Of TikTok and Tariffs: a historical and analytic perspective on Technology Transfer to China

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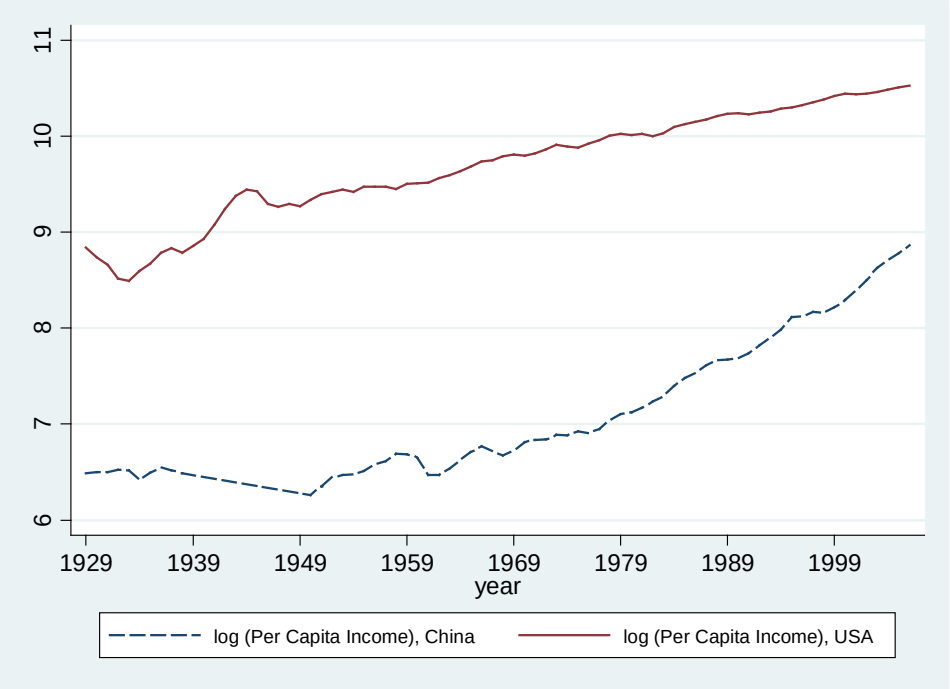
Abstract: Decades of spectacular economic development have made China into a global geopolitical player with growing political, diplomatic, and military ambitions. The improving capabilities of Chinese companies across several areas of advanced technology, especially 5G, have fueled growing concerns by US lawmakers who have complained, among other things, about "unfair trade practices" and the serial "theft of American intellectual property". We seek to inform this debate by clearing the air. We discuss the 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 IP. We also investigate the recent history of technology transfer, providing examples from the industrialization experiences of European countries. We surmise that current Chinese processes are neither novel nor particularly alarming from the standpoint of economic efficiency; nor distribution, in fact: US firms doing business with China are collecting record royalty payments for their IP and generating gangbuster profits due to their access to Chinese labor, suppliers, and the country's growing consumer market. There is just not a persuasive economic justification for the current hawkishness voiced by US policymakers about China's trade and investment practices. Instead, they seem to be exploiting Chinese firms' desire to access American markets and technology as leverage to pursue mercantilist objectives. Were they to only focus on using the economic stick to sanction China's human rights record and its authoritarianism, their hawkishness would be better justified.

China is fast becoming a pivotal player in international affairs, attested to by Beijing's increasingly assertive rhetoric and behavior. Exhibit A is the construction of artificial islands in the South China Sea and escalating belligerence towards its neighbors, especially the Philippines, Vietnam, and India (Kim 2015). Exhibit B is the draconian national security law it imposed on Hong Kong in July of 2020, thereby violating its 1997 promise not to infringe on the territory's sovereignty and threaten its liberal political and legal system. Exhibit C is the debt trap diplomacy that has accompanied its so-called Belt and Road initiative, Xi Jinping's attempt to recreate the trading networks that spanned Eurasia during the Tang's Dynasty hegemonic silk road era. Exhibit D is China's rapid military buildup in East Asia and beyond—and the fact that US superiority in the West Pacific is no longer guaranteed (Lague and Lim 2019).

Figure 1. Chinese and American Per Capita Income over the Long 20th Century



Notes: In 2007 real dollars adjusted for Purchasing Power Parity.
Source: Haber and Menaldo (2011).

China's tremendous economic development since the late 1970s has catalyzed its political and military rise. Breakneck growth rates have sometimes approached 10 percent per year and, as Figure 1 shows, Chinese real living standards doubled twice between 1979 and 2006.[1] While economic growth has slowed down since 2014 and China's economy was initially hit hard by Covid-19, decelerating below 3% annualized growth, it has since recovered. Plus, China's share of global GDP has grown steadily, irrespective of any change in living standards.

Given the fact that the United States was much wealthier than China going into this period, its Per Capita Income experienced a more muted rise: at most, it grew 3% per year (see Figure 1); and, after the 2008 Financial Crisis, America's average rate of Per Capita Income growth has been closer to 2%. The jury is still out on how strongly the pandemic will hurt its economy, but America's share of world GDP is projected by most forecasters to continue a steady decline.

Parallel to China's rise, under President Xi Jinping the Chinese state has become even more powerful. The Communist Party's removal of term limits on the executive branch from the constitution in 2018 effectively allows Jinping to remain in power indefinitely; this followed his purging of key members of the Politburo's Standing Committee. Beijing has introduced a nationwide "social credit system" that monitors and seeks to control its citizens' behavior while rolling back civil liberties in Xinjiang and Hong Kong. It has also tightened restrictions on the press and citizens' speech, especially social media (Qiang 2019).

Economic *dirigisme* has increased too. Large state enterprises have been "strategically" merged by Beijing to reach greater scale; Jinping has personally reversed privatizations of large portions of the Chinese economy. The Chinese state has bought shares in successful private firms,

[1] 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.

manipulated asset prices—through its intervention in stock markets, for example—revved up its subsidies to national champions, and promoted aggressive industrial policy in general.[2] This follows decades of subsidies to exporters that have, at different points in time, included tax breaks, tariffs on competing imports, an undervalued currency, and 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).

It is in this context that American voices on the right and left have expressed concern about China's growing technological capacity in areas such as AI, robotics, electric vehicles, the Internet of Things, semiconductors, and quantum computing.[3] This is not an abstraction. Chinese companies such as Baidu, Alibaba, Tencent, and, of course, Huawei, which earned over $107 billion dollars in revenues in 2018, now bestride the commanding heights of the digital economy and operate some of the most valuable tech platforms in the world. The Chinese state is accused by its US critics of unfairly advantaging these 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).

China hawks point to several episodes to bolster their case.[4] To acquire American technology, both the Communist Party and Chinese firms alike have engaged in widespread

[2] 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.

[3] 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. This goal is subsumed under Xi Jinping's wider ambition to "rejuvenate" China—flex its power on the world stage and "return it to greatness"—and foster the so-called Chinese Dream. This is a stark departure from Deng Xiaoping's more passive "hide our capacities and bide our time" strategy.

[4] It is by far the only economically oriented issue that has rung alarm bells in Washington, however. 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.

industrial espionage; compelled American firms of enter into joint ventures that divulge trade secrets in exchange for access to the Chinese market; conducted onerous security reviews and testing requirements; and deployed trillions of dollars to acquire US companies operating in high-tech industries.[5] Chinese companies have also attempted 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).

Yet, this is not the whole story. In this paper, 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 (IP). We also investigate the recent history of technology transfer, providing examples from the industrialization experiences of European countries. We surmise that current Chinese processes are neither novel nor particularly alarming from the standpoint of economic efficiency; nor distribution, in fact: US firms doing business with China are collecting record royalty payments for their IP and generating gangbuster profits due to their access to Chinese labor, suppliers, and the country's growing consumer market. There is just not a persuasive economic justification for the current hawkishness voiced by US policymakers about China's trade and investment practices. Instead, they seem to be exploiting Chinese firms' desire to access American markets and technology as leverage to pursue mercantilist objectives. Were they to only focus on using the economic stick to sanction China's human rights record and its authoritarianism, their hawkishness would be better justified.

[5] 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 US companies' trade secrets across a wide swath of sectors, including aviation, pharmaceuticals, and extractive industries.

