

Jonathan Lam
Prof. Bataille
SS334 Microeconomics
Final Report
5 / 8 / 22

U.S. export sanctions for advanced technologies on China

Preface from the author

The topic of technological trade between the U.S. and China has fascinated me throughout this course. Of course, these are the two largest economies in the world, and my ethnicity is Chinese. China has become a leader in the manufacture and consumption of technology, and a critical party in the discussion of many technological matters, such as cryptocurrency mining or stolen designs (as will be discussed in this paper).

These heated economic topics have far-reaching effects, such as the persecution of Chinese nationals in the United States on false claims of ties to China's Thousand Talents Plan [20]. Although I am not a Chinese national, I am saddened because these claims perpetuate a fear and lack of respect for Chinese people in the United States. The economic issues mentioned in this paper play a great role in that sentiment, especially with the emphasis of the Trump-era export sanctions, but this bigoted sentiment extends far beyond economics. Since I am ethnically Chinese and intend to work in a technological industry, this may affect me as well.

One of my blog post responses and one of my discussion forum responses discusses the relationship between the U.S. and China in tech-related exchanges, so I believe that this topic is a natural consummation of my studies for this course. (N.B. Some of the explanations in this paper are recycled from my old blog post and discussion forum because the topics are relevant.)

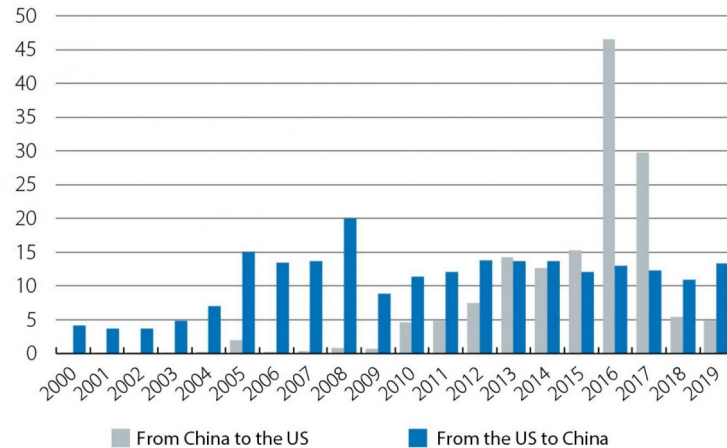
Background on relevant (technology) industries and their importance in economics

We examine the trade of advanced technologies between the United States and China, especially as it relates to recent export sanctions imposed by the United States beginning during the Trump presidency and reinforced during the (current) Biden presidency. By "advanced technologies," we are primarily referring to (but not limited to) the foundry and semiconductor chip industries and the communications industry, as these contain the main players of interest in this time period.

First, we briefly discuss international trade in general. Each group or nation has its own comparative advantages in production of certain goods or services. In the case of the United States, the comparative advantage may be in the design of advanced chip designs (such as Apple's in-house M1 designs). In the case of China, the advantage may be in the mass manufacture of smartphones containing those chips. Each nation working in isolation is limited by a maximum efficiency described by the production possibility frontier (PPF). However, a nation may exceed the PPF by means of international trade and focusing production on the goods and services for which it has a comparative advantage. This increases the size of the "economic pie" by benefitting both nations. Thus, it is usually highly desirable for any nation to engage in international trade, except in cases when domestic industries may be hurt (as we will see later in this paper). For such economically powerful nations such as the U.S. and China, there is an enormous benefit to engage in trade with each other, and this is evidenced by the high bilateral foreign direct investment (FDI) between the two nations. A plot of the FDI between the U.S. and China

is illustrated in Figure 1 by CaixaBank Research [9], emphasizing the FDI for technological goods. We will be describing the series of events that cause the massive changes in FDI beginning in 2018.

Direct investment flows between China and the US
(USD billions)



Note: In 2016, the flow of investment from China increased substantially, partly as a result of HNA China's acquisition of the Carlson hotel group. However, the flows in 2018 and 2019 are abnormally low compared to the growth trend of previous years.

Source: CaixaBank Research, based on data from The US-China Investment Hub.

