Does the United States Need a More Targeted Industrial Policy for High Tech?

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ABSTRACT

Industrial policy is experiencing a major revival in the United States as policymakers and pundits of various ideological backgrounds propose ambitious new government schemes to boost innovation in a wide variety of sectors. Much of this advocacy focuses on creating detailed blueprints to encourage industrial development in various "strategic" high-tech sectors, such as semiconductors, 5G wireless networks, and artificial intelligence. Many of these planning proposals are framed as a response to Chinese and European industrial policy efforts. The recent history of high-tech industrial policy efforts, however, is spotted with costly failures. In light of the difficulties inherent in more targeted industrial policy approaches, the United States should instead focus on the policy prerequisites that helped give rise to the computing and internet revolutions: a more generalized approach to economic development rooted in light-touch regulation and taxation of emerging technology. Of course, industrial policy will always be with us to some extent, given the sheer size of government and the many existing programs already devoted to economic development or high-tech initiatives. Policymakers should therefore favor programs such as competitions, which minimize taxpayer risk and cost while also encouraging more innovative outcomes.

JEL codes: L52, L50, O25, O38, O2, O3, O33

Keywords: industrial policy, research and development, R&D, innovation, technology, tech, planning, targeting, generality, government, regulation, competitiveness

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1. INTRODUCTION: DEFINITIONAL CHALLENGES

Questions persist about whether a more targeted industrial policy on the part of the US government could help promote greater investment and global competitiveness from American companies. Debates have raged about this topic since the earliest days of the republic, starting with Alexander Hamilton's famous *Report on the Subject of Manufactures*, which favored tariffs and subsidies to support manufacturing. The report was generally opposed by Thomas Jefferson and his fellow Democratic-Republican Party members.[1] Support for (and opposition to) this and subsequent industrial policy efforts throughout American history has often been driven by deep political divides and efforts to cater to favored interests. Mike Watson of the Hudson Institute notes that "from the beginning, the United States has enacted confused and often incoherent industrial policies driven primarily by political, rather than strategic, considerations." He notes that "the parochial interests of coalition members and internal party dynamics" have driven much industrial policymaking.[2]

Despite this checkered history, there has been an explosion of bipartisan advocacy for expansive national industrial policy in recent years.[3] Much of this advocacy is driven by a professed desire to stay competitive with Chinese and European industrial development efforts.[4] These advocates assert or imply that the United States will need to craft highly targeted industrial development plans so that it can compete in strategic sectors such as semiconductors, 5G, and artificial intelligence, among other high-tech sectors. The Biden administration is taking steps in that direction[5] and is not shying away from the idea of "picking winners and losers" using extensive government planning and spending efforts.[6] Meanwhile, Congress has advanced a 2,300-page bill, the US Innovation and Competition Act, that includes the most extensive industrial planning and spending proposals perhaps ever seen in the United States. Another bill, introduced in the Senate in mid-August, would create the Industrial Finance Corporation of the United States to help America "build the factories of the future" to compete against China.[7]

The relationship between industrial policy and innovation is complex, beginning with ongoing disagreements about how to even define either of those terms. There are many legal, regulatory, fiscal, and even military policies that, taken together, could be considered components of a nation's industrial policy. In the United States, defense spending (along with corresponding massive defense-driven spillovers) is probably the most critical component of industrial policy, but there are other policies that affect industrial development.[8] Trade and immigration policies are particularly important factors that influence the innovative capacity of a nation.[9] Antitrust policy and other forms of economic regulation also have an important bearing on

industrial structure and outcomes. Intellectual property laws, particularly patent law, also affect innovation in many ways. Educational attainment likewise has a connection to industrial capacity, both on the supply side (regarding the skill level of producers) and on the demand side (regarding the education level of consumers).[10]

Definitional disputes arise as soon as conversations about industrial policy get underway. To some, a lax stance toward antitrust enforcement might constitute an intentional industrial policy. To others, it could simply reflect a more broad-based laissez-faire approach to economic policy by government. Likewise, is strong intellectual property protection an industrial policy measure or merely a long-standing commitment to the protection of property rights? No wonder, then, that Howard Pack, in his historical overview of industrial policy efforts, laments "elastic definitions" and the fact that "there is a blurring of the lines about industrial policy—any activity that helps one industry is lumped under the rubric of an industrial policy."[11]

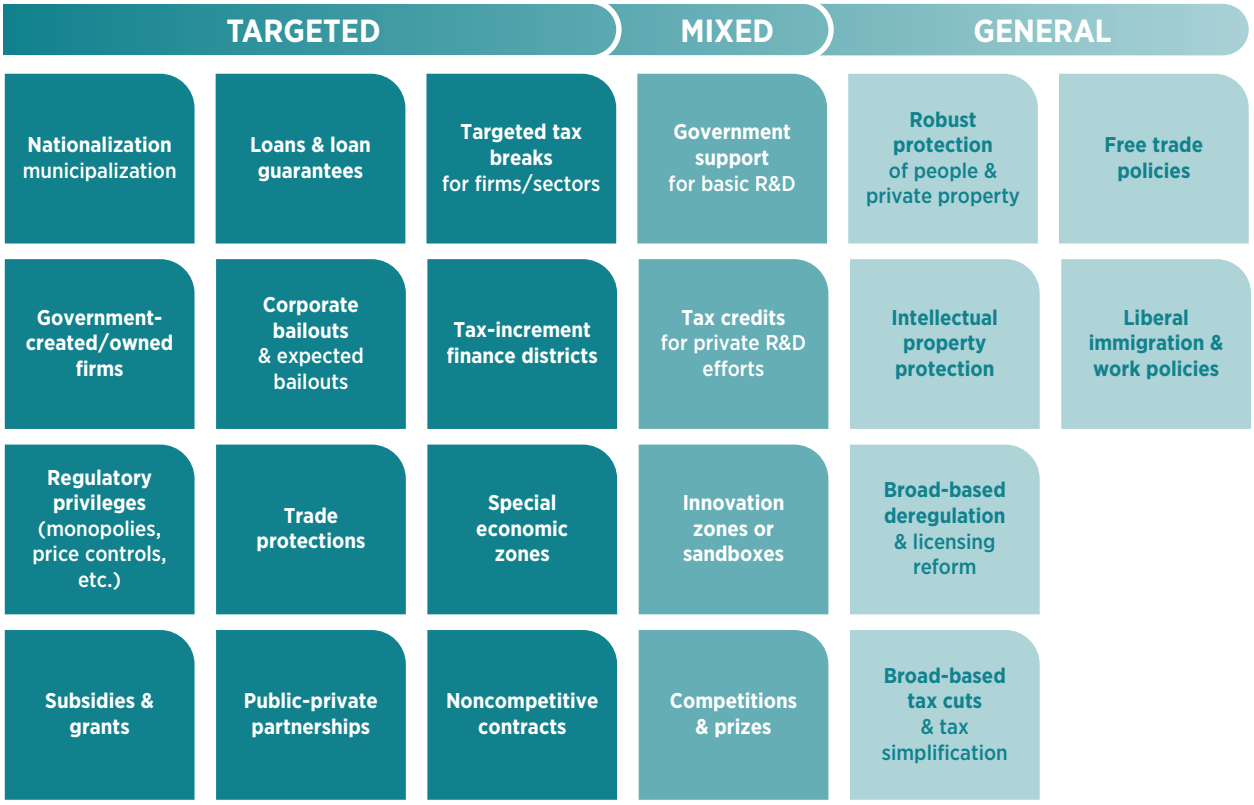
We employ a tighter definition of industrial policy here to ensure that the concept can be sensibly evaluated. To do so, we need to disaggregate it from *science policy, innovation policy*, and *economic policy* more generally.[12] It is certainly true that industrial policy could be considered a component of all these things. But to properly evaluate the effectiveness of industrial policy, we need a more focused definition of the term.

In the mid-1980s, economic historian Ellis W. Hawley defined industrial policy as "a national policy aimed at developing or retrenching selected industries to achieve national economic goals."[13] "To have an industrial policy," he argued, "a nation must not only be intervening at the macroeconomic level but also have a planning and coordinating mechanism through which the intervention is rationally related to national goals," which include specific industrial priorities and programs.[14] More recently, China policy expert Barry Naughton of the University of California San Diego School of Global Policy and Strategy has likewise defined industrial policy in a tighter fashion. "Industrial policy is any type of selective, targeted government intervention that attempts to alter the sectoral structure of production toward sectors that are expected to offer better growth than would occur in the (non-interventionist) market equilibrium," he writes.[15] Even more concisely, economist Nathaniel Lane defines industrial policy as "intentional political action meant to shift the industrial structure of an economy."[16] In other words, industrial policy has *intentionality* and *directionality*.

We adopt this tighter framing of industrial policy in this paper and focus our discussion on some of the potential pitfalls associated with more expansive versions of directed, targeted high-tech industrial policy, with a particular focus on efforts to promote artificial intelligence and related high-tech sectors and technologies.

Some scholars and policymakers insist that America is slipping behind China and the European Union on artificial intelligence (AI) and other high-tech fronts owing to the lack of a more concerted and coordinated industrial policy effort on these fronts.[17] We challenge that notion and argue that the United States should take a more guarded approach to promoting innovation for AI and related sectors, focusing on broad-based or general R&D efforts instead of highly applied or *targeted* industrial policy efforts.[18] A general approach focuses on broad-based prerequisites for economic growth and innovation, including things like sound money, stable legal institutions, low and simple taxes, property rights, and so on. By contrast, a targeted

FIGURE 1. TYPES OF ECONOMIC DEVELOPMENT EFFORTS



approach to economic development and industrial policy "selectively favors particular firms and industries with benefits like targeted tax relief, cash subsidies, regulatory dispensations, and in-kind donations of land and other valuable goods and services."[19] As figure 1 makes clear, there exists a broad spectrum of economic development efforts, including many mixed strategies.

Throughout this paper, we will return to this *general* versus *targeted* distinction and argue that—whether we are referring to federal, state, or local planning efforts—the more highly targeted development efforts typically involve many tradeoffs that are often not taken into consideration by industrial policy advocates. Downsides include government steering of public resources into unproductive endeavors, as well as more serious problems, such as cronyism and even corruption.[20]

2. CALLS FOR EXPANDING INDUSTRIAL POLICY TO BOOST HIGH-TECH INNOVATION

Calls for "revitalizing American industrial policy" have been increasing in recent years in the United States.[21] "It is past time for the U.S. government to get over the allergic reaction to 'industrial policy,'" argues Carolyn Bartholomew, sitting vice chair of the congressionally chartered US-China Economic and Security Review Commission. "Government investment in foundational research is essential to remaining competitive," she writes.[22] Mark MacCarthy of Georgetown University argues that "the 40-year old U.S. policy of hands-off tech is coming to an end" and that a "new industrial policy for tech . . . is beginning to take shape."[23] Some advocates of expanded industrial policy, like Harvard University economist Dani Rodrik, say that the governments "have not tried nearly enough to steer technology in the right directions."[24]

To some extent, the Obama and Trump administrations already started down this path for AI and other technologies in recent years. In 2016, the Obama administration created a subcommittee on machine learning and AI within the National Science and Technology Council. The council then issued several important AI-related reports in late 2016, including *Preparing for the Future of Artificial Intelligence* and *The National Artificial Intelligence Research and Development Strategic Plan*.[25] The administration proposed increasing R&D funding for AI as well as expanding the R&D tax credit to encourage firms to spend more on AI development.

The Trump administration largely followed the Obama administration's lead. In 2019, it released an updated *National Artificial Intelligence Research and Development Strategic Plan*, which built on the Obama administration's framework by reaffirming all the principles contained in the earlier report.[26] The Trump administration also proposed doubling federal R&D spending on AI and quantum computing,[27] although it simultaneously announced cuts to basic R&D efforts at the National Science Foundation and other agencies.[28] Meanwhile, in 2018, Congress passed and President Trump signed into law the National Quantum Initiative Act, promising to spend $1.2 billion on quantum research, of which $75 million was spent in July 2020 on three quantum computing centers around the United States.[29] This was followed up on in August 2020 when the Trump administration, along with the National Science Foundation (NSF) and the Department of Energy, announced an additional $1 billion investment into AI and quantum research. The funding will go toward creating seven "NSF-led AI Research Institutes" and five Department of Energy quantum information science research centers over five years at universities nationwide.[30] For fiscal year 2021, the initiative was granted $1.5 billion for AI and $700 million for quantum information sciences.[31]

In other words, there are many federal agencies already involved in AI "planning"—in terms of both governance matters and R&D efforts.

But just how applied should such support for AI (and high tech more generally) be? Determining an answer to this question involves many factors, and these efforts also encounter many of the same definitional challenges associated with AI regulatory governance: namely, how narrowly or broadly do policymakers define AI? Moreover, which *particular* AI sectors or applications are worthy of greater consideration from either a regulatory or an industrial policy perspective?