While the term “technology transfer” might sound unseemly to the casual reader, this practice has direct and indirect benefits for American firms and consumers. On the one hand, there may be nothing all that unusual or untoward vis-a-vis the majority of China’s technology acquisition tactics. As we shall show ahead, a lot of technology transferred to Chinese companies proceeds through ordinary market mechanisms: royalties paid to US firms for patent licensing, legal imports of US machinery, and FDI that strongly benefits American firms. On the other hand, the transfer of technology to China, no matter how it occurs, helps create new companies and consumers that increase their overall demand for Western processes and products—thus also creating indirect, second-order benefits. The health of US companies doing business in and with China has proven largely impervious to Chinese IP transgressions and promises to improve further as the Chinese market continues to mature.

Ultimately, attempts by China to steal trade secrets or “force” technology transfer may be inefficient and self-defeating. When original innovators or technology proficient firms do not have the right 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.

In fact, Chinese authorities have increasingly arrived at this realization, helping explain why its patent system has steadily improved. According to WIPO (2019), 44% of global patent applications were filed in China in 2019—up from just 2% in 1997. Around 10% of these patent

applications are from foreign innovators seeking patent protection in China, showcasing the continuous improvement in institutions related to IPR security within China.[6]

What should US policy on technology transfer be, then? Several prominent voices in Washington have urged the US to employ radical, previously unthinkable, steps around technological development and diffusion. To "better compete against China", American politicians such as Senator Marco Rubio have urged America to embrace, just like China, an overt industrial strategy centered on tax breaks and export controls to strengthen American manufacturing. Some proposals have called for the nationalization of critical infrastructure like the nascent 5G wireless network.[7] New tariffs, sanctions, and outright export bans directed towards China and Chinese firms continue to proliferate out of Washington.[8]

Yet China accounted for 24% of global R&D expenditure in 2017 and rank third globally in the quality of higher education (WIPO 2019). Even if the US seeks to economically decouple from China, this may do little to derail its ability to innovate over the long run. Whatever US authorities ultimately decide, it behooves them to understand the facts, logic, and evidence behind technology transfer in general and the acquisition by Chinese firms of Western technology in particular. Those are the primary tasks we set for ourselves ahead.

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[6] US citizens and businesses remain the most prolific patent applicants abroad. US-based applicants filed upwards of 230,000 patents overseas in 2019 (WIPO 2019).

[7] 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 US 5G would be built with "free market, free enterprise principles" (Swan et al. 2018).

[8] A testament to the creativity of these policies is the fact that the Trump Administration is pushing two non-Chinese 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 US 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.

This paper continues as follows. First, we consider the larger backdrop, exploring the recent history of technology transfer and industrial policy, starting with Britain on the eve of the Industrial Revolution. Second, we acquaint readers with the benchmark vehicle for transferring technology: a strong system of intellectual property rights in which inventors operating in the technological core are encouraged to patent their inventions in the periphery, license these to the firms located there, and help the latter acquire the tacit knowledge necessary to put these inventions into practice in their unique context and circumstances. We then take up the Chinese case and evaluate how the two competing camps—liberal optimists and realist pessimists—view America's growing protectionism and mercantilism vis-à-vis China. We conclude that the case for hawkishness towards China on the grounds that it is taking unfair advantage of the US and its companies and arrogating American technology is dubious at best. It instead appears motivated by US companies seeking to improve the terms of what were already pretty good deals for themselves.

A SHORT HISTORY OF TECHNOLOGY TRANSFER IN THE MODERN ERA

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.[9] They include France, Belgium, and Spain.

Beginning during the latter half of the 18th Century and up until the 20th Century, this meant engaging in a multipronged approach. Countries on the continent 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

[9] 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).

engineer them; and sent scientists, engineers, and technicians to live and study in cities such as London, Liverpool, and Edenborough, in a bid to improve their knowledge and skills. While this was part and parcel of attempts to create scientific academies, erect model factories, and foster similar institutions and repositories of knowledge, it almost always involved encouraging and bankrolling industrial espionage. Currently, China is engaging in all these same efforts.

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

The British Crown tried its hand at several methods, some draconian, to impede the kingdom's technology from crossing the English Channel during the industrial revolution. 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 if the Crown suspected it was to learn how to make or use English and Scottish machinery and tools in their home countries.

Why did Britain do this? Were these attempts successful? The chief impetus was 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). The crown also claimed it was protecting national security. This certainly sounds familiar.

Indeed, fears voiced centuries ago by London about its neighbors acquiring advanced technology echo today. For example, the US 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 China to obtain scientific insights around energy and AI due to national security concerns. The Trump Administration has also pushed big US 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.[10]

How do we judge these recent American 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. Diego 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.

How 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). The so-called Asian Tigers—especially South Korea—putatively adopted "export-oriented industrialization models". Under the auspices of this so-called development strategy they borrowed freely from already industrialized countries and relied on importing advanced machinery to do so (Asian

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

Development Bank 2015). This mirrors the experiences of France, Belgium, and Germany vis-à-vis Britain both before and during the industrial revolution.

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.[11] Nor was it sufficient for later adopters in the technological periphery 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 inadequate as a standalone approach. These strategies have helped transfer technology from the core, to be sure, but they have proven neither necessary or 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.

Indeed, technology transfer might be the wrong term to use here. Transnational networks contributed to technological advances through incremental innovations that spanned borders.

[11] This section draws closely on Menaldo (2018).

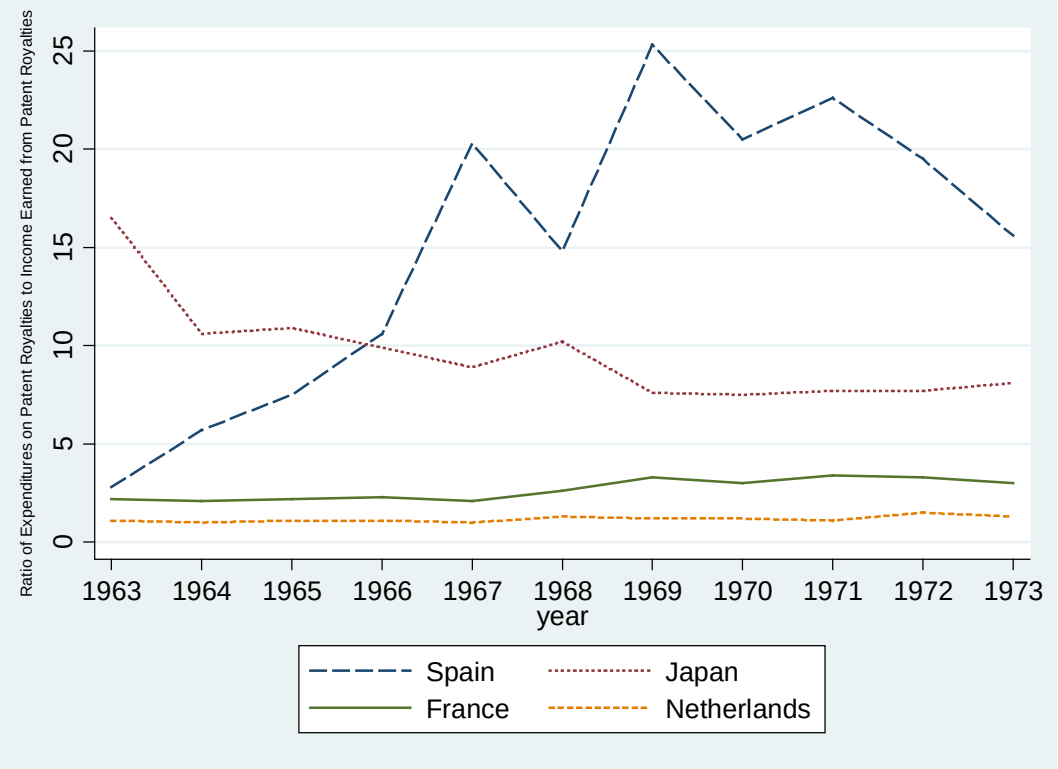
British, French, and Belgian inventors introduced and disseminated new innovations throughout the European periphery during the second industrial revolution. New international feedback loops then improved upon original inventions. As new processes were introduced in countries across the European continent, 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 tariffs by accelerating their acquisition of foreign technology. This accompanied the licensing of intellectual property owned by inventors and firms in industrialized countries beyond Britain.