Figure 1: FDI between U.S. and China

Secondly, let us examine the current state of the relevant technology industries. First and foremost is the semiconductor industries, which can be considered one of the most (if not the most) influential industries in this world where having the advanced digital technology means having an edge in innovation and profit in general (as well as national security). We may roughly divide this into two subindustries: the foundry industry (who manufactures the silicon chips, and advances the process node technology), and the chip vendor industry (who designs and sells the chips manufactured by the foundries).

In the foundry industry, there is a clear oligopoly by TSMC and Samsung, who have 55% and 17% of the global foundry market share by Q3 2021, respectively [13]. Other major players include Global Foundries, which has a 6% market share [10]. Intel also has its own foundry services, but it only manufactures its own chips, up until the recent creation of the Intel Foundry Services in Q1 2022 [14]. This monopoly is what the textbook would classify as an ownership monopoly, since these large and established companies are the only ones with the access to the technology needed to manufacture advanced chips. Notably, these foundries are very long-term investments and cannot be quickly erected; or, as Bjarin from Forbes notes, "semiconductor foundries are not startup opportunities" [12]. In the chip vendor industry, there are more players, and it is less of an oligopoly overall. However, once you look at any specialized target audience, there are clear oligopolies. For example, in the consumer desktop/laptop CPU market, there are AMD, Intel, and Apple [16]; in the smartphone CPU market, there are Samsung, MediaTek, and Qualcomm [15]; in the GPU market, there are AMD, Nvidia, and Intel [17]; in the server CPU market there are AMD, Intel, and ARM CPUs [18]; etc. for server and ASICs/FPGAs markets. These markets are probably mostly legal and ownership oligopolies, due to legal patents and ownership of human capital and entrepreneurship.

In the communications industry, there is a global oligopoly as well. Huawei is the leading company in telecommunications equipment sales, accounting for 28.7% of global market share in Q3 2021, according to the Dell'Oro Group; the top seven companies account for 80% of the global market share [19]. The China Academy of Information and Communications Technology (CAICT) showed that Huawei ranked first with 35.2% market share in the first half of 2021 in 5G equipment [6].

Another industry important to this discussion is the sale of consumer electronic devices such as smartphones. One of the notable players is Huawei, whose name we just encountered in the communications industry. Huawei led smartphone sales in 2020 (overtaking Samsung as first place, and pushing Apple to third place) in 2018, according to a report by Canalys in July 2020 [3]. In fact, Huawei is a highly diversified Chinese company who leads global sales in multiple industries, such as inverters (the electronic component) and having the fastest-growing mobile OS, HarmonyOS [6]. Huawei will be the most important company to play a part in the U.S. export sanctions, in part leading to its great diversification.

We should note that in this discussion of oligopolies that its relationship to inequality is not widely considered here. Typically, discussions of monopoly or oligopoly are intimately tied to a decrease in efficiency and an increase in inequality. Most of these advanced technological markets are dominated by some of the largest companies in the world, and are thus monopolistic markets rather than competitive markets (using the textbook's terms). This means that there is a high barrier of entry to these markets, and the set of companies that form the monopoly are relatively stable. The only likely realistic way for new companies to enter these markets is through massive government subsidies, which is a technique we will see is employed often by the Chinese government.

We cannot totally study the technology industries in isolation, because they tend to have many externalities. There is a generally positive externality of technological advancement, in that it improves efficiency in general and gives people better-performing devices. But there are also many more complicated issues, especially in the context of breaking copyright laws and stealing designs, which further advance the technology for the thief, but disadvantage the victim of the thievery. In addition, since the technological industries tend to be very oligopolistic, there is the negative externality of promoting inequality nationally or globally. Each of these externalities may have many additional effects. For the sake of this paper, we are only concerned with the primary effects of the technological trade between the U.S. and China and the immediate effects of this trade.

Causes of the U.S. export sanctions

In an ideal and simple world, societies would benefit most by producing the goods and services for which they have a comparative advantage, and trading those goods and services with other nations for goods and services for which the nation does not have a comparative advantage. However, of course the world is not so simple, as the world is always innovating and comparative advantage is always slightly shifting.

