of-the-art facilities, potential investors, and critical supply chains. The AIIA model has grown rapidly that the number of industry alliance in China's AI sector has doubled since 2017, reaching 190 in 2019.[309]

6. Government Guidance Funds (GGF)

State-backed government investment vehicles, more popularly known as GGFs, are a key state financial support mechanism utilized in developing China's strategic emerging technologies such as AI. These GGFs are set up by both local governments, private venture capital, and SOEs to not only invest in domestic startups, but also provide avenues for the importation of semiconductor manufacturing equipment, and the acquisition of foreign companies—as was the case with the China Integrated Circuit Industry Investment Fund (CICIIF).[310] China on average creates 7.57 new GGFs month, with each fund providing close to $360.99 million in capital.[311] From 2012 to 2019, China's MCF-related GGFs—

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306 Luong and Arnold, 8–9.

307 Luong and Arnold, 10.

308 Fei Wu et al., "Towards a New Generation of Artificial Intelligence in China," 313.

309 Luong and Arnold, *China's Artificial Intelligence Industry Alliance,* 4.

310 Ding, *Deciphering China's AI Dream*, 21; and Sutter, "Foreign Technology Transfer Through Commerce," loc. 60.

311 Tianlei Huang, "Government-Guided Funds in China: Financing Vehicles for State Industrial Policy," Peterson Institute for International Economics, last modified June 17, 2019, https://www.piie.com/blogs/china-economic-watch/government-guided-funds-china-financing-vehicles-state-industrial-policy.

funding directed towards defense and dual-use technologies—raised on average $17.5 billion annually.[312] In 2019, MCF-related GGFs raised a total of $126.2 billion, which accounted for 18% of the total value of GGFs raised that year.[313] According to her testimony before Congress, Kania, highlighted the key role state funding mechanisms, such as the GGFs, played in fusing together state funds and private venture capital towards stimulating high-tech industries.[314]

In order to initiate its National Semiconductor Plan, China's central government created the National Integrated Circuit Industry Investment Fund (NICIIF), sometimes known as the Big Fund or National Chip Fund, and the CICIIF.[315] A 2019 Organization of Economic Cooperation Development (OECD) report revealed the NICIIF and CICIIF were instrumental in assisting some of China's largest semiconductor companies, namely Tsinghua UniGroup, and Semiconductor Manufacturing International Corporation (SMIC), with large sums financial support.[316] When compared amongst the world's 21 largest semiconductor, Tsinghua UniGroup and SMIC received the largest sums of financial government support per share of company revenue between 2014–2018.[317] In Tsinghua UniGroup's case, government-backed funds were used to co-finance the construction of a semiconductor fabrication plant in Wuhan—called the Yangtze Memory Technologies Co., Ltd.—and assisted in the attempts to acquire foreign firms such as South Korea's SK Hynix, and U.S. companies Fairchild, Western Digital, and Micron.[318] The

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[312] Cheung, *Innovate to Dominate,* loc. 278.

[313] Cheung, *Innovate to Dominate,* loc. 127.

[314] Elsa B. Kania, *Chinese Military Innovation in Artificial Intelligence*: Testimony before the U.S.-China Economic and Security Review Commission Hearing on Trade, Technology, and Military-Civil Fusion: China's Pursuit of Artificial Intelligence, 116th Cong., 1st sess., June 7, 2019, 65.

[315] Huang, "Government-Guided Funds in China."

[316] Organization of Economic Cooperation Development (OECD), "Measuring Distortions in International Markets: The Semiconductor Value Chain," OECD Trade Policy Papers, No. 234, OECD Publishing, Paris. http://dx.doi.org/10.1787/8fe4491d-en; and Karen Sutter, *China's New Semiconductor Policies: Issues for Congress,* CRS Report No. R46767 (Washington, DC: Congressional Research Service, 2021), 6, https://crsreports.congress.govR46767.

[317] OECD, "Measuring Distortions in International Markets."; and Sutter, *China's New Semiconductor Policies*, 6.

[318] OECD, "Measuring Distortions in International Markets,," and Sutter, *China's New Semiconductor Policies,* 6.

OECD report also pointed out that the total amount of government support Tsinghua UniGroup and SMIC received had exceeded 30% of their annual revenue.[319]

GGFs were instrumental in supporting AI-related technology startups Pony AI and Cambricon. In 2016, Pony AI was founded by the Nansha GGF with a 500 million RMB investment, and has now turned into China's leading autonomous vehicle technology company, most known for its innovation in robotaxis.[320] Pony AI, was headquartered amongst a plethora of other AI startups in an area just outside of Guangzhou called *Unicorn Field* where 60 other startups worth a total of nearly 50 billion RMB ($7.5 billion) were also located.[321] Also in 2016, brothers Chen Tianshi and Chen Yunji, inspired by Google's AlphaGo, started an AI semiconductor company, called Cambricon, which created AI technologies to enhance everyday living electronic devices with intelligent capabilities. Cambricon quickly became one of China's national champions in the AI semiconductor industry after it received immediate support the Chinese Academy of Sciences (CAS), China's State-Owned Capital Venture Capital Fund, and SDIC Venture Capital. Only two years after its founding, Cambricon was valued at $2.5 billion, making it the highest valued AI semiconductor startup in the world.[322]

C. AI DRIVER #3: HUMAN CAPITAL DEVELOPMENT

China's 2017 AIDP not only played a key role in providing funds to AI startups, but also initiated the implementation of other AI talent-recruitment programs and research innovations centers. These platforms have grown in numbers and have exploited avenues for technology transfer from foreign high-tech companies. According to Sullivan, "it is in the universities where China hopes to address basic research shortcomings and pursue frontier technology breakthroughs through collaborations with Chinese and foreign entities."[323] In 2017, China invested additional financial and political support by sharply

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[319] OECD, "Measuring Distortions in International Markets."

