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Changing State-Business Relations under the U.S.-China Tech War

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Abstract

The rise of China's high-tech giants, such as Huawei and ZTE, has aroused much anxiety in policy circles, leading to a recent "tech-cold war" between the United States and China. How does the movement of Chinese firms up the technology ladder influence U.S.-China relations? More specifically, can the United States weaponize its position on the supply chain effectively to contain China? Have China's businesses collapsed after the launch of the tech war? This paper starts with the state-business alliance behind China's joint venture period and the engagement with the global value chain period, when the incentives of the state and firms were often misaligned. Then it proceeds to analyze how the interruption of the global value chain acted as an external shock that reshuffled state-business relations by aligning the incentives of the state and businesses under the structure of a new technology innovation system. It evaluates how such state-business relations, in turn, influence the effectiveness of U.S. policies in the short and long run. In the short run, the tech war directly reduced the Chinese products relying on U.S. chips, but in the long run, it facilitated the re-alignment of state and business in hardware tech industries and also propelled China into a period of self-sufficiency, an import-substitution industrialization (ISI) period that it originally skipped. Furthermore, businesses in the United States and other regions (especially in East Asia) have adopted various strategies to recover broken value chains via relocation. This means that U.S. policymakers may have overestimated the leverage of their technological advantage and weaponization and underestimated the interdependence along the value chain.

Implications and Key Takeaways

- U.S. policymakers need to look into the long-term effects of the tech war instead of only short-term goals. A long-term strategy, other than blocking or disrupting the supply chains, is needed for promoting national technological competitiveness. Specifically, the United States should continue to encourage R&D in cutting-edge technology within the electronics and IT sectors (hardware as well as digital). More importantly, the U.S. should continue to attract talent from all around the world and improve its immigration policies. To combat the recent trend that

scientists, engineers and scholars emigrate to other countries or return to their home countries, the United States should design policies that make it attractive for existing talent to stay and for new talent to come to the United States in order to sustain the long-term strategy of boosting technology competitiveness.

- The U.S.-China tech war may galvanize China to unify state and business interests and accelerate their technology development by concentrating resources that were previously misallocated elsewhere. The effect of the tech war may be counterproductive for the United States.

- The ability of the United States to weaponize the supply chain is constrained by business interests both inside and outside of the United States as these businesses can relocate supply chains to the Asia-Pacific region and seek non-American equipment.

- In order to maintain its advantages on the supply chains, the United States does not only need a technological advantage in core components but also the ability to scale up the fabrication of these components with U.S. companies in order to address the problem of lacking capability of electronics production. Otherwise, the ability to fabricate core components could be used as a bargaining chip by other countries to weaken the goal of the U.S. strategy.

Introduction

The rise of Chinese tech firms and the U.S.-China technology rivalry has certainly received much attention. Yet thus far, few academic works provide frameworks to systematically capture the influence of such a tech cold war. To fully understand the impact of China's technological development and whether the U.S. response is effective, one has to incorporate perspectives from weaponized interdependence, global value chains, and government-business relations.

Without a doubt, the United States has been trying to weaponize its advantages in supply chains (e.g. core technology in chip-making) in order to restrict China's access to key components. Global value chains and production networks in high-tech, digital industries have been among the key areas where asymmetries of power and weaponized interdependence exist.[1] The hierarchical order is often ranked by a firm's position on the value chain. Higher positions usually involve more proprietary knowledge, higher profit margins, higher barriers to entry, and more bargaining power.[2] Therefore, the United States blocked international firms from selling their own products or U.S.-designed components to Chinese firms that are blacklisted, such as Huawei and ZTE.

A crucial question, however, remains: will such a strategy of weaponization be feasible and effective in the context of China's industrial and technology development? Existing literature has yet to offer adequate answers to this question. The "weaponized" interdependence framework captures how asymmetrical power allows states to leverage their advantages in global networks, but often assumes that businesses will go along with the state's agenda. In contrast, studies of global value chains and production networks are helpful in specifying firms' upgrading strategies in each node of production, but they are less sensitive to politics and the role of the state. In fact, the development and manipulation of supply chains for political purposes are always closely associated with both state and business actors. Bringing state-business coalitions into the analysis is thus essential. As my own earlier work and other studies have shown, the building, consolidation, or fragmentation of state-business coalitions have a substantial influence on economic policies domestically and abroad.[3] Although there are obvious differences between democracies and authoritarian regimes, the state-business coalition has gained

much more influence in a globalized era where politics and economics are increasingly bundled.[4]

In order to evaluate the effectiveness of such weaponization as well as the implications for U.S. policies, one has to explore and understand the evolving state-business coalitions in China before and after the tech confrontation and the disruption of the supply chain. The next section started with the state-business relations before the US-China trade war.

