Does Technology Transfer from the US to China harm American firms, workers, and consumers? A historical and analytic investigation

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Abstract: Decades of spectacular economic growth have made China into an important geopolitical player. As Chinese companies improve their capabilities across several areas of advanced technology, including AI, some U.S. policymakers and pundits lament the country's "unfair trade practices" and serial "theft of American intellectual property"—particularly, through so-called forced technology transfer. China hawks claim these practices hurt U.S. companies, workers, and consumers. Do Chinese technology practices harm economic efficiency? What are their distributional consequences? To address these questions, we explore the different modalities of international technology transfer and flesh out their economic consequences. We also investigate the recent history of technology transfer, providing examples from the industrialization experiences of European countries and the Asian Tigers. We surmise that current Chinese processes are neither novel nor alarming from the standpoints of economic efficiency or distribution: U.S. firms are collecting record royalty payments for their IP from China and generating gangbuster profits due to their access to Chinese labor, suppliers, and the country's growing consumer market. American consumers benefit from US-China economic interdependence and so do some workers. The consequences for the U.S. economy as a whole are positive. While we are agnostic about whether these practices threaten America's national security, we offer ideas for how to prevent China from acquiring its most sensitive military technology.

China has grown rich. It has done so quickly. Since Deng Xiaoping's liberalizing reforms in 1979, it has substantially narrowed the gap in GDP between itself and the United States and has begun to close the gap in GDP Per Capita too.[1]

China accomplished this feat by, first, adopting American technology and, then, innovating in its own right. It first arose economically as an export powerhouse focusing on cheap handmade goods; but this rise was made possible by its acquisition of American technology. While China reached economies of scale with relatively abundant and cheap labor in textiles, bicycles, and toys, openness to U.S. multinationals that introduced process innovations and importing American machinery were critical to its economic ascendance too (Romer 1993). Eventually, Chinese manufacturers graduated into computer hardware, appliances, photovoltaics, and mobile handsets, which they then exported around the world. While the design and marketing of these devices still primarily occur in the U.S. and other Western nations, Chinese firms have begun to threaten American firms' supremacy in computer chips, software, digital platforms, and artificial intelligence as its economy becomes increasingly geared towards providing high value-added goods and services to its own market.

This raises a host of questions. Does Beijing and do Chinese firms engage in overly coercive practices to acquire technology from U.S. multinationals? Is China's acquisition of technology from American inventors and firms bad for U.S. firms, workers, and consumers? Should the American government limit technology transfer to China?

[1] Breakneck growth rates have sometimes approached 10% annually, allowing Chinese real living standards to double twice between 1979 and 2006. Between 1990 and 2008, China's workforce increased by 145 million people as peasants migrated from the countryside to work in megacities such as Beijing and Shanghai; labor productivity improved by more than 9% per year during that period, as did Total Factor Productivity.

According to a burgeoning conventional wisdom in the U.S., the answer to these questions is yes. In particular, some American policymakers have leveled several accusations against China about its acquisition and uses of American technology. First, that Beijing steals American trade secrets and infringes on U.S. patents with reckless abandon. Second, that it compels American firms to part with technology they would otherwise not share through coercive measures. Third, that Chinese companies use U.S. technology to gain an edge over American firms in important industries. Fourth, that China's cannibalization of American technologies comes at the expense of the U.S. economy overall and represents a threat to American consumers, workers, and firms. Fifth, that China's unfair and abusive technology practices will catapult it over the U.S.—economically, politically, and militarily.[2]

Are any of these concerns warranted? What are the facts adduced by American policymakers when they make these claims? Is the logic of their claims coherent? What evidence do they use to support these claims? Does it pass muster?

In this paper, we demonstrate that China's technology transfer policies are (1) quite typical in historical and comparative context (2) for the most part proceed lawfully and are almost always

[2] There are certainly historical parallels to the fears voiced by U.S. policymakers regarding China's economic and technological rise. The British were worried about the rise of the Netherlands in the 17th Century on the back of financial innovations such as liquid securities markets, which birthed the Dutch East India Company and the growth of a global trading Empire that encroached upon the British sphere of geopolitical influence, including in North America. This fueled the crown to engage in mercantilist policies such as the so-called Navigation Acts, which were aimed at bolstering British traders at the expense of their Dutch counterparts. It also triggered several Anglo-Dutch wars. Britain was also worried about the rise of the U.S. in the late 19th Century. However, in this case, the passing of the torch from the former to the latter was peaceful and gradual. While the U.S. had eclipsed Britain in economic terms by the early 20th Century, due in large part to the Second Industrial Revolution (electricity, the internal combustion engine, chemicals, aeronautics, and radio), the former surpassed the latter in geopolitical and military terms only after World War II. Similarly, the United States was worried about the rise of Japan in the 1980s. But these worries faded after Tokyo's 1990 stock market crash, its subsequent economic collapse, and failure to return to its former economic glory after thirty years of stagnation.

centered on voluntary exchanges and (3) not bad for U.S. consumers, workers, or firms. We therefore argue that concerns voiced by U.S. policymakers about China's IP practices are hyperbolic, overwrought, and disingenuous. They tend to ignore how technology transfer actually works and are ahistorical. They are rooted in neo-mercantilist logic of zero-sum interactions, even though technology transfer to China are largely centered on positive sum, voluntary exchanges.

In fact, these complaints are about the distribution of a huge economic surplus, one that would not exist but for American technological pioneers and IP owners transacting with Chinese technological followers and licensees in mutually agreed upon terms. Businesspeople on both sides of the Pacific have found ways to sell, lease out, buy, and rent technology for their mutual advantage. While sometimes the relative winners are in China and not the U.S., it does *not follow* that American firms, workers, and consumers are being made worse off by China's technology transfer practices, despite the occasional theft of trade secrets and patent infringement by Chinese entities, a fairly common business practices across most countries. If the price of admission is "forced technology transfer", American firms' shareholders with a presence in China are choosing to put their chips on the table and doubling down on the Sino-bet.

We follow in the footsteps of several works that have questioned the sincerity and logic behind pundits', politicians', and academics' hawkish critiques of Chinese policies, including regarding technology. Zweig and Kang (2020) show that the CCP enacted the Thousand Talents Program in 2008 to incentivize Chinese scholars and researchers to remain and work in China. While this initiative sparked some of the most recent concerns voiced by American policymakers over China's supposed IP infringement and technology theft, the authors indicate that actual instances of stealing have been few and far between. Similarly, Brautigam (2020) criticizes

Western policymakers who classify Chinese Belt and Road initiative investments as "debt-trap diplomacy", labeling this a superficial meme, not an accurate description of facts on the ground.

To support our thesis, we discuss different modalities of technology transfer and flesh out the efficiency and distributional considerations around the benchmark mechanism—developing countries acquiring technology from the innovation frontier via robust intellectual property rights (IPR). To help advance our argument, we investigate the history of technology transfer, providing examples from the industrialization experiences of European countries and the Asian Tigers. We also look at the actual facts on Chinese IP reforms, practices, patenting activity, and licensing.

We surmise that current Chinese processes are neither novel nor particularly alarming from the standpoint of economic efficiency or distribution: Technology transfer from the U.S. to China has direct and indirect benefits for American consumers, workers, and firms, even if some American firms have less than perfectly secure property rights over their ideas. The health of U.S. companies doing business in and with China has proven largely impervious to the country's relatively mundane IP transgressions and, if anything they have largely improved their innovation prospects. Moreover, when Chinese companies acquire technology from abroad, however they do so, they raise their productivity and the wages they pay workers, increasing overall demand for Western processes and products. Indeed, U.S. firms doing business with and in China are generating gangbuster profits due to their access to Chinese labor, suppliers, and the country's growing consumer market. This has had positive spillovers on the rest of the American economy.[3]

[3] While this paper is relegated to evaluating the impact of U.S.-China economic integration and the role of technology transferred from the U.S. to China, other Western countries have also benefited greatly from more trade, investment, and technology exchange with China. Consider Sweden: Ericsson, which makes equipment for wireless networks, makes 13% of its revenues from China. Other Swedish companies with big stakes in the Chinese market, either because of trade or FDI, include engineering firms, carmakers, pharmaceutical companies, and machine

Ultimately, attempts by China to steal trade secrets or "force" technology transfer are inefficient and self-defeating. When original innovators or technology proficient firms lack incentives or opportunities to also transfer the knowhow that accompanies physical and abstract technologies, the acquirer may not be able to make ready use of them. Or, supposing these innovations are eventually useful, consider the costs of theft or coercion to the acquirer. While patent licensing costs money, stealing blueprints and then trying to figure out how to put them into practice yourself is certainly not free; further below we will spell out exactly why that is the case.

The truth is that China has recognized this: it's a manufacturing powerhouse with a lot of indigenous inventive activity that has made vast improvements to its IPR system. While it has done so largely to incentivize its own nationals to engage in and commercialize domestic innovation, foreign innovators have increasingly ridden the wake of that wave, and so have Chinese firms doing business with them. Most Western technology transferred to Chinese companies proceeds through ordinary market mechanisms—royalties paid to foreign firms for patent licensing, legal imports of machinery, and FDI that strongly benefits Western firms.[4]

There are real stakes to getting these facts right. Under former President Trump, restrictions on Chinese investment in the American economy intensified, as did bans against outbound FDI and some U.S. exports to China. So, did rampant animosity towards several Chinese multinational corporations (MNCs). These actions exemplify political "de-globalization" pressures affecting international business worldwide (Witt 2019). Protectionism of this ilk threatens lucrative global trade and investment flows, transnational supply chains and, ultimately, shared prosperity. Indeed,

makers. Indeed, China is Sweden's sixth largest export market and a host to over 500 subsidiaries of Swedish firms (see The Economist 2021).