[320] Xiang, *Red AI,* loc 82–84.

[321] Xiang, loc 84.

[322] Xiang, loc 116.

[323] Sullivan, *The U.S., China, and Artificial Intelligence Competition Factors*, 35.

increasing the number of AI colleges and academic research institutions in order to reach its national development and modernization goals.[324] These AI-specific universities and research institutions, in addition to the prominent "Seven Sons of National Defense," have been instrumental in acquiring foreign technology by recruiting top-tier scientists, and sending its military engineers and scientists to study overseas.[325]

1. Talent Recruitment Programs

In addition to its state-sponsored talent recruitment programs—such as The Thousand Talents—China's talent recruitment efforts have also involved private research centers and overseas commercial recruiting centers to find AI experts at home and abroad. According to a Congressional Research Service report, since 2015, Taiwan lost approximately 3,000 semiconductor engineers to China, which include TSMC's former Chief of Operations, and R&D Director, who are now leading China's SMIC.[326] In a short amount of time, China's AI labs and institutions have been able to achieve both indigenous academic and commercial breakthroughs. China's talent pool consistently ranks first or second to the United States when comparing the amount of AI academic papers, AI startups, AI patents produced, and AI unicorns (private startups valued at $1 billion or greater).[327] According to Allison, this focused push to recruit talent has helped China produce 2.5 times more AI patents in 2018 and graduate three times as many computer scientists than the U.S in 2020.[328]

In 2018, China's Ministry of Education issued the Artificial Intelligence Innovation Action Plan for Colleges and Universities to introduce AI-related fields of study on Chinese campuses.[329] Likewise in 2020, the Ministry of Education, the NDRC, and the Ministry of

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[324] Hannas, and Chang, "China's Artificial Intelligence," loc 188.

[325] Mulvenon and Zhang, "Targeting Defense Technologies," loc 99.

[326] Sutter, *China's New Semiconductor Policies,* 7.

[327] Xiang, *Red AI,* loc 26.

[328] Graham Allison and Eric Schmidt, "Is China Beating the U.S. to AI Supremacy," (Boston, MA: Harvard Kennedy School Belfer Center, 2020), 5, https://www.belfercenter.org/sites/default/files/2020-08/AISupremacy.pdf.

[329] Fei Wu et al., "Towards a New Generation of Artificial Intelligence in China," 315.

Finance urged universities to establish graduate-level AI focused training to further enhance its talent cultivation in its education system.[330] This increase of AI-related academic programs has resulted in AI becoming an undergraduate major at more than 200 universities, where some college campuses—Nanjing University, Beijing University, and Tsinghua University—have also set up AI schools and institutes that offer AI-related PhD programs.[331]

One prominent AI scholars that was recruited to go to China was Andrew Chi-Chih Yao, winner of the prestigious Turing Award, and whose academic teaching career spanned the campuses of Massachusetts Institute of Technology (MIT), Stanford University, and Princeton University.[332] While a professor on the Tsinghua University campus, Professor Yao founded a nascent talent program in 2005 to mentor undergraduate students in the computer science department with the purpose of challenging the top talent coming from America's prestigious universities.[333] This paved the way for young entrepreneurs like Yin Qi, Tang Wenbin, and Yang Mu—mentees under Professor Yao's tutelage—who ended up starting China's largest facial recognition/image perception company in 2011, Megvii.[334]

AI's rapid development has created less of a dependency on recruiting foreign elite scholars as China's AI engineers and researchers have access to real-time breakthroughs. Although most of the top AI scholars are in the United States, a lot of their discovered algorithms, data, and results are shared online. This open-source nature of AI research has allowed China's AI scientists to scourge information on the internet for news regarding recent breakthroughs on popular websites such as www.arxiv.org—a Cornell University archive of scholarly articles in fields such as physics, mathematics, computer science, and quantitative biology.[335] AI scientists worldwide are willing to immediately share the

[330] Fei Wu et al., "Towards a New Generation of Artificial Intelligence in China," 315.

[331] Fei Wu et al., 315.

[332] Ding, *Deciphering China's AI Dream*, 19–20.

[333] Xiang, *Red AI,* loc. 45.

[334] Xiang, loc. 45.

