Research on the Manufacturing Development in China under the US-China Trade War

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Abstract. This paper aims to analyze the current condition of high technology manufacturing in China in the context of a trade war between it and the U.S. Since China and the U.S. are the largest two manufacturing countries and also the highest GDP countries, the paper presents the trend of the manufacturing within these two countries and their comparative advantage. While Chinese manufacturing wins by large scale and low production cost, U.S. manufacturing wins by its control of high technology which is more valuable to manufacturing growth today. Given the ever-intense rivalry between China and the U.S. on high-end technology manufacturing, the paper then discusses the resulted difficulty faced by China as it is experiencing a high-tech supply shortage and the solution China has used to conquer the obstacles. The solution China employed has shown its effectiveness as several high-end manufacturing areas have achieved great progress in the year after the solution was imposed. The content of the paper is meaningful to the study of the relationship between China and the U.S. and the continuing growth of Chinese manufacturing as it records the biggest tension between the two countries and the resolution China takes to save its manufacturing from a broken technology supply chain.

Keywords: Manufacturing development; High technology; US-China trade war.

1. Introduction

As the world's second-largest manufacturing country, the U.S. contributed 16.8% of global output in 2019 [1]. With decades of persistence, the U.S. manufacturing industry is now mastering high-technology production, of which core techniques cannot be self-generated by any other countries in the world. Even though the high-tech patents of U.S. manufacturing have made its technology advancement incomparable by other countries, the U.S. is experiencing a dramatic decline in its overall employment in the manufacturing sector due to its competition with China and other countries with lower-cost labor. On top of that, the U.S. manufacturing year-long focus on high-tech sectors has also inhibited the growth of lower-tech sectors, which further leads to the increase in trade deficit with China. Seeing China replaced itself as the largest manufacturing country since 2010 and further strengthened its leading role in the world, the U.S. government had decided to take on the action.

Beginning in January 2018, the U.S. has started a series of trade wars against China to diminish the U.S. decades-long trade deficit and to boost domestic manufacturing. By elevating tariffs on Chinese goods and blocking the exportation of high-tech goods to China, the trade wars between the world's biggest two countries have led to changes in the manufacturing of both countries. To minimize the loss due to the U.S. ban of technology transfer, the Chinese government has expedited its plan for manufacturing structural reformation, straining to independently achieve more and more high-tech breakthroughs and employ them in the domestic manufacturing process. During this ongoing wartime, the Chinese government has published several large-scale economic initiatives such as "Made in China 2025" and "The Fourteen Five-Year Plan", which serve as the guidelines for the manufacturing structural reformation before 2025. In addition, the outbreak of COVID-19 also had a significant impact on both sides.

After the Chinese government implemented the "open up" policy in the late 1970s, Chinese manufacturing has received a surge in foreign direct investment (FDI), and FDI has been widely accepted as the major driver behind Chinese economical progression. Regarding the effect FDI had had on the global competitiveness of Chinese goods, Zhang constructed an exportation competitiveness index using data from the Chinese manufacturing market. Zhang estimated that FDI

was a key factor of Chinese exportation success and that high-tech FDI from western countries was a more effective booster of the exportation competitiveness than the low-tech FDI from developing regions [2]. While previous scholars regarded technology spillover, which was led by the FDI, to have a positive effect on Chinese manufacturing's productivity, Buckley et al. generated a paradoxical study indicating that a positive correlation between the two was not always the case. According to Buckley et al., there existed both curvilinear and linear relationships between FDI and the productivity of locally owned enterprises, showing the possibility that weakly operated MNEs might induce a negative relationship between technology spillover and manufacturing productivity [3].

While it's undeniable that Chinese manufacturing has been benefited from the FDI and the resulting technology spillover, scholars like Buckley et al. remained prudent about the disadvantage lying inside the non-autonomous Chinese manufacturing industries, specifically in the high-technology sectors. Wen, for example, measured the technological structure of Chinese manufacturing and compared it with other big manufacturing countries like the U.S. and Japan. By employing trade data ranging through 10 years, Wen had discovered that the FDI-supported high-tech manufacturing might conceal the true capability of Chinese manufacturing technology, exaggerating the true technological competitiveness and level of Chinese export [4].