Advocates of expansive industrial policy support tend to be all over the map on these questions and often are only united by answering "more" to any general inquiry about how much government spending and direction are needed.[32] Beyond increasing basic R&D spending, many scholars and policymakers call for more aggressive planning and programs to challenge Europe and especially China because both are pursuing more aggressive and highly targeted industrial policy efforts.[33]

For example, regarding 5G communications, some have proposed large-scale public-private partnerships[34] or even a completely nationalized network to respond to the challenge posed by China-based Huawei.[35] Eric Schmidt, former chairman and CEO of Google, says the United States "should incentivize the emergence of a competitive alternative to Huawei."[36] Carolyn Bartholomew argues that

> the United States needs its own whole-of-government approach, partnered with the private sector, to address the challenges. This approach must include participation by the Department of Defense, the Defense Advanced Research Projects Agency (DARPA), the Defense Intelligence Unit, the intelligence community, the InQTel venture capital group, the Department of Commerce, the Federal Communications Commission, the National Institute of Standards and Technology, and the National Science Foundation, among others.[37]

There have also been calls for far more aggressive efforts to bolster US semiconductor supply chains amid a global shortage of certain chips. The Biden administration issued Executive Order 14017, which ordered a 100-day review of "America's Supply Chains"[38] and also proposed creating a new National Semiconductor Technology Center and dedicating $50 billion to boosting semiconductor output.[39]

Others have floated ambitious industrial policy proposals for AI. In early March 2021, the congressionally authorized National Security Commission on Artificial Intelligence released a 756-page report detailing ways to counter China on the AI front.[40] Although it avoided mentioning industrial policy, the report took an everything-and-the-kitchen-sink approach to state direction, insisting that the time has come to "drive change through top-down leadership" in order to "win the AI competition that is intensifying strategic competition with China."[41] The commission did not shy away from the price tag, advocating $40 billion in new government AI investment immediately and then suggesting that "hundreds of billions in federal spending in coming years" will be needed to support other initiatives.[42] In addition to these targeted proposals, there have been many calls to beef up bureaucracy to create more broad-based industrial planning divisions within the federal government. For example, think tanks such as the Niskanen Center have recommended a new cabinet-level Department of Industrial Strategy,[43] while the Information Technology and Innovation Foundation wants a new National Advanced Industry and Technol-

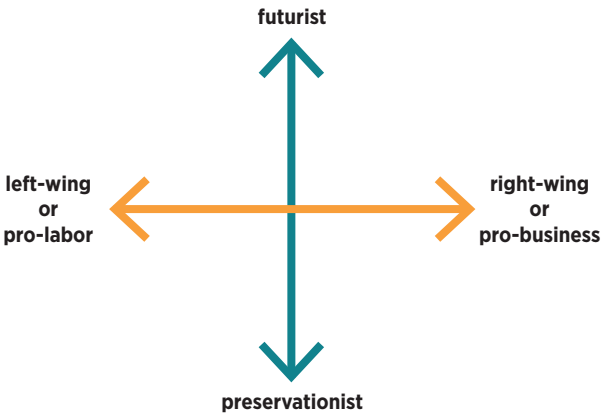
ogy Agency with a budget that matches that of the National Science Foundation.[44]

Clearly, then, industrial policy is back in a major way in America. How much more centralized direction and targeted federal spending is really needed to beat China at its own game or to top Europe's approach? And are such goals even wise?

Before we embark on a fuller exploration of these issues, it is worth noting that although industrial policy appears to enjoy bipartisan support today, proponents often have very different motivations and proposed solutions. In his 1985 book, *National Economic Planning: What Is Left?*, economist Don Lavoie highlighted the key differences between industrial policy advocates of the 1980s using a helpful image he called the Planning Spectrum (see figure 2). To plot the positions of particular advocates and proposals, he created a chart with two axes: On one axis, the scale goes from "futurist" to "preservationist"; on the other axis, it stretches from "left-wing or pro-labor" to "right-wing or pro-business."[45]

Lavoie's Planning Spectrum remains a useful tool that helps explain what drives today's industrial policy discussions, such as the way some conservatives advocate for industrial policy on national security grounds while some on the political Left favor it to advance labor or environmental priorities. Meanwhile, some industrial policy advocates want to rejuvenate employment or production capacity in older sectors (e.g., automobiles and semiconductors) while others stress the need for greater investments in newer fields (e.g., AI and quantum computing) or "infant industries." Lavoie noted that, whatever one thinks of advocates' specific rationales or proposals, the stark differences among them call into question the notion that they or government officials have a clear vision for prioritizing investments or steering the economy using industrial planning.

FIGURE 2. DIFFERENT FLAVORS OF INDUSTRIAL POLICY: DON LAVOIE'S PLANNING SPECTRUM



Source: Don Lavoie, *National Economic Planning: What Is Left?* (1985; repr., Arlington, VA: Mercatus Center at George Mason University, 2016), 199.

Regardless of these differences, what unifies almost everyone calling for industrial policy planning is the general claim that government interventions are needed to address any number of "systemic market failures around innovation, including externalities, network failures, system interdependencies, and the public-goods nature of technology platforms."[46] Advocates also accuse industrial policy skeptics of ignoring these concerns. In reality, industrial policy skeptics do not ignore these issues but instead usually suggest that government bureaucracies are not able to magically solve these problems simply by throwing taxpayers' resources at them. Moreover, when these alleged problems do hamper private innovation efforts, the question is whether they are corrected more quickly and efficiently through ongoing marketplace competition and experimentation or through more centralized state direction. A review of previous industrial policy efforts provides many reasons for skepticism about the ability of governments to wisely plan for or give rise to specific industrial outcomes.[47]

3. SOME (QUICKLY FORGOTTEN) RECENT HISTORY

In many ways, the concerns motivating calls for industrial policy today echo calls for state planning heard in previous eras. Most of the dire predictions made by industrial policy advocates previously did not come to pass, however. Most recently, in the 1980s and early 1990s, American pundits and politicians decried deindustrialization, trade imbalances, and job losses in certain sectors. Echoing concerns still often heard today, industrial policy advocates such as Ira Magaziner and Robert Reich said that "without government support, American business will find it increasingly difficult to achieve competitive leadership in today's international environment."[48] Accordingly, they advocated adopting "a coherent set of public policies for improving productivity in industry" through a high degree of government-led "coordination, collaboration, and careful strategic choice."[49]

While fear of China's growing economic power drives many of today's calls for industrial policy planning, from the late 1970s to the early 1990s the primary worry was how the United States was supposedly losing ground to Japan, and—to a lesser extent—South Korea.[50] Magaziner and Reich also stressed the supposed growing threat posed by advanced industry policies in Germany and France. They claimed that those countries had adopted targeted industrial schemes that would leave the United States behind in the race for technological global advantage.[51]

But it was Japan that attracted the most fevered attention from industrial policy advocates.[52] At the time, book titles asked, *Can America Compete?*, while others suggested that the United States was *Trading Places with Japan*.[53] Clyde Prestowitz, the author of the latter book, suggested that if the United States did not reverse course and emulate the so-called Japan Model, America risked becoming an economic "colony-in-the-making."[54] He insisted that "the power behind the Japanese juggernaut cannot stop of its own volition, for Japan has created a kind of automatic wealth machine, perhaps the first since King Midas."[55] Chalmers Johnson, who wrote two prominent books on these issues at the time, argued that "Japan's combination of a strong state, industrial policy, producer economics and managerial autonomy seems destined to lie at the center, rather than the periphery, of what economists will teach their students in the next century."[56] Other analysts went even further and argued that, because of growing economic differences between the United States and Japan, the potential for a *Second Pearl Harbor* and *Coming War with Japan* existed.[57]

The hysteria intensified among policymakers as well, with congressional lawmakers using sledgehammers to destroy Japanese electronics on the lawn of the US Capitol in 1987.[58] Congressional hearings and official government reports from this period featured repeated warnings that the United States needed to emulate Japan

and stressed the way "the emphasis of industrial policy has shifted from industry-specific to technology-specific targets."[59]

The Japan Model that proponents advocated then sounded much like what is heard today when pundits refer to China and its industrial policy model: generous (and highly targeted) R&D investments, government-led public-private consortia, industrial trade policies (a combination of export assistance and restrictions on imports and on foreign investment), and other forms of targeted government support for specific sectors or technological developments.

Scholars have debated the extent to which targeted industrial policy efforts helped Japan's "catch-up modernization" agenda in the postwar period.[60] Clearly, Japan made astonishing economic advances as it rebounded from World War II. Japan's Ministry of International Trade and Industry (MITI), which was formed in 1949, had targeted a wide variety of industrial sectors in which policymakers hoped to make advances, and many of these sectors did advance. On the other hand, the Japanese economy was primed for a rebound following a disastrous war experience that had decimated what had been a growing and technologically evolving economy. After all, Japan had displayed sophisticated technological capabilities not only during World War II but also in the Russo-Japanese War of 1905.[61] During the postwar period, therefore, many Japanese sectors that thrived (e.g., steel, automobiles, and electronics) would likely have seen a substantial degree of growth even in the absence of state direction.

Nonetheless, as the Japanese government expanded state investment in strategic industries, many American pundits worried about Japan "taking over" key technology sectors in the 1980s and '90s. One of the most prominent debates of this period concerned high-definition televisions and flat-screen displays. There were widespread calls in the United States for industrial policy efforts to support the declining TV manufacturing sector. No such industrial policy was developed, and the US share of global TV manufacturing steadily eroded. But this turned out to be neither a disaster for the United States nor much of a success story for Japan. Marc Andreessen, an early web pioneer and now a prominent venture capitalist, notes how television markets evolved in unpredictable ways on both sides of the Pacific:

> Virtually all of the experts at the time said that if Japan took the then-new flat-screen television industry the way they took old cathode ray tube televisions, the strategic consequences to the US would be disastrous, not just in lost jobs but also literally for national security—US aircraft carriers and fighter jets might not be able to source display panels in the future, and our military would be hobbled. Of course, as it turned out, we didn't implement an industrial policy for flat-screen TVs; Japan "won" and then immediately lost the industry to much lower cost competitors like Korea and China. Meanwhile, America won CPUs and software and the Internet. And last time I checked, our military gear contains plenty of flat-screen displays.[62]

Japanese officials also made efforts to boost the development of high-definition television at the time, predicting (accurately) that it would eventually become an important technology. A Japanese research lab even developed a working high-definition television system as early as 1979,

leading some observers in the United States, like Clyde Prestowitz, to claim that high-definition television was an "example of the widening U.S. lag" in high technology.[63] Things turned out quite differently from what was predicted. Unfortunately for Japan, the country made its industrial policy bet on an analog high-definition standard instead of digital, and by 1994 the industry had to abandon that standard, admitting that the digital format favored by US developers would likely prevail.[64] This was just six years after Prestowitz had mistakenly proclaimed that "there are not even any Americans involved in this struggle."[65]

Beginning in 1982, MITI also made an early effort to promote advances in supercomputing and AI with its Fifth Generation Computer Systems initiative. Ten years and $400 million later, MITI shut down the program and announced it would give away the software it had developed to anyone who wanted it. While the Fifth Generation effort had initially raised fears in the United States that Japan threatened to move ahead in advanced computing and AI, American companies such as Sun and Intel eventually surpassed the capabilities of the Japanese system. Somewhat amusingly, the *New York Times* 1992 obituary for the program noted that "some American computer scientists say privately that some of their colleagues did perhaps overstate the scope and threat of the Fifth Generation project. Why? In order to coax more support from the United States Government for computer science research." The article concluded that, overall, "the Fifth Generation venture is a reminder that even Japan's highly regarded Ministry of International Trade and Industry can make mistakes in predicting which technologies will be important in the future."[66]

Over time, other targeted planning failures by MITI became obvious, and by the late 1990s many scholars came to view most Japanese industrial policy initiatives as a costly bust.[67] In 2007, Marcus Noland of the Peterson Institute for International Economics summarized Japan's industrial policy results in bleak terms:

> Japan faces significant challenges in encouraging innovation and entrepreneurship. Attempts to formally model past industrial policy interventions uniformly uncover little, if any, positive impact on productivity, growth, or welfare. The evidence indicates that most resource flows went to large, politically influential "backward" sectors, suggesting that political economy considerations may be central to the apparent ineffectiveness of Japanese industrial policy.[68]

Noland noted that "resource transfers were worse than indiscriminate: They went predominantly to politically organized, declining natural resource sectors," and that "corruption was encouraged by the policy-instigated creation and distribution of rents."[69] There were other unfortunate indirect consequences of government intervention. Most notably, "financial sector repression and directed capital policies encouraged a bureaucratization of the banking function," and "bankers did not develop the necessary skills to evaluate alternative business plans and models."[70] In other words, public intervention and financing had crowded out not just private financing but also the development of new methods of financial analysis for newer technological sectors. Howard Pack concurs, explaining that "the empirical evidence pretty overwhelmingly shows that the sectors that were targeted positively by the Japanese government were often sunset sectors, not sunrise sectors—sectors

that were declining, which political forces tried to protect."[71] This targeted support for fading industries reflects the way rent-seeking and cronyism often become chronic problems for highly targeted, big-budget industrial policy efforts.[72]

By the turn of the century, the Japanese government itself admitted that the MITI model had not worked as well as planned. A 2000 report by the Policy Research Institute within Japan's Ministry of Finance concluded that "the Japanese model was not the source of Japanese competitiveness but the cause of our failure."[73] MITI was subsequently renamed the Ministry of Economy, Trade and Industry, and its mission shifted more toward instituting market-oriented reforms.

