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US National Artificial Intelligence Strategy against the Made in China 2025 Policy

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Abstract

The United States (US) positions itself as the world's technology and innovation leader. China's adoption of the Made in China (MIC) 2025 policy threatens US interests and national security, leading to a US-China tariff war. Additionally, China is increasingly ambitious to become a global artificial intelligence (AI) leader, as seen through its issuance of its Next Generation AI Development Plan (AIDP). Previous literatures have analysed US strategic engagement with MIC 2025 and the impact of AI on US-China relations, but none have provided an analysis of US AI strategic engagement with China. In this article, we offer a comprehensive analysis of US strategies in dealing with MIC 2025 with regard to AI, and compare the US National Innovation System with China's in the AI sector to prove that the US remains globally dominant in technology and innovation.

Keywords: *Made in China 2025, artificial intelligence, China, US*

1. Introduction

Relations between the United States (US) and China have been deteriorating for the last decade, and the issuance of China's Made in China (MIC) 2025 policy has aggravated the tension between two countries, particularly with regard to technology and innovation. Friction between China and the US on technology began when a US investigative report declared two Chinese telecommunications companies, Huawei and ZTE, as national security threats (U.S. House of Representatives Permanent Select Committee on Intelligence, 2012). This friction was exacerbated when China announced the adoption of MIC 2025 in 2015. MIC 2025 marked China's shifting point from a giant manufacturing country to a strong manufacturing country that focuses on high-technology industries, including the upgrading of China's manufacturing base by rapidly developing ten high-technology industries (Chatzky and McBride, 2019).

The original stated goals of MIC 2025 are to reduce China's dependency on foreign technology and to promote Chinese high-technology manufacturers in the domestic and global markets (Glaser, 2019). However, MIC 2025 also has the potential to significantly alter the domestic and global competitive landscape in targeted sectors (Malkin, 2020). China released another contentious policy in July 2017, the Next-Generation Artificial Intelligence Development Plan (AIDP). The plan outlined China's ambition to become the global leader in AI by 2030 (State Council, PRC, 2017).

Together with MIC 2025, AIDP threatens the US' global dominance in technology and innovation. The shift from the Obama presidency to the Trump administration also contributed to the aggravation of the US-China relations. Under the Obama administration, the US' major concern surrounding the MIC policy was practices involving government-backed technology espionage and intellectual property (IP)

theft by Chinese firms (Nash-Hoff, 2016). Following the election of Donald Trump as president, Trump's sceptical views on US-China trade relations led to the US taking further steps, such as the Section 301 investigation on MIC 2025 that discovered unfair practices (Morrison, 2018). This imbalance caused Trump to respond defensively. Trump called for the discontinuation of market-distorting subsidies and other types of support that could create excess capacity in MIC targeted industries, beginning a tariff war with China in June 2018 (*ibid.*). Trump also passed a presidential bill called the Fundamentally Understanding the Usability and Realistic Evolution (FUTURE) of AI Act to plan for national AI strategy (Delaney, 2018).

It is important to note at this point in the paper that there is no universal single definition of AI. In fact, there are many worthy definitions that serve different purposes for different communities. As defined by the National Institute of Standards and Technology, AI is a branch of computer science dedicated to developing data processing systems that perform functions associated with human intelligence, such as reasoning, learning, and self-improvement (National Institute of Standards and Technology, US, 2019).

Previous research has explained that US-China friction is caused by competition over technological dominance, that, over time, had led to growing US paranoia towards China and Chinese technology development, resulting in the US' hardline policies in response to MIC 2025 (Hu, 2018; Lu, 2018; Sun and Wang, 2018; Zhu and Long, 2019).The US and China have now entered an era of strategic competition on AI, where the US has positioned China as its key competitor in AI development (Wang and Chen, 2018). The announcement of AIDP made it clear that China aims to leapfrog the US in technology and innovation (Thomas, 2020), leading to a recommendation by Deutch (2018) that the US must both respond to

China's policies while also strengthening its own innovation capability to maintain its innovation leadership. However, there has been little research to further analyse US engagement with China as a response to China's AI development, policies, and implementation.

This paper aims to contribute by providing a comprehensive analysis of US strategies in dealing with MIC 2025, focusing mainly on AI field in the 2015-2020 period. This paper will do so in three ways. First, by examining the strategies the US employs in response to AI and MIC 2025. Second, by clarifying US engagement with MIC 2025 in AI. Third, by proving that US engagement in the AI field is capable to close the gap with China and maintain its status as a global leader in technology and innovation. This discussion is particularly important in understanding how emerging powers respond toward the US-China rivalry (Campbell, 2008; Karim and Chairil, 2016; Sinaga, 2020).

This paper is structured as follows. First, an introduction consisting of background and literature, followed by an elaboration on the framework of thoughts and methodology of the paper. The paper then explores US engagement with China's industrial policies in the AI field. In the empirical section, this paper incorporates variables from National Innovation System to examine US strategies in dealing with MIC 2025 in the AI field and to prove that the US can maintain its position as the dominant technology and innovation power through AI.