A country may attempt to bolster its ability to produce a particular good or service so that it may have a greater comparative advantage. One way to do so is to invest in the industry, either by subsidizing local production, or by acquiring foreign companies. Another way is to “cheat” by unlawfully stealing designs from other nations.

We see both of these in the influential case of Micron in recent years. Micron is a major chip designer and foundry in the U.S. In 2015, the Chinese state-owned company Tsinghua Unigroup attempted to

acquire Micron for \$23 billion, a move that was stopped by the U.S. government [8]. This is part of a 2014 Chinese initiative called the National Integrated Circuitry Investment Fund aimed to build a native memory chip manufacturing sector [21]. This move was not approved by the Committee on Foreign Investment in the United States (CFIUS) due to concerns about national security. After the failed takeover, a Chinese competitor, Fujian Jinhua, allegedly stole innovations from Micron. After allegations from Micron about the theft, China blocked Micron from exporting to China [8]. This shockingly dishonest business practice was one of the strongest pieces of evidence for Trump's export bans.

Huawei also recently became big news in 2019 when it was placed on the Entity List (a list of companies that may only be traded with with explicit approval from the U.S. government) due to claims of intellectual property theft, which prompted the beginning of the most severe export sanctions that still exist now, three years later [1]. However, the U.S. government has been wary of Huawei for many years in its communications industry. In 2008, Huawei's acquisition of the United States company 3Com Corporation failed to pass CFIUS review, also for national security concerns [6].

In addition to individual companies attempting to acquire or steal information from American companies, there are also large campaigns by the Chinese government to heavily subsidize the technological industries. The National Integrated Circuitry Investment Fund was related to the attempted Micron takeover. Another major initiative is the Made in China 2025 plan, in which the Chinese government has committed \$120 billion towards domestic semiconductor manufacturing, with the goal of domestically producing 70% of the chips for local consumption [1]. There is also the "Proposal of the Central Committee of the Chinese Communist Party on Drawing Up the 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2025," a Chinese initiative that puts strengthening science and technology at the forefront for the purposes of national security [6]. Additionally, China requires that foreign firms form joint ventures with domestic Chinese firms as a condition for market entry in some economic sectors, which many consider as a form of "forced technology transfer" [4]. In summary, hoarding of the most advanced electronics technology is at the heart of national security talks for both the U.S. and China.

U.S. export sanctions and aftermath

In March 2018, the United States Trade Representative (USTR) released findings from its Section 301 investigation, which found China's acts and policies related to tech trade "unreasonable and discriminatory and burden or restrict U.S. commerce" [5]. They mention the joint venture requirements and "cyber intrusions into U.S. commercial computer networks," strategic acquisition of American companies, and strategic subsidizing as methods that "deprive the U.S. of the ability to set market-based terms in licensing and other tech negotiations" [5]. As a result, the USTR released two lists of Chinese imports totaling \$50 billion to be taxed with a 10% tariff. The USTR decided that these did not have the intended impact, and thus increased the tariff to a list of \$200 billion worth of Chinese imports, to be taxed at a rate of 25% beginning in 2019. This tariff is not restricted to technological goods, but is rather part of the more general U.S.-China "trade war" of the Trump era.

Sanctions on Huawei also began to increase greatly along this time, with AT&T and Google breaking contracts with the company in 2018 [6]. In May 2019, Huawei was placed on the Entity List, along with 114 of its affiliates [1]. This prevents the sale of U.S. products to the company without explicit approval from the government. An amended export rule prevented shipments to Huawei from any company (including non-U.S.-based companies) that deals with Huawei and with the U.S. without explicit U.S. government approval [1]. This greatly further challenged the company, as it could no

longer do business with any U.S.-dealing company, such as TSMC. TSMC previously manufactured Huawei's custom-designed high-end chips, called HiSilicon, and China-only foundries are much less advanced [2]. The sanctions against Huawei were strengthened again in June 2021 when President Biden passed the United States Innovation and Competition Act of 2021 (USICA), which prevents the removal of Huawei from the Entity List without demonstrating that it no longer proves a threat [6].