A 2003 book coauthored by Noland and Pack evaluated the broader role that targeted industrial policy played in the growth of other Asian economies and concluded that "selective industrial policy is seen to have accelerated growth only slightly, at best."[74] Other analysts have argued that openness to trade and globalization was what primarily fueled the growth of Asian economies during the postwar period.[75] China's recent explosive economic growth, much like that of Japan and other Asian countries before it, was in large part catch-up growth. Writing on the nature of emerging economies, Michael Schuman, author of *Superpower Interrupted: The Chinese History of the World*, notes that

> lifting a country out of destitution, while by no means simple, is at least straightforward. China and other hyper-growth developing societies, such as South Korea, Taiwan and Singapore, achieved their success by integrating into the world economy, and its networks of trade and finance, and connecting their poor workforces to global supply chains. The resulting burst of productivity sent growth rates and incomes soaring.[76]

Then comes the hard part. Once developing economies achieve some success and reach middle-income status—approximately where China sits today—the low-hanging fruit of "catch-up" economic gains are mostly picked over, and the only way to propel the country into the ranks of the most advanced is to become more innovative and efficient.[77] This is where many countries get stuck and turn to industrial policy targeting to artificially boost growth after the catch-up phase is complete.[78] Even if China's industrial policy targeting played a part in steering additional public resources into *some* sectors and technologies that offered low-hanging fruit, it is difficult to answer the counterfactual question of how much of that catch-up growth would have occurred as a natural consequence of China's economic evolution and opening to market economics and global trade. Regardless, as Schuman suggests, the bigger challenge is yet to come as persistent planning efforts by the Chinese Communist Party (CCP) are confronted by growing costs, miscalculations of market demand, and other practical troubles, such as industry rent-seeking and corruption.

4. THE ROMANTIC VIEW OF INDUSTRIAL POLICY VS. REALITY

There is a sort of mythology that pervades the rhetoric of government planning. For example, industrial policy discussions often teem with mechanical metaphors. Advocates imagine state planners building or steering a large ship, or using dials and levers to finely calibrate innovation and growth in certain sectors. In reality, says Mike Watson, "industrial policy in the United States cannot be steered by a small group of enlightened individuals, because a small group of enlightened individuals will never be at the helm. Indeed, in some sense, there is no single 'helm' to speak of."[79]

Don Lavoie observed that the industrial policy debates of the 1980s often relied on civil engineering metaphors, with the nation's economy envisioned as "a great structure, a building in which certain stories (industries or regions) are the foundations that have to remain firm in order to support the whole edifice."[80] Industrial policy is then treated as a way to "shore up the weakening beams and supports upon which the survival of the rest of the structure depends."[81] Lavoie itemized the many ways such metaphors fail to explain the actual workings of an economy and end up doing more harm than good. "The point is that such relations between the health of different sectors of a modern economy are so intricate and complex that it is the height of pretense to claim that any single agency could take them all into account in its decisions to reallocate credit to certain sectors,"[82] he argued. Moreover, "any argument for offering subsidies in the form of cheap credit to some favored industries, whether old or new, is also an argument for penalizing other (possibly unidentified) industries."[83]

IGNORING TRADEOFFS

"When a government directs resources toward some industries . . . it effectively takes them away from others," notes Michelle Clark Neely, an economist with the Federal Reserve Bank of St. Louis.[84] This is how the well-known problem of government "picking winners and losers" develops, even when policymakers claim they are not attempting to do that.

Neely identifies the fundamental problem with much of the advocacy for comprehensive industrial policy planning: Proponents are typically telling less than half of the story about the tradeoffs in play. They seek to play up the *potential* benefits of public planning and spending without acknowledging any of the costs. They often do this by claiming that state support will result in significant "multiplier effects" that spur additional economic activity—new firms, new jobs, and other positive "spillovers." A proper analysis of the efficacy of any sort of economic development or industrial policy efforts must first question whether these positive externalities exist, but the evaluation cannot end there.

In a 2019 special report from the Mercatus Center at George Mason University, "The Eco-

nomics of a Targeted Economic Development Subsidy," economists Matthew Mitchell, Michael Farren, Jeremy Horpedahl, and Olivia Gonzalez identify precisely how we must evaluate the tradeoffs in play in these debates:

> The logic of a multiplier is that economic activity indirectly creates other economic activity; a new production facility and its employees create demand for products and services offered by suppliers and other producers. This logic, however, also applies to the resources that are used to fund the subsidy. Just as the workers at an LCD factory create demand for other products and services, taxpayers also create demand for other products and services. With $3.6 billion less in their pockets, however, these individual and business taxpayers create less demand for other products and services. In other words, the multiplier associated with the subsidy is only half the story. To appreciate its full effect, we must also know the size of the tax multiplier. Just as spending creates a positive multiplier, taxation creates a negative multiplier.[85]

The problem, the authors note, is that "taxation tends to discourage economic exchange, which means that there is good reason to suspect that the negative tax multiplier is, in fact, greater than the positive spending multiplier, making the net multiplier of the subsidy negative."[86] The lessons here are threefold. First, a dollar spent pursuing one objective is a dollar that could have been invested differently, and potential better. Second, the very act of imposing taxes to cover these state gambits results in costs and distortions that must be accounted for. Some of these costs are deadweight losses associated with taxes and tax collection more generally. But this points to a third lesson: The true potential costs associated with industrial policy programs also need to account for the negative secondary effects of rent-seeking, bureaucracy, and the many other downsides of the political system, included cost overruns and corruption.

PLAYING UP HITS WHILE IGNORING THE MANY MISSES

Another part of the romanticism surrounding industrial policy shows in the way advocates tend to play up the handful of "hits" while conveniently ignoring the many extremely expensive misses. We often hear about supposed government-inspired successes such as the internet, the computer mouse, and the global positioning system (GPS). We elaborate on such theories below and find that industrial policy planning played less of a role than advocates suggest.

Regardless, far less is heard about abject failures, such as how federal agencies spent more than a billion dollars on supersonic transport technology before Congress finally pulled the plug on the program.[87] Retrospective analysis of successful innovations that sprang in part from government investments needs to untangle how much of the success is attributable to basic versus applied R&D efforts—and this is often not an easy task.[88] What should not be forgotten is that there were probably many costly failures, too.

Technological forecasting is more art than science, and industrial policy planning is particularly challenging in fast-moving technology sectors, where unexpected forms of change are the norm.[89] Writing in 1983, innovation scholars

Richard Nelson and Richard Langlois offered some lessons about industrial planning after surveying American history. They concluded,

> A quick reading of the case studies is enough to dash any supposition that technological change is somehow a cleanly plannable activity. In fact, it is an activity characterized as much by false starts, missed opportunities, and lucky breaks as by brilliant insights and clever strategic decisions. Only in hindsight does the right approach seem obvious; before the fact, it is far from clear which of the bewildering array of options will prove more fruitful or even feasible.[90]

This reality is even more pertinent today, with modern technologies evolving at a breakneck pace and in completely unexpected ways.[91]

Moreover, promoting technological progress is not a precise cocktail; it is a process of ongoing trial and error. When government directs targeted technology investments, it is rolling the dice with taxpayer money, and therefore its errors could squander taxpayer money or divert public resources that could be used for other priorities. How much tolerance should the public have for failures to efficiently channel resources into productive innovations that meet actual, rather than perceived, public needs? Why choose one particular firm or technology to support while ignoring many others? Who does the choosing? And why should we trust their judgment?

These are hard questions to answer, but "basic" support is likely wiser than "applied," although even these terms can be confusing. When government is supporting basic R&D, the chances of wasting scarce resources on risky investments can be minimized to some degree, at least as compared with highly targeted applied R&D investments in unproven technologies and firms. Even defenders of strong government support for basic research and development note that "R&D money is just as easily misspent or misappropriated as any other type of government largess," and this is particularly true for more targeted initiatives because "costs can be purposefully inflated by private investors to win support for government funding."[92]

In a 1991 book, *The Technology Pork Barrel*, the Brookings Institution brought together leading scholars on these issues to review the US government's track record in promoting high-tech sectors and initiatives in the 1970s and '80s. The contributors evaluated six major commercial R&D programs that were federally backed, including supersonic aircraft and synthetic fuels programs. Their findings are damning. As summarized by the book's editors, Linda R. Cohen and Roger G. Noll,

> The case studies obviously justify skepticism about the wisdom of government programs that seek to bring new technologies to commercial practice. But the cases provide far more insight than that. They identify how and why government programs go wrong, and hence the problems in the federal decision-making process that need to be solved if performance is to be improved.[93]

In concluding the book, the editors note, "We are not sanguine about the prospects that this or any other recommendation about structuring the process by which decisions are made will dramatically raise the batting average of R&D commercialization projects."[94]

RENT-SEEKING, CRONYISM, AND CAPTURE

At least part of the reason for Cohen and Noll's conclusion, as they note in a chapter coauthored with Jeffrey Banks, is that "American political institutions introduce predictable, systematic biases into R&D programs so that, on balance, government projects will be susceptible to performance underruns and cost overruns."[95] Surveying industrial policy efforts 25 years later, another Brookings scholar, Shanta Devarajan, found that "a common issue is that industrial policies are too easily captured by politically powerful groups who then manipulate it [*sic*] for their own purposes rather than for structural transformation."[96]

Even many defenders of government-led industrial policy and economic development efforts admit that regulatory capture has been a long-standing problem. "The dirty little secret is that the U.S. already has an industrial policy, but one that's focused on pumping up profits with industry-specific subsidies, tax loopholes and credits, bailouts and tariffs," explains Robert Reich, writing many years after his initial work on the topic with Ira Magaziner.[97] Similarly, in his 2009 book, *Boulevard of Broken Dreams*, Josh Lerner documents many domestic and international examples of state-led innovation gone disastrously wrong.[98] A major culprit is "outright distortions by special interests" and a vocal "subsidy lobby," including trade associations and other groups and lobbyists who "are benefiting far more from the subsidies than the entrepreneurs the programs are designed to help."[99]

Why, then, would scholars like Reich and Lerner continue to support various targeted industrial policy schemes? It usually comes down to an asserted "market failure" that supposedly only state intervention can remedy. But Devarajan points out that while industrial policy proponents typically utilize "elegant economic models that portray [a] market failure and show how intervention can lead the economy to higher growth,"[100] these models rest on bad assumptions:

> Most of these models assume that the relevant market failure is the only distortion in the economy. In the real world, however, these economies are full of distortions, such as labor market regulations, energy subsidies, and the like. In this setting, correcting the market failure associated with industrial policy may not promote industrialization; in fact, it may make matters worse.[101]

While this does not mean that every targeted industrial policy intervention will be a failure, it raises legitimate concerns about the ability of technocratic planners to forecast the future and make wise bets with taxpayer resources.[102] "Economic theory and practical experience teach us that individual entrepreneurs and firms are better equipped to make these choices," argues Neely.[103] Thus, while some industrial policy supporters will insist that they are not out to pick winners and losers, the reality is that there is simply no escaping that result because "industrial policy intrinsically supports some sectors to the detriment of others."[104]

This sort of evaluation is particularly important in light of the price tag associated with comprehensive industrial planning efforts, which has always been significant but is exploding today. Most recently, debate over industrial policy legislation in Congress got bogged down in endless amendments, rent-seeking, and pork-barrel politics.[105] The resulting US Innovation and Com-

petition Act swelled to over 2,300 pages, with dozens of amendments on matters largely unrelated to R&D funding, including prevailing wage requirements for chip manufacturers and limits on the global sale of shark fins.[106] When the bill finally passed the Senate in early June 2021, the cost of the measure had grown to $250 billion.[107]