The data says it all. Figure 2 graphs Spain's expenditures on royalties, copyrights, and licenses, versus that of Japan, France, and the Netherlands, between 1963 and 1973. It is obvious that Spain is a big outlier. Figure 3 graphs Spain's technical assistance costs as a share of royalty payments on patents during roughly the same period. 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. During this time period, technical assistance payments averaged 10% of the total project costs for the firms represented in this figure; this was equivalent to 23% of their foreign exchange payments. In turn, these practices fueled the so-called Spanish miracle and allowed the country to converge with the living standards of its continental cousins.

Figure 2. Spanish Expenditures on Royalties, Copyrights and Licenses (1963 to 1973)



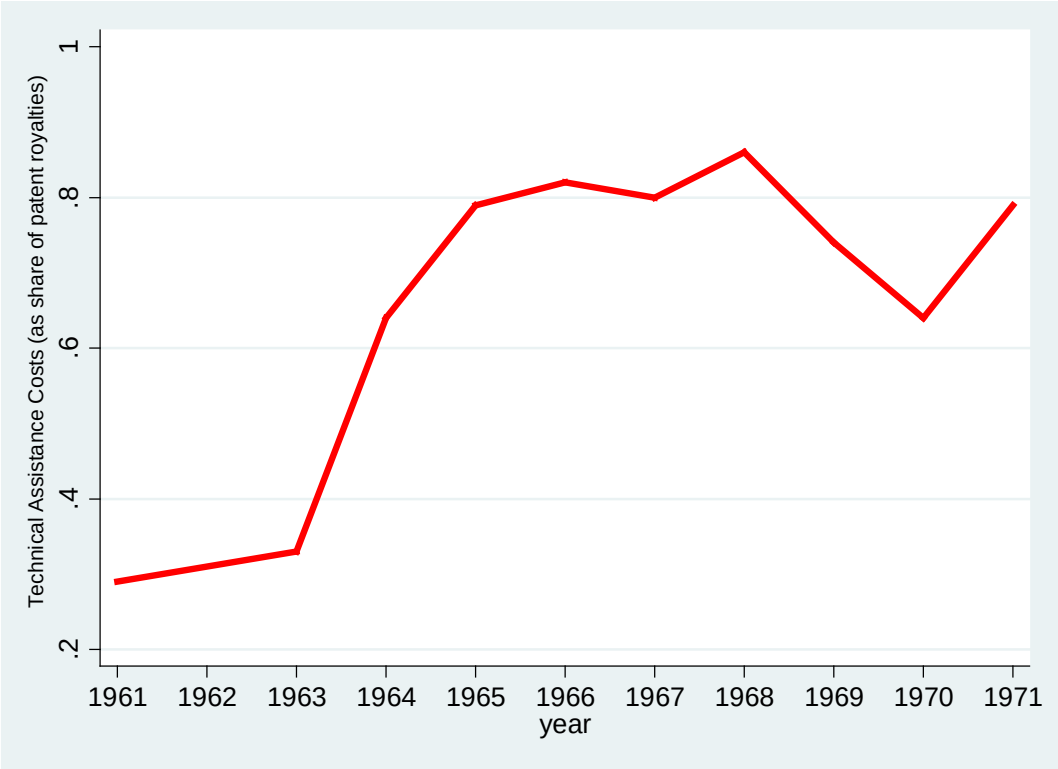
Notes: Data excludes payments for technical assistance. The denominator is the income received from abroad for royalties, copyrights, and licenses. The numerator is the expenditures on royalties paid to foreigners for royalties, copyrights, and licenses.
Source: Cebrian and Lopez 2004: 134, Table 6.8.

THE POLITICAL ECONOMY OF TECHNOLOGY TRANSFER

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 from abroad for several reasons. These include bolstering national security and improving governance. Also, they generally want companies located within their borders to perform well and generate taxable wealth, as well as

Figure 3. 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.

produce employment and high wages for citizens (Menaldo 2016). Finally, technology matters to the state because citizens are consumers and consumers benefit from technology: it helps them gain access to cheaper and higher quality goods and services, as we outline below.

Companies are interested in technology for several reasons as well. 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. The latter include things such as refining mineral ores instead of simply extracting them, undertaking advanced manufacturing, and providing digital services.

Informed by the historical record outlined above, researchers have suggested a variety of methods for transferring technology from developed to developing countries. These include cooptation and imitation—including industrial espionage—courting skilled labor from abroad, and importing machinery (Odagiri et al. 2010: 11). Another option for developing countries seeking to adopt technologies from developed ones is to cultivate FDI. While multinationals conduct a large share of their research and development in host countries, domestic firms exposed to the superior technology used by multinationals can inform their own production processes, whether operating upstream or downstream from an MNC (Romer 1993). Labor mobility from these multinationals to domestic firms may also help disseminate Western innovations (Saggi 2002).

There is, in addition, the possibility of direct government intervention in industrializing countries to address the non-pecuniary externalities associated with technological acquisition from the core: considerable search costs, for example. Even beyond search costs, learning by doing may mean that governments seek to cultivate the domestic production of goods and therefore engage in selective intervention via tariffs/quotas, subsidies, directed credit and "rationalization" that involves engineering strategic mergers and restructuring (Pack and Westphal 1985; Rodrik 2005). Taken together, these policies help industrializing countries to 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 are also possible. These include inhouse research and development, or its outsourcing to specialized firms—consider the role that computer chip design spearheaded by firms such as Qualcomm and Broadcom play in the microprocessor industry, for example. The recruitment of scientists or skilled workers from other companies that have already mastered it is also a tried-and-true method, as is cooperation with higher-education

institutions or research labs. Another tactic is cooperation with other companies, possibly foreign ones. Companies may also license technology from standalone inventors or firms. We now turn to exploring the economics and logistics of this avenue.

Patents as an Incentive to Invent

A popular contention in economics is that absent government provided incentives or subsidies, inventions will be underprovided, decreasing social welfare in the process (see Arrow 1972). The logic is as follows: Individuals cannot be excluded from deploying ideas once they are in the public domain. Yet, this poses a problem: If others can simply draw on freely available ideas without delay or restrictions, then inventors will not be able to recover the (relatively high) fixed costs associated with developing and producing new ideas. This deters would be inventors from investing their time, energy, and resources in inventing new things.[12] And this ultimately hurts the rest of society, which is potentially deprived of new ideas and innovations that could make everybody better off by reducing the costs of making products or launching new products.

The incentive view of patents sees this predicament as a market failure in need of correction (Arrow 1972; Posner 2005). Potential inventors and entrepreneurs will require some type of reward or protection to incentivize them to develop new inventions and bring them to market in light of the fact that ideas are a public good that is non-excludable and non-rival. Intellectual property rights are a potential solution.[13] By restricting access to inventions for a limited time, patents confer inventors and entrepreneurs with the (short run) market power—the ability to price above

[12] Those who freeride on inventions created by somebody else only face the variable costs involved in using or selling inventions, endowing them with a powerful competitive edge. Arrow (1972) also argues that would be inventors may potentially underprovide new ideas because of risk aversion, since the returns to investments in new processes and products are uncertain.