2. National Innovation System

The global dominance of a nation's technology and innovation is influenced by its adoption and implementation of relevant national policies. Considering that such national technology and innovation policies are the focal point in this paper, we decided to use the concept of the national innovation system. National innovation systems are part

of political economy studies, focusing on the study of technical change and innovation with the purpose of constructing a selection environment which facilitates entrepreneurs to be able and willing to embark on new investments, despite the hazards which inevitably accompany such activities (Freeman, 2001). According to Christopher Freeman, a national system of innovation is the network of institutions in the public and private sector whose activities and interaction initiate, import, modify, and diffuse new technologies (Freeman, 1995).

This paper employs Freeman's (2001) concept, based on his research titled "A hard landing for the 'New Economy'? Information technology and the United States national system of innovation". In his research, Freeman highlighted features that contributed to US technological and economic performance since the 1990s. Specifically, he examined how US firms regained their leadership over Japanese firms after Japan had previously successfully displacing US leadership with a Japanese management concept called lean production back in the 1980s (Freeman, 2001). Freeman's research identified that there are three key features of US innovation: small firms, federal and state governments, and universities. This paper looks at the role of these three elements in analysing the performance of the US national system of innovation.

3. Methodology, Data Collection, and Working Hypothesis

This paper employs a qualitative method, with its case study qualitative design bounded by time, particularly looking at the period following the adoption of MIC 2025 and AI policies, as well as progress made by the US and China related to MIC 2025, to obtain deeper information and data related to US strategies, including policies, implementation, and AI innovation. For data collection, this thesis adopted the document analysis method to extract information and data through media tracking,

books, journals, and government reports. This allowed the authors to gather data over time.

Both primary and secondary data were used for this thesis. Primary data consisted of official statements from US and Chinese government agencies and private entities, with the official statements employed to clarify official US and Chinese strategies and goals in the AI sector. Secondary data used included published articles, books, reports, publications of business and industry associations, reports prepared by research scholars and economists, public records, and statistics.

This paper aims to asks how the US is maintaining its current position as the dominant technology and innovation power against the Made in China 2025 policy. In answering that question, this paper argues that the US maintains its current position through small firms' role in research and development (R&D) investment and the commercialization of AI technology and products; the role of federal and state government policies and regulations on subsidies for the AI sector; tax regimes and foreign trade; and the role of universities through higher education and research.

4. The US Engagement with China's Industrial Policies

The Chinese revolution in information technology began in earnest when, in 2015, President Xi Jinping called for the development of strategic emerging industries with the aim of making China a leading high-end manufacturing power. MIC 2025 was released by the State Council on 19th May 2015. The policy consists of three phases of strategic goals: Chinese manufacturing capability enters the base rank of global manufacturing power by 2025; later it envisions to enter the middle rank of global manufacturing power by 2035; and finally enter the forefront of global manufacturing power by 2049 (Morrison, 2019).

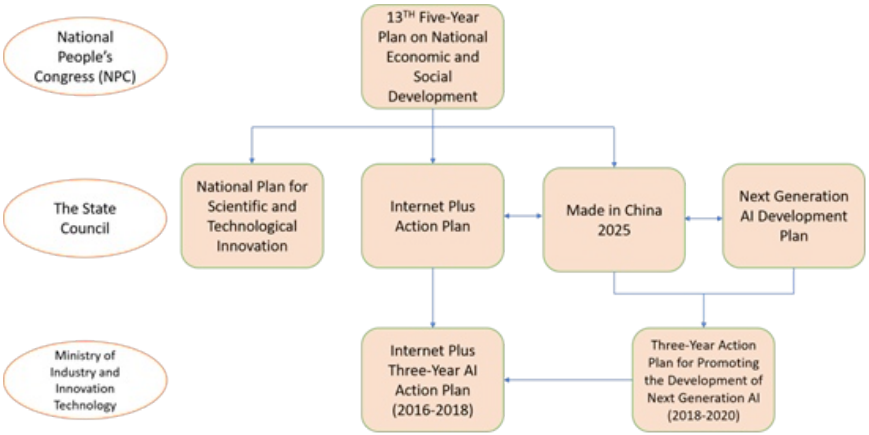
The motive behind this decision is that despite the growth of the Chinese economy and the fact that it has been successfully leading in mass manufacturing, it still lacks national core technology capability and remains dependent on Western supplies (Wübbeke *et al.*, 2016).

Another motive behind MIC 2025 is to avoid the middle-income trap. This is a phenomenon of economic stagnation that often occurs in middle-income countries, ultimately inhibiting them from transitioning to high-income countries (Kharas and Kohli, 2011). China as a high middle-income country currently faces unbalanced economic growth, severe pollution, and a declining population of people of productive age, which potentially could slow its future growth. Therefore, MIC 2025 seeks to upgrade the Chinese manufacturing value chain by utilizing innovative manufacturing technologies or so-called 'smart manufacturing' (Morrison, 2018).