Senator John N. Kennedy (R-LA) referred to the measure as an "orgy of spending porn."[108] Some of the lead sponsors of the bill pushed for money and programs to benefit interests in their home states. Senator Maria Cantwell (D-WA), who chairs the Senate Commerce Committee, came under fire for introducing an amendment that could directly benefit Boeing and Blue Origin, both located in her state.[109] The committee's lead Republican, Senator Roger Wicker (R-MS), proudly highlighted how the bill includes support for the Stennis Space Center, located in his home state.[110] Senator Chuck Schumer (D-NY), who cosponsored the legislation, boasted in a press release how subsidies for the semiconductor industry would benefit companies in his state.[111] The technology pork barrel rolls on.[112]

5. THE CHALLENGE OF CREATING "NATIONAL CHAMPIONS": EUROPE'S FAILURES

While proponents of more targeted industrial policy efforts often castigate the United States for not adopting a more aggressive approach to sectoral investments, if this model is so successful, wouldn't competing countries already be far ahead of the United States on most high-tech fronts? "History records few examples of democracies in which political leaders have successfully steered their economies by targeting industries for support," writes Thomas J. Duesterberg, a senior fellow at the Hudson Institute. "Japan gave up central planning decades ago. Europe's efforts to create national champions have largely foundered."[113]

We have already discussed how Japan retreated from many of its earlier targeting efforts. Next we consider some of Europe's recent attempts to create digital technology platforms and other "national champions" that can compete with US-based tech giants. As we show, almost all these European efforts have failed to live up to expectations.[114]

- *Minitel and internet access.* Minitel was France's attempt to develop its own early version of the internet in the 1980s and '90s. Minitel terminals were distributed free of charge and eventually gave an estimated 25 million French citizens access to bank accounts, the yellow pages, and various other services. But Minitel's centralized and closed network model ultimately could not serve consumers as well as the wide-open global internet. "It was the whole model that was doomed," says Benjamin Bayart, the former head of France's oldest internet provider, French Data Network. "Basically, to set up a service on Minitel, you had to ask permission from France Telecom. You had to go to the old guys who ran the system, and who knew absolutely nothing about innovation."[115] Users of Minitel also faced steep costs, roughly $22.95 per hour (accounting for inflation)—a noted downside of the technology.[116] As for the French government, the development of the service cost tens of billions of French francs before it was finally discontinued in 2012.[117]
- *Galileo and GPS.* In 1999, the European Union announced a public-private endeavor to establish Europe's own global positioning system, called Galileo. Within three years, the project was "almost dead," but the European Union continued on, allocating $5 billion for Galileo.[118] By 2006, the public- and private-sector partnership had dissolved, and the project was officially nationalized.[119] After billions of dollars of cost overruns and poor strategy, Galileo finally got satellites in the sky in 2011 for a validation test, but it was not until 2019 that satellites became fully operational. The project was 12 years late and triple the original budget, and provided virtually no novel technology to the continent.[120]

- *Quaero and search.* In 2008, Germany and France teamed up to launch Quaero, a $400 million search engine that was initially hyped as a "Google-killer."[121] While many in Europe were optimistic about the creation of a service that would rival what was on offer from American tech companies, within a year the Franco-German alliance began to fracture.[122] The project officially ended in 2013, with no semblance of a search engine to show for a boondoggle costing hundreds of millions of euros.
- *GAIA-X and cloud services.* GAIA-X represents the latest European push to develop home-grown tech—in this case a unified, interoperable ecosystem of cloud services throughout Europe.[123] In October 2020, EU countries issued a joint declaration to collectively fund a "European Alliance on Industrial Data and Cloud" to create a "common approach to building the European cloud supply [that] will reinforce Europe's digital sovereignty and increase the competitiveness of European business and industry."[124] So far things are off to a slow start, however, and public funding has been limited.[125] According to recent reports, the initiative "continues to face serious challenges and delays" and "many startups have complained about too much bureaucracy at Gaia-X."[126]
- *France's Netflix (SALTO).* Meanwhile, other industrial policy efforts are also afoot in France, which recently gave a group the green light to create its own version of a Netflix-like video streaming service, dubbed SALTO.[127] The project is being taken on by a conglomerate made up of the TF1 Group, which was founded in 1975 by the French government but went private in 1987; the Groupe M6, a private media conglomerate; and France Télévisions, the state-owned French public broadcasting company. This mélange of the French public and private sector is intended to rival American video streaming giants such as Netflix, Disney, and HBO Max. The company went fully live in October 2020 and has amassed 60,000 paying subscribers. Aside from that, the company has not released any numbers so far, "which they surely would have done if it had been successful," according to Sebastien Robin, a French video streaming consultant.[128] The endeavor has also been criticized by notable French politicians—Senator Roger Karoutchi sees it as a waste of public money in light of the dominance of Netflix and other streaming giants.[129] And in May 2021, two of SALTO's owners—TF1 and M6—announced a plan to merge and create "a French streaming champion," even though that was ostensibly the purpose of SALTO.[130] Considering that two of SALTO's founding companies seemingly plan to create a different version of it, though they have committed to remaining a part of SALTO,[131] its fate seems to be in jeopardy. The paucity of publicly released financial data is an equally ominous sign.
- *France's Airbnb.* A video-streaming service is not the only popular technology the French are trying to emulate. The country's government has said it also plans to develop its own version of Airbnb and Booking.com so as to "regain a link" with tourists.[132] While France obviously wants to push back against US-based tech giants like Airbnb, it's not clear that this is in the best interests of French

tourism. Indeed, 23 percent of Airbnb guests said they would not have visited France had it not been for the option to use Airbnb.

Targeted European industrial policies like these demonstrate the problems associated with state-led efforts to steer technology or incubate certain companies or sectors. The case studies provide a cautionary warning about more recent claims that governments can easily "steer" public resources into AI and other high-tech sectors and create national champions or meaningful innovations.

6. ADVERSE EFFECTS OF STATE-LED PROMOTION: THE CHINA MODEL EXAMINED

Another potential problem with the United States inching closer to a European or Chinese conception of highly targeted industrial policy is that the policy runs the risk of being accompanied by elements of the respective governance visions employed in those places. Industrial policies are not free lunches; conditions often get attached to forms of assistance, and various costs must be borne to support them. This section highlights the tradeoffs associated with China's approach to industrial policy.

To begin with, it is worth noting that the much-discussed Chinese industrial policy model is actually of recent creation and, more importantly, cannot be credited with China's economic growth. In his new book *The Rise of China's Industrial Policy*, China policy analyst Barry Naughton argues that "the explosive growth that propelled China out of poverty to become the second-largest economy in the world was due to deep structural factors and market-oriented reforms. Industrial policy played no role in it, since industrial policies essentially did not exist before 2006."[133]

Much like Japan and South Korea before it, China enjoyed a period of rapid catch-up modernization after liberalizing markets and opening its economy to global trade in the late 1990s and the beginning of the next decade. China also benefited from lower-cost labor as it began this transition and sought to engage globally. "The Chinese never adopted a laissez-faire philosophy towards technology," Naughton writes, "but practically speaking, the Chinese government by 2001 had stopped trying to enact specific industrial and technology outcomes" and "committed to a new, market-driven process."[134] "So long as we retain a relatively narrow definition of industrial policy, it is quite clear that China through 2005 had very little of it," he argues, "and that what it had was rarely even implemented, much less in an effective way."[135]

A sea change in approach started around 2005, however, when the CCP began taking a more active role in promoting "strategic emerging industries" through detailed five-year plans and other industry development blueprints. Some of the more notable recent planning documents are the *Made in China 2025* plan, released in 2015, and the *Innovation-Driven Development Strategy* and the *Three-Year Guidance for Internet and Artificial Intelligence Plan*, both released in 2016. In planning statements such as these, the CCP not only sets up specific sectoral objectives but also bestows privileges on certain companies (i.e., national champions).

This type of formula may work for a period and help boost the fortunes of certain large firms favored by the government. With the weight of the CCP at their backs, their market status is virtually guaranteed. The Chinese government's mercantilist trade policies also assist these firms by discriminating against foreign companies.[136]

This approach has drawbacks, however, in that a select few within the Chinese government are controlling everything in a centralized fashion to boost Chinese innovation in AI and other strategic tech sectors. A single point of control can also become a single point of failure. What some regard as China's greatest advantage in technological development—its top-down, coordinated vision—could be its biggest potential liability by disallowing the sort of decentralized, spontaneous innovative activities that propelled the internet revolution in the United States.

When government becomes a more dominant funder of R&D and a targeted industrial planner, this can have many costs and unintended consequences. How much private R&D is crowded out or channeled inefficiently in China because of the oversized role played by the state? It is impossible to know, but the Chinese government's sizable role in steering economic resources and decisions has been accompanied by bribery and corruption problems in the past. Studies have revealed that there is "clear evidence that corruption is rampant in China" and that "corruption is a first-order concern when it comes to R&D subsidies in China," as a 2018 Harvard Business School study noted.[137]

Recognizing this problem, Xi Jinping, general secretary of the CCP, has advanced a variety of anti-corruption efforts over the past decade, including a National Supervision Commission that was created in 2018 to oversee "all public servants exercising public power."[138] But, as Naughton points out, the massive growth of Chinese industrial policy planning efforts "creates new incentives for 'soft' corruption":

> Government funds are being channeled into highly risky and speculative investments at an unprecedented rate. Especially at the early start-up phases, venture capitalists expect most investments to fail (but enough good ones to succeed for their profits to compensate for the majority of losers). This creates a huge incentive to channel funds to related parties who then make a half-hearted effort to run "start-ups" that they actually expect to fail. This is already happening. Many in urban China are familiar with cases of individuals running shoddy, flimflam operations supposedly engaged in AI or some web-based platform, but which are actually speculating in real estate or other short-term ventures.[139]

Meanwhile, the CCP's supposed effort to crack down on government corruption has instead been used to harass and intimidate private businesses and individual entrepreneurs.[140] NPR's Emily Fang notes that recent anti-corruption campaigns are "enabling officials across China to lock away entrepreneurs and other citizens whom they perceive to have gained too much wealth or influence independent of the party."[141] State officials have even used such tactics to control firms generally favored by the CCP as national champions.

In late 2020, for example, "Chinese President Xi Jinping personally made the decision to halt the initial public offering of Ant Group, which would have been the world's biggest, after controlling shareholder Jack Ma infuriated government leaders," the *Wall Street Journal* reported.[142] Ma, who had made the e-commerce company Alibaba a global powerhouse and become China's richest citizen, had apparently angered party officials by criticizing how the government's expanding financial regulations were

holding back technology developments and innovative startups. In speeches, Ma stressed how this could limit Chinese economic opportunities and growth. "The financial industry needs disrupters," he said.[143]

In response to Ma's outspoken advocacy for more independence and regulatory flexibility, the party took steps that seemed aimed at punishing his company, including opening an antitrust investigation.[144] China's State Administration for Market Regulation issued a major set of new regulatory restrictions that, according to a *Bloomberg* report, "wiped out $290 billion in market value and signaled the most sweeping overhaul of the country's technology industry since the founding of the People's Republic six decades ago."[145]

One market analyst notes that "the Chinese state has already effectively nationalized some of the financial infrastructure Ant built," and that more sweeping nationalization efforts or heavy-handed regulatory control may be forthcoming.[146] Indeed, Ma's companies are not the only companies feeling pressure from Chinese party officials. In July 2021, Chinese ridesharing giant Didi, which "was once heralded as a source of national pride" and was one of China's largest unicorns,[147] was ordered to remove its mobile app from mobile app stores and undergo a security review by the Cyberspace Administration of China. This was part of a broader effort by the CCP to clamp down on Chinese companies seeking to sell shares abroad,[148] which could limit state control and surveillance of the firms.[149] Indeed, Chinese companies have already begun ditching plans to go public in Western markets,[150] and "American investors are asking whether China Inc. is still worth the risk following a widening series of regulatory crackdowns."[151]

This sort of state control is widening. According to another *Wall Street Journal* report by Lingling Wei, published in late 2020,

> Xi Jinping, long distrustful of the private sector, is moving assertively to bring it to heel. China's most powerful leader in a generation wants even greater state control in the world's second-largest economy, with private firms of all sizes expected to fall in line. The government is installing more Communist Party officials inside private firms, starving some of credit and demanding executives tailor their businesses to achieve state goals. In some cases, it is taking charge entirely of companies it regards as undisciplined, absorbing them into state-owned enterprises.[152]

Thus, after taking steps to nurture national champions, "the risk for China is that Mr. Xi's vigorous assertion of statist prerogatives will dull the kind of innovation, competitive spirit and unbridled energy that powered China's explosive growth in recent decades."[153] Importantly, these actions have been directed at firms once *favored* by the CCP. Other entrepreneurs, especially among repressed Uighurs, have faced far more despotic acts of control and intimidation by the government.[154]

When governments repress the entrepreneurial spirit of their most innovative creators and companies, this is bound to have negative ramifications for long-term competitiveness and economic growth.[155] Heavy-handed industrial policy schemes can contribute to this sort of repression as the state gains more levers of control over private companies.