[13] Using this line of reasoning, other potential solutions that have been proposed include trade secrets, first mover advantages, prizes, government subsidies for R&D, and the government itself undertaking R&D (Posner 2005).

marginal costs—that they need to recover their fixed R&D costs. This therefore incentivizes them to incur the time, effort, and resources needed to bring new inventions to market.[14]

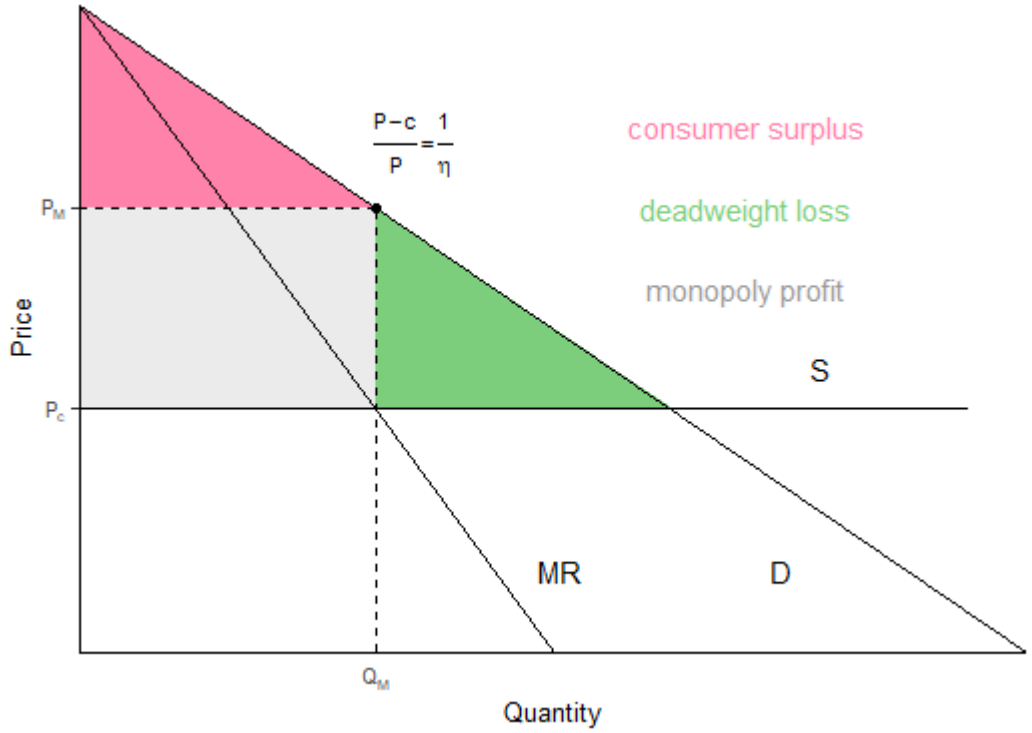
Market Power Rents, as alluded to above, are when firms price above marginal cost by constraining quantity. That means that the cross-elasticity of demand between its products and potential substitutes is inelastic enough that they enjoy the luxury of constraining supply and the room to increase price. Monopoly power is the extreme of this situation, where producers are able to reduce quantity by half and maximize revenues where their own marginal revenues intersect with the marginal cost curve. In this situation, the cross-elasticity of demand between its products and potential substitutes is fully inelastic (it faces no substitutes).

The upshot is that the monopolist earns Lerner Margins whereby the price cost margin is equal to $P - c/P = 1/\eta$ where η = the elasticity of demand (the percent change in price if there is a percent change in quantity). It follows that, the more inelastic the demand curve (notice we are speaking about the demand curve for the firm's product now, not the cross-elasticity of demand between products), the bigger the wedge. What does this mean in practice? At an elasticity equal to 1, the margin/rent as percent of price will be 90; at an elasticity equal to 2, it will be 50; at an elasticity equal to 4, it will be slightly south of 30.[15]

Figure 4 outlines the basic features of a market with a single producer. A monopolist faces the entire demand curve and optimizes as described above. On the one hand, if it were to produce any greater quantity it would sacrifice a higher price, therefore reducing its rents. On the other hand, if it would increase the price further, it would sacrifice quantity and reduce its rents

[14] Researchers argue that patents should constitute a socially efficient solution to this public goods problem because they are temporary and force inventors to disclose information (see Posner 2005). Any static reduction in consumer welfare associated with the deadweight loses produced by the market power granted by a patent should therefore be temporary.
[15] This discussion draws heavily on Galetovic and Haber (2017).

Figure 4. The Rents Earned from Monopoly Power



Notes: the supply curve is flat, which bespeaks the price over the long run. In the case of this product, a single firm earns Lerner Margin economic rents (the gray rectangle) because the final price reflects its ability to equate its marginal costs with its marginal revenues, which in turn intersects the demand curve at the point illustrated by the black dot. Horizontal to that dot on the Y-axis is the price at which $P - c/P = 1/\eta$.

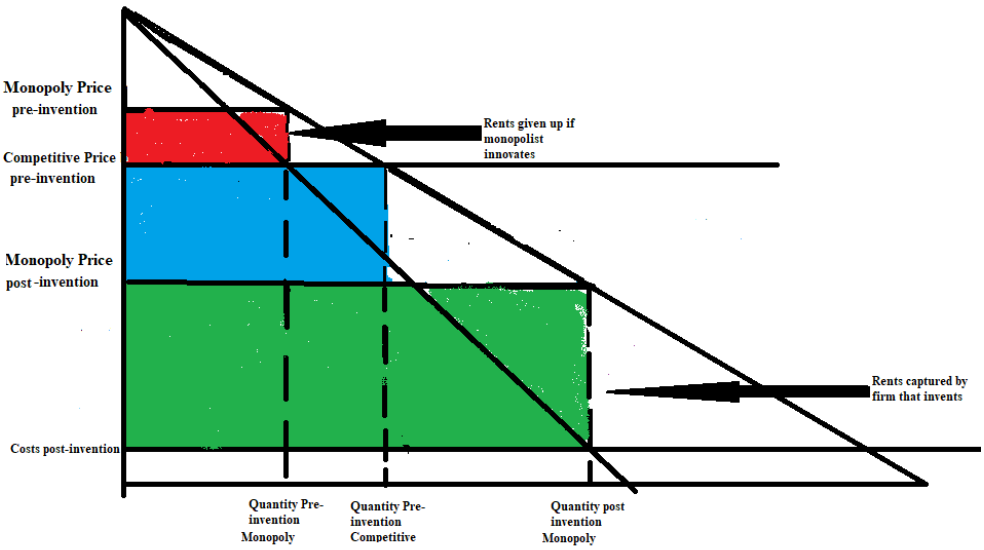
accordingly. The Lerner margin, by contrast, generates the largest amount of rents possible with a price that remains appreciably greater than marginal costs. The social costs are a reduction in consumer surplus and the existence of deadweight losses; the magnitude of the latter is determined by the elasticity of the demand curve.[16]

Other authors take a more measured tone when thinking about the benefits and costs of patents. While they agree that patents help inventors and entrepreneurs make a return on their investments, they caution that a legal monopoly only rarely, if ever, translates into an economic

[16] When the elasticity of demand is high, the deadweight losses are bigger; relatively inelastic demand means smaller deadweight losses.

monopoly. Haber (2016) argues that (i) there are usually several substitutes for any new invention and (ii) inventors tend to license their inventions widely. Both militate in favor of reducing inventors' market power.[17] Conversely, he argues that it is only when a new process or product cannot be reverse engineered that a firm will potentially enjoy an economic monopoly. But this market power will *not* be the result of a patent; instead, it will be abetted by trade secrets.[18] In fact, taking out a patent might be a poor strategy when attempting to obtain a monopoly position if keeping technologies secret is an option. Patents require the detailed explanation of how a piece of technology works and its applications, which makes the related technology highly transparent.

Figure 5: The Benefits to Consumers of Drastic Process Innovation



[17] Indeed, Galetovic, Haber, and Levine (2015) find that the prices for devices covered by standard essential patents (such as personal computers) experience greater price decreases over time than similar devices not covered by standard essential patents (such as mainframes). Galetovic and Haber (2017) explain this pattern by arguing that the inventors and entrepreneurs in industries that use standard essential patents are not looking to use patents to lock up market power; rather, they seek to shift out the demand curve for their new processes and products. We illustrate the mechanics below.

[18] In this situation, a firm should not bother acquiring a patent, because that would only serve to broadcast its invention to the world while granting it only a time-limited monopoly in return. It is much more profitable to keep this invention a secret and price above marginal costs indefinitely.

Notes: the supply curve is flat, which bespeaks the price over the long run. If the monopolist innovates it sacrifices the rents represented by the red square. It must therefore subtract those from the green square. It also incurs the fixed costs of innovation. A new entrant into a competitive market can create a new process that drastically reduces costs, way below the costs currently characterizing the competitive price, pre-invention. Because the post-invention marginal costs are so low, the new entrant can charge monopoly prices that are much lower than the price charged by a monopolist pre-invention. In fact, even though there are deadweight losses compared to what a competitive market would look like post-invention, the price is lower than the competitive price pre-invention. This leads to a substantial increase in consumer surplus, represented by the blue rectangle.