[4] This is not only relegated to China: U.S. citizens and businesses remain the most prolific patent applicants abroad. American-based applicants filed over 230,000 patents overseas in 2019 (WIPO 2019).

the emerging consensus that economic engagement with China is bad for the West presages a slower pace of global innovation, especially regarding the internet of things (IOT) and artificial intelligence (Deng, Delios, and Peng 2020).[5]

We hasten to emphasize that this paper is *not* about some of the potential negative knock on effects of voluntary exchanges centered on IP between American and Chinese firms. We do not aim to argue that technology transfer from the U.S. to China never poses national security risks to the former, for example. If U.S. officials conclude that the transfer of certain technologies indeed threatens American security because they have special military applications, then that is a separate issue altogether.[6] We address this possibility towards the end of the paper.

THE POLITICO-ECONOMIC CONTEXT

Countless goods manufactured across the world now require microchips, modems, and software. All kinds of devices, including smartphones and even refrigerators, stream billions of terabytes of data every day to the cloud and to each other. Constant software updates are required for these devices and networks to operate smoothly. All manner of business transactions call upon service providers to reliably vouchsafe their customers with infrastructure, maintenance, and customer service.

Many Chinese firms have mastered this new reality and have excelled in a few high-tech areas. This includes electric vehicles and high-performance batteries. Tech platforms are also on this list, including Baidu, Tencent, and Alibaba. In AI applications, Chinese firms have a

[5] The authors argue that Chinese MNCs, like those from other countries, face unique challenges besides hostility voiced by critics in Western countries. This includes relatively weak institutional contexts at home, interference from their governments, entering foreign markets at a relatively early stage in their maturation process, a dearth of managerial and technological capacity, and strong ties to their home country.

[6] For example, see O'Connor (2019).

comparative advantage in terms of their access to reams and reams of data from domestic users due to a huge population and lax privacy protections.[7] China has tiptoed into producing semiconductors, especially in light of recent U.S. restrictions on American firms selling microchips to Chinese companies such as Huawei. It is also a world leader in digital payments, including blockchain and distributed ledger technology.

China's workforce is far from a monolithic mass of cheap labor, a tired stereotype. In terms of the quality of its higher education system, it ranks third globally (WIPO 2019). China boasts millions upon millions of highly skilled technicians operating in precision manufacturing and advanced engineering.

Chinese firms are not resting on their laurels. China accounted for 24% of global R&D expenditure in 2017. Huawei boasts the biggest collection of 5G standard essential patents.[8] These efforts are wedded to China's attempt to become the first country to deploy a 5G wireless telecommunications infrastructure nationwide. Relative to 4G, its predecessor, 5G is 100 times faster and promises much less latency; this, along with the proliferation of cheap sensors and AI algorithms, is slated to allow the IOT to blossom and fuel driverless cars, fully automated factories and warehouses, and even remote surgery. Beijing hopes that, by being first to launch 5G at scale, Chinese tech firms will be able to exploit a seamless high-speed wireless network with close to a billion users to develop new digital platforms and AI applications.

Bringing the Chinese State Back in

[7] However, they do lag considerably behind American firms in terms of the efficacy of the algorithms they use to identify patterns and personalize and target information to users (see The Economist 2019).

[8] Huawei is the world leader in the IT behind the 5G wireless network, and earned over $107 billion dollars in revenues in 2018.

At the same time, Chinese economic *dirigisme* has increased substantially. Beijing has strategically merged large state enterprises to reach greater scale; Xi Jinping has personally reversed privatizations of large portions of the Chinese economy. The Chinese state has bought shares in successful private firms, manipulated asset prices—through intervention in stock markets, for example—revved up its subsidies to national champions, and promoted aggressive industrial policy.[9] Beijing has also turned to using huge government procurement contracts to endow Chinese firms with inimitable advantages, such as reaching economies of scale vis-à-vis global markets.[10] Further, China insists it will not compromise in securing access to energy-related natural resources.[11] This follows decades of subsidies to exporters that have, varyingly, included tax breaks, tariffs on competing imports, an undervalued currency, access to cheap credit, labor, and land. The state's share of investment is back to levels last reached in the late 1990s (Taplin 2019a).

Technology is no different. Beijing has aggressively promoted AI, robotics, electric vehicles, the IOT, semiconductors, digital payments, and quantum computing.[12] To make 5G a reality across the country, the Chinese government plans to spend over $200 billion dollars on base stations, new cell towers, and other infrastructure; it has allocated significant chunks of radio spectrum that mixes fast speeds with moderate transmission distances to three state owned

[9] For example, Chinese government agencies have pumped out a growing list of domestic market-share targets for Chinese firms, especially around electric and hybrid vehicles.
[10] Government procurement is centered on computers, telecommunication infrastructure, office equipment, software, renewable energy, and energy efficiency.
[11] As Lind and Press (2018) argue, China's energy mercantilism makes sense from a national security perspective in light of imperfect contracting, supplier collusion, geographic concentration, and a high risk of conflict.
[12] The Chinese State Council famously introduced a ten-year $300 billion plan in 2015 labeled "Made in China 2025" that declared the country's intentions to become a world leader in semiconductors, AI, and electric vehicles, among other high-tech industries.

telecommunication companies. It has directed national regulators and provincial and local governments to coordinate the nationwide rollout of 5G, using its muscle over land rights (Woo 2019). It has also awarded Huawei lucrative contracts to provide equipment to the network.

PROMINENT COMPLAINTS BY US POLICYMAKERS & THEIR LOGIC

U.S. critics accuse Beijing of unfairly conferring an advantage on Chinese firms while hurting American economic interests. In the words of FBI Director Christopher Ray: "Put plainly, China seems determined to steal its way up the economic ladder at our expense" (cited in The Economist 2019). American critics accuse Beijing of actively breaking WTO rules in the pursuit of creating international market-beating companies.

As China hawks have become obsessed with the technology question, they point to several episodes to bolster their case.[13] To acquire American innovations, both the Communist Party and Chinese firms engage in widespread industrial espionage; compel American firms to enter joint ventures that divulge trade secrets in exchange for market access; conduct onerous security reviews and testing requirements; and deploy trillions of dollars to acquire U.S. companies operating in high-tech industries.[14] American firms have also accused Beijing and Chinese firms of pressuring local courts to invalidate their patents and licensing contracts, filing specious antitrust investigations, and employing regulatory panels that vacuum up trade secrets and share them with their Chinese rivals (Wei and Davis 2018).

[13] Outside of technology, American politicians have also complained about Chinese tariffs on American imports, China's supposed currency manipulation, its subsidies for state-owned enterprises, and its flooding of the international market with cheap industrial goods such as steel.
[14] On all of these points see Navarro (2018). According to the FBI and US Joint Chiefs of Staff, the Chinese government is behind the theft of billions of dollars of U.S. companies' trade secrets across a wide swath of sectors, including aviation, pharmaceuticals, and extractive industries.

American policymakers have also blanched at attempts by Chinese companies to acquire American technology by recruiting computer engineers and data scientists in Silicon Valley. Foreign executives who work for multinationals in China have voiced fears that "their greatest IP risk [is] theft by their own employees" (The Economist 2019). The U.S. government has tended to agree with this assessment.

By extension, China currently stands accused by some analysts of underinvesting in domestic R&D (Atkinson et al. 2017). The idea is that this practice has freed up capital to acquire foreign inventions, ideas, and knowhow. It also allows the Chinese government to subsidize market-beating national champions that undercut prices through low labor costs and low fixed costs as well—including those associated with R&D. The implication is that China is free-riding on American innovation efforts and the U.S. essentially gets taxed twice: jobs are offshored to China, where goods can be produced more cheaply, while the Chinese state exploits its large internal market and deep pockets to unfairly advantage national champions at the expense of American companies (Atkinson 2020).

Yet, ironically, when they are not accusing Beijing of stealing American IP, U.S. policymakers decry the fact that China's indigenous innovations are a potential threat to American competitiveness. Its firms' standard essential patents, chips, and equipment may establish best practices around both 5G handsets and network equipment that may be exported abroad. Plus, the Chinese government may use Huawei—a private company in name only, critics assert—as a backdoor to seize access to data. And some China hawks have argued that China seeks to use 5G—and its attendant influence over associated standards, platforms, and patent pools—to influence telecommunications laws and regulations in other countries, which will allow it to foist its own,

ideological and potentially totalitarian, version of the internet on the global community (see Coughlan 2020).

Thus, Huawei and TikTok have been characterized by Western critics as political entities, not profit-maximizing firms (Rosenberger 2020a). According to this view, these firms are but an extension of an increasingly assertive, authoritarian state, spreading propaganda and using international standard setting boards to hijack national laws and promote surveillance (Rosenberger 2020b)

Several prominent voices in Washington have therefore urged the U.S. to employ radical, previously unthinkable, steps. To "better compete against China", American politicians such as Senator Marco Rubio have urged America to embrace an overt industrial strategy centered on tax breaks and export controls to strengthen American manufacturing. Other proposals have called for the nationalization of critical infrastructure like the nascent 5G wireless network.[15] New tariffs, sanctions, and outright export bans directed towards the Chinese government and Chinese firms continued to proliferate out of Washington during President Joe Biden's early days in office.

Consider Washington's Huawei obsession. It blocked the Chinese technology giant from doing business with the federal government and barred American chipmakers from supplying Huawei essential smartphone components.[16] The Trump Administration pushed two non-Chinese

[15] In early 2018, documents were leaked by an unknown source that showed the White House was considering a wholesale nationalization of the nascent 5G wireless network. Members of Congress objected, forcing National Economic Council Director Larry Kudlow to aver that U.S. 5G would be built with "free market, free enterprise principles" (Swan et al. 2018).