Even ignoring the problems associated with state corruption and intimidation tactics, there

is little reason to believe that China's experiment with comprehensive industrial policy will end any better than it has for other nations that have tried it before. The reality is that the CCP faces the same knowledge and resource constraints all previous industrial policy planners have. More specifically, Chinese planners now face a major moral hazard problem. While they profess to still believe in market principles, the government's policy statements make it clear that the government simultaneously "will stand ready to bail-out bad investments."[156] But the Chinese government cannot have its cake and eat it to. As Naughton summarizes,

> Ultimately, the government is subsidizing returns for tens of thousands of uncoordinated investments in perhaps a hundred related sectors. The situation is replete with moral hazard, because the government is offering multiple implicit guarantees which it will be unable to sustain if returns from these investments are less robust than the government hopes. The economic risk could thus be manifest in acute or chronic economic illness. Acute crisis could develop if the interlocking network of investments suddenly breaks down, due to some sudden withdrawal of liquidity. Chronic economic illness will develop if government is unable to liquidate multiple poor investments in which it has a stake, tying up credit and real resources in poorly performing assets and zombie companies. These risks are real, over a 3 to 10 year horizon.[157]

Eventually the bill will come due for the CCP and the costs of comprehensive industrial policy targeting and spending will become evident. "It is unlikely that the institutions created recently by Chinese policy-makers will be as efficient and trouble-free as Chinese leaders seem to think," Naughton concludes, because "they are laced with incentive problems that will emerge at a later stage of development."[158] The next section provides a deeper look into how this dynamic is already playing out in AI markets.

7. WHERE DOES REAL COMPETITIVE ADVANTAGE COME FROM?

For the reasons laid out in the previous section, among others, America's goal should not be to "imitate China" or "copy its playbook"[159] when it comes to targeted industrial policy and technological governance of AI and other high-tech sectors. Europe's approach, although not as heavy-handed, is also not a good model. Not only would the Chinese and European approaches potentially undermine the permissionless innovation ethos that made America's tech companies become global powerhouses,[160] but expanded industrial policy efforts would entail massive state bets on risky ventures using taxpayer resources. "America is not China, and it would be a fatal mistake to equate competing with China with imitating what China does," argues China policy expert Weifeng Zhong of the Mercatus Center. "Doing so would risk the advantageous U.S. position as the world's chief innovator, whose ideas are turned into products by vibrant private sectors both domestically and internationally."[161]

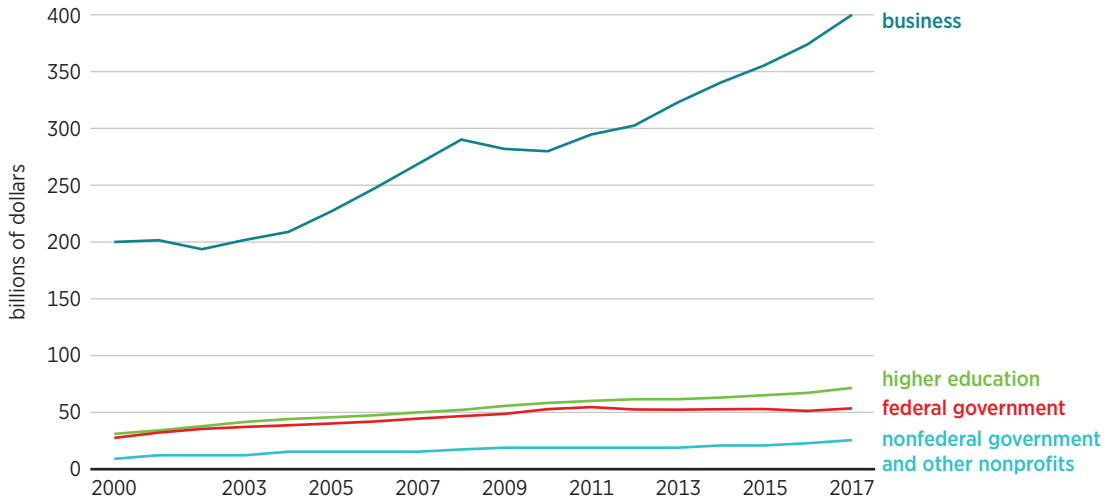
A 2018 Harvard Business School study estimated that more than 22 percent of private R&D spending in China was provided through government subsidies.[162] "To match China's R&D funding ratio," Robert Atkinson of the Information Technology and Innovation Foundation argues, "Congress thus would have to appropriate $86 billion more per year in direct funding to support industry R&D."[163] It is highly unlikely that US policymakers would be willing to match that sum annually. "It would be a huge mistake for the U.S. to try and match Chinese government spending," argues Scott Kennedy, a senior adviser at the Center for Strategic and International Studies. "So much of it is thrown down bottomless pits, leading to over-investment, lower profits, slower innovation and more debt."[164]

Nor does the United States need to do so. Private R&D spending plays a more important role in the aggregate in the United States by necessity—American businesses have nearly doubled R&D spending over the last decade (see figure 3)—and that is likely a good thing.

The United States has the most vibrant venture capital (VC) market in the world, and this market helps support risky ventures without gambling with taxpayer dollars. In a new book that provides a comprehensive history of VC, Tom Nicholas of the Harvard Business School argues that VC "is largely an American invention" that "has been embraced with more impact in the United States than anywhere else in the world."[165] "Most countries would kill for an industry like this," he says.[166] "The message is clear," agrees Josh Lerner: "the venture capital revolution drove the transformation of the U.S. economy in recent decades,"[167] and it was clearly the driving force behind the success of US-based digital technology companies over the past quarter century.

A 2015 report called "The Economic Impact of Venture Capital: Evidence from Public Com-

FIGURE 3. US R&D EXPENDITURES BY PERFORMING SECTOR, 2000–2017

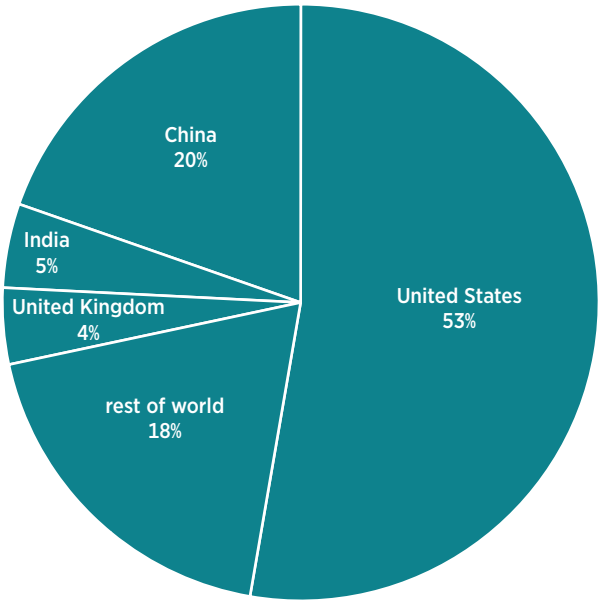


Source: National Center for Science and Engineering Statistics (database), National Science Foundation, Alexandria, VA, accessed October 2021, https://www.nsf.gov/statistics/.

panies" surveyed the 1,339 public US companies founded after 1974 and found that 556 (or 42 percent) of them were VC-backed.[168] The authors found that VC backing has a major impact on R&D spending, "with VC-backed firms making up an overwhelming 85% of the total R&D of the post-1974 public companies."[169] The authors found that these firms "have been a prime driver of both economic growth and private sector employment" and that many of them (Apple, Google, Microsoft, Cisco, Oracle, Adobe, Dell, Twitter) became global giants with some of the biggest market capitalizations, even among firms from other industrial sectors.[170] "In terms of the global distribution of startup success," notes the *State of the Venture Capital Industry in 2019*, "the number of private unicorns has grown from an initial list of 82 in 2015, to 356 in Q2 2019," and fully half of them are US-based.[171] Data from CB Insights, a tech research group that tracks global VC activity, shows that from 2010 to mid-2021 the United States created 53 percent of global unicorns, compared with 20 percent for China (see figure 4). Even during the COVID-19 crisis, "VC not only survived, but thrived," posting a record year in 2020 with deal volume topping $130 billion.[172]

Will these trends be reversed for AI and other high-tech sectors in coming years? More specifically, is China really taking the lead on AI, as many pundits and politicians in the United States fear or suggest? The answer depends on what we mean by AI. Some scholars, such as Jeffrey Ding, break down AI into three cross sections: (1) scientific and technological inputs and outputs (scholarly output, patents), (2) different layers of the AI value chain (startups, venture capital, manufacturing), and (3) different subcategories of AI (natural language processing, facial recognition software). We find that a nuanced approach, such as that proposed by Ding, best captures the respective capabilities of China and the United States so that we may judge their industrial policy efforts accordingly.[173]

FIGURE 4. GLOBAL NEW UNICORNS BY COUNTRY, 2010–JUNE 2021



Source: CB Insights, "The Complete List of Unicorn Companies," accessed July 15, 2021, https://www.cbinsights.com/research-unicorn-companies.

In the first category, that of scientific and technological outputs, the United States holds a decisive lead. According to the Center for Data Innovation, in 2017, the United States had 28,536 "AI Researchers" compared to China's 18,232. But even if we only consider "top talent," the United States still prevails. As of 2018, the United States had 10,295 of the top AI researchers at academic conferences compared to China's 2,525.[174] That makes the United States the leader in technological inputs as measured by the gross number of top researchers. The United States likewise has the lead in outputs. According to the Center for Data Innovation, the United States has double the field-weighted citation impact (a metric used to measure citations in research fields) that China has.[175]

Regarding different layers of the AI business value chain (startups, venture capital, manufacturing), the answer to the dominant player question is an unsatisfying "it depends." It depends largely on whether we are most concerned with general technological prowess or the ability to implement AI for specific ends. Kai-Fu Lee, head of Sinovation Ventures and former head of Google China, notes that "the winner in this race will likely depend on whether the final bottleneck is about core technology or implementation details. If the bottleneck is technical—major improvements for core algorithms—then advantage U.S. If the bottleneck is about implementation—smart infrastructure or policy adaptation—then advantage China."[176]

America is the leader in technological ability, thanks to both its advantages in human capital and a thriving venture capital economy, as noted previously. When it comes to venture capitalism and startups, "The most promising startups using artificial intelligence are U.S.-based companies working in the fields of health care,

retail and transportation," according to a study that looked at budding AI companies around the world. Of the top 100 startups in AI, 65 percent were based in the United States, though some of those had dual headquarters in China or elsewhere, according to CB Insights.[177]

But beyond the creation of new AI tech lies the implementation thereof, where some argue China holds a lead because of how it overcomes collective action problems. The Chinese city of Hangzhou proves insightful for understanding how China excels at *implementing* AI in certain instances. In Hangzhou, public policy and private actors have joined forces to create perhaps the most technologically advanced city in the world. Traffic is directed by Hangzhou's "City Brain," speeding up traffic by 15 percent, and AI has reportedly been used to streamline healthcare services in the city.[178] Though the technology in Hangzhou is not groundbreaking relative to other AI developments, its implementation most certainly is.

Kai-Fu Lee's insight that contrasts implementation and innovation exemplifies the two countervailing benefits of Chinese and American industrial policy. One strategy allows for expedient mass adoption of AI technology, so long as it can be developed, while the other allows for greater technological design flexibility, experimentation, and boundary pushing. But we should be mindful of the downsides that a techno-authoritarian approach engenders in China, which are good reasons for America to be wary of such an approach. China's "environment of increasing extralegal powers and personalized authority has exacerbated a bureaucratic paradigm that prioritizes political performance and loyalty, even over efficiency."[179] The recent shakedowns of Alibaba and Didi exemplify this downside well.

The third layer of AI market analysis—the different subcategories of AI—indicates that the United States is in the lead. While China is world-leading in technology driven by very simple data—like human faces or voices—the United States is further ahead in high-end AI technology. For instance, China excels in AI technologies like facial recognition payment systems and natural language processing (though China is still second to the United States in the latter when it comes to English, though it leads in Mandarin). The commonality among much of China's most cutting-edge AI is that it is able to be used to further China's surveillance state. China's largest domestic tech companies have developed advanced content screening tools to assist the government in censoring political content. It is not unlikely that China's biggest AI export will be censorship software, finding willing buyers in repressive regimes across the globe.[180] But that is not something the United States would want to emulate, not only because such technology is likely to be used for nefarious ends but also because it is not the type of AI that significantly increases a nation's productive capacity.

When it comes to high-end AI systems, like autonomous vehicles and military-oriented AI, the United States has a decisive advantage.[181] Analysts point out that the United States has advantages in applied robotics as well, while China has stumbled.[182] High-end AI applications like these are facilitated by the US ability to use neural networks and machine learning in ways that China cannot, simply because of American microprocessor superiority.