State-Foreign Joint Ventures Under "Market in Exchange for Technology"

When China initially open up for foreign investment, the major approach of striking an alliance is forming joint ventures between Chinese state-owned enterprises and foreign firms facilitated by the state under the rubric "market in exchange for technology (以市场换技术)." The term originated from China's automobile industry in the early 1980s and was later widely used as the central tenet in support of policies for encouraging inward foreign investment in most manufacturing industries. The main argument was that by allowing foreign investment to enter the domestic market, China could use its huge domestic market as a powerful bargaining chip for the introduction of advanced technology.[5]

The China Joint Venture Law stipulated that such technology and machinery should be advanced and "appropriate to China's needs," and that when foreign investors intended to cheat the Chinese partner with "backward" technology and machinery, they should be compensated.[6] The 1986 "Decision of the State Council to Encourage Foreign Investment" further provided these enterprises with lower charges of basic utilities, priority loans from the bank, and a wide range of tax exemption policies.[7] Any joint ventures with at least 25 percent of the shareholding from a foreign firm can be categorized as foreign-invested firms (FIEs). Typical JVs between China and United States included Shanghai GM, and beyond the United States in the hardware high-tech sector, there were many examples, such as Beijing Panasonic, Shenzhen SEG Samsung, Shanghai Philips, and the investments of Huajing and Huahong in the "908 Project" and "909 Project."[8]

Joint ventures, however, turned out to be difficult marriages, due to a range of factors such as conflicting firm cultures and the divergent business goals

in profits or amount of production. But most fundamentally, the key logical assumption behind "market in exchange for technology" was challenged. Foreign firms followed the plan from their parent company and prioritized their dominance of China's market. They had no intention of conducting real R&D in their China branches. Yet the China side assumed that the market would provide enough leverage and incentive for technology transfer. When the China side sought to establish their own R&D branch within the joint venture, it was discouraged from the foreign side. But more often than not, the Chinese SOEs also did not have enough incentives to push forward for learning as they were accustomed to the state handing them the resources without taking their own initiative to learn.[9] The slow-moving feature and the lack of incentive to improve efficiency means that once the production line was finally in place, technology already marched to a new generation where the older generation of products was hard to find a home.[10]

The Chinese state and municipality governments certainly participated in many negotiations to place pressure on the foreign side for technology transfer, but they themselves also came to realize that direct technology transfer or R&D in key technology was unlikely to be done through the JV format.[11] Therefore, the state often acted as a thankless matchmaker or broker between domestic firms and foreign partners, although such marriages often turned out to be too difficult to produce results.

Because the state's focus was on acquiring modern technology from foreign firms through forming joint ventures with state-owned firms, they paid little attention to indigenous private firms or start-up firms during this period and did not set them as a priority for overall state policy. However, the latter in general had far more incentives for technology learning and innovation than the former. Therefore, it can be argued that the state's effort was wrongly placed on the JVs between domestic SOEs and foreign firms.

Fragmenting State and Business: Global Value Chain and the Barrier to Indigenous Innovation

Between the 1990s and the mid-2000s, as China further opened up and decentralized authority of foreign investment and trade to localities, China was further integrated into the global value chain. As localities started to

build thousands of development zones for FDI attraction, governments at the central and local levels also started to form coalitions with foreign firms. Government officials provided a wide range of preferential policies in terms of tax breaks, funding, utility, and land discounts. Bureaucrats from various departments went out of their way to attract investment in a beehive campaign mode.[12] China thus rose to be the largest manufacturing house and exporter in the globe. It was also during this wave of global offshoring that technology hardware industries or the ICT industry (such as computers, tablets, mobile phones, etc) rose to be the major exporting sector in China and across the globe. Lead firms such as Apple, Intel, Foxconn, Nokia, Samsung, and Philips all outsourced or offshored their production.