[335] Lee, *AI Superpowers*, loc. 112–13.

results of their findings for fear of not getting credit for their discoveries in a rapidly changing environment where improvements to AI are made on a constant basis. As Figure 6, *China's AI Publications versus the Rest of the World (2020),* reveals China far outpaces the United States and other advanced industrialized nations in terms of AI publications in 2020. According to Chou, in 2020 alone, China published 254,098 AI-related "journal articles, conference papers, book chapters and more," compared the 57,121 for the United States, 20,508 for India, and 14,947 for the United Kingdom.[336]

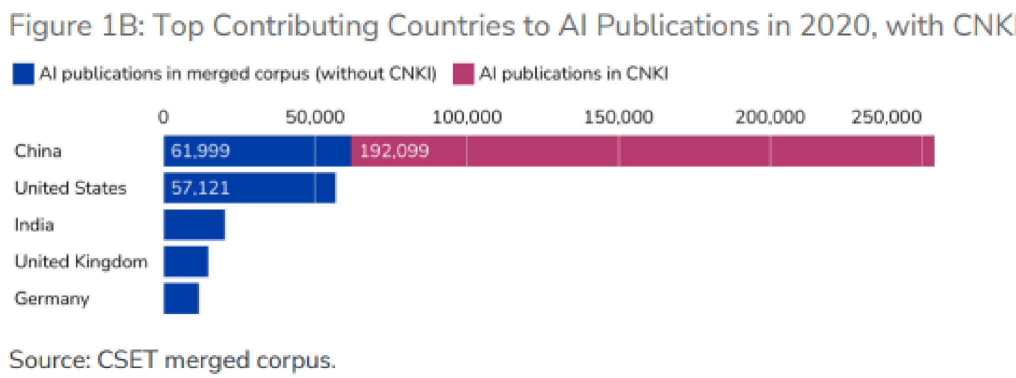

Figure 6. China's AI Publications versus the Rest of the World (2020)[337]

2. Domestic Innovation

China's major tech players have risen to the top in large part to the MOST's establishment of a "national AI team".[338] These AI national champions—a total of 15 companies appointed to drive AI such as Alibaba for smart cities, Baidu for autonomous driving, Tencent for medical imaging, Xiaomi for smart homes, and Huawei for hardware—have been allocated a specific domain to pioneer research and innovation.

[336] Daniel Chou, *Counting AI Research: Exploring AI Research Output in English-and Chinese-Language Sources*, CSET (Washington, DC: Center for Security and Emerging Technology, July 2022), https://doi.org/10.51593/20220010.

[337] Source: Daniel Chou, *Counting AI Research: Exploring AI Research Output in English-and Chinese-Language Sources*, CSET (Washington, DC: Center for Security and Emerging Technology, July 2022), https://doi.org/10.51593/20220010.

[338] Erik Wernberg-Tougaard, "China's AI Champions," *China Experience,* last modified February 23, 2021, https://www.china-experience.com/china-experience-insights/chinas-ai-champions.

However, with the vast improvements in China's high-tech and AI sectors, Chinese tech giants and unicorn startups have not only competed against some of the world's leading companies, but also amongst themselves. In 2019, China's national champions—namely Baidu, Alibaba, and Tencent—have funded 53% of the 190 major AI-related companies in China.[339] Even though Baidu, Alibaba, and Tencent are focused on different industries—Baidu in internet search indexing, Alibaba in e-commerce, and Tencent in social media—their investments into other AI domains reveals their desire to compete against each other. China's commercial entities are not solely directed by the central government, but fiercely driven by maximizing their own interests and profit.

U.S.'s Silicon Valley maybe at the forefront of producing AI software, but China's Shenzhen has claimed supremacy in high tech hardware. China now hosts 17 out of the top 100 S&T clusters globally, some of which are hosted in AI innovation hubs along the Shenzhen-Hong Kong-Guangzhou corridor.[340] According to Kai-Fu Lee, China's southern coast possesses an abundance of domestic talent and entrepreneurs who can, "build new drones, robots, wearables, or intelligent machines. In Shenzhen, those entrepreneurs have direct access to thousands of factories and hundreds of thousands of engineers who help them iterate faster and produce goods cheaper than anywhere else."[341] China now has an AI ecosystem that hosts world-class facilities and an abundance of highly trained talent pool to compete with the world's leading AI companies.

D. CONCLUSION

Google's 2016 AI achievement—China's AI "Sputnik" moment— proved to be the clearest inflection point that galvanized the Chinese government towards AI development. Since then, China has achieved a rapid pace of AI innovation, driven in large part by geostrategic competition, strong government support, and a growing indigenous talent pool. The revelation of AI's dual-use capabilities led CCP leaders to launch the 2017 AIDP,

[339] Karen Hao, "Three Charts Show How China's AI industry is Propped Up by Three Companies," MIT Technology Review, last modified January 22, 2019, https://www.technologyreview.com/2019/01/22/137760/the-future-of-chinas-ai-industry-is-in-the-hands-of-just-three-companies/

[340] Sullivan, *The U.S., China, and Artificial Intelligence Competition Factors*, 32.

[341] Lee, *AI Superpowers*, loc. 160.

which acted as a national roadmap for China's military branches, commercial enterprises, and civilian institutions to participate in a whole-of-society approach towards AI development. This national policy had the biggest impact on local government officials as they created an AI-friendly environment for researchers and scientists with state-of-the-art facilities, AIIAs, and GGFs. China's technology incubation centers and research labs have not only contributed to cultivating AI innovation, but also spurred economic growth. To continue attracting AI startups, local government officials have relied on offering benefits such as startup subsidies, free office space, favorable loans, and even housing for the employees and their family members.