Yet, even if there are no apparent substitutes for a new product that is covered by a patent, consumers may still not necessarily come up as losers in the short run. First, according to the contestable market thesis, firms with the potential to exercise market power to charge monopoly prices may abstain from doing so to deter entry by more innovative firms (Baumol 1982). And, even if innovative firms leverage new processes or products to dominate a market and are able to price like monopolists, if the innovation is drastic enough then prices may be lower than they were previously. Indeed, they will not only be lower than under a previous monopoly exercised by a less innovative incumbent firm, but lower than what obtained in a competitive market as well (Arrow 1972). This occurs when the supply curve is dramatically shifted out due to process innovations (Figure 5).[19] The upshot is that consumers are better off, despite the new monopoly, in terms of both quality and price.[20]

[19]Arrow argues that an incumbent monopolist has fewer incentives to innovate than firms operating in a competitive market or firms seeking to enter and displace the incumbent: If the incumbent monopolist innovates, it replaces its own market and rents. While the gains from, for example, drastically reducing its marginal costs might be substantial, and the rents available in this new market may be sizable, they may not be sizable enough to offset the fixed costs of innovating. A new firm, however, does not have to sacrifice the status quo rents from monopoly and therefore will innovate provided that the rents obtained once it becomes the new incumbent are greater than the fixed costs of innovation. See Figure 5.

[20] Drastic product innovation tells a similar story. Consider what happens if the demand curve shifts out significantly, which is a way to represent a startup entering the market with something significantly new that is highly valued by consumers. To be sure, if it establishes a monopoly through product innovation the price for the new product will be higher than the price for the old product under both competitive markets (determined by the intersection of the old demand curve

Additionally, the dynamic social benefits associated with incentivizing the creation of new products, processes, and markets do not stop there. New markets may include not only the one directly associated with a new process or product, but those that are indirectly connected to it: future inventions and innovations that build upon inventions that enter the public domain. In turn, due to efficiency gains, these developments should eventually lead to lower, not higher, prices—even if, in the short run, the legal monopoly that grants inventors and entrepreneurs an exclusive right over a new production process or product translates into an economic one. An instructive example are smartphones: their quality adjusted price has declined steadily over decades, despite the fact that standard essential patents may grant some chip manufacturers market power (see Galetovic and Haber 2017).

Patents Help to Commercialize Innovation

Some researchers maintain that the most important function that patents serve is not necessarily incentivizing private agents to invest in the "research" process that drives new inventions, but facilitating the "development" process that brings these to market (Barnett 2009; Haber 2016; Kieff 2006; Mossoff 2007; Smith 2013; Spulber 2013). First, consider that it may be impossible for policymakers to offer a one-size-fits-all method of incentivizing inventive activity. The ideal patent strength and length needed to motivate one particular inventor to invest in the production of new ideas may differ from the ideal strength and length required to motivate another inventor (Kieff 2006). On the other hand, a system of intellectual property rights provides an ideal

and supply curve) and monopoly (the price also circumscribed by the old demand curve). Also, deadweight losses are created due to monopoly pricing under the new demand curve. Yet, consumers as a whole are potentially better off than they were before in a competitive market with the old demand curve. If the startup shifts out the demand curve drastically enough, the new monopoly price will be less than the increase in value between the product before the invention and the product after the invention. Obviously, the amount of the product produced also increases.

framework for inventors to bring their ideas to market, whatever the original motivation driving them to invent something new.[21]

IPR can be a boon to the commercialization of innovation for several reasons associated with the ability of secure property rights to underpin "a web of contracts" (Haber 2016). Haber (2016: 812) argues that "[patents are] a temporary property right to something that did not exist before that can be sold, licensed, or traded."[22] Because an enforceable, publicly recorded patent discloses information about an invention and threatens exclusion, it acts as a beacon. It allows different players in the innovation ecosystem—including developers, managers, laborers, financiers, manufacturers, and distributors—to coordinate and forge an agreement: reach out to each other, communicate, and contract with one another (Kieff 2006). Thereby, a patent commodifies something intangible, the functionality and know-how related to a new invention. As a result, a patent enables the inventor to trade his invention and others to acquire it.

While it is generally assumed that stealing innovations is costless, this is often not the case. For example, the mere plan for the construction of a piece of technology does not include the technical know-how of those who will assemble it, produce interoperable pieces of technology, or create spare parts. So, while licensing technology from an inventor might not be free, stealing it and attempting to replicate it without any guidance is not costless either. Often, close cooperation with patent holders is necessary for those who license the patents, to ensure minimal costs in technology application.

[21] Barnett (2009) argues that, rather than provide a blanket incentive to invest in R&D, patents change the distributional dynamic associated with innovation, and are more "progressive": they make it easier for smaller and newer firms that cannot recruit alternative ways to appropriate the gains from new inventions to enter the market; incumbent firms can usually rely on other advantages besides patents to appropriate these gains (see Posner 2005).
[22] See also Mossoff (2007); Smith (2013); and Spulber (2013).

There are key differences between inventors and entrepreneurs in both comparative advantage and financial constraints. Because they can sell or license their inventions to downstream entrepreneurs, inventors do not necessarily have to be the ones who commercialize their ideas; they can instead focus on what they have a comparative advantage in: the process that brings these new ideas forth. By the same token, entrepreneurs can specialize in what they do cheapest: commercializing innovation to satisfy new or untapped market demands.

Moreover, if clear and enforceable property rights to ideas exist, these can be used as collateral to finance innovation (see Spulber 2013). Either inventors, entrepreneurs, or both can use their patents to attract bank loans or venture capital.[23] These rights can also be sold to patent assertion entities, which can then recover their costs by litigating against patent infringement (see Haber and Werfel 2016; Khan 2014; Lamoreaux and Sokoloff 2003).

Finally, the fact that patents disclose new inventions fuels further innovation. While in the absence of a patent the nuts and bolts behind an invention may be kept secret, the information contained in a publicly available patent can be availed by other inventors. As they attempt to work around an invention—to avoid infringing the patent—they may develop new, and perhaps better, ideas that they would not have otherwise had on their own (Odagiri et al. 2010: 15). Along these lines, Mokyr (2005) avers that the advent of modern patent systems helped to fuel the industrial revolution by placing knowledge in the public domain, thus reducing "access costs".[24]

[23] Entrepreneurs tend to come from higher-income families than inventors (Levine and Rubinstein 2015); this implies they face higher financial constraints (Haber and Werfel 2016). Moreover, there is usually an appreciable wedge separating the rate of return needed by an inventor who self-finances her ideas and the rate of return that outside investors seek (Hall and Lerner 2010).

[24] As did other mechanisms that reduced these costs, including the spread of the scientific method and scientific and technical knowledge.

Spulber (2013) discusses several of the positive equilibrium effects associated with a property rights system approach to innovation. Because patents transfer and divide rights, as well as certify and standardize them, they reduce transaction costs and increase the gains from trade. By creating a market for innovative control, patents promote allocative efficiency, ensuring that invention rights are allotted to their highest valued uses. They also promote productive efficiency; they encourage the continued investment in processes, such as marketing, which seek to extract the greatest possible market value from an invention.

Haber (2016) reviews the empirical evidence supporting these claims. He discusses historical evidence focused on early industrializers and cross-country evidence derived from samples that pool both developed and developing countries. This literature demonstrates that strong patent regimes increase inventive activity, innovation, investment, and economic growth. They do so by providing incentives to invent and a framework of property rights that underpins the web of contracts that foster the commercialization of innovation. They also stimulate follow up innovation by disclosing inventions.

Patents and International Technology Transfer

Some researchers argue that patents complement the ability of imports and FDI to transfer technology from the technological core to the periphery.[25] 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

[25] Some 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 IPRs supposedly allow late industrializers to draw freely on the best ideas and imitate the most innovative practices, including via reverse engineering (see Kelly 2009).

transfer (Odagiri et al. 2010). Yet there is a stronger claim to make about the power of strong IPRs on their own.

Consider that technology cannot simply be transferred in a simple and 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.

Without patent licenses and their ancillary benefits, even the most highly skilled and accomplished entrepreneurs may not 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.[26]

Therefore, it is simply not enough for potential users to rely solely on the information available in a patent document available freely online—Google Scholar, for example—to put the idea described into practice. Indeed, even importing the technology itself and attempting to reverse engineer it may prove insufficient. Fortunately, when original, foreign inventors secure patents in countries other than their own, they may enjoy incentives and opportunities to help entrepreneurs

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

implement and commercialize innovations in industrializing countries—because they can ensure to profit themselves through royalty payments via the patent system.