By the mid-2000s, however, most of China's engagement with the global value chain was at the bottom segment, focusing on processing and assembly, generating razor-thin profits and relying on sweatshops. The situation raised alarms among observers and the Chinese central state (ministries and central leaders), who proposed an "indigenous innovation" program in 2006 that sought to promote the indigenous innovation of Chinese domestic firms and pushed them up the value chain.[13]

Since then, China experienced a complicated period during which government officials in different bureaucracies started to cultivate and advance the interests of their own business clients. On the one hand, with the fall of JVs and the increase of wholly-foreign owned enterprises with direct offshoring, officials in the internal commerce coalition sought to cultivate a friendly environment for foreign firms and encourage expansion of their investment and production. On the other hand, officials promoting domestic technology and indigenous innovation also sought to promote domestic firms (which were their clients) with available resources in preferential policies. As a result, the types of global value chains that took shape across China generated very uneven regional patterns, with some much more suitable for indigenous technology progress than others.

The overall ecology of production in the tech sector before the 2018 trade and tech war, however, was heavily influenced by the hierarchical logic of production along GVC created by firms in western countries, especially the United States. In such a hierarchical order, the higher a firm's position on the value chain, the higher a profit margin a firm could receive and the stronger its

bargaining power over prices. Higher positions on the value chain also mean more proprietary knowledge and a higher barrier of entry for competition. An upper-level producer, unless upgraded to an even higher position, has incentives to refrain from transferring proprietary knowledge to firms at lower levels so as to prevent sublevel suppliers from directly competing with itself. A firm that sought to outsource production activities down the value chain would have fewer obstacles than a firm that sought to move up the value chain. The hierarchical order that was broken down in a corporation was re-established at the global level. In such a hierarchical order, U.S. firms (together with other OECD countries) occupied the top of the value chain, whereas Chinese firms which sought to climb up the tech ladder had to fight an uphill battle. It was much easier for them to expand their production lines at the bottom of the value chain rather than climb upward to compete with their western clients.

Although, as mentioned above, indigenous firms may have the support from the officials who seek to provide domestic tech upgrading, the overall ecology of production works against Chinese firms from making direct progress on key technology. Bureaucrats in charge of promoting tech innovation in the electronics and IT sector had complained about the lack of incentives from the firms' side, even when they actively provided funding for firms to apply for patents or conduct R&D.[14] While most firms acknowledged the importance, both the risk and the cost of developing technology and creating new markets against the competition from global incumbents were too high.

Therefore, when Premier Li Keqiang launched the "Made in China 2025" plan, it was as much a compromise as an ambitious plan. While observers tend to place the plan in the same category as those that sought to turn China into a technology powerhouse—such as the "indigenous innovation" and the mid-to-long-term science and technology development plan, the essence of "Made in China 2025" was different. Among other aspects, the plan emphasized advanced manufacturing instead of cutting-edge innovation (thus not "Innovated in China 2025"). Instead of getting rid of the label of "Made in China," which is often associated with cheap, low-quality production, "Made in China 2025" sought to take advantage of China's manufacturing capacity in the GVC and boost some key industries such as new materials, equipment, and green energy. The plan included objects

broader than conducting R&D in crucial, key technology, as the latter did not always succeed.

Firms such as Huawei and ZTE grew from small to large under such an environment in the electronics and IT sector. With state-owned, private, and foreign firms all entering the sector, the structure of the value chain was such that major semiconductor chips, memory cards, touch screens, and Bluetooth systems were designed and produced in foreign countries, with Chinese firms all located at the bottom of the value chain. While most of the firms in the electronics and IT sector devote resources to conduct R&D, at a percentage often higher than other industries, the decisive role of the global value chains and power asymmetry still pushed the Chinese firms to the bottom, where competition was extremely fierce. In order to carve out markets at the lower niches that were not directly in competition with foreign companies and thus also reduce the dependent relationship, Chinese firms fought aggressively with each other for market share in domestic China and abroad (such as South Asia, Southeast Asia, and Africa). For example, some of the seemingly ambitious concepts associated with Huawei, such as "wolf culture" and "mattress culture" were all developed to describe the aggressive battles that the firm had to fight with its competitors, the most important of which was ZTE. Internal interviews indicated that the competition between the two firms was so intense in the decades from the late 1990s to the late 2000s that sometimes if one side lost a market to another, the former's regional market manager would be fired.[15]