Several national policies have also been put in place to support the performance of MIC 2025. One is the Internet Plus Action Plan, designed to operate in line with MIC policy, which aims to promote the integrated development of domestic mobile internet, big data, cloud computing, and Internet of Things (Sendler (ed.), 2018). Later, the Internet Plus Action Plan led to the announcement of Internet Plus Three-Year AI Action Plan (Figure 1). (Zhao, 2018) The Thirteenth Five-Year Plan on National Economy and Social Development (2016-2020) also supports both MIC 2025 and the Internet Action Plan by deepening the integration of information and manufacturing technology and promoting the development of high-end, smart, and green manufacturing to foster a new competitive edge (Wang *et al.*, 2020). Additionally, the National Plan for Scientific and Technological Innovation is designed for technological innovation development and aims to extensively improve China's technology and innovation

capabilities to push China into the global top 15 states (State Council, PRC, 2016).

Figure 1 Chinese Policies Related to Made in China 2025 in the AI Field, Based on Nomenclature



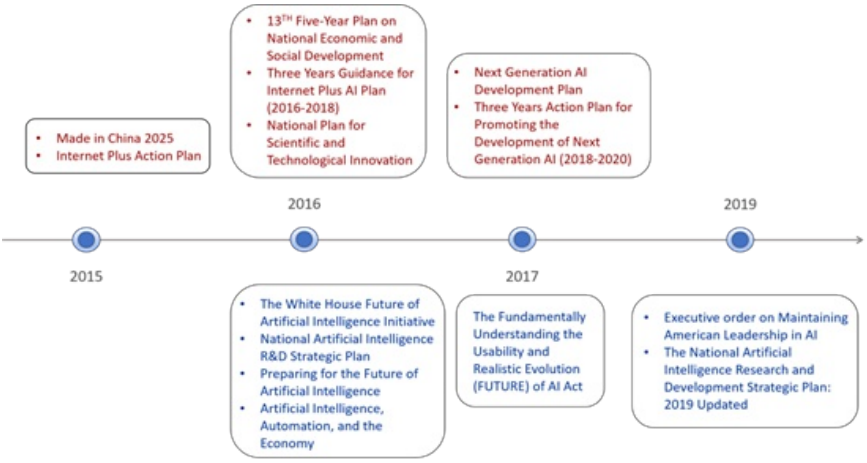
Source: Authors.

The MIC 2025 policy was disadvantageous for the US, and lead to a serious response. MIC 2025 undermines US high-technology industries as well as its economic leadership through unfair trading practices, such as the Chinese government's efforts to fund and direct acquisitions of foreign technology firms and IP to advanced its own industrial policy (McBride and Chatzky, 2019). In response to MIC 2025, President Donald Trump launched Section 301 to investigate MIC 2025, discovering unfair practices in its implementation including forced technology transfer, unfair licensing requirements, government-backed cyber-theft, and attempts to acquire US technology and IP through

acquisitions to support MIC plans (Office of the US Trade Representative, 22nd March 2018). In response to these findings, Trump decided to cease providing market-distorting subsidies and other types of support that could strengthen MIC listed sectors, and increased tariffs for targeted products that benefited from MIC, eventually leading to the current US-China tariff war (Belton *et al.*, 2020).

The US government was the first of the two countries to release AI-related strategic planning documents in 2016 (Figure 2). First, the National AI R&D Strategic Plan listed priorities for federally-funded R&D in AI with the purpose of tracking and maximizing the short and long-term impact of AI R&D investment (Parker, 2018). To accompany the previous document, the US National Science and Technology Council and Executive Office of the President (EOP) released a paper entitled "Preparing for the future of artificial intelligence", which provided technical and policy advice related to AI and aims to monitor AI development technology across industries, research institutions, and government agencies (Bundy, 2017). The EOP then issued "Artificial intelligence, automation, and the economy", which outlined recommended policy responses regarding the effects of AI-driven automation on the US job market and economy (Executive Office of the President, US, 2016). Before releasing those three documents, the Office of Science and Technology Policy (OSTP) held the White House Future of AI Initiative in May-July 2016, aimed at engaging the public on AI through a series of workshops and identifying the challenges and opportunities it entails (Figure 2). The progress of this initiative can be seen in the "Preparing for the future of AI" document.

Figure 2 Timeline of AI Policies Related to Made in China 2025



Source: Authors.

Along with technological development, China is progressively pursuing AI technology. China's Next Generation AI Development Plan (AIDP), launched in July 2017, focuses specifically on the development of China's artificial intelligence industry. AIDP is the first China AI policy that consists of AI development strategic plan and is marked as a national priority. The policy consists of three phases of strategic goal: by 2020, AI technology and application reach globally advanced level; by 2025, AI basic theory (big data intelligence, quantum, and brain-like intelligence computing) makes breakthroughs; and eventually become global AI leader by 2030 (State Council, PRC, 2017). China's decision to pursue AI development may have been inspired by digital *go* program AlphaGo's win over *go* world champion player Lee Sedol that highlighted the enormous potential of AI, specifically US-led AI achievement (Kania, 2018).

One month prior to the announcement of AIDP, in June 2017, the Chinese Minister of Science and Technology pinpointed AI as a key area for advancement as part of the MIC 2025 plan (Xinhua, 21st July 2017). As stated by Xi Jinping, AIDP and MIC 2025 form the core of Chinese strategy to becoming the global leader in AI technology and reducing its vulnerable external dependency for key technologies and advanced equipment (Figure 1). Moreover, MIC policy is at the centre of China's AI policy, serving as a foundation for regional governments to develop AI policies (Allen, 2019).