Beijing's quest to become a military superpower coupled with its security concerns at home and abroad have been strong drivers towards AI innovation. As soon as the CCP realized AI's unlimited dual-use capabilities, AI became China's new focus for its defense industries. Chinese military initiatives in AI and autonomous systems were motivated to counter U.S. military power projection. The CCP and PLA leaders were gravely concerned about the military technological gap with the West. To meet its national security needs, China's national champions—Baidu, Alibaba, Tencent, iFlytek and others—collaborated with the PLA in developing dual-use technologies to bolster its capability to defend itself using asymmetric intelligent military applications. Some of these capabilities included UAVs and UUVs with next-generation stealth and swarming capabilities, and maneuverable hypersonic projectiles that can be controlled in real-time.

In addition to addressing foreign security threats, China has utilized AI to respond to its domestic security concerns. Hundreds of thousands of cameras have been placed around its cities and towns to suppress dissent using its facial and voice recognition technology. China has always held maintaining domestic stability as a high priority, and AI surveillance system has enabled China to repress and control anti-government groups such as its Muslim Uighur population and pro-democracy activists.

There were signs that China has relied on AI-related technology transfer from foreign commercial and academic institutions, but it was not a main driver for China's AI development. China possesses a domestic talent-pool that far outnumbers any other nation in terms of the amount of AI-related university degrees. Although the elite AI scholars and researchers are still largely represented in the United States, China is rapidly catching up in terms of the number of patents produced and intelligent algorithms solved. Now, China's national champions can compete with Western technology titans like Google, Facebook, Amazon and Microsoft. However, one lingering issue that China has had difficulty in further developing has been manufacturing semiconductors. China fears that its economy and defense systems are vulnerable from being cut off from Western supply-chains for vital AI semiconductors. In response, China has initiated domestic production of the much-needed hardware.

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IV. CONCLUSION

This thesis attempted to investigate the main drivers that catapulted China's MCF strategy to the forefront of its national strategy promoting economic growth and military modernization. China's post-Mao leaders, in the face of rising threats had to figure out ways to bolster both its economy and military; they found the answer with the concept of civilian and military resource sharing—also known as MCF. The first section of the conclusion will provide a historical overview of the relationship between China's geostrategic concerns, and government intervention—the two main MCF drivers identified from the thesis—under each Chinese leader. In addition, this section will also provide a summary of findings concerning the relationship between China's main MCF drivers and China's AI strategy.

The second section of this conclusion will highlight some weaknesses of China's MCF strategy. Even though China's economy and military have made vast improvements, it appears that its economy, more so that its military, has run into some problems that very likely can be attributed to China's MCF strategy. The weaknesses highlighted below are: the overcapacity of industry, the vast amount of accumulated corporate debt, and a dangerous trend of decoupling from the West. The data collected in this section is the most recent and is meant to shed some light of a downward trend in China's ability to efficiently pull the resources that can contribute to growth. China's decades long robust economic growth and military modernizations now actually looks like it may have some chinks in its armor.

The conclusion's third section will make three policy recommendations for the United States to consider. The recommendations are: to bolster technological alliances, increase government spending for basic and applied research in S&T fields, and to preserve its status as a hub and leader of S&T innovation by welcoming foreign talent.

And lastly, this conclusion's fourth section will brainstorm potential future research proposals due to some signs of weakness within China's MCF ecosystem, and also due to China's growing geopolitical and security challenges.

A. MAIN FINDINGS

In line with this research, three drivers had the most impact on China's MCF strategy: geostrategic concerns, government intervention, and foreign technology transfer. The research concluded that geostrategic concerns—which could have been in the form of economic or military threats—were the initial drivers that prompted the central government to implement policies in response to the geostrategic security concerns. China's reliance on foreign technology transfers waned as China's technological indigenous innovation base improved. The same applied for the AI case study, wherein it was discovered that the reliance on foreign technology transfer was the least significant factor in driving AI development due to the nature of the industry where the crossflow of information was shared more freely between organizations and across borders. A summary of findings will be broken down below for each era of China's leadership.

1. Geostrategic Concerns and the Government Intervention Under Deng

China's MCF strategy morphed throughout the different eras under China's leadership as the strategy gradually became a vital mechanism relied upon in utilizing the resources from the PLA, commercial, and civilian sectors to achieve the dual task of military modernization and economic development. China's geostrategic environment influenced China's state-directed industrial policies in many ways. When Deng took over the reins of China from Mao in 1978, he inherited a relatively benign security environment—due to rapprochement with the United States and Japan in the 1970s—thereby allowing him to focus on demilitarizing the PLA and liberalizing the economy. Deng's Reform and Opening policy converted China's inefficient military factories to civilian production. This trend continued throughout the Jiang era wherein China's defense industries' contributions towards the civilian economy grew from only 10% in 1980 to around 80% by the mid-1990s. Another of Deng's signature MCF policies was the launching of the 863 Program, which targeted China's weak and neglected S&T industrial base with state funding in geostrategic areas, such as aerospace, biotechnology, energy, IT, and new materials. These S&T fields did not solely have a focus modernizing the military, as they did under the Mao era, but strove to make China economically competitive in global markets.