Emerging at the same time were numerous start-up tech firms during this period supported by policy packages in the high-tech zones. While some indeed involved cutting-edge technology, especially those who returned from Silicon Valley, it was hard for them to scale up without industrial buyers. Most demands still went to incumbent firms in OECD countries with mature products. Thus the approach of engaging with GVC while pushing for technology upgrading and innovation through competition seemed to be a plausible strategy for domestic firms in China, but in reality, the focus almost became horizontal expansion at the same node of the value chain. This was the case even for firms such as Huawei and ZTE, who were aware of the importance of technology.

The U.S.-China Tech War in Two Rounds

Precisely because of such a hierarchical structure and unequal power, the United States was able to weaponize its global supply chains. In April 2018, the Commerce Department banned U.S. chip exports to ZTE, claiming the Chinese communications company had violated a 2017 settlement on illegal ZTE exports to Iran and North Korea. Afterward, the United States also issued a ban on exporting chips to Huawei and other Chinese companies. The first round came in 2019, when the United States prohibited firms from providing hardware and EDA software to Huawei and Chinese companies on the U.S. Entity List. However, the first round had many loopholes with the hardware, as third parties can still provide Huawei with U.S. products. It was also during this time that Huawei started to stock up chips. The second round of the tech war made sure that no part of the supply chain touched China and no third-party firms could use American equipment to manufacture components for exporting to China. This was a much stricter ban and had major disruption on the global supply chains, and such disruption has fundamentally reshuffled state-business relations. In addition to the export ban, the Federal Communications Commissions (FCC) also issued a ban on U.S. telecommunication industries purchasing products from Chinese companies (Huawei, ZTE, Hytera, Hikvision, Dahua) inside the United States.

China's Counter Strategy and New State-Business Relations

The launch of the tech war and the cut-off of supply chains for businesses such as Huawei and ZTE have given rise to techno-nationalism in China. As mentioned above, before the tech war and under the "Made in China 2025" plan, China avoided head-on competition in tough tech components such as computers and mobile phone chips. Instead, it sought to use manufacturing to break into emerging areas where China still can be a leader, and aimed to establish China as a major global competitor in advanced manufacturing. Yet after the tech war, the often taken-for-granted supply chain was no longer there, and the focus on core, crucial technology has re-emerged in national policy and narratives. Furthermore, unlike the 1990s, forming joint ventures

in chip manufacturing was no longer an attractive option. Rather, directly conducting R&D and exploring chip-related technology in hardware industries were strongly encouraged, as these were identified by the central leadership as the choke points for China's technology survival. A nationwide system of innovation has been developed.

After the Chinese tech firms were put in the spotlight in U.S.-China competition and their success or failure was interpreted as a matter of national survival. The Chinese state leadership recognized the importance of supporting high-tech firms and digital technology. The pressure from the United States has galvanized Chinese businesses and the state to carry out more intensive R&D and raised a strong sense of urgency. China started to build a national ecosystem that runs at multiple levels and connects numerous actors for technology innovation.

At the national level, the state has provided support for businesses to make a faster technology leap in chip-making, investing $29 billion in initial funding.[16] In late 2020, the Politburo held a collective study of quantum technology and emphasized the importance of having a major breakthrough in core and crucial technology. The 14th Five Year Plan also devoted significant attention to creating a nationwide system (*juguo tizhi*) that supports science and technology development, which is the only place where a "nationwide" system is mentioned in the plan. Although the support of science and technology is not new and can be traced back to the establishment of the country, the emphasis in recent years has been on the "central role" of businesses and firms rather than pure research institutions or government agencies such as the ministry (bureaus) of science and technology.