The inability of China to create high-end microprocessors is the Achilles' heel of Chinese AI developers because without it China is incapable of running the complex neural network systems required to make breakthroughs in

technologies like military-grade systems, driverless vehicles, and other complex forms of AI.[183] Earlier efforts by China to use industrial policy efforts to promote its domestic semiconductor industry seem not to have borne much fruit either. "Long-term programs devoted to semiconductor development have yielded a few modest successes but have mostly resulted in floundering companies that are nowhere near the cutting edge," writes China market analyst Dan Wang.[184] Brookings Senior Fellow Christopher A. Thomas has similarly concluded that while "China spent more than 30 years and tens of billions of dollars to build a domestic semiconductor industry, showering its national champions with resources to compete with Western companies," it did not amount to much, as "Chinese semiconductor companies make up a relatively small part of the global market."[185]

Wall Street Journal columnist Andy Kessler argues that, although China announced a National Integrated Circuit Plan in 2014 that allocated $150 billion for semiconductor manufacturing, "it didn't work because you can't throw money at the problem. . . . It takes state-of-the-art equipment and homegrown expertise" to fully develop sophisticated semiconductors, he notes.[186] Cato Institute analysts Scott Lincicome and Huan Zhu summarize China's semiconductor woes and explain how industrial policy has failed here:

> Government support also has not stopped six multibillion-dollar Chinese chip projects from failing over the past two years, and high-profile manufacturers, such as Wuhan Hongxin, Tacoma, and Dehuai, have dissolved or declared bankruptcy. . . . Indeed, industrial policy shoulders much of the blame for the current state of the Chinese semiconductor industry, which features rampant misallocation of resources, ineffective implementation, corruption, and a significant shortage of human capital, as well as heavy reliance on well-funded but uncompetitive SOEs [state-owned enterprises].[187]

China's disadvantages here are exacerbated by the fact that it is subject to severe export controls, limiting it from purchasing the technology required to make cutting-edge semiconductors. A Dutch company, ASML, is the only company in the world able to make the machine that can create 3-nanometer (and, in the future, smaller) microchips.[188] ASML, however, refuses to export its machine to China, thanks in part to lobbying efforts started by the Trump administration to block the machine's export, and to continued pressure exerted by the Biden administration. This "effectively turned into a choke point in the supply chain for chips,"[189] a choke point that presently only the United States and its allies can get around. Instead of benefiting from chips as small as 3 nanometers, China is left with chips measuring 14 nanometers, severely hampering the complexity of the AI Chinese innovators can develop.[190]

Meanwhile, scholars have noted that China is likely looking to counter the early US lead in deep learning frameworks led by TensorFlow and PyTorch, developed by Google and Facebook. But "while Chinese alternatives to TensorFlow and PyTorch exist, they have struggled to gain ground."[191] Europe's AI-related industrial policy efforts have not fared much better. It does not help that European countries have adopted a highly precautionary regulatory model for new digital sectors that shuns risk-taking and focuses

on maximizing other values at the expense of disruptive change. This approach has resulted in fewer national champions, and it has cost Europe in terms of global competitive advantage.[192] By contrast, China has tolerated greater risk-taking by national leaders, but it has done so with a heavy dose of state control—so much control that many of these firms became the equivalent of appendages of the state. The hyperpermeable barrier between the Chinese state and Chinese enterprise means that the two invariably affect one another. The likely result is that too much state control has thwarted the potential for greater technological innovation in China, which is why China has not managed to keep up with the United States in developing AI. Again, these are not policy models that the United States should be emulating.

8. INDUSTRIAL POLICY DID NOT GIVE US THE INTERNET AND THE IPHONE

But what about the internet, GPS, and the iPhone? Aren't these examples of successful government-directed industrial policy in the United States?[193] That is the argument Mariana Mazzucato makes in her book, *The Entrepreneurial State*.[194] She argues that government planning has been the primary force in expanding successful innovations such as these, and calls for "a bolder vision for the State's dynamic role in fostering economic growth" and technological innovation.[195] Mazzucato outlines an expansion vision and plan for "empowering government to envision a *direction* for technological change and invest in that direction."[196] She wants the state fully entrenched in technological investments decision-making throughout the economy because she believes that is the best way to expand the innovative potential of a country.

Science writer Matt Ridley refers to this as a "creationist" view of innovation, in which new technological development "is a product of intelligent design by government."[197] In his most recent book, *How Innovation Works*, Ridley explains why the creationist perspective is "unpersuasive" in light of historical and empirical evidence.[198] Alberto Mingardi, general director of the Bruno Leoni Institute, has also taken issue with Mazzucato's "idyllic vision of industrial policy," which he says "mistakes unintended consequences for intended ones."[199] Specifically, it attributes far too much causality to government planning, even when none was occurring.

Mingardi and Ridley point out one obvious problem with Mazzucato's thesis: it ignores the explosion of innovative activity during the 19th century, when almost no targeted industrial policy efforts existed. No credible economic historian would claim that the Industrial Revolution was the product of technocratic state planning and financing. What we know *did* drive much innovation during that period was information sharing and clusters of knowledge—the same things that drive innovation today. As Cato Institute analysts Terence Kealey and Martin Ricketts note, the Scientific Revolution and the Industrial Revolution

> were characterized by a move to cooperation and openness as researchers came together to share knowledge in societies such as the Royal Society (1660), the Society for the Encouragement of Arts, Manufactures, and Commerce (1754), and the Lunar Society (1765)." . . . The purpose of those societies was to encourage competitors not to be secretive but, rather, to share knowledge.[200]

As noted below, governments did sometimes help facilitate the creation or growth of such societies, but the role of the state was more limited than some suggest, and none of the sort of highly targeted or applied industrial policy efforts were evident. Silicon Valley became a prominent tech hub partially because profes-

sors at Stanford University made a habit of going off and creating their own companies, capitalizing on the knowledge and connections they had gained there. Of course, that same process has unfolded over time across many different university systems—the fact that universities have received generous public financing does not mean that government was responsible for giving rise to specific innovations.

THE INTERNET AND THE IPHONE

Mazzucato argues that government had a role in bringing about the internet and the digital revolution in modern times. But the story does not work as well as she imagines. It is important to remember that today's internet looks nothing like its predecessor, the Advanced Research Projects Agency Network (ARPANET). ARPANET was developed by DARPA, part of the US Department of Defense, and grew out of a Cold War–era fear that traditional communications networks might fail during an enemy attack.[201] While ARPANET remained under government control, however, it was mostly just the domain of government agencies and university researchers. Importantly, it was entirely noncommercial in character.

It was only in the mid-1990s, when the Clinton administration decided to allow open commercialization of ARPANET, that the modern internet became possible.[202] There was no grand industrial policy vision for the broadband networks, online commerce sites, or social media platforms that make up today's internet.[203] In his detailed history *How the Internet Became Commercial*, Shane Greenstein notes that there was "no such thing as an advanced plan for the Internet, and no single organization orchestrated the design, building, and operation of the Internet."[204] He finds that "despite the absence of any large, coordinating government planner," it was highly decentralized "innovation from the edges" undertaken by a multiplicity of actors following privatization that gave rise to the modern internet.[205]

This reality undercuts the notion that the internet was the product of top-down industrial policy design. "Mazzucato simply assumes that if something goes right, government must be responsible," Mingardi observes. "But in the real world the mere existence of government money doesn't account for the different nuances of institutions."[206] Thus, while it is certainly true that early government support for ARPANET had some positive spillovers for the growth of the primitive networking system that eventually grew to become the internet, it would be revisionist history to suggest that any targeted government plan or program was responsible for the internet as we know it today.[207]

It is similarly a stretch to argue that the iPhone came about primarily because of government design, though Mazzucato makes this argument. For example, even though researchers at government-funded universities had earlier made efforts to create touch screens, it was Apple's developers who figured out how to tie together such technological capabilities with the many other features that constitute the modern smartphone. A closer review of this case study makes it clear that, as one skeptic wrote, "state interventions in science that were conducive to the iPhone were neither crucial, nor entrepreneurial, not [*sic*] as numerous as Mazzucato tries to show."[208]

Entrepreneurial initiative and consumer demand seem to be almost entirely missing from Mazzucato's narrative about the iPhone and other modern digital technologies. A major rea-

son that many innovations took off in the United States but not Europe, for example, is that consumer demand and purchasing power were greater on America's side of the Atlantic. No matter how much Europe hoped to spur the development of its own digital giants using industrial policy schemes, it was not enough to overcome an adverse regulatory environment or the less robust consumer marketplace for digital goods and services.

If Mazzucato's thesis were correct, then Europe's more ambitious industrial policy efforts should have generated far greater positive spillovers and more "collaborative ecosystems," as she calls them. Moreover, as Mingardi notes, "Mazzucato gives little consideration to the impact the taxes needed to support these 'collaborative ecosystems' might have on private enterprise or consumer demand."[209] The aggregate fiscal burden of state planning likely took a toll on entrepreneurialism and innovation in Europe, leading to a general decline in the global competitiveness of European firms. This also likely explains why many other nations with expensive industrial policy schemes (like Japan) or top-to-bottom state economic planning (like the Soviet Union) were unable to generate lasting economic growth.[210]

SEMICONDUCTORS

Semiconductors are another example of a sector some believe benefited greatly from industrial policy measures. As the semiconductor sector became increasingly visible and important in the 1980s, calls multiplied for stepped-up government support. In a 1982 *Harvard Business Review* article, Robert Reich lamented that the United States had spent a paltry $55 million (mostly in defense-related spending) to support its semiconductor industry, whereas other governments, such as those of France, West Germany, and Great Britain, all spent more ($140 million, $150 million, and $110 million, respectively). He argued that "the very directness of their approach is more rational and more efficient than that of the United States," and would eventually have negative ramifications for the competitive standing of the American semiconductor industry.[211]

Heeding such calls, the Department of Defense helped form SEMATECH, a public-private partnership dedicated to advancing domestic semiconductor production. Judge Glock, a senior policy analyst at the Cicero Institute, notes that the effort failed to support the chips that became the most important in the future and that "the most likely result of the government subsidies was to allow the industry to spend less on research."[212] Other commentators described SEMATECH as "a well lobbied subsidy to a group of companies."[213] Claims that government funding given to the SEMATECH consortium was necessary to revitalize the chip industry were considered "dubious then and remain dubious to this date."[214]

Semiconductor industrial policy did not help Japan much in the long run either. According to Howard Pack, a professor of business and public policy at the Wharton School at the University of Pennsylvania, "In the 1980s, there was a fairly widespread demand [in the United States] for efforts to counter a Japanese resurgence in the semiconductor industry. It was beaten back by a variety of forces, and since then . . . the Japanese firms have basically had to abandon the field to either Korean firms or American firms, in this case Intel and AMD."[215]

Recently, there have been many calls for renewed semiconductor industrial policy in the United States. As noted, the Biden administration

and Congress have pushed for more than $50 billion in subsidies for US semiconductor manufacturing facilities and research and development.[216] While this effort is primarily a response to recent chip shortages and supply chain issues, it is not clear that subsidizing the industry will improve sectoral innovation. Intel, a leading American and global semiconductor manufacturer and developer, expressly stated that its development strategy "does not depend on a penny of government support or state support . . . to make it successful."[217] Despite subsidy supporters' claims that more money will ensure a robust American semiconductor ecosystem capable of supporting America's national security needs, it is unclear how much subsidizing the industry benefits the nation. The Center for American Progress criticizes subsidies of this kind because of how little they affect a single company's corporate decision-making. Moreover, they note that "targeted incentives frequently happen through opaque processes," echoing the criticisms levied against SEMATECH for being "a well lobbied subsidy to a group of companies."[218] In other words, what is often described as "industrial policy" is in reality nothing more than industrial *politics*.

Many proponents of semiconductor subsidies again cite China as a reason for needing a targeted industrial policy for domestic semiconductors. To be sure, it is crucial that the United States remain competitive in this field because of semiconductors' military applications. But the United States already has a strong foothold in this sector. The United States accounts for nearly half of global chip sales, and 44 percent of global manufacturing is done in the United States, compared to just over 5 percent in China.[219] And this gap is only widening. Nikkei reported in May 2021 that China's progress in advanced semiconductor technology was slowing. Indeed, China is still manufacturing 14–28-nanometer chips.[220] For reference, the American company IBM reported in May 2021 that it had created the world's smallest and most powerful microchip, coming in at 2 nanometers[221]—three to four generations ahead of the most cutting-edge Chinese technology. As noted earlier, export controls ensure that China is unable to purchase the machinery necessary to manufacture similarly sized chips.[222] This indicates that the US Innovation and Competition Act's stated goal of ensuring the United States remains on the cutting edge of the industry may well be accomplished with little or no subsidizing at all, allowing the government to steer clear of turning a well-meaning subsidy into pork-barrel spending on companies that, by their own admission, do not need the money.[223]

Former industry executives are also skeptical of the government's role in fixing any issues currently present in the semiconductor industry. T. J. Rodgers, founder of Cypress Semiconductor—a $9 billion American semiconductor company—argues that the organization he used to be chairman of—the Semiconductor Industry Association—"is recycling old Sematech-era arguments for pork-barrel funding."[224] Rodgers also worries that "'free government money' induces horribly inefficient spending and undeserved payouts to executives and shareholders." "There is no need to give taxpayers' money to some of the smartest and richest corporations in the world," he contends—particularly not when the industry is already adapting to market changes.