[16] This follows on the heels of the Federal Communications Commission labeling both China's ZTE Corporation and Huawei national security threats, banning ZTE and Huawei from providing equipment to America's wireless communications network, and ending federal subsidies directed to these firms and meant to increase internet coverage. Washington has also pushed other countries, such as Germany and the UK, to preclude Huawei from helping to build their 5G networks. The UK did just that in July of 2020. Policymakers around the world claim, without much evidence, that the Chinese government will be able to exploit its cozy relationship with

providers of telecommunications equipment, Nokia and Ericsson, to shift their own supply chains outside of China over concerns that their facilities there could be compromised and their products' security jeopardized (Woo and Volz 2019). The U.S. Senate has also pushed for the development of a so-called open architecture system for 5G centered on cloud computing and software that would bypass equipment such as Huawei-made switches and routers.

PUTTING TECHNOLOGY TRANSFER IN PERSPECTIVE

While policymakers in D.C. have converged on the view that technology transfer to China from American firms is proceeding through illicit means and hurts the U.S. economy, an analytic and historical account of international technology transfer can help put this in perspective.

Technology transfer is the conveyance of processes, goods, and new ways of organizing production from one country to another. It can lead to improved efficiency and help firms achieve economies of scale. Importantly, technology transfer can complement, or even substitute for, indigenous technological development. Indeed, technology transfer may be the most important development driver in the industrializing world (Abramovitz 1993; Romer 1993).

Governments are interested in acquiring technology to bolster national security and improve governance. Also, they generally want companies located within their borders to perform well and generate taxable wealth, as well as produce employment and high wages for citizens (Menaldo 2016). Finally, technology matters to the state because citizens are consumers that benefit from technology: it helps them gain access to cheaper and higher quality goods and services, as we outline below.

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these firms to weaponize 5G: use backdoors built into Huawei equipment such as routers to spy on foreign governments and citizens and sabotage critical infrastructure such as power grids. Besides telecom gear, Huawei also makes handsets and microchips and provides cloud computing services.

Companies are interested in technology for several reasons also. Access to process innovation is crucial for firms seeking to raise labor productivity and total factor productivity. This often allows them to move up the quality ladder and secure competitive positions in more lucrative, high value-added endeavors.

What does History teach us About Technology Transfer?

Since even before the Industrial Revolution, countries at the technological periphery have attempted to obtain technology from those at the frontier. During this time period, several Continental European countries sought to acquire knowledge and technology from Britain through a variety of methods.[17]

During the latter half of the 18th Century and until the 20th Century, this meant countries such as France, Belgium, and Spain engaging in a multipronged approach. They hired English and Scottish scientists; encouraged skilled machinists to migrate from Britain; incentivized the importation of cutting-edge machines and tools from across the English Channel, sometimes in a bid to reverse engineer them; and sent scientists, engineers, and technicians to live and study in Britain's leading industrial cities to improve their knowledge and skills. While the Continent's governments also created scientific academies, erected model factories, and fostered cognate institutions and repositories of knowledge, their efforts almost always involved industrial espionage. Currently, China is engaging in many of these same efforts.

Attempts by governments to coax technology transfer from elsewhere were not unique to the European Continent. Long before the Industrial Revolution, Henry VII tried to lure skilled wool weavers from the Netherlands and Venice to England to acquire their technologies and

[17] Usually, governments, industrious individuals, or firms were motivated to develop higher value-added manufacturing as sources of higher profits, wages, or taxes (Landes 1969; Reinert 1995).

knowhow. In the same way, China has attempted to attract Western scientists and engineers to its shores, sponsoring conferences and poaching top talent from U.S. tech firms. Both the government and the country's national champions such as Alibaba have done this.

However, during the Industrial Revolution, the British Crown was not above hypocrisy: it tried several methods, some draconian, to impede the kingdom's technology from crossing the English Channel. This included passing laws that barred skilled machinists and engineers from emigrating abroad; restricting exports of "sensitive technologies"; and preventing foreign technicians and engineers from visiting Britain. The crown feared that foreign entrepreneurs and businesses acquiring British technologies would compete away the profits accruing to the island's market incumbents (see Reinert 1995; Landes 1969). London also claimed it was protecting national security. This certainly sounds familiar.

Indeed, fears voiced centuries ago by Britain about its neighbors acquiring advanced technology echo today. For example, the U.S. Energy Department banned its employees and contractors from participating in Chinese foreign talent-recruitment programs in 2019. Their declared rationale was that these programs are sponsored by the Chinese military and they do not want Beijing to obtain scientific insights around energy and AI due to national security concerns. The Trump Administration also pushed big U.S. tech firms like Microsoft to reduce their exchanges with Chinese businesses for fear of trade secrets leaking out or, simply because, even if these firms were to legitimately purchase goods and services from American firms, it would allow them to accelerate their own technological progress.[18]

[18] The U.S. government has also restricted investments from China in American firms that produce sensitive technology, including Chinese venture capital meant to fund startups (Winkler 2019).

How do we judge these recent U.S. efforts in light of the historical evidence? Surprisingly, despite increasing technological complexity, important innovations around textile manufacturing, coal extraction, machine tools, and wrought iron managed to find their way over the sea and eventually reached the continent, British attempts at mercantilism notwithstanding. They also reached American shores. Technological diffusion from the innovation core to the periphery then accelerated. Comin et al. (2008) show that, while developing countries needed decades to fully assimilate innovations such as the steam engine, electricity, and telephones, it has taken a handful of years for smartphones and similar digital technologies to fully transfer across the world.

Why did this happen? Several researchers have argued that many late industrializers did not necessarily rely on strong patenting to catch up to industrialized countries. They instead coopted existing ideas, particularly process inventions (e.g., Richter and Streb 2011). France, Belgium, and Germany sometimes imported machinery from Britain during the Industrial Revolution and figured out how to put it into practice.

Yet these types of explanations are overblown. First, no amount of industrial espionage conducted by late industrializing countries could hope to deliver the sophisticated knowhow required to introduce new processes and products tied to advances in physics, chemistry, electromagnetism, material sciences, and organizational dynamics—let alone quantum mechanics and computer programming relevant for recent technologies.[19] Nor was it sufficient for later technology adopters to lean exclusively on their citizens' experiences studying and working abroad, knowledge of basic science, exposure to technical literature, membership in international technical societies, and travel to industrial exhibitions. Importing technology has also proven

[19] This section draws on Menaldo (2021).

inadequate as a standalone approach. These strategies have helped transfer technology from the core, but they have proven neither necessary nor sufficient.

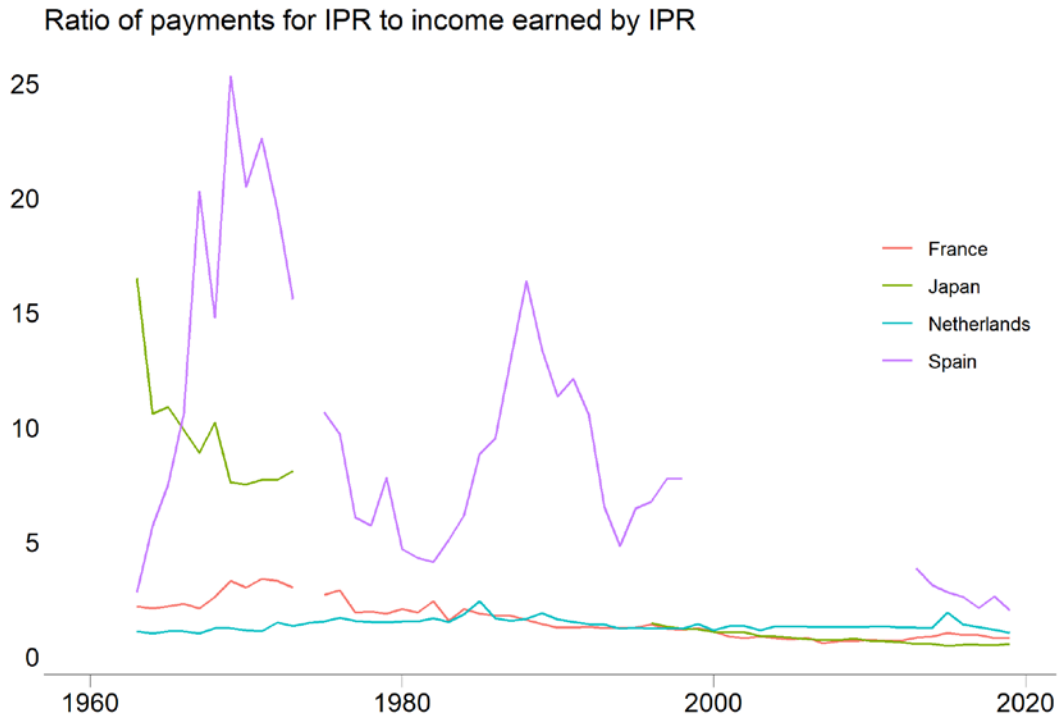
Instead, since the mid-19th Century, original inventors who license their patents in host countries, as well as entrepreneurs and laborers acting at their behest, have travelled to distant lands to help their licensees introduce inventions to new markets, adapt them to those markets, and help with their upkeep. Examples include the transfer of process innovations associated with the manufacturing of textiles, glass, pulp and paper, machinery, metallurgy, chemicals, electricity, the telegraph, and railroads. In this way, industrialization was broadly promoted across Sweden, Norway, Finland, Belgium, and Spain by foreigners—mostly from Britain, but also Germany—patenting and then disseminating their inventions over the 19th Century in an effort to profit from the uptake of their technologies beyond their geographic place of origin.

Indeed, technology transfer might be the wrong term to use. Transnational networks contributed to technological advances through incremental innovations that spanned borders. British, French, and Belgian inventors introduced and disseminated new innovations throughout the European periphery during the Second Industrial Revolution. New international feedback loops then improved upon original inventions. As new processes were introduced in countries across the European continent, original inventors met with—often unexpected—differences in the type and quality of raw materials, other key inputs to the production process, and logistical problems.