Patent licensing contracts outline how critical knowhow will be conveyed from licensors to licensees (see Arora 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.

RETURNING TO THE CHINA QUESTION

Countless goods manufactured across the world now require microchips, modems, and software. The same is true of critical infrastructure. All kinds of devices, including smartphones, but not only them, 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. A few that operate primarily in their domestic market have excelled in a few high-tech areas.[27] This includes electric vehicles and batteries. Tech platforms are also on this list, as Baidu, Tencent, and Alibaba are among the most industrious in the world, if not quite profitable in their own right. In AI applications, Chinese firms have a comparative advantage in terms of their access to reams and reams of data from domestic users due to lax privacy protections, even though they lag considerably behind American firms in terms of the efficacy of the algorithms they use to identify patterns and target information (see The Economist 2019). China has tiptoed into producing semiconductors, especially in light of recent US restrictions on American firms selling microchips to Chinese companies such as Huawei. Finally, China's workforce is far from the stereotype of a monolithic mass of cheap labor; rather, much of it is highly skilled in precision manufacturing and consisting of trained engineers.

How to Think About Technology Transfer to China

Western critics have condemned China's technology acquisition policies; this includes the country's IP enforcement and its R&D policies. In 2007, the US 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. 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

[27] This section draws on the Economist (2019).

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 US 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 US companies (Atkinson 2020).

So, what do the facts say about these criticisms? China has joined all major international IP conventions.[28] In 2002, the Chinese government waged an extensive anti-counterfeiting and anti-piracy campaign and created additional enforcement capacity in the form of intellectual property affairs departments (Yang 2009). While in 2007 the WTO generally concurred with most of the allegations leveled by the US (see above), the resulting verdict did not force China to change its criminal persecution 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, resulting in a dramatic increase in patenting activity by Chinese research and business entities—including a 488% increase in 2007 (WIPO 2009).

On the enforcement front, China has become substantially better. As Nguyen (2010) points out, especially after 2001, IP law enforcement has continuously improved and Chinese owners of intellectual property have successfully used the judicial system to enforce their rights. The total number of intellectual property cases filed in China increased from 12,205 in 2004 to 20,781 in

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

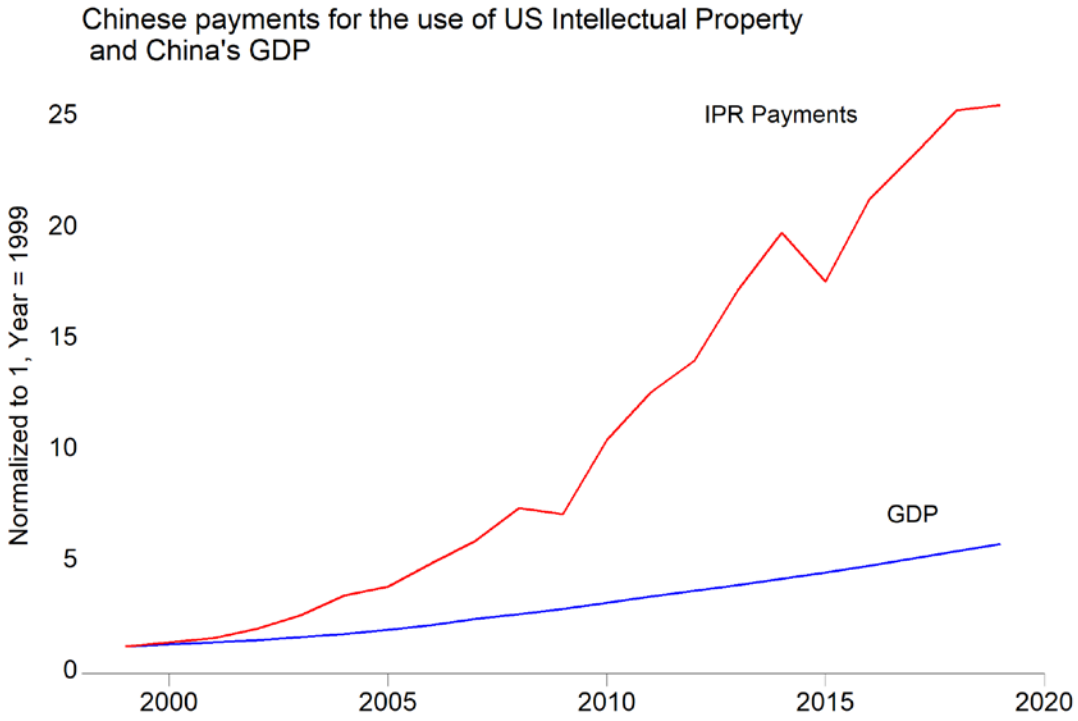
2007 (Nguyen 2010).[29] Further, in discussing several cases decided by Chinese courts, "Chinese trademark owners view their trademarks as important assets in their business operations. They are not hesitant to enforce their trademark rights, they utilize judicial means to enforce their rights, and they rely on the judicial system to enjoin the alleged infringing conduct" (ibid: 806). China has also bolstered IP enforcement by eliminating pockets of judicial antipathy towards foreign IP and creating oversight bodies and regional intellectual property courts (see Weightman 2018).

Such efforts have considerably improved IP security for foreign companies. 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). In 2018, injunction rates averaged around 98%, indicating that China has dramatically improved its protection of domestic and foreign IP (Weightman 2018). Indeed, consider China's remarkable growth in its domestic innovative capacity: it has increased its global share of annual patent applications from 2% in 1997 to 44% in 2017 (WIPO 2019).

Further, contrary to conventional wisdom about China's disrespect for IP, Chinese companies have acquired foreign technology from the US 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 to the rest of the world for the legal use of Intellectual Property. The US accounted for roughly 23% of this amount (World Bank 2020; OECD 2020).

[29] For comparison, the total number of Patent, Trademark and Copyright cases filed in US District Courts during 2006 was 11,406—the highest number between 2002 and 2007 (ibid).

Figure 6: 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.

Figure 6 shows that China's royalty payments to the US grew dramatically faster than its GDP over the last two decades, echoing the substantial improvements in IP protection described above (also, see Lardy 2018). This demonstrates the extent to which US holders of IP benefit from continued Chinese economic growth—contrary to the contention made by China hawks that the country's growth is built on opportunistic theft. And, as is common in the US and other Western countries, in the vast majority of lawsuits brought by MNCs 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.

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.

China has also compelled American companies and firms from advanced industrial nations to undertake joint ventures with Chinese firms. What this means is that China is offering tough bargains to Western MNCs in exchange for access to its massive market and relatively cheap, skilled, and productive labor force. 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 MNCs from complaining about IP theft (Yap and Strumpf 2019).

Yet, evidenced by the fact that they are feely operating in China—nobody in the US forced them to enter this market to either sell or produce their products—Western companies have accepted the bargain they made and are better off from having done so. For example, even during the rocky first quarter of 2020, the Chinese market made up 20% of Apple's total sales and almost 15% of its total revenue. Indeed, in 2019, nearly 70% of American firms doing business in China claimed they were profitable (the Economist 2019). If the price of admission has been forced technology transfer, these firms' shareholders are voting with their wallets and, saying, that's just fine by us!

There are other advantages to Western firms operating in China and possibly sharing technology with Chinese firms: access to relatively inexpensive suppliers that are innovative in

their own right. These small, privately owned manufacturers face global competition and thus are 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, 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).[30]

The mutual benefits go further than that. Partnerships between 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. This includes royalty revenues generated by IP licenses. Until a similar 2019 ban, several US tech firms also earned a pretty penny exporting computer chips and related technologies to the Chinese government and Chinese firms to power its supercomputer industry.

Also, as Chinese workers become more productive, Chinese companies pay them higher wages, which raises China's aggregate consumption, offering Western firms located there or exporting to there a growing consumer market. Either Chinese imports of US made products and

[30] US 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.

services will increase or US MNCs will produce more goods in China for sale to Chinese consumers or provide more services. In turn, they will repatriate some of the profits to the United States, if not the fruits of the R&D and learning by doing they conduct and accumulate in China.