2. Current trends in China and the U.S. manufacturing

2.1 Important numbers

In the past decade, China's economy has grown at an eminent rate, with the country's GDP surging over 20.8% and GDP per capita increasing by 19.8% on a yearly average. [5] In 2020, Chinese GDP has reached 15.68 trillion dollars, retaining its position as the world's second-largest economy since 2010, below that of the U.S. ($20.93 trillion) by 25%. The manufacturing sector is still a significant contributor to the GDP in China, but not in the U.S. In 2019, China's manufacturing has achieved an added value of $3.823 trillion, outstripping that of the U.S. ($2.35trillion) by 62.7%. Although Chinese industry output has shown a downward trend in recent years, it still contributed 38.6% of the country's GDP in 2019, contrasting 18.2% of that in the U.S. [5-7]. When comparing jobs offered by the industry sector of the two countries as a percentage of the whole employment, we see that since 2004, the Chinese industry has been providing more percentage of employment than the U.S.; the gap reached its peak of 10.56% in 2012 but is narrowing down recently due to the manufacturing transformation from the basic towards high-tech. The change in manufacturing employees in the two countries corresponds to the trend of percentage of total employment, as the numbers of employees in Chinese manufacturing outstripping the U.S. by 337% and the discrepancy narrowed down to 199% in 2019 [5, 8].

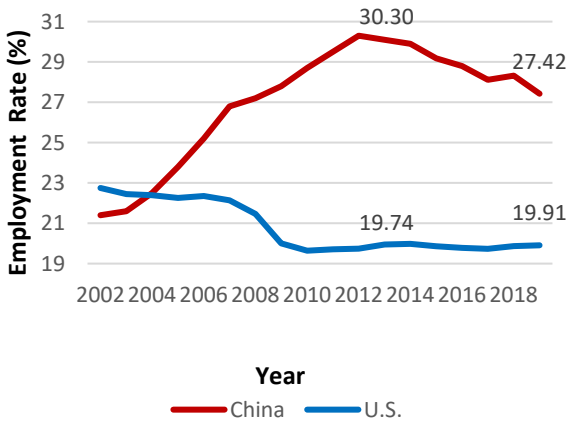

Fig. 1 Employment in industry (% of total employment)

2.2 The manufacturing advantage of China and the U.S.

China and the U.S. have their areas of dominance in manufacturing (Table 1) and distinctive reasons behind these successes, and the premise of comparison is the accumulation of national technology for many years. Among China's 525 manufacturing subdivisions, Communication Equipment, Ship, Machine Tools, Rare Earth, and Construction Machinery have obtained an indispensable world-leading role, outperforming that in the U.S. and other countries by an eminent level. The country's humongous population has not only brought sufficient labor force but also a huge domestic market demand for manufacturing goods; the steady flow of demand further boosters the supply sides to maximize the benefit under the enlarging-scaled economics, achieving purveyance stability that is incomparable around the world. Taking Communication Equipment as an example, only the "Chinese scale" can sustainably support a world demand of over 1.38 billion units of mobile phone components with its lowest production cost, achieving annual exportation of 966 million mobiles that values over 1,342,014 billion USD (2020) [9, 10]. Moreover, the Ship manufacturing industry, which is listed in the "Made in China 2025" (MIC 2025) initiative as the main development focus, had completed 3583 tons of shipbuilding in 2020, contributing to 43.05% of the global total production and outpacing the second largest shipbuilding country South Korea by 15.8 percent points. Meanwhile, in the first half of 2021, China has received 51.4% of the world's new ship orders, which is 1.8 times the number of ships completed in the same period, indicating that the shipbuilding industry of China will continue to flourish in the future and will need to become more efficient to accommodate for the numerous new orders. Despite the Chinese manufacturing has low labor cost and the enormous economic scale. However, it is also worth pointing out that what sustains and solidifies Chinese manufacturing's leading role on the world's stage is the country's abundance in natural resources such as aluminum, antimony, and rare earth - the essential components of electronic vehicles, missiles, power tools, cellphones manufacturing.