Vertically, this means that the local governments (at the provincial, city and the district levels) would provide capital investment for major projects, offer funding or rebates for R&D cost, implement tax breaks, and attract talent from a highly-educated pool. Horizontally, this means that with firms occupying the major role in research and innovation, the system connects interactions with numerous other entities, including high-tech development zones, high-tech parks, incubators, research institutions, and universities. In some selective cities, the administrations of high-tech industrial parks have risen to be on par with city governments, and sometimes they were referred to directly as high-tech district governments.

At the same time, firms are embedded in the ecosystem through multi-tiered institutions, seeking to avoid the previous situation of applying one method to all kinds of entities (*yi dao qie*). Among high-tech firms, some firms are much larger and stronger, such as Huawei, and others are smaller, start-up firms. Among the smaller firms, there are initial start-up tech firms, gazelles (those that passed the initial risky periods and have entered high-growth periods) and unicorns (those that were valued at over $1 billion). The tiered ranking has been used by local governments and industrial parks. Different tiers of firms involve different evaluation criteria for acquiring government funds, and the higher the stakes are, the more comprehensive the evaluations are. For higher stake projects, the evaluation process involves departments such as bureaus of finance, science and technology, and environmental protection, as well as independent experts from these areas.

Therefore, at least in the area of promoting high-tech firms (but not necessarily in other areas), local governments are still responding strongly to central government signals. For example, as soon as chip-making became a trend since the start of the U.S.-China tech war (similar to what solar panels and electrical vehicles used to be), local governments were reported as giving up on real estate sectors (which contained many bubbles) and invested billions in chip-making so as to gain central funding and to increase investment and revenue.

An important difference before and after the tech war was not only China's enhanced effort in developing chip technology, but the re-alignment of interests among different parties. As mentioned above, prior to the U.S.-China tech war, competition between Huawei and ZTE was fierce. Yet in face of a bigger challenge from the United States, overcoming the technology bottleneck became the priority. Huawei not only front-loaded orders with TSMC, but also started chip fabrication using Chinese equipment vendors (such as Shanghai IC R&D center). The company also invested in domestic EDA (Electronic Design Automation) startups to deal with the technology pressure for chip design.[17] Between 2018-2020, Huawei cut 1,600 personnel in non-R&D areas and acquired 2,500 personnel in R&D.

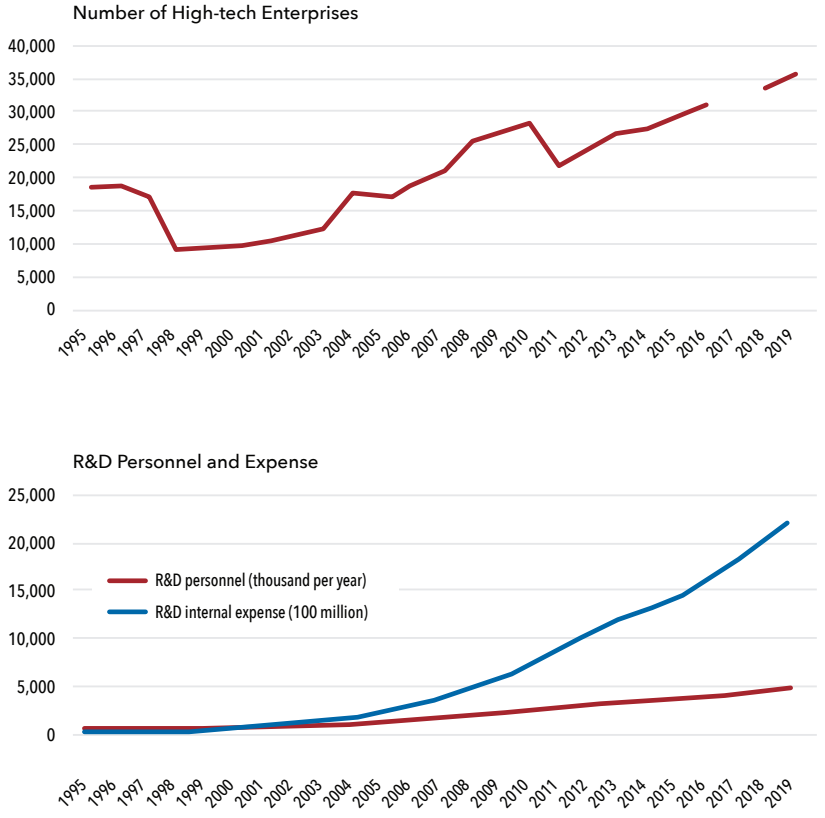
In addition to firms that were directly impacted by the tech war, such as Huawei, there were also many startup firms. Many of these high-tech startups focused on cutting-edge technology during the Hu-Wen era and before the