The Pessimist, Realist, and Hawkish View:

Of course, there is a contrary view: When it comes to China, many argue that the US is facing a rogue actor that seeks to harm its national interests and is using technology to actively repress its own people. This makes economic efficiency calculations—as laid out above—completely misplaced when crafting policy towards this country.

In previously dealing with China, Western leaders hoped that, as China developed economically and its middle class grew, it would embrace Western ideals: freedom of speech and assembly, human rights, more accountable government, freer internal markets, and freer international trade and capital flows. Yet, China's behavior has repeatedly demonstrated that this was a false hope. This includes its increased authoritarianism, repression of ethnic minorities such as the Uighurs, theft of US intellectual property, restrictions placed on American firms doing business there, and its overtly illiberal political, military, and diplomatic ambitions.

In the shadow of these developments, Donald Trump has more than lived up to his 2016 US presidential campaign promise to break from the dovish approach practiced by his predecessors and be tough on China. In what is perhaps a quixotic quest to reduce the US's trade deficit in goods with China, Washington has slapped tariffs on hundreds of Chinese imports and pushed China to buy more US agricultural products (Rhode 2019). Under Trump, restrictions on Chinese investment in the US economy have intensified and Chinese technology giant Huawei has been blocked from doing business with the US government; US chipmakers, such as Qualcomm, and

Google, have been barred from supplying Huawei essential smartphone components.[31] In August 2018, the Foreign Investment Risk Review Modernization Act was passed by the US government; it was (at least) partly intended to reduce Chinese FDI in areas that are deemed sensitive to US national security. As export bans of US technology to China have proliferated, Washington has threatened to prevent Chinese students from attending US universities. Trump leveled sanctions against Beijing in response to its national security law, which is the culmination of its crackdown against pro-democracy protests in Hong Kong. Trump has also threatened to ban the very popular social media platform TikTok, although Microsoft is in talks to purchase it.

This may be just the beginning. While the first step in this process may have been when the Trump Administration labeled China as a "revisionist power" and "rival" instead of a "friend" and "partner", many erstwhile and current players in the Trump Administration, including former chief political advisor Steve Bannon and current economic advisor Peter Navarro, have openly advocated for a wholesale "decoupling" of the US economy from China's (Bown and Irwin 2019). The goal is to reduce US dependence on its imports and capital, stop the Chinese government from acquiring American technology, and, in general, crimp China's economic dynamism.[32]

[31] 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. What policymakers around the world fear is that the Chinese government will be able to exploit its cozy relationship with 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.

[32] See US National Security Strategy (2017). This ended a policy of engagement and even entanglement that began with President Richard Nixon in 1972 and reached a high-water mark when the US helped to broker China's entry into the WTO in 1999, and which was presaged by its membership in the IMF, World Bank, and UN Security Council. We should note that the EU has

Challenging China is not necessarily a partisan issue, however. There has been a lot of handwringing by Republicans *and* Democrats in Washington, both within executive branch agencies and the halls of Congress, about its economic mercantilism. For example, several individuals who served in the Obama Administration have welcomed Washington's harder stance on China whilst criticizing Trump's unilateral moves, such as imposing tariffs outside of the WTO framework, which they claim has undermined a more coordinated response by the international community against Beijing's perceived abuses (see Rhode 2019).

To explain America's recent efforts to directly challenge China's rise we can look beyond what politicians say is motivating them, however, and turn to international relations theory, and the realist school in particular. This may be a rational, if not prudent, response to the fact that the gap in relative power between the US and China continues to narrow. What may make the most sense, therefore, is for the US to press its fading advantage now and slow China down before it's too late, before the US loses whatever remaining leverage it still has. According to this logic, a similar inflection point in the bilateral relations between both countries would have happened even if China had democratized and not scoffed at the international rules of the road by indulging in economic mercantilism and serially violating human rights.

This phenomenon is known as the "Thucydides Trap." The idea is that a rising power such as China is doomed to frighten an incumbent power such as the USA, especially when its ascendance is rapid. The latter will, in turn, inevitably pick a fight with it, such as when Athens warred against Sparta during classical times and Germany fought against Britain in World War I. A fading power may strategically challenge and even go to war with a rising power as the fading

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also branded China as "a systemic rival promoting alternative models of governance" (EU Commission 2019).

power starts to lose ground and fears that in the future it will not be strong enough to take on the rising power. In other words, it strikes against the rising power before it is too late.

Chinese leadership is not unaware of this phenomenon by any means. This is attested to by Xi Jinping himself, who stated on a trip to the United States in 2015 that: "There is no such thing as the so-called Thucydides Trap in the world. But should major countries time and again make the mistakes of strategic miscalculation, they might create such traps for themselves."[33] This alludes to another fundamental IR tenet: the so-called security dilemma. The idea here is that war can sometimes occur when one state infers that another state's actions are offensive in nature and reciprocates in kind, even though these actions were intended as defensive all along.

Do US policymakers run the risk of miscalculating China's intentions in this manner? Jinping's warnings about the Thucydides Trap notwithstanding, and contrary to Beijing's rhetoric that its foreign policy is focused on "win-win" cooperation and respect for global institutions (Zhang, 2015). China's recent decisions do seem by many observers as a bid to challenge or even displace American global leadership.[34] In what follows, we outline their basic argument.

On the economic front, Beijing is allegedly not pushing for comparative or even competitive advantage, but absolute advantage in all leading technology sectors (Atkinson, 2012; 2020). China is closely hueing to its "Made in China 2025" industrial plan; it actively seeks to "overtake" Western industrialized nations in key markets for high-technology manufacturing and AI. The plan is to dominate these markets, not rely on an international division of labor.

[33] Cited in Graham (2015).
[34] Feigenbaum (2020) demurs from this view and argues that China is only selectively revisionist, and happy to go along with Western institutions and respect American power when it suits its economic interests.

China is achieving this not by competing on an even playing field, but by heavily subsidizing its national champions, glutting several international markets with goods sold below marginal cost, such as steel, stealing intellectual property, and using huge government procurement contracts to endow Chinese firms with unfair advantages, such as reaching economies of scale vis-à-vis global markets.[35] Indeed, in going this, China is actively breaking WTO rules in the pursuit of creating international market-beating companies. This may cost Western countries just as many jobs, if not more, than when China "shocked" Western manufacturing sectors after its entry into the WTO.[36] This itself has national security implications for the US in particular: it may augur further political polarization and populism that destabilizes American society.

At the heart of these criticisms is the Chinese state's policies towards and use of cutting-edge technology. State supported companies such as Huawei are aggressively extending their influence in international standard-setting bodies that coordinate product architecture and design for high-tech devices and applications. At best, China seeks to use these venues to increase the reach of its national champions. Indeed, a top state official is quoted as saying that "Third tier companies make products; second-tier companies make technology; first-tier companies make standards" (see Breznitz and Murphee 2013). Fittingly, Huawei boasts the biggest collection of 5G standard essential patents. At worst, it seeks to control the content of worldwide communications itself and access sensitive data at its own discretion for political purposes.

[35] Government procurement is centered on computers, telecommunication infrastructure, office equipment, software, renewable energy, and energy efficiency. This has been codified by Beijing in a series of so-called indigenous innovation policies.

[36] China's export-led development has had an enormous impact on US manufacturing after its entrance to the WTO. Acemoglu et al. (2016) estimate that Chinese import competition between 1999 and 2011 reduced US manufacturing employment by 2 to 2.4 million workers. Relatedly, Colantone and Stanig (2016) show that Chinese import competition contributed to the success of the Leave campaign in the UK that culminated in Brexit.

These efforts are wedded to China's attempt to become the first country to deploy a 5G wireless telecommunications infrastructure nationwide.[37] 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 Internet of Things to blossom and fuel driverless cars, fully automated factories and warehouses, and remote surgery. Beijing hopes that, by being first to launch 5G at scale, Chinese tech firms will be able to exploit a seamless highspeed wireless network with close to a billion users to develop new digital platforms and AI applications. In turn, companies such as Tencent will quickly acquire an inimitable first mover advantage and command over both direct and indirect network effects, as well as attract venture capital and talent. The US Defense Innovation Board concurs with this assessment, and has framed this Chinese policy as a matter of American national security, especially because this edge could translate into advanced weapons (see The Economist 2019).

Being the first to 5G also carries other benefits. Chinese firms' standard essential patents, chips, and equipment may establish best practices around both 5G handsets and network equipment that may be exported abroad. This goes beyond dominating hardware such as modems and bay stations: The Chinese government may use Huawei—a private company in name only—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

[37] To make this happen, 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 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.