Indeed, despite recent chip shortages and supply chain issues, semiconductor chip innovation is booming for both startups and industry giants, so much so that "a trickle of new chip companies is now approaching a flood," according to the *New York Times*.[225] Cerebras—a startup that sells massive AI processors—has brought in

nearly half a billion dollars in investment funding, and similarly situated startups have experienced similar success.[226] For industry giants, the chip industry's boom was evident in quarterly earnings reports. While policymakers were formulating huge new subsidies for the sector, the US semiconductor industry was enjoying one of its best economic quarters ever, with combined total revenue rising to a record $22.75 billion in the first quarter of 2021.[227] NXP Semiconductors—a chipmaker that provides chips for automobiles, communications, and other industrial sectors—increased its revenue by 27 percent despite temporarily closing its factories because of a historic Texas cold snap.[228]

It is thus unclear why over $50 billion in taxpayer dollars should be reallocated to the semiconductor industry. History has shown that similar industrial policy initiatives have turned into a boondoggle, becoming a subsidy for the wealthiest, most profitable companies, which—by their own admission—do not need the funding. Moreover, sometimes companies and entire industries just need to learn from their mistakes and better plan for an uncertain future. This need partially explains recent shortages in the semiconductor field.[229] Some firms ramped up production or stockpiled chips while others didn't.[230] Why should those that failed to plan for bad spells get bailouts?

But it is not just about wasting taxpayer money by throwing dollars at companies and endeavors that do not need or deserve them. The government can also crowd out investment that would otherwise happen or skew innovation in unnatural, inefficient directions.[231] As Senate debate over semiconductor subsidies was wrapping up, the *New York Times* noted how it "exposed disagreements in what kind of semiconductors the federal government should be funding" because most of the focus was on the short-term shortage of chips used in automobiles. The reporters noted how "giving priority to the auto industry could come at the expense of investing in more cutting-edge semiconductors, those that use the smallest circuitry and would power next-generation products."[232] This reflects the high-risk nature of targeted industrial policy for rapidly evolving technology markets.

SUMMARY AND DISCUSSION

Proponents of more aggressive industrial policy efforts will insist that government officials and agencies can help steer resources in efficient ways and make wiser bets on future technologies to boost technological development or global competitiveness. Of course, it is true that if government officials roll the proverbial industrial policy dice enough times, some bets are bound to pay off, at least indirectly.[233] As Mingardi observes in a new book with economist Deirdre McCloskey, "in view of the gigantic increase in public spending since 1900 it would be strange indeed if *none* of the dollars didn't finance *something* technologically relevant."[234]

On balance, however, that does not mean it is worth wagering taxpayer resources on risky and massively expensive technological bets. Two factors must be reiterated. First, there is an entire economic sector designed to bet on risky ideas: private venture capital. Second, industrial policies are not free lunches. There are significant opportunity costs—and often many strings—attached. It is impossible to determine the precise amount of R&D spending that will incentivize breakthrough AI innovations, but unlimited research budgets are neither practical nor desirable. Better to let private VC bear more of the risk

than to expect taxpayers to shoulder this burden, especially when the benefits remain uncertain for government-led efforts.

A major 2003 report from the Organisation for Economic Co-operation and Development, *The Sources of Economic Growth in OECD Countries*, revealed that, while public R&D spending can sometimes produce some positive technology spillovers in the long run, "the results also point to a marked positive effect of business-sector R&D, while the analysis could find no clear-cut relationship between public R&D activities and growth, at least in the short term."[235] Importantly, the study results "provide some support for the idea that the tax pressure—especially when focusing on so-called 'distortionary' taxes affecting economic behavior—could have an overall negative impact on output per capita, by influencing the efficiency of resource allocation across different investment projects."[236] Again, this calls into question the effectiveness of public R&D spending and highlights the tradeoffs associated with an increased tax burden to support such initiatives.

Finally, it is also worth revisiting the dire forecasts of the industrial policy advocates and "deindustrialization" critics of the previous generation, who argued that Japan, South Korea, Germany, and even France were doing a better job of adopting sophisticated industrial policies than the United States and would leave America far behind.[237] Another frequently heard complaint by these critics was that US capital markets would not support the large-scale technology investments needed to advance critical technologies or sectors.

Not only did these pessimistic predictions not match market realities, but the exact opposite proved to be the case. Most of the industrial policy schemes adopted elsewhere proved to be costly boondoggles while the US venture capital market was heavily investing in sectors and technologies that generated substantial benefits for the country and consumers. Unfortunately, the failed forecasts of earlier industrial policy advocates are conveniently forgotten by those making similar claims today when they push grandiose industrial schemes using similar rhetoric.

9. EVALUATING OTHER INDUSTRIAL POLICY EFFORTS

Generally speaking, many economists and political scientists who study industrial policy agree with James A. Robinson's assertion that, at times, there may be "great potential to promote economic development" associated with industrial policy efforts.[238] But they also typically caveat that claim by acknowledging, as he does, that "this potential can only be realized if the political environment is right,"[239] and that "for every such example [of success] there are others where industrial policy has been a failure and may even have impeded development."[240]

George Mason University economist Tyler Cowen notes that "the U.S. already has an industrial policy—and has for some time. It is a collection of programs and policies at the federal and state level, many of which are highly imperfect, and so the focus should be on fixing what is already in place."[241] This section explores some of the tradeoffs associated with other major industrial policy efforts that are likely to continue and grow.

REGIONAL TECH DEVELOPMENT EFFORTS

Promoting local or regional "innovation hubs" or "tech clusters" has been a long-standing priority of many state and local officials.[242] This effort has now captured the attention of leaders at the federal level, who hope to replicate the Silicon Valley regional development success story by creating tech clusters in many other regions across America.[243] The Senate-passed version of the US Innovation and Competition Act included almost $10 billion for the Department of Commerce to help find and fund 20 new innovation hubs "in a manner that ensures geographic diversity and representation from communities of differing populations."[244] A similar proposal that is moving in the House, the Regional Innovation Act, proposes almost $7 billion for 10 regional tech hubs over five years.

Meanwhile, in late July 2021, the Department of Commerce's Economic Development Administration announced plans to allocate $1 billion in pandemic recovery funds to create or expand "regional industry clusters."[245] The agency listed ideas such as an "artificial intelligence corridor," an "agriculture-technology cluster in rural coal counties," a "blue economy cluster" in coastal regions, and a "climate-friendly electric vehicle cluster."[246]

Over just the past decade, there have been many federal efforts to promote the spread of high-tech sectors and jobs, including the multiagency Rural Jobs and Innovation Accelerator Challenge and the Advanced Manufacturing Jobs and Innovation Accelerator Challenge, both launched in 2012.[247] Around the same time, President Obama also launched the "Startup America" initiative and signed the 2012 JOBS Act (Jumpstart Our Business Startups), both of

which included various measures to support the spread of advanced manufacturing and high-tech startups.[248] Many other government efforts like these already existed. A 2008 Brookings Institution study of federal efforts to stimulate regional innovation and entrepreneurialism found that during fiscal year 2006, the government had spent almost $77 billion across 14 different federal agencies and departments on 250 separate programs.[249] The authors noted that, with so many efforts in play, "a lack of coordination is understandable" and the programs "have evolved in a wildly ad hoc, idiosyncratic, and uncoordinated fashion."[250] Such programs and efforts have only expanded since then at the federal, state, and local levels.

Much of this activity is driven by an understandable desire to replicate the Silicon Valley success story and create the next great innovation hub. Unfortunately, the government's track record for developing innovation hubs, research parks, and similar things has been disappointing. "Despite several attempts, Silicon Valley has not been successfully copied elsewhere," notes Mark Zachary Taylor, author of *The Politics of Innovation*.[251] Judge Glock has a more blistering assessment of such efforts: "Almost every American state has tried to fund the creation of biotech clusters, projects that almost inevitably end with weeds growing through the parking-lot pavement and a trail of corrupt bargains."[252]

These conclusions have been documented in many economic studies. Efforts to incubate the next Silicon Valley stretch back over several decades, as economist Scott Wallsten showed in a 2001 study of government efforts to promote regional science and technology parks.[253] Wallsten also reviewed the effectiveness of efforts by the Small Business Innovation Research (SBIR) Program to boost capital investment in this regard. Wallsten found that "neither SBIR funds nor research parks have significant impacts on regional technology indicators. Indeed, the results seem to suggest that SBIR funds seem to chase success, rather than vice-versa, while research parks chase failure (regions experiencing reduced economic growth) and do not generally reverse it."[254]

In *Boulevard of Broken Dreams*, Josh Lerner documents dozens of similar targeted development failures from around the globe. He concludes that "for each effective government intervention, there have been dozens, even hundreds, of failures, where substantial public expenditures bore no fruit."[255] Lerner also notes that the small business investment companies (SBICs)—federally backed risk capital programs sponsored by the Small Business Administration that started in the late 1950s—have included "hundreds of funds whose managers were incompetent or crooked."[256] Another study he highlights showed that "nine out of ten SBICs violated federal regulations in some way."[257]

In a comprehensive 2014 survey of research on efforts to create tech clusters, Aaron Chatterji, Edward Glaeser, and William Kerr conclude that existing evidence "suggests that the regional foundation for growth-enabling innovation is complex and that we should be cautious of single policy solutions that claim to fit all needs."[258] "Even if clusters of entrepreneurship are good for local growth," they argue, "it is less clear that cities or states have the ability to generate those clusters."[259] The more targeted the efforts, the more likely failures become. "Economists, who are persuaded by the historical track record to be skeptical about governments, typically argue against firm-specific policies," they note.[260]

The case study of Foxconn in Wisconsin is the latest prominent example of regional tech

promotion failing to live up to expectations. In 2017, Wisconsin offered the Foxconn Technology Group up to $3.6 billion in direct payments, tax incentives, and other privileges in the hope that it would build a $10 billion, 13,000-employee facility in southeast Wisconsin to produce liquid crystal display panels. Proponents of the deal also hoped to create "a virtual village, with housing, stores and service businesses spread over at least 1,000 acres."[261] Then Republican Governor Scott Walker and President Donald Trump touted the deal as one the biggest economic development efforts ever and insisted it would help bring manufacturing jobs to the state. Policymakers were willing to turn a blind eye both to the fact that the deal would cost the state $231,000 per job created and to the fact that Foxconn had reneged on a 2013 promise to invest $30 million in a Pennsylvania-based "high-end technology manufacturing facility" and to create 500 jobs.[262]

The Wisconsin deal went off the rails almost immediately, and it seems unlikely that the company will follow through on its initial promises. To salvage something from the deal, in late April 2021, Wisconsin announced that it was scaling back the tax credits it was offering the firm and that overall investment was dropping to $672 million (instead of the $10 billion promised), while the number of new jobs associated with the investment would fall from 13,000 to just 1,454.[263]

None of this should have been surprising. "Economic theory offers little reason to think that targeted economic development subsidies benefit the broader communities that ultimately pay for them," note the authors of the Mercatus study "The Economics of a Targeted Economic Development Subsidy."[264] They highlight the extensive economic literature finding that "the net effect of targeted economic development subsidies is likely to be negative" because "the taxes funding the subsidies will discourage more economic activity than will be encouraged by the subsidies themselves."[265]

Despite such failures, efforts to spawn new high-tech facilities and clusters continue because many policymakers have a strong and continuing desire to create Silicon Valley–like success stories of their own and to boost jobs and wages in the process. This concern is understandable. Silicon Valley and eight other big-city areas (New York City, Boston, Los Angeles, Seattle, San Diego, Austin, Chicago, and Washington, DC) continue to attract an enormous amount of startup investment. Cities have many traditional advantages for attracting skilled labor and risk capital, and they also tend to have a high concentration of universities and research labs. The good news, however, is that private venture capital investment *is* spreading to many areas beyond these nine areas. A 2021 study called "The State of the Startup Ecosystem" by Engine, a research and advocacy organization supporting startups, revealed that

> as Series A funding grew over the last fifteen years, more of that growth has started to shift to areas located outside of the largest ecosystems. From 2003 to 2018, the number of Series A fundings grew faster outside of the top ecosystems as those rounds began to comprise a larger share of all Series A deals. The number of Series A rounds outside of the top five ecosystems grew nearly 900 percent, while the number of rounds outside of the top nine grew nearly tenfold. In 2003, the share of Series A fundings outside of the top five ecosystems was 38 percent. That share

> grew to 43 percent in 2018. For fundings outside the top nine ecosystems, the share of total fundings grew from less than a quarter of all fundings in 2003 to nearly a third in 2018. The increase in deal location diversity over this period reflects an increasing spread in venture capital investment across the country and less centralization of investment in areas like Silicon Valley.[266]

Most of this activity is happening without any sort of central direction or plan. In a sense, it mimics past tech hub success stories. As Chatterji, Glaeser, and Kerr note, "while Silicon Valley and [Boston's] Route 128 certainly benefited from federal research funds, neither arose as a result of a cohesive federal vision and plan, perhaps with not even much intentionality from any level of government or academic institution."[267]

Finally, some of the most important policy steps to help promote tech clusters have less to do with traditional industrial policy efforts and more to do with issues such as openness to immigration,[268] labor mobility, housing policy, and access to various educational or research institutions.[269] Governments can take steps to improve these factors without engaging in the sort of targeted industrial policy efforts that have repeatedly proved prone to failure.