After the announcement of China's AIDP in July 2017, the US responded by issuing the Fundamentally Understanding the Usability and Realistic Evolution (FUTURE) of AI Act in December 2017, which established the Federal Advisory Committee on the Development and Implementation of Artificial Intelligence (Weaver, 2018). The FUTURE of AI Act followed the three earlier US documents on AI released in 2016.

The announcement of the FUTURE of AI Act coincided with the release of the Three-Years Action Plan for Promoting the Development of Next Generation of AI (2018-2020) by the Chinese Ministry of Industry and Information Technology (MIIT) in December 2017. This plan represents the first strategy document under AIDP, and aimed to achieve breakthroughs in core competencies of AI products and establish an international competitive advantage by 2020 (New America, 26th January 2018). It outlines major areas for China to focus on with regards to AI development, mentions specific industries as well as sub-technologies that fall under the AI sector, and outlines plans to implement a conducive infrastructure (Lee, 2018). The action plan is the convergence between MIC policy and the AIDP, as it implements both policies, therefore it will be the focus of analysis in this paper (see Figure 1).

In facing intense global competition, China and the US have pursued different strategies. On one side, China manages strategies to avoid AI arms races among countries, as suggested in the AI Security White Paper published by the China Academy of Information and Communications Technology (CAICT) in 2020 (CAICT, 2020). Moreover, the AIDP recommended that China deepen international cooperation on laws, regulations, and international rules relating to AI, in order to jointly cope with global challenges. On the other side, the US has taken more protectionist moves, as unveiled in their National Strategic Plan on Advanced Manufacturing that focuses on defending the economy, expanding manufacturing employment, and ensuring a strong manufacturing and defense industrial base as well as a resilient supply chain (Allen, 2019).

5. The US National Innovation System against China's with Regard to AI

5.1. The Role of National Firms

The first feature of a national innovation system (NIS) is the role of small firms, with R&D investment and commercialization as the indicators. The first indicator, R&D investment, is measured by private R&D investment and patent application by firms. Private R&D investment plays a significant role in developing innovation and updated technology. The prominence of private R&D investment is frequently stated in both US and China AI policies.

China promotes public data sharing to increase data accessibility for government agencies, firms, and universities (Li *et al.*, 2021). These accessible dataset resources encourage small firms to invest and develop new inventions from basic research or data that has been processed by

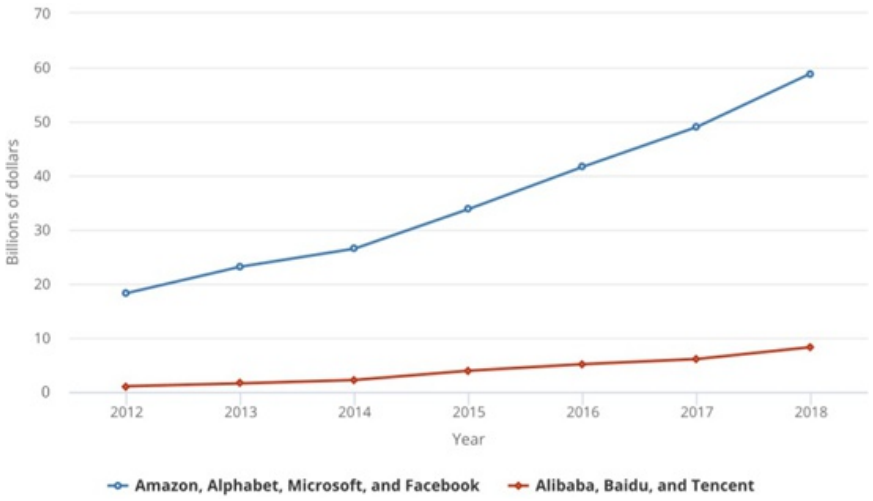
research institutions and universities. China's promotion of public data sharing was emphasized in the Three-Years Action Plan for Promoting Next Generation AI Development and the Hunan Action Plan on Promoting the Development of a Next Generation of Artificial Intelligence Industry (2019-2021), to consolidate data sharing and develop information databases, an exchange platform, and an open data platform for government and public services, industry entities, and R&D (Hunan Provincial Department of Industry and Information Technology, 2019). Following that, the Guangzhou Action Plan on Promoting the Development of a Next Generation of Artificial Intelligence Industry (2020-2022) promotes data sharing between government entities as well as guides AI firms to develop the circulation of data assets and establish public data ecology (Guangzhou Municipal Bureau of Industry and Information Technology, 2020).

The US responded with a similar strategy to facilitate public shared datasets. The American AI Initiative proposed that agencies make federal data, models, and computing resources more available to US AI R&D experts, researchers, and industries (The White House, 2019). This effort is undertaken in parallel with the President's Management Agenda to maximize federal data sharing with the local public (The White House, 2018). The US government also began partnering with industry-leading cloud service providers to develop a data-sharing platform that enables researcher access to major data assets that are funded across the National Institutes of Health (NIH), to be stored in cloud environments through the NIH Science and Technology Research Infrastructure for Discovery, Experimentation, and Sustainability (STRIDES) initiative (National Science and Technology Council, US, 2019).