Clearly, these tariffs and trade restrictions are intended to be punitive towards China, aiming to coerce China into falling in line with U.S. trade and copyright restrictions. Companies such as Micron initially celebrate trade restrictions, but was quickly hit by the export restriction to Huawei, since Huawei represents 13% of Micron's sales at the time of the export rule [8]. This is true of any domestic technology manufacturer in the U.S., and it seems that all experts agree on one thing (as well as the teachings from our course): these export restrictions hurt everyone in the long run, and not least U.S. producers. The United States SEMI industry group protested against President Trump's proposal to impose an export ban on China's Semiconductor Manufacturing International Corporation (SMIC) [1]. Similarly, suppliers have lobbied against the passing of the Export Control Reform Act (ECRA), and a large number of exceptions to the export rules have been passed on a case-by-case basis to help suppliers [6]. The president of the Information Technology and Innovation Foundation (ITIF), a U.S. think tank, summarizes: "Let's be clear, the trade war has been very bad for the semiconductor industry in many ways" [8]. Using our microeconomics knowledge, we know that any sort of trade restriction or tariff imposes a deadweight loss that decreases the size of the economy. Additionally, export restrictions decrease demand and hurt domestic suppliers' revenue.

The next question is whether the punitive actions have the intended effects. The answer here is also no. If we consider overall trade between U.S. and China, we see that trade and foreign investments have both rebounded since 2018 [4]. Another major indicator is that Huawei's current business is booming, as it remains the top communications equipment vendor and one of the top smartphone vendors. For example, by the end of 2021, Huawei had signed more than three thousand commercial contracts for 5G industry applications, and HarmonyOS is the fastest growing mobile operating system after Huawei was banned from using Android on its devices [6]. This is despite the strengthened sanctions on Huawei, and partly due to diversification to other industries such as self-driving cars and green energy.

Present day, normative recommendations, and conclusions

It is clear that the trade war did not have the intended punitive benefits, and caused a lot of collateral damage to suppliers in the U.S. In particular, the trade restrictions do nothing to curtail China's use of subsidies, which play a large part in China's strategy [8]. The Carnegie Endowment states that "punitive trade measures have had little effect on altering economic outcomes, and sanctions usually do little to cause governments to change their core beliefs" [4], and this is clear with China hardly changing their practices throughout. There has been some improvement in the enforcement of intellectual property rights, however: a 2020 Business Climate Survey by the American Chamber of Commerce in China found that 70% of surveyed U.S. firms in China felt that enforcement of intellectual property rights in China have improved [4]. Carnegie Endowment also states that this improvement may simply be a matter of time, since it takes generations for sound intellectual property rights to emerge, as it did in the U.S.

Luckily, the hostility that pervaded the Trump presidency is fading. Andy Purdy, Huawei's Chief Security Officer, is "heartened by the company's ability to shift business and grow profits," and states that there's been a "calming down of the rhetoric that was used a couple of years ago" [7]. The sanctions that blanketed many categories of goods from the initial USTR tariffs in 2018 have now

become more fine-grained and strategic, “to address the comprehensive challenge of China’s rise to the U.S. in the political, economic, military, scientific and technological, diplomatic, and humanistic fields” [6], which prevents too many U.S. suppliers from being needlessly affected.

One of the important lessons learned, particularly from Huawei, is the importance of diversification. Despite being given seemingly-insurmountable obstacles that essentially shut its supply chain off from the U.S. and the U.S.’s trade partners, it managed to maintain the global leader in communications equipment and even maintain competence in its smartphone sector. It shows a resiliency and innovation that any technology company should strive for.

To truly tackle the issue of dishonest business practices and intellectual property theft, many people have proposed the idea of international alliances or committees aimed at tackling these issues. For example, several leaders of important tech firms in the U.S. have formed the China Strategy Group (CSG) and have proposed the creation of the “T-12,” an alliance of twelve nations dedicated to tackling such issues [11]. In particular, this would advocate and monitor a “disentangling” of the tech spheres of the U.S. and China – the alternative to which is “a world in which China's non-democratic norms have ‘won.’” Another alliance called “Five Eyes” dedicated to monitoring China in the view of international public opinion on human rights and cybersecurity has been proposed [6].