2. Geostrategic Concerns and the Government Intervention Under Jiang

Jiang pivoted away from primarily focusing on economic development to shift more attention towards modernizing the country's military in response to China's growing external threats. Jiang's geostrategic concerns dwarfed Deng's and Hu's in that he faced quantitively more external threats, especially in the form of strict American export controls on advanced technologies concerning space, satellites, and nuclear energy. American military preeminence during the 1991 Gulf War and 1999 Kosovo War highlighted the importance of developing informatized warfighting capabilities. However, it was the 1995–96 Taiwan Strait crisis and the 1999 Belgrade embassy bombing that further galvanized China's leaders to heed Jiang's call to win "local wars under high-tech conditions."[342] China's ASBM and ASAT capabilities were directly linked to those international conflicts with the United States.[343] One of the least mentioned Jiang-era programs, the 995 New High-Technology Program, was launched in response to the 1999 embassy bombing to develop asymmetric weapons systems—which many Western scholars have referred to as "Assassin's Mace"—targeting American military weaknesses.

Geostrategic concerns drove Jiang to accelerate weapons development in order to expedite its ability to confront its growing challenges. Jiang launched two significant MCF policies that spilled over into the Hu era. The first was the IDAR methodology, which improved China's defense and commercial industries through the acquisition and reverse engineering of foreign technologies. IDAR produced concrete gains in China's aerospace industry with the production and design of the J-10, J-11, and J-20 jet fighters. However, Jiang knew that in addition to acquiring foreign technologies, China would have to acquire foreign technological know-how. This led to Jiang's second significant MCF contribution, which was the creation of the talent programs. The Hundred Talents Program focused on

342 Cheung, *Fortifying China,* 158.

343 McReynolds and Mulvenon, "The Role of Informatization in the People's Liberation Army Under Hu Jintao," 227.

recruiting overseas technical experts, and eventually led to the creation of many more like it such as the Thousand Talents Program and Changjiang Scholars.

3. Geostrategic Concerns and the Government Intervention Under Hu

Unlike the geostrategic concerns that Jiang faced, Hu experienced a relatively low level of security concerns during the first half of his presidency; he got to enjoy a period of sustained rapid economic growth bolstered by the S&T sector. However, geostrategic concerns were still the main driving force behind Hu's MCF strategy as China began to project its power into its near and far peripheries as it became the second largest economy. By, 2010, as China overtook Japan as the second largest economy, 55% of its GDP comprised foreign trade, 90% of which flowed into China by sea. China's national interests naturally began to expand into key extraterritorial domains, namely maritime, space and cyberspace, which meant that China was no longer satisfied with protecting its interests solely within its borders, but along key trade routes deemed critical to China's national security and sovereignty. This newfound power projection and geostrategic concern was exemplified in the commissioning of China's first aircraft carrier in 2012, the *Liaoning*.

Just as Jiang witnessed American air and space superiority during the First Gulf War in 1991, Hu realized the importance of developing informatized warfighting capabilities after witnessing U.S. military dominance in the Iraq and Afghanistan wars in the early 2000s. In 2006, Hu was the first to promote informatization as part of his PLA modernization efforts, stating that China needed to prepare for "local wars under informatized conditions."[344] CCP and PLA leaders viewed MCF as an integral part of the defense and commercial industries in helping the PLA make this transition. In order to achieve these military modernization efforts, Hu allocated four times the amount of his predecessors combined towards the legacy 863 Program, and also launched his signature 2006–2020 MLP, which emphasized the importance of pursuing indigenous innovation.

[344] McReynolds and Mulvenon, "The Role of Informatization in the People's Liberation Army Under Hu Jintao," 227.

4. Geostrategic Concerns and the Government Intervention Under Xi

Even though Xi faced geostrategic concerns that rivaled Jiang's, Xi's drive to pursue an even deeper level of integration between China's national economy and military was predicated on achieving China's dream of national rejuvenation. U.S.-China relations during the Obama administration (2009-2017) were characterized by cooperation as both countries tried to deconflict concerns via high-level meetings through the Strategic and Economic Dialogue (S&ED).[345] Riding on the wave of improved U.S.-China relations, Xi launched his signature domestic policies of the Belt and Road Initiative (2013), Made in China 2025 (2015), and 2017 AIDP. These initiatives were meant to address China's concerns of a pending economic slowdown by streamlining its defense, commercial, and private industries, as well as securing supply chains of key industries. Xi hoped that his national guidelines and policies would help China's economy become more competitive and self-sufficient. It was not until the Trump administration (2017-2021) when U.S.-China relations hit a new low point as both sides traded barbs, and the U.S. began to impose stricter exports of high-end technologies, such as advanced semiconductors, to China. This denial to vital technologies further reinforced Xi's MCF strategy and drive for indigenous innovation.

5. Geostrategic Concerns and the Government Intervention Role in AI

The AI case study reveals that China's AI development strategy, much like its MCF strategy, was driven by geostrategic security concerns, and strong state intervention. The United States and China have dominated the AI industry, and the emerging technology's impact has transformed the defense, commercial, and civilian sectors. China's AI development plans have been driven by external factors, such as commercial competition with the United States; however, China's nascent AI industry has relied less on foreign technology transfers as China's young entrepreneurial talent pool has been able to achieve a high-level of indigenous innovation. China's tech-savvy homegrown talent fills the AI R&D labs of private companies, which have been the main source of the PLA's AI-related advanced equipment. However, the main linchpin that galvanized China's AI researchers

[345] Allen, "Trends in People's Liberation Army International Initiatives Under Hu Jintao," 461.

and private and commercial enterprises was the Chinese government. More specifically, it was the central government that acted as a beacon by outlining the overall national strategy, which then unleashed the local provincial and municipal governments to adopt AI-friendly policies to attract private and commercial investment. If China's geostrategic security concerns were the keys that turned the ignition, then China's state-directed policies were the fuel that kept the AI development going.