Nevertheless, firms' R&D expenditure varies significantly between the two countries. Leading Chinese AI firms' R&D expenditure is still lower than that in the US (see Figure 3). Therefore, the Chinese central

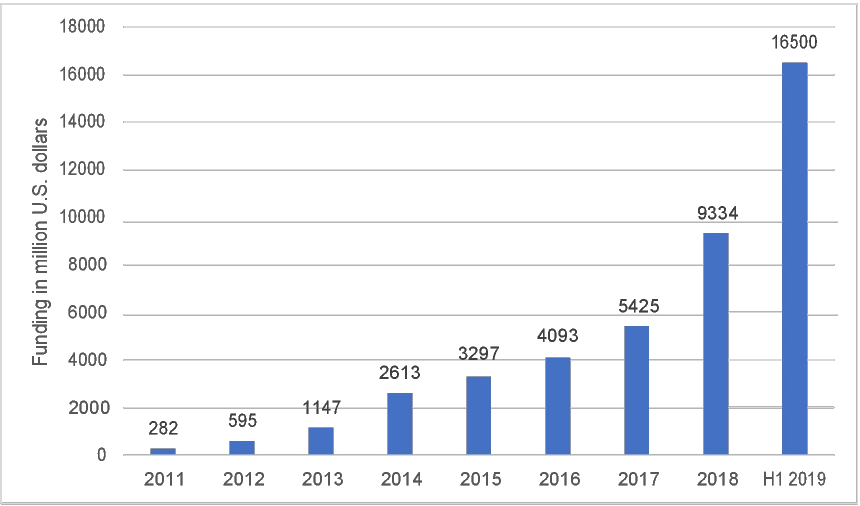
government encourages provincial governments and firms to increase investment for AI development and projects, as stated directly in Hunan and Guangzhou Action Plan. Meanwhile in the US, US firms appear to already be keen on robust R&D investment, so the federal government does not need to encourage firms to increase their R&D investment. After the US began to facilitate more public datasets, US AI firms' R&D investment grew rapidly in 2019 (see Figure 4).

Figure 3 R&D Spending of US and Chinese Giant AI Corporations (2012-18)



Source: Liu (2020).

Figure 4 AI Firms' Funding in the US from 2011-2019 (in million USD)



Source: Liu (2020).

US AI firms' investment in R&D is far higher than Chinese firms' (see Figure 3), both before and after the announcement of MIC 2025 in 2015 and the Three-Year Action Plan in 2017. Since US AI initiatives began developing during the Obama administration, there have been some efforts to engage industry into AI development such as the establishment of National Science and Technology Council's (NSTC) Subcommittee on Machine Learning and Artificial Intelligence in 2016 to foster inter-agency coordination, provide technical and policy advice on topics related to AI, and monitor the development of AI technologies across industry, the research community, and the federal government. In addition, there has been a series of public outreach activities arranged under the White House Future of Artificial Intelligence Initiative

(Executive Office of the President, US, 2016).

The second indicator of national innovation system (NIS) is the commercialization of AI products, as examined through patent applications based on if the patent application field of 'AI' is selected. Patent application indicates a desire by applicants to commercialize their invention (WIPO, 2019). The higher the number of the patent application, the higher the chance of a technology or product being commercialized. Given the evidence of unfair practices in the Chinese market, such as IP theft and unfair licensing requirements, China decided to develop an AI IP system, as planned in AIDP. Through the implementation of the Tianjin Action Plan on Promoting the Development of a Next Generation of Artificial Intelligence Industry (2018-2020), it encouraged the construction of a patent database for the AI industry (Tianjin Municipal People's Government, 2018).

China's strategy to increase commercialization targets the core needs of industries, including inspection and testing platforms, as well as other public service platforms, such as through the Hunan Action Plan (Hunan Provincial Department of Industry and Information Technology, 2019) and initiatives in Guangzhou, where the provincial government supports an exhibition and display centre to expose AI technology for business opportunities (Guangzhou Municipal Bureau of Industry and Information Technology, 2020).

In comparison, the US – with its priority to commercialize qualified and eligible products – choose to remove regulatory barriers by reducing the lengthy approval process, such as when Trump signed a Presidential Memorandum to permit states and localities to conduct innovative commercial and public drone operations currently prohibited under FAA regulations (The White House, 2017). Programs such as the Commercialization Accelerator Program (CAP) offer to help and introduce businesses with approval processes, reviews, and requirements

related to their technology or product (National Institutes of Health, US, 2016), leading to the commercialization of a larger number of products without any compromises on standards.

As a result of US strategy, the US has been able to maintain its position in patent applications that will lead to product marketization. Of the world's 20 companies with the most patent applications in 2019, three are US firms (Alphabet, IBM, and Microsoft) while only one is Chinese (SGCC) (WIPO, 2019). Although China has shown notable progress in the domestic AI application sector, China lacks core technologies, such as hardware and algorithm development, to build high quality AI products and compete with the US (Allen, 2019).