To confront these challenges, foreign firms and indigenous entrepreneurs found ways to jointly adapt new processes to their countries' unique circumstances. And, sometimes, these improvements made their way back. For example, during the 19th and 20th Centuries, several German and French inventors who improved upon English inventions after acquiring licenses then turned around and obtained patents in England to protect and disseminate their improvements.

Consider Spain. It underwent a strong wave of trade liberalization beginning in 1959, in the wake of an acute economic crisis. Spanish firms responded to a sharp reduction in import tariffs introduced by Francisco Franco by accelerating their acquisition of foreign technology. This accompanied Spaniards' increased licensing of IP owned by inventors in industrialized countries.

Figure 1. Spanish Expenditures on Royalties, Copyrights and Licenses (1963 to 2019)



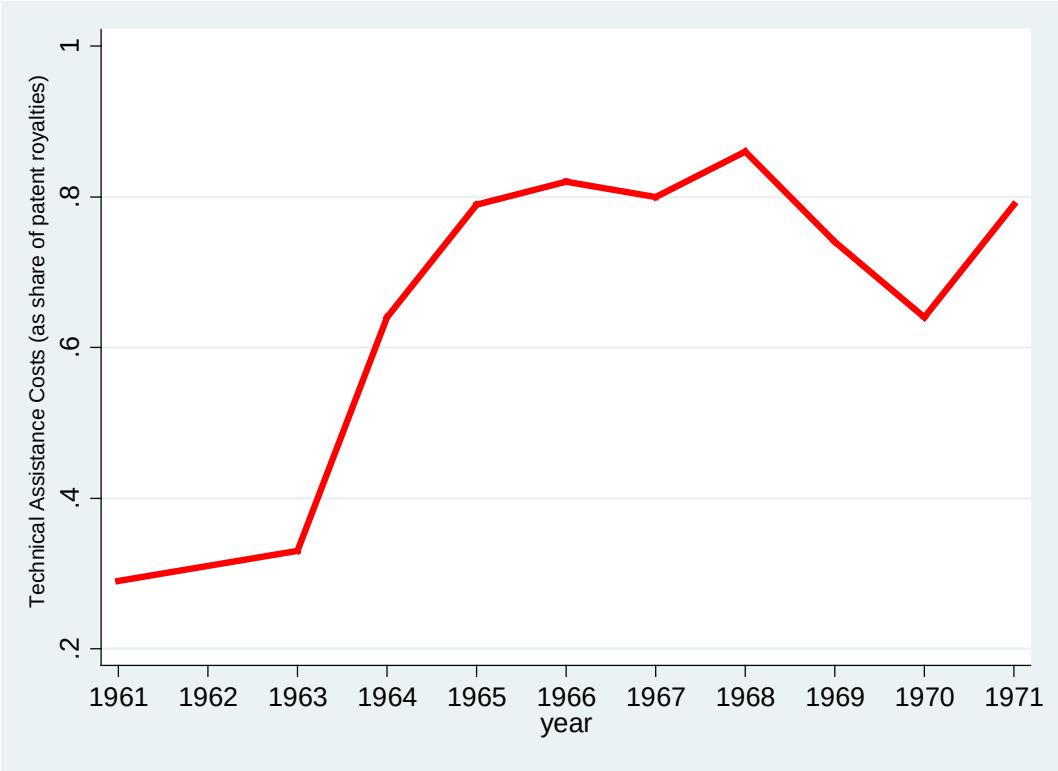
Notes: Data excludes payments for technical assistance. The denominator is the income received from abroad for royalties, copyrights, and licenses. The numerator is the expenditures on royalties paid to foreigners for royalties, copyrights, and licenses. Sources: Cebrian and Lopez 2004: 134, Table 6.8; supplemented with data from the International Monetary Fund (IMF) Balance of Payments Statistics Yearbook and data files for the time series after 1973. Interruptions in the timeseries indicate missing data.

Figure 1 graphs Spain's extraordinary expenditures on royalties, copyrights, and licenses, versus that of Japan, France, and the Netherlands, during most of the post-World War II era. Spain's acquisition of foreign technology through the licensing of IP from industrialized countries

undergirded a so-called economic miracle in which Spain cultivated manufacturing capabilities in textiles, automobiles, and machinery.

Similarly, Figure 2 graphs Spain's technical assistance costs as a share of royalty payments on patents between 1961 and 1971, the heyday of Spain's post war industrialization. On the back of patent licenses paid to foreign firms, Spanish firms spent an ever-growing amount of money to acquire the knowhow needed to put inventions into practice. Simultaneously, technical assistance payments averaged 10% of total project costs for the firms represented in this figure; this was equivalent to 23% of their foreign exchange payments. In turn, these practices allowed Spain' living standards to converge with its continental cousins (Menaldo 2021).

Figure 2. Technical Assistance Payments in Spanish License Contracts (1961 to 1971)



Notes: Data is aggregated from patent license contracts; the numerator is payments for administrative and technical assistance services and the denominator is total royalty payments.
Source: Cebrian and Lopez 2004: 135.

The Asian Tigers are the next stop in our historical technology transfer tour. Researchers have suggested a variety of methods by which South Korea, Singapore, Taiwan, and Hong Kong acquired technology from the frontier. These countries' early strategies centered on cooptation and imitation—including through industrial espionage, courting skilled labor from abroad, and importing machinery (Odagiri et al. 2010: 11; Asian Development Bank 2015). They also cultivated FDI so that domestic firms exposed to multinationals' superior technology could improve their own production processes (Romer 1993). Labor mobility from these multinationals to domestic firms also helped disseminate Western innovations across the Asian Tigers (Saggi 2002).

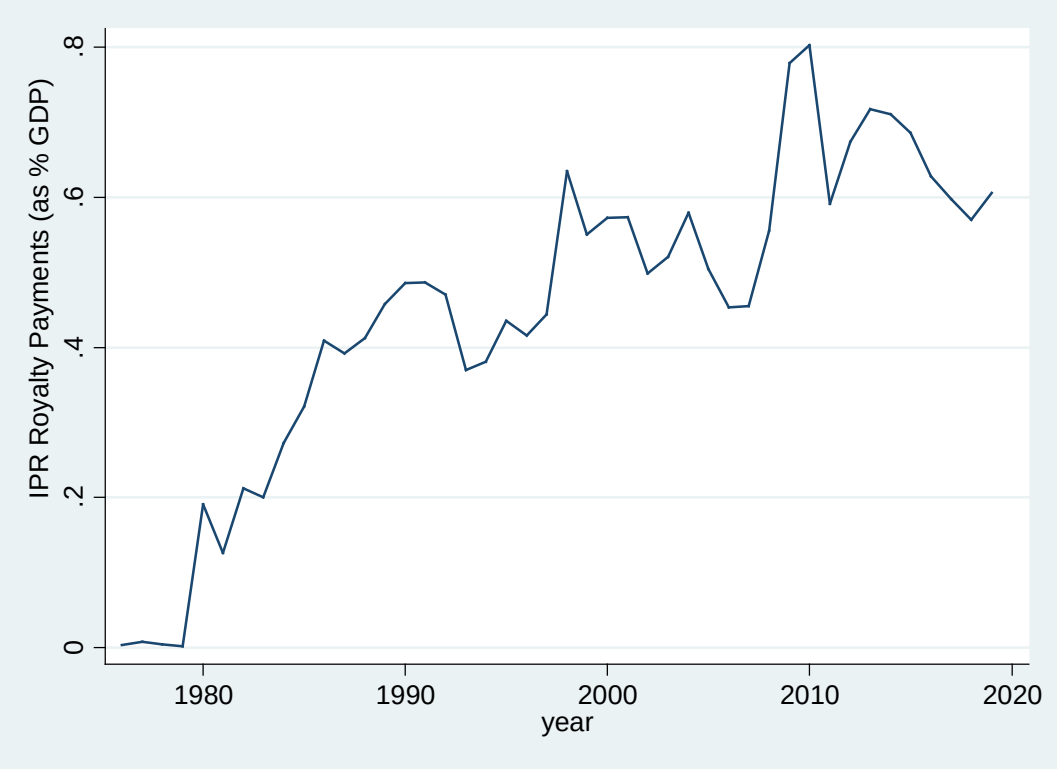
These countries also practiced direct government intervention as they industrialized to address the non-pecuniary externalities associated with technological acquisition from the core—including prohibitive search costs, for example. Even beyond search costs, learning by doing dynamics inspired governments from Seoul to Taipei to cultivate the domestic production of goods and therefore engage in selective intervention via tariffs/quotas, subsidies, directed credit, and "rationalization" that involved engineering strategic mergers and restructuring (Pack and Westphal 1985; Rodrik 2005). Taken together, these policies helped the Asian Tigers innovate new processes and products on their own, or at least develop the "absorptive capacity" needed to acquire and use Western technology (Keller 1996; Mingyong, Shuijun, and Qun 2006).

Yet, more decentralized, market-based approaches on the back of the licensing of foreign technology—and therefore IPR—also proliferated in the Asian Tigers, especially after the end of the Cold War. Silicon chip designers such as Qualcomm and Broadcom began to license their innovations to so-called chip foundries in Taiwan during the early 1990s, for example. In South

Korea, firms such as Samsung, LG, and Hyundai increasingly paid royalties to American and European firms to rent their technology, enabling them to acquire cutting edge innovations.

Figure 3 conveys the increasing importance of technology licensing in South Korea. This graph indicates that IP played a less prominent role during earlier stages of South Korean industrialization, but gained importance as the country graduated up the value chain and thus focused on producing more high-tech manufactured products such as flat screen televisions, computer chips, advanced appliances, computers, and mobile handsets.

Figure 3. Payments for Intellectual Property in South Korea (1975 to 2019)



Notes: Both IPR payments and GDP are expressed in current US dollars (USD).
Source: IMF Balance of Payments Statistics Yearbook and data files.