In addition, the AI case study also reveals that AI discoveries and breakthroughs are shared more seamlessly between researchers, thereby lowering China's need to conduct illicit espionage activities. AI scientists and researchers openly post their breakthroughs and want to be accredited for their algorithmic discoveries. This free flow of open-source information has helped China's nascent AI industry to rapidly catch up with the United States; many project China to supersede the United States in just a few years. The United States and its allies have tried to thwart China's AI development by imposing strict export controls, especially on equipment dealing with the fabrication of semiconductors, to limit China's ability to produce high-end semiconductors. In China's leaders' view, denial of this capability validates China's fears that foreign powers are trying to suppress China's rise, and its efforts in becoming for self-sufficient.

B. WEAKNESSES WITHIN CHINA'S MCF STRATEGY

1. China's MCF Weakness #1: Overcapacity

China's MCF strategy is heavily weighted towards bolstering its defense capabilities, however, its economic focus should not be neglected. Despite the resurgence of China's commercial enterprises and defense SOEs taking bigger roles within China's military industrial complex, China's economy seems to be a step behind its military aspirations. After decades of the Chinese government flooding high-tech industries and R&D centers with subsidies, state-of-the-art facilities, and protection from foreign competition, some of China's high-tech enterprises have not been able to reach a scale of production needed to become profitable, due to problems of rampant overcapacity.[346]

[346] Orlik, *China: The Bubble That Never Pops*, loc. 182.

China's semiconductor industry has faltered despite being the recipient of billions of dollars in investment.

China investment into its semiconductor industry has created too many entrants without producing a challenger against the likes of a Samsung, Nvidia, or Taiwan Semiconductor Manufacturing Co., Ltd (TSMC). In 2014, the CCP launched its National Integrated Circuit Industry Investment Fund (NICIIF)—the largest MCF-related GGF valued at $14.82 billion—focused on semiconductor development.[347] With a strong drive to achieve semiconductor self-sufficiency, China launched many large-scale projects that have yet come to fruition. For example, in 2018 China invested $18.97 billion to create the Hongxin Semiconductor Industrial Park, and in 2019, it launched seven semiconductor silicon wafer manufacturing companies, all of which have already ceased operations due to a lack of funding.[348] In reference to Figure 7, *China's Overly Saturated Semiconductor Industry (2020),* China's semiconductor industry experienced dramatic growth, which peaked in 2020, in response to the NICIIF, recording a new high of 13,000 newly registered semiconductor companies.[349] But, the growth in companies has actually hindered semiconductor development as resources were wasted on companies that did not produce any net gain. China, instead should focus on developing those who have shown the greatest propensity to innovate and compete on a global scale.

[347] Barry van Wyk, "Mayhem in China's Semiconductor Industry as 'Chips Madmen' are Arrested," SupChina, last modified August 1, 2022, https://supchina.com/2022/08/01/chinas-microchip-great-leap-forward-has-also-ended-in-chaos/.

[348] van Wyk, "Mayhem in China's Semiconductor Industry as 'Chips Madmen' are Arrested."

[349] Kathrin Hille and Sun Yu, "Chinese Groups Go from Fish to Chips in New 'Great Leap Forward'," Financial Times, last modified October 12, 2020, https://www.ft.com/content/46edd2b2-1734-47da-8e77-21854ca5b212.

Figure 7. China's Overly Saturated Semiconductor Industry (2020)[350]

2. China's MCF Weakness #2: Too Much Debt

China's soaring accumulation of corporate debt is closely related to its struggle with overcapacity. China's non-producing loans in new emerging industries led to too much debt. In 2019, various international financial and regulatory institutions—the Bank for International Settlements, Bloomberg Economics, and the International Monetary Fund—have calculated China's debt to range anywhere between 259.4% to 328% of its GDP.[351] This huge debt to GDP ratio has placed China in an unfavorable position in trying to achieve the level of high-income Western economies. Figure 8, *China versus other Major Economies: Debt to GDP per Capita,* reveals that even though China's debt-to-GDP levels, measured at around 250%, are on par with other high-income countries, its GDP-per-capita, at approximately $17,000, is on par with emerging markets, thereby exacerbating China's long-term economic stability.[352] China's problems with corruption, and almost carefree practice in providing loans have contributed towards its growing debt problem. If China

350 Source: Hille and Yu, "Chinese Groups Go from Fish to Chips in New 'Great Leap Forward'."

351 Orlik, *China: The Bubble That Never Pops*, loc. 176.

352 Orlik, *China: The Bubble That Never Pops*, loc. 177.

wants to become a modern society, a leader in technological innovation, and build a world-class military, as advocated within its MCF strategy, then it will have to find ways to overcome its issues with inefficiency and overcapacity in manufacturing.