tech-war experienced a significant change. When core tech components were readily available from the United States (such as Intel or Qualcomm) prior to the breakdown of the supply chain, it was hard for these Chinese startups to convince any customers to purchase their products. As one manager interviewee asked, "Why would I bother taking risks to try out unstable new products rather than purchasing chips from established chip makers?" Startup firms lacked any feedback for technology improvement or opportunity for scaling up their markets. With the tech war taking place, Chinese firms immediately started to look for their potential domestic backup suppliers and turned to these high-tech startups that they previously ignored, which directly stimulated the demands for products from these startups.

The acceleration of development in high-tech hardware did not imply the immediate success of China in this regard, especially given the uncertainty, risks, and difficulties associated with these industries. The recent collapse of the 100 billion yuan HSMC chip project in Wuhan was a clear case where both local governments and the experts in chip-making were cheated by a team of outsiders who persuaded the district government of Wuhan to make the investment but covered the actual debt in the money-raising process. When the project was found to be fraudulent and collapsed, the team took part of the money and fled.[18] Similar processes took place in Anhui province and other localities.[19] This phenomenon, later regarded as cheating to obtain government subsidies (*pian bu*), showed that in order to make the state-led development work, it is important to have basic knowledge in semiconductor, electronics, AI and other industries in the decision-making process for local officials when making investment and allocating resources.

Despite these initial problems and even considering a high proportion of failed projects, the emergence of such a multi-layered nationwide innovation system that expanded vertically and horizontally at a rapid speed will overall likely accelerate the pace of innovation in areas deemed as crucial technologies, such as integrated circuits, AI, and quantum technology. Although under the Xi regime, key decisions such as approving developing zones and other major economic and social initiatives were more centralized, in terms of supporting hardware tech firms' innovation behavior, the Chinese state has been consistent. And although other policy areas can experience policy disruptions due to changes of priorities, the state has carved out a relatively safe

FIGURE 1: Number of high-tech enterprises, R&D personnel and expenses



Source: *China High Tech Industries Statistical Yearbook*; *China Science and Technology Statistical Yearbook*

space for hardware high-tech industry, with support in the format of capital, fixed assets and tax breaks.

Crucial to this consistency and relative stable space for high-tech development in hardware is China's understanding of the "high-tech" industry. Unlike western countries, which often equate tech firms with online-platform companies or digital giants such as Amazon, Google or Facebook, China's understanding and pursuit of core, crucial technology lie in the hardware tech parts, and their ideal role models are companies such as Apple and Intel. An overview of China's high-tech industry catalog also conveys a similar meaning: technology needs to be combined with industries that produced tangible products. Companies with digital technology such as Alibaba, JD, Didi and Tencent developed fast, but they did not fall into the usual category of high-tech industries in China. The rise of digital companies deserved a separate space for study, but these companies, with access to digital data and private information and succeeded mainly due to their first-mover advantages in collecting rents, were major targets of state control, rather than a major target for high-tech development.[20]

Observers have recently pointed to China's crackdown on tech firms to point out that there are risks associated with increased state control. As mentioned above, one has to pay attention to China's definition of "high-tech" firms, which specifically focuses on hardware technology and such definition is different from the west. Firms such as Huawei, ZTE, SMIC fall into that category. Not all internet firms or their affiliated firms undoubtedly fell into that category (e.g. Alibaba and Baidu), except for specific sub-divisions that invested in R&D in technology (e.g. AI). However, for any parts that are directly related to online platforms only, hence involving data management and security, or sectors that come with potential bubbles such as finance (e.g. Ants Group) or real estate, regulation was quite different. In the hardware technology, which is the focus of the paper, the state issued more supportive policies to attract business investment and encourage R&D, rather than direct crackdown. Therefore the potential pitfalls involved in supporting these sectors are the usual ones associated with government intervention in industrial policies, corruption and information asymmetry, as mentioned above through the local examples. For digital and online platforms, the risks are new for the state and the regulations are considerably tighter.