But does the History of Technology Transfer Apply to China?

Of course, these historical examples may not represent valid comparisons vis-a-vis the transfer of technology from the U.S. to China today. Contemporary China is, in many ways,

idiosyncratic: both in terms of its sheer size and the nature of the technology in question. While the technologies transferred to the Asian Tigers during the 1960s and 70s involved process innovations around steelmaking, chemicals, electronics, and vehicles, the technology acquired by China today involves semiconductors, computer hardware, telecommunications infrastructure, robotics, software, and cloud computing.

The upshot is that Chinese firms such as Huawei competing in wireless communications can potentially exploit access to Western technology to outperform Western firms like Nokia. This phenomenon is amplified by the fact that many high-tech sectors today are so-called winner-takes-all industries composed of superstar firms (Autor et al 2020). Due to China's unparalleled market size, the hybrid nature of technologies that commingle hardware, software, and telecommunications, and Beijing's "aggressive" industrial policy, Huawei was able to rise to the top of the wireless equipment industry, whereas South Korean Samsung, although internationally competitive, is one of several, more evenly matched, rivals doing business in the smartphone marketplace (see Atkinson 2020).

More simply, while the Asian Tigers may have sometimes played fast and loose with IP during their economic rise during the late 20th Century, whatever infringement of Western patents they engaged in, and whatever trade secrets they pilfered, pale in comparison to China's IP transgressions. An important reason for this is, once again, the country's immense size and economic importance. For example, suppose for sake of argument that only one percent of Chinese nationals studying in the U.S. "steal" American technology; this alone would equal more cases of IP theft than those represented by the Asian Tigers combined.

On the other hand, China's huge market and the economic value it adds in the international supply chain is also amplified by its size. That means that technology transferred to China, even if

some of it happens illicitly, creates efficiencies related to economies of scale and geographic agglomeration effects (e.g., the sheer amount, size, and density of the country's so-called special economic zones). Therefore, even if China is indeed a worse offender of IPR than previous cases of industrializing countries, western MNCs may be willing to look the other way because of these unique production efficiencies. And, in any event, ahead we argue that China has significantly improved its patent system and that the lion's share of its technological acquisitions occurs through lawful means, including leasing foreign inventions.

TECHNOLOGY TRANSFER VIA PATENTING

Some researchers argue that patents complement the ability of imports and FDI to transfer technology from the technological core to the periphery.[20] For example, host countries with robust IPR regimes may attract greater FDI inflows and have an easier time securing imports from firms at the technological frontier; in combination, these forces may drive international technology transfer (Odagiri et al. 2010). Yet, there is a stronger claim to make about the power of strong IPR on their own.

Consider that technology cannot simply be transferred in a frictionless process. Technologies tend to be specific and individualized. Technologies and their associated skills consist of bundles of complementary attributes, and these bundles vary across countries. For example, a country's level of physical and human capital conditions the scale and sophistication of technologies employed by its firms and individuals.

[20] Other researchers claim that patents retard innovation and economic development in developing countries. They may foster technology transfer from developed to developing countries only in some industries (e.g., Lee and Mansfield 1996), or under specific conditions (see Braga and Fink 1998). A few researchers argue that patents needlessly increase the costs for developing countries of acquiring state-of-the-art technology from countries at the innovation frontier (Grossman and Helpman 1993). Weak IPR supposedly allow late industrializers to draw freely on the best ideas and imitate the most innovative practices, including via reverse engineering (see Kelly 2009).

Without patent licenses and their ancillary benefits, even the most highly skilled and accomplished entrepreneurs may not be able to introduce new technologies into their countries. Even if technologies can be fully employed *as is* in developed countries, knowledge about how to use technology cannot be fully codified by inventors as important elements remain tacit. However, knowhow is costly to transfer (Arora 1992). Many end users in the developing world do not share the same technological, managerial, and financial resources as implementers in the developed world—and these resources may be critical to allowing them to adopt new technologies. Consider also that new users in the developing world simply lack the knowledge and experience accumulated by inventors and first users, including the "learning by doing" tied to trial and error.[21]

Therefore, stealing innovations is not costless; while licensing technology from an inventor might not be free, stealing it and attempting to replicate it without any guidance is expensive and wasteful. For example, the plans required by machinists to assemble a piece of technology does not include the technical know-how they need to use it, and to create interoperable components and spare parts. Therefore, it is not enough for the potential users of the technology to rely solely on the information available in a patent document, which is often available freely online, to put the idea described into practice. Often, licensees who lease patents must cooperate closely with original inventors—even in situations in which they may be able to import the technology.

Fortunately, when original, foreign inventors secure patents in countries other than their own, they may enjoy incentives and opportunities to help entrepreneurs implement and commercialize innovations in industrializing countries. The ability to earn royalty payments through enforceable licenses motivates them to lend a hand and the patent licensing contracts themselves outline how critical knowhow will be conveyed from licensors to licensees (see Arora

[21] On these points see Arora (1992): 15-26.

1992; 1995). A licensing contract can specify how a licensor will gain access to plans, goods, services, and human capital that accompanies a patent license. This includes not only the provision of drawings, blueprints, and machinery, but bespoke tutorials and training as well. The latter may even mean that the licensee "borrows" engineers and skilled workers from the licensor and its partners to acquire tacit knowledge—and this knowledge may go beyond narrow mechanical processes and include management innovations not included in the patent.

This also means that the licensor takes on the role of intermediary. The license may obligate herself to connect the licensee to a network of suppliers and customers. Acquiring a patent license may thus serve as a conduit for acquiring physical and human capital, as well as knowhow, from upstream firms that manufacture inputs to the novel processes. This is important because differences in social, cultural, geographic, and economic conditions may affect the ability of end users in new markets to fully exploit a technological device or even a software application. Licensors help licensees adjust technology to their capital-labor ratios and market idiosyncrasies. Thus, patent-licensing and the connections it furnishes licensees with the owners of IP is the most attractive option for those seeking to acquire technology, not seeking to obtain it against their will.

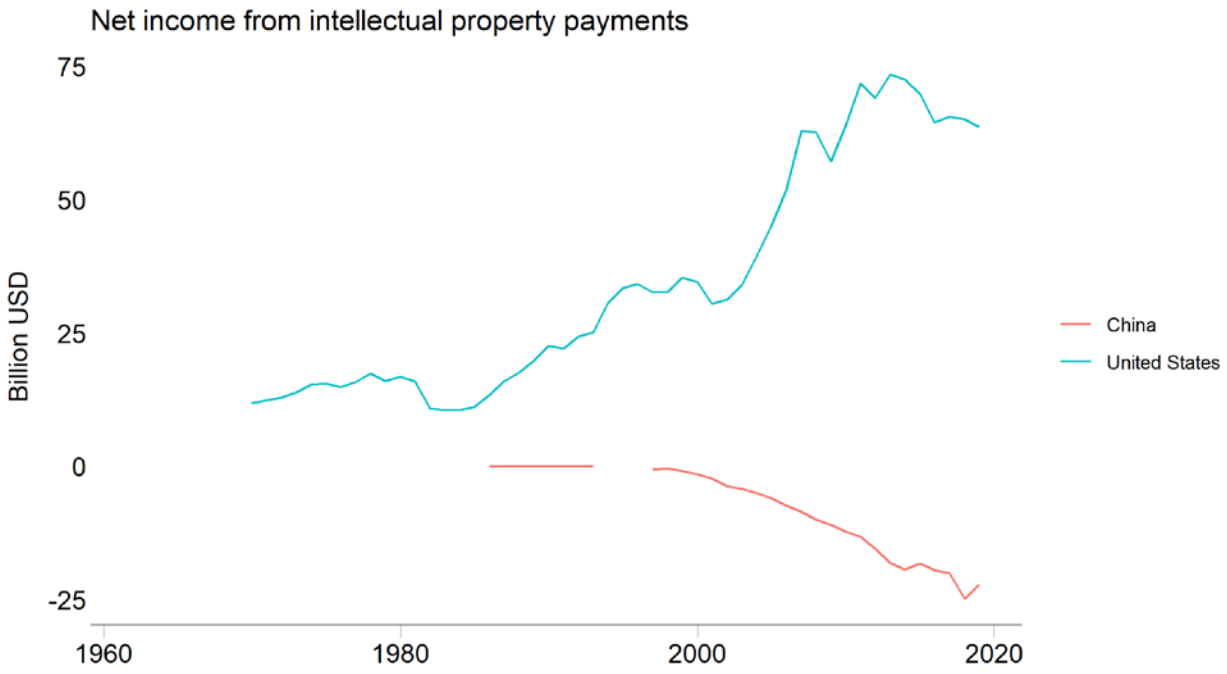
How the Distribution of Increased Surplus Comes into Play

While a voluntary exchange between those who have ideas and those who rent them from the former is, by definition, a pie expanding interaction, this does not mean distributional conflicts over the producer surplus are absent (see Lamoreaux and Haber 2021). Those firms at the bottom of a supply chain, many of them located in developing countries, manufacture (outsourced) goods designed elsewhere, usually in developed countries. Because the value chain is vertically disintegrated, those at the top, the idea makers, fight for stronger property rights to enhance their negotiating leverage and thus appropriate a larger share of the surplus. Meanwhile, those at the

bottom (the assemblers and distributors) fight to weaken IPR in order to reduce the royalties they pay for these ideas and thus increase their share of the surplus.

The upshot is that fights over the distribution of the surplus are articulated by antagonists in the language of efficiency: the size of the pie. In seeking a larger share of the spoils those at the bottom of the chain accuse those at the top of raising prices and stifling innovation and, in turn, those at the top do something similar. And, in doing so, both types of players try to lobby policymakers to use the law and regulation to weaken each other's property rights and thus reduce their respective share of the surplus. Before that step, or in conjunction with that step, they also litigate (on all these points see Lamoreaux and Haber 2021).