Table 1. China vs U.S. Top Industries

China	The U.S.
Machine Tools	Aerospace
Ships	Automotive
Rare Earth	Chips
Communication Equipment	Precision Instrument
Construction Machinery	Chemical Industry

While China's largest backup in manufacturing is its advantage in production cost, the US's largest key of success is a more hard-to-overturn one—sophistication in high-end technology. The control of high technology has made the U.S.'s role as a dictator in much high-profitability manufacturing incompatible as the U.S. is the sole provider of core technology in much high-profitability manufacturing process. The leading high-tech industries mastered by the U.S. include Aerospace, Automotive, Chips, Precision Instrument, Chemical Industry, etc. America's leading role in Aerospace started with the Boeing Company's establishment in 1916. The Boeing Company has become the world's largest manufacturer of both civil and military aircraft, with more than 70% of its revenue coming outside of the U.S. The AIA reported in 2020 that the U.S. aerospace industry had achieved a revenue of 909 billion dollars, representing 1.8% of the country's total GDP and underlining the industry's crucial role in the U.S. economy [11]. The Automotive (and Auto Parts industry) is another advantage area of U.S. manufacturing, representing 3% of the U.S. GDP in 2020 [12]. Although the U.S. only produced 2.2 million automobiles in 2020, and nearly all of them contain parts imported from China, the core high technology hardware and equipment such as engines, transmission, and automated emergency steering systems are produced domestically by the U.S. manufacturers [13].

2.3 Imparity roles in cooperation

Given every country's distinct advantage in manufacturing and the benefits derived from efficient allocation of resources, international cooperation is indispensable in many manufacturing sectors. As the two largest manufacturing countries, China and the U.S. have their manufacturing fortune closely tight together. While it is true that mutual benefit is generated, China's role in this cooperation is always a subordinate one, and the reason behind this discrepancy implies the persisting disadvantage of Chinese manufacturing. The disparity in roles and magnitude of the gains between the two countries is predetermined partly by the U.S. exclusive ownership of high-end technology and the low profit that comes with the advantage in low production cost in Chinese factories.

Taking automotive manufacturing as an example, all cars in the U.S. has some of their basic components produced in China because the U.S. car manufacturers like the low labor cost and high efficiency of Chinese factories; however, a slightly inferior level of efficiency can be found in other developing Asian countries as well, making China's role in the production process replaceable and granting U.S manufacturers more power to bargain. As a result, the indeed low profits are further diminished. On the opposite, all the so-called "Chinese domestically- manufactured cars" mostly have their engines imported from the U.S or other western countries who are in the U.S. alliances because Chinese factories cannot produce engines independently. Since engines production will require a large amount of capital invested in R&D persistently which cannot be obtained in a meantime, cars in China are either have their core components or whole cars imported from the western countries; indeed, China is the third-largest export country of U.S. automotive in 2020 [14]. The same disparity in trading roles can also be seen in aerospace manufacturing. The Boeing Company of the U.S. started its partnership with China after U.S. President Nixon's China trip in 1972. One can see from the data provided by the Boeing Company that in this cooperation, China also takes a secondary role: in 2019, Boeing has become the largest international customer of China's commercial aviation manufacturing industry, with over 10,000 Boeing's airplanes in use had parts and assemblies, all non-core process, built-in Chinese factories; meanwhile, more than half of all commercial airplanes flying in China were produced by the Boeing Company, mainly because China does not have essential parts like engines produced by the GE Aviation in Ohio, U.S.