Implications for United State's Policy Effectiveness

The launch of the tech war had the overall goal of containing China's technology competition or convergence with the United States, with both economic and security concerns. Thus far, U.S. strategy has mainly been cutting off supply chains. The most recent move was placing restrictions on start-up firms worldwide (such as Xpeedic) to provide or invest in technology for EDA tools in China. While the cutting off of the supply chain may work to reduce products from Chinese firms in the short run, the long-term effects were more worrisome.

In the short run, the disruption of the supply chain has been effective in directly reducing Chinese products that involve using these core components. Huawei's mobile phones sales plunged in 2020 and 2021 and its smartphone market shares shrank in China, showing the direct influence of the U.S. ban on chips.[21] In fact, the export ban was said to produce a harder than expected hit on Huawei's revenue.[22] To mitigate the influence, Huawei sold its Honor brand to a consortium of businesses backed by Shenzhen. Therefore, despite Huawei's shrinking markets, if one combined both Huawei's and Honor's shares in 2021 (20 percent), it still surpassed Apple (16 percent) in China's domestic markets, but definitely was superseded by Vivo and OPPO, two other Chinese smartphone brands.

We do need to be more concerned, however, with the longer-term influence from the weaponization of the supply chain and evaluate its effectiveness. First of all, the longer-term influence on China is quite mixed and complicated. Comparted to the JV period, when the state chose an inappropriate ally, and the GVC period immediately before the tech war, when businesses that cared about core technology development were embedded in the wrong structure, the urgency for investing in and developing choke point technology seemed to be quite convincing and attractive to the business community and local governments. Furthermore, the cutting-off of the supply chain also forced businesses to be more reliant on the state. Both the pull and push sides propelled a re-focus on hardware technology. Although success or failure was highly unpredictable, at least the rise of techno-nationalism (or tech alarmism), state-business alliance, and reshuffling of the structure of production were all in place. In the process of economic and technology catch up, the East Asian developmental states of Japan, South Korea and Taiwan had all experienced

an import substitution industrialization (ISI) stage, where infant industries were protected from international competition. China's domestic reform and opening to outside almost took place at the same time, which meant the country skipped this stage in the post-Mao era. The disruption of the supply chain and return to self-sufficiency may entail the start of a delayed ISI stage, even though it is currently termed as a dual circulation strategy.

China, however, is fundamentally different from its East Asian neighbors. Although the United States had witnessed the rise of tech firms in Japan, South Korea and Taiwan, and even offered economic and security aid during the cold war period, the rise of Chinese tech firms has different implications.[23] These firms were reported to be connected and supported by the Chinese authoritarian state, and China now plays an opposite geopolitical role compared to its East Asian neighbors. Furthermore, the hardware technology that China seeks to develop currently is closely connected to 5G and AI technology that Chinese firms will continue to develop and has gone beyond "shallow" products into "deep technologies" that affect countries' economic, political, and security matters.[24] This means that the Chinese firms' move up the value chain will further intensify the threat perception of U.S. policy elites and their desire to weaponize the supply chains. This policy would in turn push China to develop indigenous technology domestically, leading to stronger techno-nationalism and state-business collaboration, thus wiping out foreign firms' influence in telecommunication and unleashing a vicious cycle in U.S.-China relations.

Second, businesses in the United States and other countries may not be aligned with the U.S. government. Historically, the U.S. government does not necessarily have easy control of businesses' behavior during sanctions.[25] As mentioned in the previous GVC stage, U.S. firms were beneficiaries due to their top positions on the value chain, which allowed them to reap huge profits from providing core components, and the China market was still attractive. Companies like Flex, Broadcom, and Qualcomm were the largest revenue makers from Huawei, earning around 6.2 billion yuan each year. Meanwhile, firms like NeoPhotonics were the most dependent on Huawei, with 48 percent of the company's revenue deriving from Huawei. Not surprisingly, U.S. firms worried about unfair competition with foreign rivals that were not banned from conducting trades with Chinese firms and urged the U.S. government

to approve non-sensitive component sales.[26] For example, the Huawei ban alone is estimated to result in a $30 billion revenue loss on the U.S. part.[27] Therefore, at least in the digital and telecommunication industries, the initial reaction of the U.S. firms was that they had an interest in continuing to trade with Chinese firms due to their different positions on the supply chain. More recently, according to interviews, U.S. firms learned to accept the fact of the tech war and were exploring markets outside of China and shifting their supply chains in case the tech war lasts for a long time. However, this process was going to take a long time without guaranteed success.