Figure 4: Payments for and income generated from intellectual property.



Notes: To create this variable we subtract income generated through the sale and licensing of IP from payments made to acquire it. Values are expressed in constant 2010 USD (normalized for inflation using the Consumer Price Index).
Source: IMF Balance of Payments Statistics Yearbook and data files.

Figure 4, above, shows that the U.S. has developed into a significant net exporter of IP, and its firms thus gain substantially from licensing contracts, while China is a big net IP importer. This places the countries' respective firms—and, by implication, their governments—at antagonistic ends of the global supply chain as described by Lamoreaux and Haber (2021).

RETURNING TO THE CHINA IP QUESTION

Western critics have condemned China's technology acquisition policies. In 2007, the U.S. filed a complaint with the WTO accusing China of rampant incidences of copyright piracy and trademark infringement (Greguras 2007; Yang 2009). Huawei, in particular, has been accused by American firms such as Cisco, Motorola, and T-Mobile of stealing its trade secrets and reverse engineering products on the back of this abscondment. China has also compelled American companies and firms from advanced industrial nations to undertake joint ventures with Chinese firms, leading to complaints by leading American firms and the U.S. government.

The facts, however, suggest these are relatively rare events and, even if quite common, reflect fights over the distribution of the producer surplus, not threats to greater efficiency. There has been a dramatic increase in patenting activity by Chinese research and business entities—including a 488% increase in 2007 (WIPO 2009). This has helped China increase its global share of annual patent applications from 2% in 1997 to 44% in 2017 (WIPO 2019). And, according to WIPO (2019), around 10% of these patent applications are from foreign innovators seeking patent protection in China.

A big reason for these patterns is that China has steadily improved its IPR over the last twenty years. It has joined all major international IP conventions.[22] In 2002, Beijing waged an

[22] China has joined the World Intellectual Property Organization (WIPO), the Berne Convention for Protection of Literary and Artistic Works (copyright), the Universal Copyright Convention, the Paris Convention for the Protection of Industrial Property (patent and trademark), the Patent

extensive anti-counterfeiting and anti-piracy campaign and created additional enforcement capacity in the form of IP affairs departments (Yang 2009). While in 2007 the WTO generally concurred with most of the allegations leveled by the U.S. (see above), the resulting verdict did not force China to change its criminal prosecution thresholds for IP violations but, rather, prescribed a set of regulatory recommendations (Yang 2009).

China then took steps to liberalize the individual ownership of state-funded patents. In 2020, a new foreign investment law and implementing regulations went into effect, which made stronger commitments to protecting foreigners' IPRs, including trade secrets and patents, and displaced the Chinese-Foreign Equity Joint Venture Law, the Chinese-Foreign Cooperative Joint Venture Law and the Wholly Foreign Owned Enterprise Law, a trio of laws imposing joint ownership requirements on western firms that justified forced technology transfers.

On the IP enforcement front, China has substantially improved. As Nguyen (2010) points out, especially after 2001, IP owners have successfully used the judicial system to enforce their rights. China boasts specialized IP courts that move with alacrity and relatively low litigation costs, at least compared to the U.S. (see Morinville 2018). It has also bolstered IP enforcement by eliminating pockets of judicial antipathy towards foreign IP and creating oversight bodies and regional IP courts (see Weightman 2018).

China's patent enforcement process is designed to benefit inventors through negotiated settlements.[23] There are three main reasons why the parties to a patent dispute tend to reach licensing agreements. First, patent owners are obligated to notify infringers before launching a lawsuit. Second, patentholders are incentivized to sign a nondisclosure agreement, under which

Cooperation Treaty, the Agreement on Trade-Related Aspects of Intellectual Property Rights, and the Madrid Agreement for the International Registration of Trademarks (Greguras 2007).

[23] This section draws closely on Morinville (2018).

they are able to divulge technical information and discuss disputed issues. Third, because the likelihood a Chinese court will impose an injunction on an infringer is relatively high—in 2018, injunction rates averaged around 98% (Weightman 2018)—this increases the odds that parties sued for infringement will try to seek a negotiated solution that culminates in royalty payments for patentholders.

Several facts corroborate this logic. The total number of IP cases filed in China increased from 12,205 in 2004 to 20,781 in 2007 (Nguyen 2010).[24] Further, in discussing several cases decided by Chinese courts, "Chinese trademark owners view their trademarks as important assets in their business operations. They are not hesitant to enforce their trademark rights, they utilize judicial means to enforce their rights, and they rely on the judicial system to enjoin the alleged infringing conduct" (ibid: 806). Foreign patentholders have also benefited from China's improvements to its IPR enforcement. Between 2006 and 2011, for example, foreign companies brought 10% of patent infringement cases in China and won over 70% of them (Love, Helmers, and Eberhardt 2016).

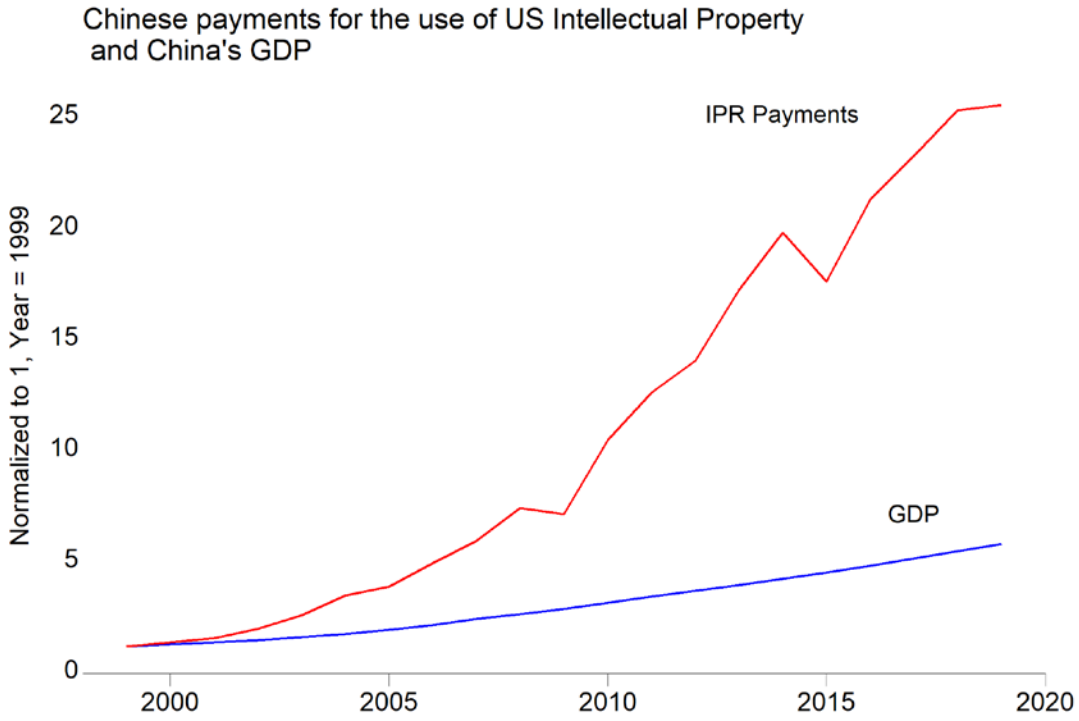
Finally, contrary to conventional wisdom about China's disrespect for IP, Chinese companies have acquired foreign technology from the U.S. and other industrialized countries through copious patent licensing. Chinese companies operating in sectors such as transportation, energy, and robotics have paid top dollar to foreign patent holders to gain access to technology from the industrial frontier: Japanese and American firms have received billions of dollars in royalties in exchange for these licenses (Taplin 2018). In 2019, alone, China paid over $34 billion

[24] For comparison, the total number of Patent, Trademark and Copyright cases filed in U.S. District Courts during 2006 was 11,406—the highest number between 2002 and 2007.

to the rest of the world for the legal use of IP. The U.S. accounted for roughly 23% of this amount (World Bank 2020; OECD 2020).

Figure 5 shows that China's royalty payments to the U.S. grew dramatically faster than its GDP over the last two decades, echoing the substantial improvements in IP protection described above (see also Lardy 2018). This demonstrates the remarkable extent to which American based IP holders benefit from continued Chinese economic growth—contrary to the contention made by China hawks that the country's growth is built on opportunistic theft.

Figure 5: Chinese IPR payments to US entities compared to its GDP, 1999 to 2019



Notes: Data is normalized so that 1999 is the reference category. This graph shows that IPR payments to US entities increased 25-fold over the depicted timeframe; GDP, measured in constant 2017 international dollars, and adjusted for Purchasing Power Parity, increased roughly 5-fold. Source: World Bank and OECD indicator on Trade in Services and charges for IP.

So how did companies like Huawei rise to the top if they did not rob American companies blind? Consider that Huawei's R&D budget was over $15 billion dollars in 2018, fourth in the world after Google, Amazon, and Samsung (Yap and Strumpf 2019). Prior to its recent success,

many of its innovations were a consequence of hiring engineers who had lost their jobs in the wake of the dot.com crash in the early 2000s (ibid)—in other words, opportunistically tapping the labor market, as good capitalists do. And, as is common in the U.S. and other Western countries, in the vast majority of lawsuits MNCs brought against Huawei for stealing trade secrets, the parties have reached out-of-court monetary settlements or the MNCs have been awarded monetary damages (Taplin 2018). To be sure, these are not the same as an injunction issued against Huawei from selling products that use infringed upon IP. But it's not nothing either.

Do the Aggregate Figures Tell the Whole Story?

Of course, some American technology is simply not available through market channels. There are two types of technology for which this is the case. Some U.S. companies, for whatever reason, refuse to license their patented technology to Chinese firms. And some American firms with trade secrets do not make their technology available to outsiders because they do not want it to be reverse engineered. So, overall patent licensing statistics may not accurately reflect whether China's IPR behavior is commonplace, flagrant, and a major problem.