It is clear to see that compared to the advantage the U.S. has in technological sophistication, the advantage China has in low production cost cannot sustain the country’s manufacturing flourishment in the long term and will compromise its profits when involved in high-technology manufacturing. In the face of the ever-intensive trade relationship between it and the U.S. countries, China's need to acquire high-end technology is imperative than ever.

Nevertheless, there are also many U.S. manufacturing sectors having a strong dependency on China's natural resources, and China is taking more of a dominating role in such cooperation. For example, 80% of the U.S. rare earth supply in 2018 was imported from China [15]. As a result of the trade war, many U.S. manufacturers who demand such raw materials from China are facing an enlarging predicament.

2.4 China power in the COVID-19 explosion

In the months after the first case of COVID-19 reported in China, the country’s economy has surprisingly gone through an economic disruption that was much milder and much shorter than that experienced by many developed countries, including the U.S. In the most catastrophic days, the new cases detected had once reached 1693 cases daily in Hubei Province; however, the state government used only two months to rapidly gain control over the viruses spreading and achieved zero new cases for the first time in March [16]. Such quick recovery could not be done without people’s sheer observation of the Communist party’s dictation. Under the order of the Communist national government, transportation and shipment within the country were ensured to be run regularly and efficiently and that most of the manufacturing sectors were undisturbed. According to data, China’s PMI dropped below the critical line of 50% only in February, when the country's extant cases reached the highest [17]. Moreover, China was the only G20 country that still retained a positive GDP growth

(+3.2%) in Q2, 2020, when the outbreak was the most serious [18]. The U.S., in contrast, had experienced the largest economic recession during Q2 of 2020, with its GDP plunging 32.9% on an annualized basis, and its unemployment rate reaching 14.7% in April 2020 [19].

Undoubtedly, COVID-19 has given China's economy a chance to closer the GDP gap between it and the U.S. Economists have once estimated that in 2028 China's GDP would surpass the U.S., but given the pandemic shock, the time could arrive sooner, in 2026 [20]. For the growth of Chinese GDP in 2020, manufacturing's contribution cannot go unnoticed. Basic manufacturing goods including face masks, alcohol disinfectants, and goggles were largely demanded by western countries, which helped to booster the related sectors' efficiency and revenues. Also, as an advantage of independent production, the supply of basic manufacturing goods such as small home appliances within China remains unbroken, and the increasing popularity of online shopping due to the quarantine lifestyle bolstered the domestic demands for manufacturing goods such as small home appliances. Therefore, under the pandemic, Chinese manufacturing sectors producing goods that can be used at home were flourished. As the U.S. depends on the importation of common goods from China, such growth in manufacturing was non-exist.

3. Problem

3.1 Policy – the trade war

Beginning from January 2018, the Trump administration imposed tariffs on imported goods from China in response to, as the White House claims, the Chinese government's illicit stealing of the U.S. high technology, manipulation of its currency, and building of barriers around its domestic industries. Three months later, the Chinese government imposed its retaliatory tariffs on the U.S. imported goods. Until January 2021, 66.4% of the Chinese goods are affected by the levitated tariffs of the U.S., and 58.3% of U.S. exports are subject to the Chinese tariffs [21].

Deeply understanding the impendency and significance of technology upgrade to China's economic dominance, the U.S. has used its power to impede other western countries from forming high-tech trades with China, especially on chips. Although both China and the U.S. are participating in the global supply chain of chips, the role of packaging Chinese manufacturers take is negligible while the designing role taken by the U.S is the most vital and irreplicable one. Utilizing its absolute dominance in chips making and the constriction force of the Wassenaar Agreement - an export control regime participated by 43 states mainly from the EU and North America - the U.S. has forged a global semiconductors blockage against China. Chinese high-tech companies like Huawei and SMIC whose products depend on western countries' supply of semiconductors have become the main target of the Wassenaar Agreement [22]. To occlude China's chance of getting new semiconductors, the U.S. has not only limited its semiconductors sales to Chinese companies, but the Trump administration has also pressured Dutch chips firm ASML to cancel its EUV lithography machine – a key production machine of semiconductor- sales to China [23]. Despite the Chinese government's efforts on centralizing all its domestic technology intelligence on imitating high-end EUV lithography techniques, a considerable time is still believed to be needed.