Because of business interests, the long-term monitoring cost was also substantial. The major unit in charge of the Entity List and the export ban is the Bureau of Industry and Security (BIS) under the Department of Commerce, which may not be able to watch over all transactions and products. Thus from time to time, the major tech firms were supposed to submit their supply chain information for the state's review, which may be against the will of the businesses.[28] While various industrial associations may be able to help, prioritizing certain firms while excluding others was against the principle of open trade, standard development and neutral technology that most industrial associations advocated for.[29]

The picture is also quite different when supply chains beyond the United States and China are taken into consideration. Although political leaders in European countries seemed to be more on board with the U.S. tech war in the Biden administration compared to the Trump era, overall uncertainty is high. Particularly, perceiving possible disruption in the GVC involving the United States and China, companies will try to take supply chains to regions out of the United States and into other regions to maintain production stability, especially the Asia Pacific region. In fact, the very success of Apple itself during the Covid period precisely lies in its increase of supply chains in Asia rather than in the United States. The equipment producer, KLA, also attempted to offshore to Southeast Asia by not using American equipment.[30] This implies that direct offshoring of production to Asia or China without selling core components to Chinese companies can become the dominant trend, through which U.S. companies' success becomes tightly bounded with development in Asia by using non-American equipment, thus starting their de-Americanization process. Another important player is of course Taiwan's

TSMC, which has been wedged between the politics of the United States and China. Although TSMC could not sell chips to firms on the entity list anymore, there has been major talent flowing from TSMC to the Chinese mainland in several major semiconductor projects in Shanghai and Wuhan.[31]

South Korea is another example. The country's four big companies, Samsung, Hyundai, SK Group and LG, are under pressure to manufacture semiconductors and batteries in the United States, largely due to the shortages of chips partly resulting from the stocking strategy in the tech war, the outbreak of Covid-19, and the fundamental lack of ecosystem for electronics production.[32] The Korean firms, in turn, have lobbied to get export licenses to supply U.S-.blacklisted Chinese companies, such as Huawei and chipmaker Semiconductor Manufacturing International Corp (SMIC).[33] Under such pressure, the U.S. Department of Commerce did grant them licenses, which directly countered the United States' own goal of blocking Chinese companies from having the key components.

These factors jointly suggest that in the current era, the U.S. government cannot single-handedly block off everything to create an export vacuum for Chinese firms because there are business players both in and outside of the United States that still seek to recover the broken supply chain. While the United States did maintain its overall technology advantages, the recent chip shortages indicate that technology advantages themselves are no guarantee of effective weaponization of the supply chain, as the United States also depends on business actors to manufacture high-tech products. The level of interdependence along the supply chain was higher than expected by U.S. policymakers. The United States could increase its control over the business if it seeks to continue weaponizing the supply chains. However, over the short- to mid-term, this is unlikely to succeed and may cause further backlash from businesses. Furthermore, as shown in this paper, continued sanctions will propel China to accelerate its pace of core technology development.

Therefore, a long-term strategy is needed for promoting national technological competitiveness other than blocking or disrupting the supply chains. More specifically, the United States should significantly increase R&D in cutting-edge technology in sectors such as electronics and IT (hardware as well as digital). More importantly, the U.S. should continue to attract talent from all around the world and improve its immigration policies. Against the

recent trend that scientists, engineers and scholars emigrate to other countries or return to their home countries, the U.S. had to design policies that made it attractive for talent to stay and for new talent to come in in order to sustain the long-term strategy of boosting technology competitiveness. In addition, the U.S. does not only need a technological advantage in core components but also the ability to scale up the fabrication of these components with U.S. companies.

The views expressed are the author's alone, and do not represent the views of the U.S. Government or the Wilson Center.

Notes

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