One thing that all nations have to be worried about is the possibility of a “splinternet,” which will be a huge negative impact for all nations due to the immense impact of the Internet. The Internet is more or less a global public good, since it is non-exclusive and non-rival (assuming that the infrastructure exists); making certain areas exclusive will greatly hamper its ability. If the T-12 calls for a global bifurcation of our technological markets, it must not be an absolute bifurcation to avoid the risk of such a dramatic split. More generally, this should emphasize that we need to create a global arena of respect; the existence of global alliances should never alienate a country beyond reason, otherwise nations will revert to similar punitive methods that have no effect out of a populist antagonism.

Finally, the most straightforward recommendation is to simply reciprocate China’s strategic subsidizing of the advanced technology sector. This seems to be the most successful strategy, and is not inherently devious. China has laid out very clear plans with its Made in China 2025 campaign and similar plans, allowing it to rise to be a global superpower in technology in a very short period of time. This plan does not tackle the problem of intellectual property theft or other unethical practices; however, I personally believe that these are unavoidable to some degree. Instead of trying to constantly punish the other side (and often to no avail), focus instead on innovating at a fervid pace, and always stay one step ahead of the imitations. In other words: try to improve the U.S. domestic companies, without worrying about punishing China.

While it is idealistic to completely ignore China, I believe that this method is beneficial because it is simple, non-antagonistic, does not incur a dead-weight loss by imposing trade barriers, and focuses all efforts on maximum innovation (rather than diverting some of that effort and funding to punitive actions). Luckily, there are a number of large spending initiatives in the U.S. similar to China’s campaigns dedicated towards strategically keeping U.S. technologies at the forefront. These include the Creating Helpful incentives to Produce Semiconductors (CHIPS) Act, the American Foundries Act [1], and the America Creating Opportunities for Manufacturing Pre-Eminence in Technology and Economic Strength (American COMPETES) Act of 2022 [6]. These each allocate billions of funding towards development in semiconductor and related industries.

In summary, I believe that a strong push towards subsidizing domestic innovation, mixed with special interest groups or targeted international alliances to act as advisory committees, is a good general framework to tackle the current U.S.-China technological trade war.

References

- [1] Ioannou, Lori. "A Brewing U.s.-China Tech Cold War Rattles the Semiconductor Industry." *CNBC*, CNBC, 19 Sept. 2020, <https://www.cnbc.com/2020/09/18/a-brewing-us-china-tech-cold-war-rattles-the-semiconductor-industry.html>.
- [2] Kharpal, Arjun. "'Bleak but Salvageable': Huawei Has Limited Options as U.S. Sanctions Cut off Supply to Smartphone Chips." *CNBC*, CNBC, 12 Aug. 2020, <https://www.cnbc.com/2020/08/12/huawei-options-as-us-sanctions-cut-its-supply-of-smartphone-chips.html>.
- [3] Kharpal, Arjun. "Huawei Overtakes Samsung to Be No. 1 Smartphone Player in the World Thanks to China as Overseas Sales Drop." *CNBC*, CNBC, 30 July 2020, <https://www.cnbc.com/2020/07/30/huawei-overtakes-samsung-to-be-no-1-smartphone-maker-thanks-to-china.html>.
- [4] Huang, Yukon. "The U.S.-China Trade War Has Become a Cold War." *Carnegie Endowment for International Peace*, <https://carnegieendowment.org/2021/09/16/u.s.-china-trade-war-has-become-cold-war-pub-85352>.
- [5] "USTR Finalizes Tariffs on \$200 Billion of Chinese Imports in Response to China's Unfair Trade Practices." *United States Trade Representative*, <https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/september/ustr-finalizes-tariffs-200>.
- [6] Chen, Dingding, and Wang Lei. "Where Is China-US Technology Competition Going?" – *The Diplomat*, For The Diplomat, 5 May 2022, <https://thediplomat.com/2022/05/where-is-china-us-technology-competition-going/>.
- [7] Fried, Ina. "The Chinese Tech Giant Trump Couldn't Kill." *Axios*, 29 Mar. 2022, <https://www.axios.com/2022/03/29/huawei-chinese-tech-giant-trump-couldnt-kill>.
- [8] Swanson, Ana, and Cecilia Kang. "Trump's China Deal Creates Collateral Damage for Tech Firms." *The New York Times*, The New York Times, 20 Jan. 2020, <https://www.nytimes.com/2020/01/20/business/economy/trump-us-china-deal-micron-trade-war.html>.
- [9] Canals, Clàudia, and Jordi Singla. "The US-China Technology Conflict: An Initial Insight." *CaixaBank Research*, 9 Nov. 2020, <https://www.caixabankresearch.com/en/economics-markets/activity-growth/us-china-technology-conflict-initial-insight>.
- [10] Alsop, Thomas. "Top Semiconductor Foundries Market Share 2021." *Statista*, 12 Apr. 2022, <https://www.statista.com/statistics/867223/worldwide-semiconductor-foundries-by-market-share/>.