Thus, we can conclude that US firms remain ahead of Chinese firms. In terms of AI firms' R&D investment, the US has been able to maintain its superiority for decades because of its much longer history of technology and innovation (Nelson, 1990), compared to China's fairly new endeavours in this field since the adoption of MIC 2025.

5.2. The Role of Federal and Local State Government

The second feature of an NIS is the role played by federal and local state governments, with AI sector subsidies, tax regimes, and foreign trade as the indicators. Subsidies in the AI sector are measured by public expenditure. Public expenditure is the primary source of funding for long-term, high-risk research initiatives that private industry does not pursue.

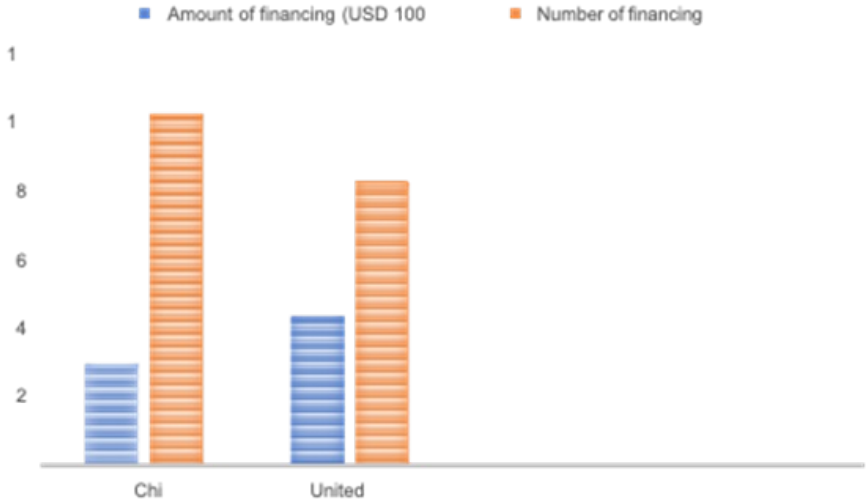
Guided by the Three-Year Action Plan, China is planning to maximize its existing funds for industrial transformation and upgrades through MIC 2025, along with other state funds such as major projects and national science and technology programs. China also encourages local governments to increase their investments in AI products, pilot demonstrations, and platform construction (New America, 26th January

2018). For example, in support of the Action Plan, Guangzhou municipal government is targeting its R&D investment in key AI technical equipment (Guangzhou Municipal Bureau of Industry and Information Technology, 2020). Additionally, the Tianjin Action Plan coordinates various financial funds including 10,000,000,000 yuan (1,510,000,000 USD with annual average rate of 0.151 in 2018) for basic research, product development, public platform construction, and support of AI firm development (Tianjin Municipal People's Government, 2018).

Meanwhile in the US, where the key technical equipment is already in use, the federal government has decided to centre its investment on high-priority, fundamental, and long-term AI research to maintain its leadership position (National Science and Technology Council, US, 2016). The 2016 National AI R&D Strategic Plan outlined a clear set of R&D priorities that address strategic research goals and focus of federal investments on areas in which industry is unlikely to invest. It also acts as guidance to identify scientific and technological needs in AI, track progress, and maximise the impact of R&D investment. It was updated under the Trump administration in June 2019, who reaffirmed the seven strategies of the 2016 plan and added an eighth strategy emphasizing public-private partnership (National Science and Technology Council, US, 2019). The 2016-2019 progress report mentioned several AI R&D programs performed by federal agencies, such as the "AI Next" campaign, which incentivized the creation of a range of new AI capabilities and applications (*ibid.*).

Thus, we can see that the US has great ambition in maintaining its global superiority and is attempting to do so by allocating a massive amount of investment, especially in comparison to China (Figure 5). The data indicates that US investment in AI positively contributes to the rapid progress of AI development.

Figure 5 Comparison of AI Financing between China and the US in Q1 2019 (Unit: 100,000,000 USD)



Source: Shenzhen Foresight Industry Research Institute (2019).

5.3. Tax Regimes

Government efforts in tax regulation through preferential taxation can help boost industry development by reducing taxes for companies, meaning they can allocate the finance to R&D investment and product development.

In China, the need for preferential tax policies for firms in the AI sector was stressed in the AIDP, and China also enacted preferential tax reduction for high technology enterprises by 15 per cent, while eligible R&D expenses of science and technological SMEs were reduced by 75 per cent (CPC Hangzhou Municipal Committee, 2017). In 2017, China's preferential tax policy supporting mass entrepreneurship and innovation

provided enterprises with tax cuts exceeding 500,000,000,000 yuan (73,500,000,000 USD with an annual average rate of 0.147 in 2017) (Xinhua, 24th March 2021).

Meanwhile in the US, R&D tax credits were offered to companies with specific terms and conditions as well as lower corporate tax rates. Enacted in 1981, the federal R&D tax credit allows a credit up to 13 per cent of eligible spending for new and improved products and processes (Goulding *et al.*, 2017); President Obama signed a bill making the R&D tax credit permanent on December 18, 2015. In addition, in December 2017, Trump signed the Tax Cuts and Jobs Act that lowered the corporate tax rate from 35 per cent to 21 per cent, enabling firms to invest more in R&D and product efficiency (Clausing, 2020).