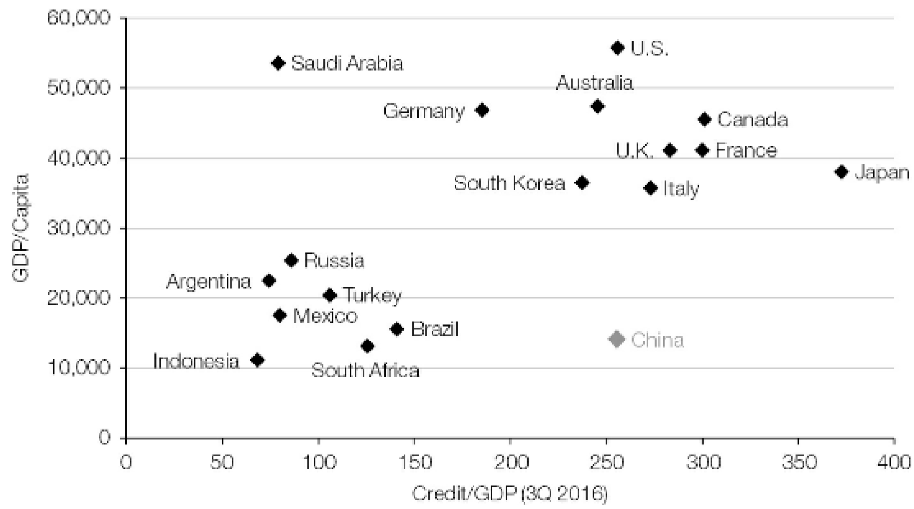

Figure 8. China versus other Major Economies: Debt to GDP per Capita[353]

Some of China's most popular MCF-related technology giants are responsible for China's economic slowdown and increased debt levels. One of China's "Four AI Dragons," Megvii has struggled to turn a profit despite its products—its patented Face++ technology for facial recognition—being widely used with China's domestic security and surveillance programs.[354] Tencent, the creators of China's largest texting social media application called WeChat, has experienced sharp declines in profit beginning in 2019.[355] More significant, Tencent's slowdown in its two major subdivisions with close MCF-related applications—its cloud and smart businesses, and its internet platform—have caused it to

353 Source: Orlik, loc. 177.

354 "One of China's Four AI Dragons," SupChina, last modified August 3, 2022, https://thechinaproject.com/company-profiles/megvii/.

355 Quentin Webb, "Tencent is Latest Tech Giant Where Sales are Falling," The Wall Street Journal, last modified August 17, 2022, https://www.wsj.com/livecoverage/stock-market-news-today-08-17-2022/card/tencent-is-latest-tech-giant-where-sales-are-falling-Di0ISq8CgRFkNP5iJGYB.

downsize its total workforce by 10% to 20% in 2022.[356] In November 2020, Tsinghua UniGroup, one of China's largest integrated and mobile phone semiconductor manufacturing SOEs, defaulted on a $198 million bond, which caused investors to doubt the stability and profitability of SOEs, which make up for than half of China's $4 trillion corporate debt market.[357] Despite Tsinghua UniGroup's early successes and contributions towards decreasing China's reliance on imported semiconductors, in 2022, its former chairman was arrested with accusations that linked him with the company's inability to pay large debts. This was also significant because Tsinghua UniGroup was a large beneficiary of the NICIIF, which provided the SOE with more than $8.07 billion of investment in 2014.[358]

3. China's MCF Weakness #3: Decoupling is Detrimental

China has long strived to be a self-sufficient nation, resistant to the economic pressures of the liberal rules-based system erected by the West. Part of China's MCF strategy strives to establish a shared ecosystem between its national economy and defense industries that can lower their dependence on foreign resources and technologies. However, with regard to AI, Cowhey, Shirk, and Schell contend that the "AI ecosystem is global and AI research progress thrives on openness," thereby necessitating open channels of trade, ideas, and communication between China and the West.[359] Although China has witnessed marked improvements to its own education system, the West's talent pool, specifically America's, significantly dwarfs China's. According to Allen, in 2019 China "[ranked] eighth in the world in terms of Top AI talent, with only 977 individuals compared to the United States' 5,518."[360] As U.S.-China relations have continually grown hostile during

[356] Houston Scott, "Tencent and Other Tech Firms Downsize, Stocks Recover," SupChina, last modified March 17, 2022, https://supchina.com/2022/03/17/tencent-and-other-tech-firms-downsize-stocks-recover/.

[357] Jeremy Goldkorn, "Markets Shiver as Big Chinese State-Owned Firms Defaulting on Their Debts," SupChina, last modified November 24, 2020, https://supchina.com/2020/11/24/markets-shiver-as-big-chinese-state-owned-firms-defaulting-on-their-debts/.

[358] van Wyk, "Mayhem in China's Semiconductor Industry as 'Chips Madmen' are Arrested."

[359] Cowhey et al., *Meeting the China Challenge:* 41.

[360] Allen, "Understanding China's AI Strategy," 11.

the Xi era, China will have to find a delicate balance between its short-term goals of acquiring much needed foreign technology transfers, while decoupling itself from the West without further stoking the flames of animosity and distrust.