- [11] Allen-Ebrahimian, Bethany. "Former Google CEO and Others Call for U.s.-China Tech 'Bifurcation.'" *Axios*, 26 Jan. 2021, <https://www.axios.com/2021/01/26/scoop-former-google-ceo-and-others-call-for-us-china-tech-bifurcation>.
- [12] Bjarin, Tim. "The Semiconductor Industry's Competitive Dilemma." *Forbes*, Forbes Magazine, 4 Mar. 2021, <https://www.forbes.com/sites/timbjarin/2021/03/04/the-semiconductor-industryscompetitive-dilemma/>.
- [13] Park, Shin-Young. "Samsung Overtakes Intel as Foundry Looms as next Battlefield." *KED Global*, KED Global, 2 Aug. 2021, <https://www.kedglobal.com/semiconductors/newsView/ked202108020009>.
- [14] "Its Fabless Chips Rivals Flat-Footed." *Fortune*, Fortune, 15 Feb. 2022, <https://fortune.com/2022/02/15/intel-tower-semiconductor-foundry-acquisition-fabless-chips-rivalsnvidia-amd-qualcomm-tsmc/>.
- [15] Weissberger, Alan. "Counterpoint Research: Mediatek Is World's #1 Smartphone Chipset Vendor." *Technology Blog*, 25 Dec. 2020, <https://techblog.comsoc.org/2020/12/25/counterpoint-researchmediatek-is-worlds-1-smartphone-chipset-vendor/>.
- [16] Hruska, Joel. "Apple, AMD, and Intel Are Pursuing Three Different Strategies to Win the Laptop Market." *ExtremeTech*, 25 Feb. 2022, <https://www.extremetech.com/extreme/330417-apple-amd-andintel-are-pursuing-three-different-strategies-to-win-the-laptop-market>.
- [17] "[Q3 2021 Overall GPU Market Share]." *Hardware Times*, 16 Dec. 2021, <https://www.hardwaretimes.com/amds-dgpu-market-share-4-1-nvidia-20-intels-igpu-share-at-62-q3-2021-overall-gpu-market-share/>.
- [18] Alcorn, Paul. "AMD Sets All-Time CPU Market Share Record as Intel Gains in Desktop and Notebook PCs." *Tom's Hardware*, Tom's Hardware, 9 Feb. 2022, <https://www.tomshardware.com/news/intel-amd-4q-2021-2022-market-share-desktop-notebook-serverx86>.
- [19] Fletcher, Bevin. "Huawei Still Dominates Telecom Equipment Market." *Fierce Wireless*, 16 Dec. 2021, <https://www.fiercewireless.com/wireless/huawei-still-dominates-telecom-equipment-market>.
- [20] Thomas, Will. "US Research Security Campaign under Strain as Cases Falter." *American Institute of Physics*, American Institute of Physics, 25 Jan. 2022, <https://www.aip.org/fyi/2022/us-research-security-campaign-under-strain-cases-falter>.
- [21] Shields, Anne. "Micron Gets a \$23 Billion Takeover Offer from Tsinghua." *Yahoo!*, Yahoo!, 22 July 2015, <https://www.yahoo.com/entertainment/s/micron-gets-23-billion-takeover-130924921.html>.