The impact of such tax regulations can be analysed from their efficiency, noting that a key government task is to coordinate and ensure their regulations resulted in the progress as they expected. To obtain a progressive result, firms' capability to manage and allocate their finances is also significant. When a country's tax regulation is efficient and firms are able to manage their finance effectively, overall AI development is boosted, including R&D investment, productivity, and patented inventions.

Claiming tax reductions is different between the two countries, however. In China, the process to claim reductions uses a self-assessment system, which has a risk of the possibility of taxpayers disputing claims made earlier, making the Chinese tax regulation less efficient (*ITR*, 4th December 2015). In the US, tax regulation can be said to be more efficient, and this can be seen by higher R&D investment of US AI firms and the US' dominance in terms of AI patent applications globally.

5.4. Foreign Trade

Government policies on foreign trade determine whether they can promote as well as protect domestic technology from international competition. Chinese firms and their practices are often ethically problematic and cause disadvantages for US national security and interests, resulting in the US government tending to become more protective in permitting cooperation and partnership between US and Chinese firms, especially related to technology and AI (*BBC News*, 3rd December 2020). China, on the other hand, with its ambition to be a global leader in AI and its weakness in high technology infrastructure, tends to cling with the idea of international cooperation, especially with leading countries such as the US (Meltzer and Kerry, 2021).

In terms of IP protection, China seems eager to build a conducive IP system. This was emphasized in AIDP, which outlined the need to set up an AI IP system and public patent pool, which was also specified as one of the major tasks in Three-Year Action Plan. This was later translated in the Tianjin Action Plan by encouraging the construction of an IP protection alliance and a patent database for the AI industry, promoting the in-depth integration of IP protection, and increasing IP protection for AI (Tianjin Municipal People's Government, 2018). Moreover, the Tianjin Intellectual Property Protection Regulation was implemented and become the first provincial-level IP regulation in China in 2019 (General Office of the Standing Committee of Tianjin Municipal People's Congress, 2019). Under these regulations, examination channels for AI patent applications are prioritized. The Guangzhou Action Plan also plans to strengthen the research for legal guarantee and IP protection to enhance government systems (Guangzhou Municipal Bureau of Industry and Information Technology, 2020). Finally, in China's efforts to promote international cooperation, the Hunan Action Plan encourages deeper cooperation with global high-end AI resources

and support domestic firms as well as research institutions to set up specialized agencies and manufacturing enterprises in other countries, and *vice versa*, to promote international trade (Hunan Provincial Department of Industry and Information Technology, 2019).

In the US, however, their protective behavior does not appear to limit domestic market access, but rather promotes an internationally-friendly environment and open market for American firms while strengthening protection against unfair practices by foreign firms (The White House, 2019). This aim of protecting the US economy and national security interests, as well as their technological advantage in the AI sector, was emphasized in the American AI Initiative. The significance of the US IP framework is also emphasized in the US Chamber of Commerce Principles on AI, which suggested that the government should pursue IP protection on AI and recommend firms not to transfer or provide access to AI-related IP such as source codes, algorithms, and data sets (U.S. Chamber of Commerce, 2019).

Thus, it can be concluded that the US has successfully adopted policies that both respond to China while strengthening US capability. This has allowed the US to focus on developing its technology without fretting about China's unfair practices. In addition, US protective tariffs on Chinese imports and closer scrutiny of Chinese investment are part of US strategy to impede China's technological innovation and industrial upgrading.

Based on the analysis of the three indicators above, we can conclude that the US has managed to maintain its supremacy over China. US national subsidies for the AI sector remain ahead of Chinese subsidies; US tax policies and regulations are more efficient and comprehensive; and the US has taken strong steps to protect its domestic technology. China, meanwhile, lacks a progressive tax regime and public investment remains limited.

5.5. The Role of Universities

The third feature of an NIS is the role of universities, with higher education and academic research serving as indicators. Higher education is measured through science, technology, engineering and mathematics (STEM) graduates and AI talent. They represent the foundation to achieve technology and innovation leadership since they are the actors who perform R&D and create inventions. In accelerating AI talent, China through its Guidelines for the Development of Manufacturing Talents aims to develop capable human resources for industrial manufacturing by 2025 (Ministry of Education of the People's Republic of China, 2017).

Following the Three-Year Action Plan, the Guangzhou Action Plan also strengthened China's support for AI talent development by assigning municipal bureaus to encourage the establishment of relevant higher education courses, and guide enterprises and training institutions to establish joint AI training bases (Guangzhou Municipal Bureau of Industry and Information Technology, 2020). Hunan province is planning to strengthen cooperation with the world's top AI research institutions and firms, encourage joint multiform talent training. and optimize the allocation of AI-related courses (Hunan Provincial Department of Industry and Information Technology, 2019).