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.

Thus, Huawei and TikTok have been characterized by 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)

Indeed, China hawks argue that the country uses cutting edge technological capabilities—whether "stolen" from the West or developed indigenously—against its own citizens. This was first evidenced in the Uighur Concentration Camps in Xinjiang and continued with the introduction of the so-called social credit system.[38] Beijing's crackdown against pro-democracy activists in Hong Kong is also an example. What's more, China is not new to this game, as it has abused technology in the past to engage in reeducation campaigns and coercive population control (Leibold, 2020). Critics of the Chinese regime also accuse it of exporting surveillance technology to other authoritarian states around the globe (Romaniuk and Burgers 2018). The fact that China heavily regulates and censors the internet within its borders is almost an afterthought in light of these disturbing facts.

In short, China pessimists argue the US must wake up to the reality that it is not Japan or Germany, but a rogue actor that threatens American prosperity, international stability, and human rights.[39] They argue that we can start by doing something about its abuse of technology.

[38] Every Chinese citizen is assigned a rating based on their behavior at work and in public, along with their credit history. Government officials mark down citizens who commit petty offenses, including jaywalking; penalties for low ratings include employers passing on otherwise qualified applicants.

[39] During a US House of Representatives' hearing on the Security Law China imposed on Hong Kong in July of 2020, Speaker Nancy Pelosi argued that the US would lose all moral authority to promote human rights if it failed to speak out against China because of commercial interests.

WHAT TO MAKE OF THIS DEBATE?

We cannot help but view some of the critiques leveled by China hawks as twofaced. Out of one side of their mouth they accuse China of pilfering Western 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—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.

Yet, the Chinese economy suffers from several economic ailments and perhaps China needs more, not less, Western technology to sustain its economic development. It is still a middle-income country with a Per Capita Income that approximates Mexico's; it continues to struggle with poverty and underemployment, as well as underconsumption and underinvestment vis-à-vis its level of GDP. The rise of its much-vaunted national champions masks the fact that the return on assets for privately owned industrial companies has fallen by almost 40% since 2014 (Taplin 2019a). While some economic forecasts predict that China will overtake America's GDP by 2030, others, especially in the wake of the Covid-19 pandemic, have downplayed this possibility.

There are good reasons to be bearish about Chinese economic growth. Take your pick: financial repression and the rampant misallocation of capital—headlined by inefficient state-owned enterprises and local government spending initiatives—overinflated property values, a domestic debt overhang, and the reshoring of supply chains back to Western countries.[40] One can add to this an alarming level of environmental degradation, an aging population coupled with

[40] While this trend has accelerated in the wake of the Covid-19 pandemic, it was underway before that, in part because of the increasing importance of so-called additive manufacturing, which allows Western firms to hold smaller inventories and respond to changes in demand more nimbly. Greater proximity to end markets and innovation clusters is a key feature of this model.

diminishing returns to urban migration from the countryside and, because of these factors and rampant speculation in real estate at the expense of alternative capital investments, slowing productivity. That means more spending on pensions and healthcare even though the size of the workforce is shrinking and its efficiency is stagnating.

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. 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 leaderships' priorities. It is not unreasonable to assume that China will continue to improve its IPRs and Western firms' royalties from IP licensing will mushroom, even if joint ventures also remain a tool used by the state for acquiring technology from Western countries. This seems inevitable as the Chinese economy continues to shift away from cheap exports towards semiconductors, electronics, and biotech.

Clashes between the Chinese government and American firms are not necessarily about efficiency, but distribution: how to divide the mutually beneficial gains from trade between firms and consumers on both sides of the Pacific. The size of the overall pie has increased much more than it would have without US-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. In the future, more productive Chinese firms will produce newer, better, and cheaper goods and services, which will benefit Western consumers. Chinese consumers will buy more American corn, benefitting US firms, and American workers will benefit from increased Chinese demand for American imports.

The stakes in the debate regarding technology transfer to China could not be higher. The sheer size of its economy alone, whether it overtakes America's or not, is reason enough to think

carefully about how to proceed. Any change in China's economic policy or US-Chinese trade will have profound effects for the US economy.[41] Readers should recall that 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 power the Fourth Industrial Revolution.

We therefore submit that if there is a case to be made for US hawkishness vis-à-vis China it is a narrow one animated by genuine national security concerns, not mercantilism. Several of the technologies privileged by the Chinese government have obvious military applications, whether or not Chinese firms actually overtake American ones when it comes to the innovations that will shape the future.[42] Moreover, the US government and military are just as likely as private firms to use wireless networks, hardware, and software.[43] Therefore, having sensible antihacking strictures in place and targeting export bans to the most sensitive technology, including around radar and perhaps quantum computing, makes some sense. Of course, the US government is within its rights to use—or threaten to deploy—economic weapons to punish Beijing for its deteriorating

[41] 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, devastating banks' balance sheets, and precipitating a bank run and credit crunch that led to the Great Recession.

[42] 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).

[43] Analysts speculate that over 70% of the technology that the US 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).

human rights record and increasing authoritarianism. But that does not seem to 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.

CONCLUSION

China is not unique in seeking to improve its economic potential by acquiring technology from the innovation frontier. While it has leaned on seemingly untoward strategies to do so, this mirrors the historical record. To be sure, Beijing has pushed some firms and scientists to steal trade secrets and has engaged in practices described as "forced technology transfer" around joint ventures. But, even then, these techniques may have been less than optimal from the Chinese perspective and may prove counterproductive in due time. It is also not clear it has really cost American firms much in profits—indeed, the latter seem to be making a calculated gamble that any lost IP royalties today will be more than made up for with a bigger slice of the growing Chinese market tomorrow. Moreover, China has firmly moved in the direction of improving its intellectual property rights regime, including the enforcement of foreigners' IP.

The latter is a smart move on China's part. Strong patents give foreign inventors both incentives and opportunities to introduce their innovations to new markets. These inventions cannot simply be appropriated by developing countries through espionage or copying. Instead, because they are complemented by a deep substrate of tacit knowledge, the original inventor's willing consent and her ongoing cooperation is required. Often, these can only really be secured by her with an enforceable patent license.

There are several interconnected reasons for this. Patent licensing contracts outline how critical knowhow will be conveyed from licensors to licensees—licensees cannot rely solely on information available in the patent to put idea described into service. These contracts, which are

essentially grafted upon their intellectual property rights, specify how a licensor will gain access to the plans, services, and human capital that accompany a patent license. This includes drawings, blueprints, and machinery, on site tutorials, and training. Also, inventors who license patents abroad must often travel to distant lands to help licensees adapt processes and products to differences in type/quality of raw materials and other inputs and logistical problems. These adjustment processes are usually accompanied by additional patenting and licensors commit themselves, via the patent, to help their licensees with upkeep and continued improvements.

However, even in these cases, tacit consent by firms in advanced economies is usually required. While "forced technology transfer" conjures up images of companies being robbed by rogue agents at gunpoint, what this phrase actually refers to in most cases are the Chinese authorities driving hard bargains with foreign firms—using access to the large Chinese market as a bargaining chip that impels them to license their technology, albeit sometimes without receiving any royalties. Usually, Western firms acquiesce because they have something to gain—and this something outweighs the costs of missing out on a robust flow of royalty revenues. In China today, what those firms seek is access to what is slated to be the biggest consumer market in the world and the profits associated with a larger, future market share.

Whether the US government should become intimately involved in regulating the voluntary exchanges between American firms and the Chinese government and firms that have made this bet is another question. Ultimately, doing so may be to confuse genuine national security concerns for rent-seeking: to help US firms improve the terms of a deal that was already in their best interest, evinced by their presence in China in the first place. Plus, the drastic policy proposals to contain China floated by both Trump insiders and his critics alike can take on a life of their: no matter how Beijing responds, China hawks have the power to upend the international trading system and

depress global economic development, if not make conflict and outright war more likely (Sachs 2019). As the US continues to bring down the "economic iron curtain" on China, this might precipitate a new "Cold War" between these rivals (Hirsch 2019). We hope that this paper has allowed readers to step back and better understand whether the economic rationale behind this escalation put forward by both politicians and pundits is actually warranted.

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