3.2 Education – technology spillover

As a late-comer of technology, China has long relied on technology spillover from foreign-owned enterprises or from Chinese students who've acquired skills in high education institutions in the U.S. Starting from the 2010s, the influx of international students from China to the high education institution in the U.S. According to data, over 372,000 Chinese students are studying in U.S. colleges, accounting for 35% of the international student population (Figure 2) [24]. The joining of Chinese students has brought lucrative revenues for U.S. education institutions but has also formed an unignorable long-term threat to U.S. leading place in the world economy. Recognizing China's fast catch-up in manufacturing technology is closely related to the technology support brought back by overseas returnees, the Trump government imposed a series of educational restrictions, especially on

international students pursuing STEM fields, to impede U.S. intellectual property from fostering manufacturing in other countries. Furthermore, resulting from the COVID-19 pandemic and the growing tension between it and China, the U.S. lifted the ban on a direct flight from China in April 2020, almost extirpated the chance of new Chinese students coming into the U.S. and discouraging many Chinese students from pursuing a U.S. degree in the future.

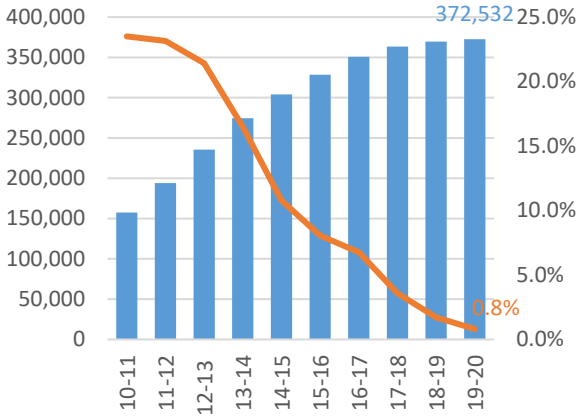

Fig. 2 Growth of Chinese Students Population in the U.S.

3.3 Inefficient market–Central Planning Economy

One of the biggest problems that remained in the Chinese market is the inefficiency within the fundamentally central-planning market. Although the level of inefficiency has been lessened to a certain extent after CCP was determined to transform into a socialist market economy, the sovereign role of the Chinese Communist Party (CCP) in the market inevitably sustains the inefficiency. Specifically, the prevalent beneficial policy to state-owned companies imposed by the CCP has brought many privileges and created incentives for corruption in them. As a result, the real driver behind Chinese economic growth – the private companies – are losing profit opportunities and efficiency. Therefore, besides the benefit that the state-owned companies can grow collectively and rapidly under CCP's control, the Chinese market, in general, has a lower efficiency than that of the western countries. The U.S. is such a free trade western country that has always prevented the government from interrupting the free market. In face of the lag of high technical sophistication, it becomes more imperative for the Chinese government to balance the roles of state-owned and private firms — giving sufficient support to the state-owned firm's technology innovation on one hand, and on the other hand, hedge themselves from diminishing private technology firms' free trade opportunities too much.

4. Solution

4.1 A booster shot of technology given by the trade war

Although the trade war has brought Chinese manufacturing industries into an unignorable impediment, it has also served as a caveat for technology development to the Chinese government. With the break of the U.S. technical supply chain which Chinese manufacturing has been relying on for hundreds of years, China could not see its lag in technology clearer. To address the technology shortage led by the explosion of the trade war, CCP has listed high-technology development as the country's prior goal in nearly all new planning. For example, in the "14th Five-Year Plan (2021-2025)", the CCP has set "above 7% growth in research & development spending" as a major target to achieve [25]. Comparing the 14th-5 to the 13th-5, the location of key projects related to technology has been moved to the very top of the document, indicating the CCP's strong willingness to develop

high-technology (Table 2) [25]. According to data, in 2020 China has spent approximately 2400 billion CNY on R&D, with a growth rate of 10.2% [26].