Both countries' strategies are responding to the evidence that China is producing a large number of STEM graduates. In 2016, the World Economic Forum reported that China produced 4,700,000 STEM graduates, while the US only produced 568,000 (McCarthy, 2017). Despite this, the US continues to have more AI talent, including those counted as 'top' (Table 1). In other words, China is pursuing a strategy to increase AI talent, while the US prioritizes boosting the number of STEM graduates. For example, in 2017, Trump signed a presidential memorandum prioritizing high-quality STEM education, with a

particular focus on computer science education, and committed 200,000,000 USD in grant funds (The White House 2017). Despite such policy, there is still little progress achieved by the US in increasing its AI talents (Gelhaus, 2021). Moreover, federal US agencies are prioritizing computer science, data science, and engineering graduates in their graduate fellowship programs to ensure US workers are capable of taking full advantage of AI (National Science and Technology Council, US, 2019).

Table 1 Global Distribution of Top AI Talent (Top AI Talent as a Percentage of All AI Talent in Each Country)

Country	Number of top AI talent	Number of total AI talent	Top AI talent as a percentage of all AI talent in each country
United States	5158	28536	18.1%
United Kingdom	1177	7998	14.7%
Germany	1119	9441	11.9%
France	1056	6395	16.5%
Italy	987	4740	20.8%
China	977	18232	5.4%
Spain	772	4942	15.6%
Japan	651	3117	20.9%
Canada	606	4228	14.3%
Australia	515	3186	16.2%

Source: China Institute for Science and Technology Policy (2018).

The US has a remarkable record in generating AI talent compared to other countries. China, on the other hand, still has much work to do to improve its quality of education and training to generate the best AI talent. Since it takes decades to generate such talent, the US will maintain its leadership for the next few years.

Academic research is measured by the number of academic papers published. After all, research is the basic foundation of innovation. From initial research, findings must be further developed by firms or other entities into applied research as the second foundation in developing innovation. Initial research done by universities helps diversify areas of technology and innovation development, and helps firms in developing innovation, because it means they do not have to start from nil.

Both the US and China are encouraging partnerships between public and private institutions that contribute to AI development. For example, China is increasing its construction of basic support platforms by encouraging universities, research institutes, and key AI enterprises in Hunan to build innovative platforms for AI front-end basic technology research, core technology R&D, and typical application development (Hunan Provincial Department of Industry and Information Technology, 2019). China Electronics established the Artificial Intelligence Manufacturing Technology and Innovation Application Industry Alliance, which aims to create an integrated innovation system between industry, universities, and research institutions by jointly carrying out research and technological innovation, as well as exploring new mechanisms for industry development (Xinhua, 22nd October 2019). Tianjin municipal government is relying on universities' R&D capabilities to establish an innovative platform in Tianjin, and carry out basic theoretical research on AI (General Office of the Standing Committee of Tianjin Municipal People's Congress, 2019).

The US has responded with the same strategy as emphasized in its national R&D strategic plan 2019. That is, to maintain its government-university-industry R&D ecosystem and generate technological AI breakthroughs through collaboration and joint research in areas of potential AI application (National Science and Technology Council, US, 2019). The US government also ensures it is providing cloud computing that is accessible for university research. So far, the National Science Foundation (NSF) has partnered with four major cloud computing vendors to make resources available to academic researchers through its BIGDATA program (*ibid.*).

6. Conclusion

For decade, the United States has been the global leader in technology and innovation (Deutch, 2018). Under the presidency of Donald Trump, the US became more assertive in dealing with China, particularly with regard to its industrial policy. The Made in China 2025 policy and its practices are assumed to be a threat to the US economy and its national security interests. Consequently, the Trump administration maintained the US' position in technology and innovation, releasing an AI strategy which resumed the previous initiative under the Obama presidency. When China released the Next Generation AI Development Plan and Three-Year Action Plan, soon afterward the US signed the FUTURE AI Act to plan its own national AI development.

From this analysis, we can conclude that the two countries' strategies employ different strategies in their attempts to be the global leader in technology and innovation. China is currently almost on par with leading countries such as the US, meaning that its next step would be to overtake the US as dominant state and become a global leader. Meanwhile, the US itself remains in a good position to maintain and

reinforce its dominance in the field. Thus, China's strategy sounds more ambitious, as it must consistently appear to be two steps ahead of the US in order to become the global AI leader, while the US focuses on maintaining its dominance while also widening the gap between its progress and China's.

Using Christopher Freeman's analysis of the national system of innovation, there remain many limitations in China's progress towards AI development in comparison to the US. For example, China's investment in private AI R&D remains minimal and the number of patent applications is insignificant. National expenditure in AI is also low, the tax system lacks efficiency, and there is a deficiency of AI talent and academic research.

From the three features making up a national innovation system, the US is leading China with regards to artificial intelligence. The US has so far succeeded in maintaining its dominance in technology and innovation through supporting small firms to invest heavily in R&D and commercialize their AI technology and products. The US supports AI innovation through policies, regulations, and subsidies, as well as beneficial tax regimes and foreign trade. Finally, US higher education and research remains strong, despite China's best efforts to challenge the US.

This paper focuses on analyzing US strategic engagement with MIC 2025, and compares the US and China's national innovation systems to determine who dominates technology and innovation, specifically with regards to AI. As a result, this paper may overlook other aspects of explaining US-China competition on global technology and innovation domination. Therefore, future research may need to cover other fields to explain both countries' efforts relating to technology and innovation.

Notes

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