C. FUTURE POLICY RECOMMENDATIONS FOR THE UNITED STATES

1. U.S. Response #1: Strengthen Technology Alliance

In order to counter China's military rise in the Indo-Pacific, the United States has launched multilateral strategic blocs such as the Quadrilateral Security Dialogue, more popularly known as the Quad, and the collective security alignment of Australia, the United Kingdom and the United States (AUKUS).[361] Similarly, the United States should create technological innovation blocs with other advanced nations in Asia and Europe.[362] It is not enough for the U.S. alone to confront China on securing global supply chains of advanced technologies; the U.S. must have the concurrence of its partners and allies. One area in which the United States has been successful with this approach is in the semiconductor industry. Washington has requested the likes of Tokyo, Taipei, and Amsterdam to cease the export of semiconductors and the equipment to manufacture high-end semiconductors.[363]

2. U.S. Response #2: Increase Government Funding

In addition to requesting to help of America's allies, Washington needs to increase domestic investment in emerging technologies involving AI, quantum computing, space, and robotics, that have dual-use capabilities to fight future wars and innovate future technologies. According to Cowhey, Shirk, and Schell, "in 2019, the federal government spent only $83.4 billion on basic and applied research."[364] Much of America's

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[361] Cheung, *Innovate to Dominate,* loc. 292.

[362] Cowhey et al., *Meeting the China Challenge:* 10.

[363] Ding, *Deciphering China's AI Dream,* 17; and Jillian Deutsch, Eric Martin, Ian King, and Debby Wu, "U.S. Wants Dutch Supplier to Stop Selling Chipmaking Gear to China," Bloomberg, last modified July 5, 2022, https://www.bloomberg.com/news/articles/2022-07-05/us-pushing-for-asml-to-stop-selling-key-chipmaking-gear-to-china.

[364] Cowhey et al., *Meeting the China Challenge:* 16.

technological innovation has been led by commercial enterprises, but additional government support will be needed to maintain U.S. leadership in basic research. Carter and Manuel assert that America's strategy should "build on an already world-leading research and innovation base and further incentivize public-private collaboration in cutting edge technology."[365] Unfortunately, a trend since the early 1960s reveals that U.S. government funding towards basic S&T research has been in steady decline, reaching its lowest point in 2018 at 0.16% of GDP.[366] With U.S. dominance in S&T diminishing, many U.S. analyst and scholars recommend increasing U.S. R&D expenditure to at least 1% of GDP.[367]

3. U.S. Response #3: Preserve Open Ecosystem and Bolster Cyber Defense

In recognition of China's whole-of-society approach in utilizing its commercial and civilian industrial and academic bases, the United States should not impose a blanket blacklisting of Chinese nationals at U.S.-based universities and high-tech companies. Instead, America should preserve its open R&D system as placing restrictions would force talent to migrate towards other countries or back to China, which would significantly erode America's advantage. In 2020, Silicon Valley's diverse workforce—of which 67% between the ages of 25–44 comprised of workers with Chinese and Indian descent—were the main source of S&T talent and innovation.[368] America's open society has been one of the main pillars of technological innovation and leadership, as it has been able to attract a globally diverse talent pool. Cowhey, Shirk, and Schell argue that a complete decoupling in commercial and academic exchange from China would be both "unrealistic and destructive to our vibrant society, economy, and innovation ecosystem."[369] In addition to preserving an open ecosystem, another option would be enhancing cyber security

[365] Elsa Kania et al., *How Should the U.S. Respond to China's Military-Civil Fusion Strategy?"* (New York: Center on U.S.-China Relations at Asia Society, 2021) https://www.chinafile.com/conversation/how-should-us-respond-chinas-military-civil-fusion-strategy.

[366] Cowhey et al., *Meeting the China Challenge:* 5.

[367] Cowhey et al., *Meeting the China Challenge:* 15.

[368] Cowhey et al., *Meeting the China Challenge:* 17.

[369] Cowhey et al., *Meeting the China Challenge:* 5.

mechanisms in both commercial and civilian domains that can protect vulnerable proprietary information and IP from cyber-attacks.

D. FUTURE RESEARCH IMPLICATIONS

China's security and economic landscape appears to have changed its trajectory of rapid development and growth, to one that is now stymied by a global pandemic (COVID-19), a strict "zero-COVID" policy, and increased geopolitical challenges in addition to the AUKUS and QUAD. Xi's vast infrastructure project, the BRI, has also hit a bump in the road as many non-performing loans are beginning to add up to China's debt. China's rise is no longer viewed as peaceful, and many governments have been forced to choose between the Washington or Beijing, in response to China's overt actions in Hong Kong, Xinjiang, and Taiwan. Since China's MCF strategy has been mainly attributed towards its economic and military rise, many countries have also grown wary of China's intentions on the economic front as many business, academic, and commercial deals may have military applications.

In this context, future research on China's MCF strategy should focus on the following topics. Will China's MCF strategy have to restructure itself? Will the government step aside and let market forces take the lead after it has been revealed of its vast inefficiencies? China's MCF strategy has already been elevated to national prominence and would be a significant sign of weakness if it was overturned. It would be interesting to see if China's MCF ecosystem will be robust enough to meet the needs of its economic and defense requirements, as it simultaneously reduces its reliance on foreign resources in the wake of mounting geostrategic challenges.

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