Under the orientation of the CCP, Chinese high technology has been experiencing a surge. In 2020, SMIC had put its production of 28nm wafers into the scale and strived to conquer 7nm production. The domestic aerospace industry also had a significant breakthrough in high technology products since 2020. Comac has placed its first domestic produced aircrafts C919 into commercial use, implying the possible future of China's rivalry with the U.S. in aerospace high-end production.

In general, the trade war in some way serves as a booster shot for the high-tech manufacturing productivity in China. The high-tech shortage is pushing the country to devolve most of its resources into high technology sectors' production and forcing them to tackle down the technological barrier.

Table 2. Key projects in 13th and 14th five-year plan

13th 5-Years	14th 5-Years
Technological innovation	Technological Frontier
Talent project	Science and technology infrastructure
Finance	Manufacturing competitiveness
Agriculture modernization	Infrastructure
High-end equipment innovation	Modern energy system
Strategic emerging industry	National water systems
Information technology	Digital economy
Infrastructure	Digital application

4.2 New opportunities for small firms

In 2021, One of the major changes in financial sectors is the establishment of the country's third Stock Exchange in Beijing (BSE). The main purpose of BSE is to serve small and medium sizes firms in China. Unlike the two old Stock Exchange, the barrier of BSE is much lower, and the examination procedure takes a shorter time. Therefore, the existence of BSE has provided more financial opportunities for the small firms, especially those technical firms who are earning a high profit but have a low market value that cannot pass the barrier of joining the two old stock exchanges. With the financial support from stock markets provided by BSE, technology innovation in a small company can be sustained, and the country's overall technological productivity can be bolstered on a broader level.

Besides BSE, thousands of superlative small firms in China are categorized as "Zhuanjingtexin SMEs" and are backed by the government on their development. More than half of the firms that have been included in "Zhuanjingtexin" devote more than 10 million CNY on R&D each year, and they are thus the contributors to China's high technology progress. By imposing a beneficial tax system, refining credit and loan policy, pushing the production chain's innovation synergy, etc, CCP has provided these excellent small firms with a privileged market environment. Chinese government's support to the small-scale firms would surely encourage the development of these companies and redistribute the resources from large state-owned firms to small private firms.

4.3 M&A as an implicit method to obtain

Although the trade war has made technology spillover extremely difficult for China, there exists an expedient of the current technology shortage. A business strategy like mergers and acquisitions can be an effective shortcut to provide high-tech supply for China in the meantime. In 2020, China's technology tycoon Wentai Technology added its semiconductor link by acquiring a UK chips firm Newport wafer fab. Newport does not obtain the advanced semiconductors techniques China is eager to have, nevertheless, the acquisition helps enlarge Wentai's semiconductors production capacity. Moreover, Wentai Technology can rely on the well-built relationship between Newport and other western high-tech firms and expand its purveyor net overseas. Whereas the chance of a successful

takeover of a firm is quite small, it still worth a try since it's the most effective way to enlarge high-tech production capacity.

5. Conclusion

The paper opens its discussion on Chinese manufacturing from the introduction of China and the U.S. manufacturing condition and their comparative manufacturing advantage and then it transits toward a discussion on the trade war explosion started by the U.S. to prevent too much technology spillover to China. The paper then discusses the obstacles China's manufacturing is facing and the solutions the Chinese government and manufacturers are employing. While the shortage of high technology supply resulting from the trade war severely blocks China's steps forward, emergency solutions enforced by the CCP have shown its rudimentary effect in the rapid development of manufacturing areas such as chips and aerospace. Therefore, China should continue focusing on high-end technology development and seek opportunities to increase its high-tech production capacity to counter the shortage of supply.

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