Moreover, concerns voiced by U.S. policymakers about China's IP practices are centered on specific types of patents, not inventions overall. Specifically, the number of total patents obtained in China by Chinese citizens/firms and foreign inventors/MNCs may not fully capture concerns voiced by Washington, D.C. and American private sector actors concerning semiconductors, artificial intelligence, and biotechnology. There is substantial evidence that these sectors are particularly vulnerable to the theft of trade secrets, patent infringement, the weakening of patent licensing contracts, and so-called forced technology transfer (see U.S. Congressional Research Service 2020).

American policymakers are particularly concerned about China gaining access to American microprocessor technology, which is reflected in the so-called Entity List: a set of restricted goods for which US companies must gain a special license to export to China. During the Trump Administration, the Commerce Department added some advanced semiconductors, silicon transistors that are ten nanometers or smaller, exported to certain Chinese companies and universities.

However, the same sectors in which Chinese transgressions against IP are the highest are also those in which *complaints against* Washington's hawkishness are the loudest. Although U.S. policymakers' professed reason for harsher trade policy towards China is to perpetuate American leadership in advanced technologies, semiconductor industry trade groups have vociferously complained about the potential loss of profits and jobs associated with these bans.[25] American companies beyond semiconductors, including some involved in AI and biotechnology, have objected to export bans and other trade restrictions because they are worried about losing access to China's lucrative market and because, ironically, they are worried about weakening the R&D transnational networks that involve China.

American Companies Accept the China Deal

IP challenges are the price of doing business in China, a price internalized by American companies: they are willing to eat these costs in exchange for access to the Chinese market and the profits it entails. In 2019, nearly 70% of American firms doing business in China were profitable, many of them very much so (the Economist 2019). For example, even during the rocky,

[25] A 2020 report by the Boston Consulting Group commissioned by the U.S. Semiconductor Industry Association, concludes that the Trump administration's policies will undermine the competitive position of American chip companies, reducing market share, revenues, and employment (Varas and Varadarajan, 2020).

Covid-19 pock marked first quarter of 2020, the Chinese market made up 20% of Apple's total sales and almost 15% of its total revenue.

There are three main reasons for this. First, U.S. companies gain access to China's relatively cheap, skilled, and productive labor force. Second, growing Chinese demand for U.S. technology basically bankrolls several large American companies. Third, whatever the IP issues, Chinese firms are integrated into a global R&D network that is critical to U.S. innovation. Below we explore the last two reasons in greater detail.

As Chinese workers become more productive, Chinese companies pay them higher wages, which raises China's aggregate consumption, offering Western firms located in China or exporting to it a growing consumer market. To help satisfy new demands, either Chinese imports of U.S. made products and services increase, or American MNCs produce more goods and services in China for its consumers. In turn, they repatriate some of the profits they earn to the U.S., if not the fruits of the R&D they conduct in China and the learning by doing they accumulate there.

Enter the other benefit to American firms doing business in China: access to relatively inexpensive suppliers that are innovative in their own right. These mostly small, privately owned manufacturers face global competition and are thus much more productive and profitable than large, state owned firms (Taplin 2019b). They are able to deliver critical inputs to MNCs operating in China that assemble goods for international markets and allows them to deliver their products in a timely and flexible manner.

Together, Western MNCs and their Chinese suppliers coordinate product design, assembly, and distribution, which allows the MNCs to be more innovative and nimbler. For example, American firms such as General Motors have patented innovations developed in their Chinese

manufacturing facilities (Li 2017). For its part, Apple enjoys sizable cost savings from being able to produce iPhones and other devices in China (by outsourcing to Taiwanese owned Foxconn).[26]

The mutual benefits go further. Partnerships between Western MNCs and private Chinese firms help the latter hone their productive capacities and innovation potential. American firms, in turn, become suppliers in their own right to these improved Chinese firms. For example, until the Trump Administration banned these practices in 2020—or at least required a license to engage in them—Qualcomm, Broadcom, Micron, Intel, Microsoft, IBM, and Google, provided Huawei with everything from microchips to software to consulting services, earning billions of dollars in the process.[27] This includes royalty revenues generated by IP licenses. Until a similar 2019 ban, several U.S. tech firms also earned a pretty penny exporting computer chips and related technologies to the Chinese government to help power its supercomputer industry.

So, what then is all the complaining about on the part of American firms? Liu and Woo (2018) liken China to Walmart, which leverages its strong market position to attain discounts from suppliers. To be sure, the tactics it resorts to are often unseemly; e.g., Beijing has been accused by some of using the threat of antitrust and anti-money laundering laws to keep Western MNCs from complaining about IP theft (Yap and Strumpf 2019). However, evidenced by the fact that they are feely operating in China—nobody forced U.S. companies to enter this market to either sell or produce their products—they have accepted these bargains and are better off from having done so.

OTHER CRITIQUES MADE BY CHINA HAWKS

[26] U.S. consumers benefit doubly as they get access to a wider variety of cheaper goods that otherwise might not exist at all, both from Apple and other firms that outsource production to Taiwanese firms operating on the Chinese mainland and other Chinese firms.

[27] China is the biggest buyer of semiconductors produced by American companies, typically purchasing about 25% of their microprocessors (amounting to $300 billion dollars in sales).

China hawks in the U.S. voice national security concerns as one of the major reasons for their desire to reduce economic engagement with China. In August 2018, the U.S. Government passed the Foreign Investment Risk Review Modernization Act; it was (at least) partly intended to reduce Chinese FDI in areas that are deemed sensitive to U.S. national security. And, indeed, several of the technologies that the Chinese government privileges have obvious military applications, whether or not Chinese firms actually overtake American ones when it comes to the innovations that will shape the future.[28] Moreover, the U.S. government and military are just as likely as private firms to use wireless networks, hardware, and software.[29]

China's acquisition of sensitive military technologies is only one of many other problems that America's China hawks attribute to economic integration between the two countries. Even if particular U.S. firms, workers, and consumers benefit in both absolute and relative terms from increased trade, investment, and technology flows between China and the U.S., there is the possibility that American firms and labor *as a whole* do not benefit in absolute terms. Or, even if greater integration with China has fed higher American living standards, perhaps it has worsened inequality. Also, specific geographies within the U.S. may be adversely impacted by trade-competition with China. Moreover, politically adverse consequences may obtain from greater economic integration between the countries in the US, including increased support for anti-Globalist populism.

These Other Critiques Also Fall Short

[28] Some have less obvious, but just as salient, applications: achieving supremacy over quantum computing may allow China to obtain satellite communications that cannot be hacked and radar capable of piercing through stealth antidetection capabilities (see The Economist 2019).
[29] Analysts speculate that over 70% of the technology that the U.S. military relies on is off-the-shelf and commercial, which means that international supply chains expose it to a major vulnerability: potential hacking and sabotage by America's enemies (The Economist 2019).

China has become a top export market for American companies such as Boeing, General Motors, Coca Cola, Nike, Microsoft, and Apple. This includes their suppliers too. Indeed, a larger and sophisticated market for American semiconductors has been a godsend to American companies such as Intel, Sun, and Qualcomm. Consider the latter company, which focuses exclusively on designing computer chips.[30] Due to America's greater integration with the Chinese economy, its costs are lower, its profits higher, its R&D budgets bigger, and its products (contained in the vast majority of the world's smartphones) are of higher quality and available to consumers at reduced prices. In turn, these benefits have trickled down to its clients, Apple and Motorola, not to mention Google (Android) and app developers, if not American digital platforms such as Facebook.

Using this same logic, increased economic engagement with China is beneficial for both American firms and workers in general, across the U.S. economy. As trade and capital restrictions have fallen, as well as barriers to technology transfer, scarce resources, including capital, raw materials, intermediate goods, final goods and services, and technology, have been allocated to more efficient uses. While American firms have operated in vertically disintegrated supply chains and specialized in higher value-added endeavors, such as product design and financial services, a larger market for U.S. goods and services has blossomed in China. And as Chinese capital and technology have flowed into the U.S. from China, it has expanded the size of the American pie.

Indeed, America benefits when FDI from China enters its shores and when Chinese nationals loan money to the U.S. government and U.S. firms. Speaking macroeconomically, it allows the U.S. to consume more Chinese made products and thus compensates for its trade deficit with China, while also reducing interest rates on American sovereign debt, which in turn decreases

[30] This section draws closely on Barnett (2011).

its overall borrowing costs and tamps down on inflation.[31] More directly, as billions of Chinese Yuan flow into U.S. sectors that include food and beverages, auto components, plastics, and business services, this generates American jobs and increases American savings and consumption. Accompanying this FDI and imports of Chinese goods and services is technology travelling from China to American shores. Consider Huawei wireless equipment, for example, which helped the U.S. build its 4G network.

And while it is unclear whether China is enjoying the largest share of the gains from increased economic integration with the U.S., an argument may perhaps be made that the U.S. has done relatively better than China if we measure welfare improvements strictly as consumer surplus. Consider just one example. Past buying behavior and surveys of American consumers reveal they are willing to pay thousands upon thousands of dollars for a smartphone, but typically only end up paying a fraction of that price. The reason? A globally disintegrated supply chain centered on a relatively high level of respect for American firms' IP rights that relies on China's skilled and unskilled labor to produce supercomputers that fit in users' pockets and can be purchased for as low as $30 dollars. We know that consumers bought 1G phones during the 1980s for $10,500 in today's money. Taking that as a lower bound estimate of their willingness to pay for 2021 smartphones, the consumer surplus enjoyed over the last decade by American consumers

[31] This is not to rule out potential negative externalities. Consider what Obstfeld and Rogoff (2009) have argued about the 2008 Global Financial Crisis: A global savings glut exacerbated by China's trade surplus and concomitant buildup of foreign reserves qua US treasuries depressed real long run interest rates. This allegedly helped spur the creation of new asset classes that could generate higher yields, but that were riskier than first realized by investors. They included mortgage back securities and other collateralized debt obligations. The latter's prices deteriorated sharply after American homeowners defaulted on a wide swath of mortgage loans with variable interest rates after they had ballooned, devastating banks' balance sheets, and precipitating a bank run and credit crunch that led to the Great Recession. We can of course dispute whether this was indeed a causal, linear process running from U.S.-Chinese economic integration to the crash.

who purchase handsets easily exceeds three hundred billion dollars (for a similar exercise see Galetovic and Haber 2017).

Also, trade with China increases demand for goods and services produced by U.S. exporters and their suppliers, boosting employment in those industries, even if these products are only designed in America. For example, U.S. semiconductors purchased by Chinese consumers who buy iPhones create jobs for American software engineers, app developers, and even hardware manufacturers, including the makers of complementary products such as headsets (not all of them are made in China, some are made in Colorado). In turn, other U.S. workers see welfare improvements too: increased jobs and incomes in export sectors generate "derived demand" for domestically produced products and services, such as haircuts and restaurant meals, in turn creating more jobs. Finally, global supply chains mean greater profits for American firms, allowing their R&D budgets to grow—think Qualcomm again. This leads to innovations that not only grow the pie but makes workers better off too. They ultimately pay less money for improved products, freeing up income they can use to purchase other things. This leads to further job growth.

There is evidence that American laborers in particular have benefited from greater economic integration between the U.S. and China. Increased trade, capital flows, and technology transfer to China is associated with greater net U.S. job creation and improvements in American living standards on average (see Oxford Economics 2017).

Does greater economic integration with China also translate into *relative* gains for American labor? There are good reasons to think so. Dao et al. (2017) argue that in advanced economies such as the U.S., the impact of trade with developing countries on inequality has been relatively small. Plus, over the long-term wage earners may benefit to a greater degree than capital

owners. If overall demand for labor expands as countries grow richer from trade, labor's earnings may increase at a faster rate than the return on capital.[32]

What about the effect of economic integration between the U.S. and China on labor in the American rustbelt—places like Ohio, for example, which once housed and continue to host some heavy industry, including steelmaking and the manufacture of automobiles, appliances, machinery, and chemicals? While Freeman (1995) suggests that the expansion of global trade has modestly reduced employment and wages among U.S. low-skilled workers, Acemoglu et al (2016) estimate that increased import-competition associated with China's accession to the WTO in 2001 created losses of between 2.0 to 2.4 million jobs in the US manufacturing sector between 1999 and 2011. Autor, Dorn, and Hanson (2013) note that these effects are geographically concentrated in areas previously focused on manufacturing. They stress that labor market adjustments to trade shocks have been remarkably slow in the last decade. American workers exposed to increased trade competition experience greater employment insecurity and persistent reductions in income, especially unskilled labor.

Among low skilled workers in particular, however, the effects of increased trade with China and other developing countries have been heterogeneous. In terms of economic effects, while trade exposure has created job losses in some sectors, such as toys, furniture, and textiles, it has created employment and raised wages in others, such as agriculture, machinery, and vehicle parts. In terms of policy effects, it may have increased support among unskilled workers for trade

[32] To be sure, the scholars who model these dynamic effects in the U.S. focus on skilled (educated) labor to explain why the returns to college degrees have mushroomed, despite the fact that the pool of college educated workers has grown steadily over time (e.g., Goldin and Katz 2006, Acemoglu 2009). Conceivably, however, the same process may apply to unskilled labor too, at least during several post World War II periods, including more recent ones (Gordon 2009).

protectionism.[33] In terms of political effects, it is not clear that the American industrial heartland is an atypically strong bastion of support for rightwing populism. In 2020, Joe Biden won in former manufacturing centers across the rustbelt. They include Detroit, Michigan, Milwaukee, Wisconsin, Akron, Ohio, Chicago, Illinois, Buffalo, New York, Corning, NY, Rochester, NY, Utica, NY, East Lansing, Michigan, and Flint, MI.

Some blue-collar voters certainly resonated with Trump's anti-globalist message, both in 2016 and 2020. But they tend to be the same voters who responded favorably to his nativist and potentially racist appeals. They gave pride of place to policies against immigration and multiculturalism; opposition to freer trade and investment were important, but only in the sense that they were linked to a nationalist, zero-sum view of the world (Finley and Esposito 2020). While Trump's anti-Globalist message emphasized the putatively adverse effects of trade and immigration, he framed these in terms of nationalist self-determination and pride ("America First"), not an economic threat (ibid 2020). Most particularly, tariffs on Chinese imports were construed by Trump as a show of force against Beijing, which many Trumpists view not merely as an adversary, but an enemy (Noland 2020). In the same way in which some Trump supporters

[33] Of course, it is not irrational for voters who have suffered employment losses directly due to the offshoring of their jobs to seek redress. This may include the desire to place tariffs on competing imports, which are in turn passed on to consumers as higher prices for domestically manufactured products. Nevertheless, if targeted correctly, tariffs ensure that these products become (artificially) cheaper than foreign made ones. While this may constitute a rational response for the laborers who produce these goods, this may not be the most optimal response. First, their jobs may be automated away anyway, no matter the level of trade protectionism: domestic workers will remain relatively expensive and the costs of automation keep dropping like a stone. Second, it might be more advantageous for workers exposed to trade to favor policies that reform education, create vocational training, and promote lifelong on-the-job training. Also, investments in green energy systems may be more effective in creating lasting economic opportunities than futile attempts to force the reshoring of inefficient steel manufacturing. Therefore, while support for protectionist policies that may or may not save domestic industrial jobs in the short term are rational, they are also myopic, and therefore possibly explained by high discount rates (see Magistro 2020).

are menaced by demographic change within the U.S., those same supporters view China as a threat to an identity rooted in nationalism and relative, rather than absolute, political, economic, and social power.[34]

DISCUSSION AND CONCLUSION

We cannot help but view many of the critiques leveled by American China hawks as two-faced. Out of one side of their mouth they accuse China of pilfering U.S. technology. Out of the other side they lambaste Chinese firms for developing their own technology—or at least dominating the international standards by which firms from around the world jointly develop technologies such as 5G—for nefarious purposes. Of course, both things may be true; but the message from Western critics seems to be that China can do no right. This is a mistake.

The size of the overall pie has increased much more than it would have without U.S.-China economic integration, no matter how much Beijing tilts the playing field in its national champions' favor via tariffs, subsidies, and restrictions on access to the Chinese market. The international trade networks and global supply chains that connect product designers in California to chip foundries in Taiwan to end point manufacturers in Shenzhen helped build Amazon, Apple, Google, and Microsoft. They therefore gave us smartphones, tech platforms, and AI. They are poised to continue to power the Fourth Industrial Revolution and underpin continued improvements in machine learning and the IOT.

[34] Survey evidence suggests that in both the 2016 and 2020 elections, hardcore Trump supporters favored him because of his opposition to (i) immigration, (ii) liberal cultural values, (iii) disdain for political correctness, and (iv) mockery of experts and the media (Tucker et al 2019; Sherman 2018; Major, Blodorn, and Blascovich 2018). These studies also provide strong evidence that nativism and even outright racism fueled Trump's rise and continued political success (Noland 2020), with opposition to trade ranking near the bottom of the list. Moreover, the reasons given by Trump supporters for backing him do not vary geographically; his voters in the rustbelt voiced similar concerns as those located elsewhere.

The bottom line is this: clashes between the Chinese government and American firms are not necessarily about efficiency, but distribution: how to divide the producer surplus generated by mutually beneficial exchanges between American and Chinese firms. This has always been the case, both across time and place, in vertically disintegrated supply chains in which idea makers are located upstream and those that put ideas into practice are downstream. Therefore, the former lobby for stronger IPR and the latter attempt to weaken their claims (Lamoreaux and Haber 2021).

But this may be beside the point now: In light of slowing productivity, it is likely that China's appetite for Western technology will only increase, along with its willingness to pay for it (Taplin 2018). As its labor force shrinks and becomes more expensive, its export advantages will continue to recede. Growing the domestic economy will therefore loom larger among its national priorities. It is not unreasonable to assume that, as the Chinese economy continues to shift away from cheap exports towards semiconductors, electronics, and biotech, Beijing will continue to improve China's IPR and Western firms' royalties from IP licensing from China will mushroom, even if joint ventures also remain a tool used by Chinese firms for acquiring technology.

We end with some modest policy prescriptions. The gap in military capacity between the US and China is vast; growing Chinese economic and technology prowess will probably not change this (Brooks and Wohlforth 2016). However, the U.S. government is justified in imposing sensible strictures against antihacking and targeting export bans to the most sensitive American technology, including around radar and quantum computing. That does not entail blanket export bans or bans on inbound Chinese investment. Nor does it call on kicking Chinese students out of

American universities or research labs without due process or indiscriminately imposing tariffs on Chinese imports with no rhyme or reason. That is simply not the American way. Plus, it's stupid.[35]

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[35] Bouet and Laborde (2018) provide evidence suggesting that increasing import restrictions on China will lead to a welfare loss for the U.S. The modeled impact of a 35% increase in bilateral tariffs between the U.S. and China may benefit workers in some isolated sectors like textiles, but would hurt workers in significantly more sectors such as chemicals, plastics, agriculture, and motor vehicles. All scenarios modeled by Bouet and Laborde would reduce average wages across both skilled and unskilled workers. Bekkers (2019) suggests that short of much more dramatic changes in policy, extending Washington's trade restrictions on Chinese imports will not affect U.S. manufacturing employment tangibly; moreover, it will continue to hurt American consumers and workers.

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