Taylor concisely summarizes the literature on this topic: "The consensus is that top-down policy interventions are almost always ineffective at successful cluster creation." Therefore, "the best role for government might be to clear itself, and other obstacles, out of the way of natural cluster formation." In particular, government attempts to artificially create clusters where "a critical mass of infrastructure and skilled labor do not yet exist" will almost certainly fail, he argues.[270] This again points to the benefits of generalized economic development policy as opposed to riskier targeted development efforts. We will return to this point in the concluding section.

R&D TAX CREDITS

The late economist William Niskanen once noted that a primary goal of government support of science and technology should be to make it "something more than a raid on the Treasury."[271] Accordingly, he proposed limiting that potential fiscal threat by focusing on federal tax credits to support basic civilian R&D efforts. He also suggested that federal support for university-based R&D efforts should focus on matching grants to supplement investments already made by private actors, whom he felt had a better chance of making wise investments. That remains good advice. Grandiose industrial policy schemes, by contrast, are likely to be the most reckless sort of "raid on the Treasury" that Niskanen feared.

Determining the optimal R&D tax credit rate and structure is more complicated, however. In 1981, the United States became the first country to enact a tax credit for R&D, but other countries have since enacted even more generous R&D tax credits. America's R&D tax credit system has undergone multiple revisions since its inception[272] and was made permanent only in 2015. Some scholars favor a considerable expansion of the R&D tax credit, arguing that it represents an effective means of increasing research spending,[273] especially among large tech firms.[274] But, as noted above, R&D spending (and the tax credit policies that support it) are not necessarily tightly correlated with innovative outcomes. Many other factors are also at work.

A 2015 Mercatus Center report by Jason Fichtner and Adam Michel explained how the

tax credit "inefficiently distorts the types of investments companies carry out." The authors also documented how "the costs of lobbyists, lawyers, and IRS compliance agents directly cut into the projected benefits."[275] For such reasons, many scholars, like Fichtner and Michel, prefer broad-based tax reform over expanding tax credits, deductions, and other methods of rigging tax systems to favor investment. Lowering corporate tax rates could encourage firms to expand R&D efforts without seeking special favors or dealing with confusing and costly filing requirements.[276] It is unlikely that the United States would ever eliminate its R&D tax credits while other nations continue to pursue their own, however.

Regardless of which experts are correct about the effectiveness of R&D tax credits, as Niskanen suggested long ago, tax credits at least represent a somewhat more efficient way for government to support tech investment than more direct or targeted industrial policy efforts.

UNIVERSITY RESEARCH AND DEFENSE-RELATED EFFORTS

Government support for universities has also played a particularly important role in furthering various industrial policy objectives. Eli Lehrer and M. Anthony Mills have noted that the American higher education system that emerged in the 19th century "was strikingly diverse and multifaceted in several important respects. These institutions supported an enormous range of knowledge," they argue, and "this diverse system of higher education arrived on the American scene at just the right time to make a major difference in the fields of science and technology."[277] Many of these universities receive generous government grants to this day that help facilitate technological experimentation that is often quickly commercialized. Meanwhile, a wide variety of government programs continue to support R&D in biomedicine and pharmaceuticals, energy, defense, and other fields. Much of this support is channeled through universities and university research centers, although that support has been declining in recent years.[278]

Another significant portion of the existing industrial policy infrastructure is defense programs and spending. "One of the most important implementers of federal industrial policy in the modern age is the Department of Defense," notes Mike Watson.[279] As noted earlier, while some defense-related R&D efforts have resulted in positive R&D spillover effects in the information technology sector, this does not mean that conscious industrial policy design was responsible for the systems and technologies we enjoy today, such as the internet and the iPhone.

Moreover, defense-related programs have also been prone to highly inefficient contracting procedures and massive cost overruns.[280] Unfortunately, defense contracting today remains "plagued by the same kind of political engineering and its associated cost overruns" as have been seen throughout American history, says Watson.[281] He comments on the some of the more notable recent fiascos:

> Today's aircraft carriers are built and maintained by over 2,000 firms scattered across 46 states. One of the newest carriers, the U.S.S. *Gerald R. Ford*, cost $2.8 billion more than originally budgeted. Lockheed Martin sourced parts for the F-22 stealth fighter from over 1,000 suppliers across 44 states—doubtlessly to provide the U.S. Air Force with the greatest capabilities at the lowest possible cost. Similarly, F-35

> fighters are being built in 45 states as well as Puerto Rico. Perhaps unsurprisingly, Congress frequently requires the Defense Department to purchase more F-35s than the Pentagon requests. All of this prompted the late senator John McCain to denounce the F-35 program as "a scandal and a tragedy with respect to cost, schedule and performance."[282]

Given the problems associated with defense-driven R&D efforts, is it wise to promote a military-industrial complex model and war-economy-like spending in the hope of generating positive high-technology spillovers for the rest of the economy?[283] There are serious tradeoffs associated with such a model that are beyond the scope of this paper.

SUMMARY AND DISCUSSION

The industrial policy efforts discussed in this section are likely to expand in coming years. While each of these approaches is quite different, all are rooted in the idea that governments can take policy steps to boost research and development to help the economy, at least indirectly.

Surprisingly, however, even the most basic forms of traditional R&D support are difficult to correlate with real-world innovation outcomes. For example, while Mark Zachary Taylor defends government support for research and development, he also points to data showing that

> some highly innovative countries have suffered declines in their relative position even though they increased their [public] R&D spending per GDP. Two examples stand out: Sweden and Switzerland have steadily increased their share of R&D spending from 1981 onward but have gotten mixed results. Switzerland's scientific productivity has soared, but this is not translating into better rates of technological invention. Sweden is doing well in technology but slowly losing its lead in science. In contrast, Canada has for decades consistently spent less than 2% of GDP on R&D and yet has remained one of the world's top sources of high technology. Conversely, some of the lowest R&D spenders in the OECD have nonetheless remained midlevel innovators.[284]

For example, New Zealand, Ireland, and Spain all spent less than 1.25 percent of GDP on governmental R&D in recent decades, "yet they have not completely disappeared from the technological frontier," Taylor notes.[285] In other words, more R&D spending does not automatically equate to better innovation outcomes; many other factors influence technological advances and global competitiveness.

Measuring the effectiveness of R&D spending is also complicated for other reasons. "There is no easy way to determine the right amount of R&D spending," writes John J. Seater, professor emeritus of economics at North Carolina State University. "But simply looking at the amount of spending as a share of a growing GDP isn't informative of much." Specifically, Seater argues that the much-lamented decline in federal R&D spending as a share of gross domestic product is due entirely to the defense component, and that "the fall in defense federal R&D as a share of GDP is due to economic growth, not a fall in research spending." Finally, regardless of how one measures these trends, "government R&D crowds out more efficient private research spending," Seater

argues. Therefore, "if anything, the fall in federal R&D should be good for technical progress."[286]

This reflects the ongoing debate among economists and other analysts regarding the optimal amount of government support for R&D and the question of how to even measure those efforts and outcomes properly. Cross-country comparisons are further complicated by a range of other factors, including the wide variety of government R&D support mechanisms as well as considerable variations in the tax treatment (including expensing) of private-sector R&D investments.[287]

The crucial takeaway here is that policymakers need to temper expectations about public R&D spending and acknowledge the tradeoffs associated with increasing such expenditures. International affairs experts Bruce Guile and Caroline Wagner observe how "many of the current plans to increase domestic R&D engage in magical thinking, vaguely promising that investment in broad areas of science and engineering will somehow yield improvements in U.S. prosperity and economic security."[288] Things are never that simple, they note, and many other variables affect real-world innovation outcomes.

The evaluation of industrial policy efforts will always be challenged by the fact that we cannot know the counterfactual case: What would have happened to the firms or sectors *without* state support? But the evaluation challenge also rests on the simple fact that there exists a huge range of factors that affect innovation outcomes at the firm or sector level. One 2014 meta-review of 77 studies of various government support schemes across the globe noted that "the empirical literature has tended to focus on a subset of the issues at stake while disregarding others" and has "been constrained by a lack of information and analysis."[289] Overall, the authors of the survey concluded that "empirical evidence on the effectiveness of public subsidies is mixed and therefore inconclusive."[290]

Finally, we have not yet explored a very different critique of industrial policy efforts: the argument that public spending efforts might end up being too timid to make much of a difference. Writing in 1986, Mancur Olson noted how "government investment programs are almost always too conservative" owing to the fact that "some of the most promising ventures and technologies will fail, and the official who lent public money to an undertaking that failed will risk notoriety."[291] Generally speaking, agency officials wish to avoid the spotlight and the threat of congressional attention that might threaten them or their budgets. "It is precisely in the areas of uncertainty like high technology and new industries that private venture capital has the greatest advantage," Olson concluded.[292] The inherent conservatism and red-tape delays associated with government R&D funding programs and processes continue to draw attention today,[293] so much so that some scholars have proposed using competitions or even lotteries to award grants.[294] We turn to that issue next.

10. USING COMPETITIONS AND PRIZES TO ENCOURAGE INNOVATION MORE EFFICIENTLY

Government-sponsored competitions and prizes represent another way to incentivize innovative activity without overly centralized direction or heavy-handed technocratic planning. With competitions and prizes, governments can set broad goals to help facilitate the search for solutions to important societal needs. The competitions and prizes then create a powerful incentive for innovators to pursue those goals, to win not only money but also recognition from peers and the public.[295]

Competitions and prizes avoid the widely cited problem, associated with traditional grantmaking programs, of government officials "picking winners and losers." Instead, policymakers announce a general goal, as well as metrics for success, and then open up the competition for many players to compete for the prize. At least in theory, this also means less bureaucratic meddling and "strings" associated with government efforts to support innovative activities.

In the early 1700s, the British government established a £20,000 prize competition to find a solution to the "longitude problem" in maritime navigation.[296] At the time, latitude could be measured with precision, but longitude was left to "dead reckoning," which involved much guesswork. This made navigating the seas extremely dangerous and stymied both military and commercial seafaring efforts. To help find a solution, the government created a Board of Longitude to run the competition, and it "was also allowed to give smaller grants for inventors with promising schemes or prototypes to develop their ideas, making it one of the earliest R&D agencies."[297] It helped spur a solution to this vexing problem in the form of the marine chronometer.[298]

Three hundred years later, both the public and the private sectors have embraced similar competition and prize-based methods to spur innovation. The US government created a competition to spur the development of driverless cars. In 2003, DARPA launched the Grand Challenge competition to encourage the development of workable autonomous vehicle technologies.[299] While no team claimed the $1 million prize the first year of competition (in 2004), the following year the Stanford Racing Team won the competition's $2 million prize by beating five competing teams.[300] Many of the innovators involved in the original competition still work on driverless car tech today for leading firms in the field. Government officials such as Jason Furman, chairman of the Council of Economic Advisers under President Obama, have credited the Grand Challenge with "dramatically accelerating" the progress of autonomous vehicle technology.[301]

In early 2010, President Obama also signed into law the America COMPETES Reauthorization Act, which included a new provision granting federal agencies the authority to create prize competitions to advance innovation opportunities or address agency goals. Later, in 2017, President Obama signed the American Innovation and

Competitiveness Act, which expanded the incentive prize authority and also included the Crowdsourcing and Citizen Science Act that expanded the pool of participants eligible to take part in prize competitions. The Obama administration also created Challenge.gov, a web portal that brings together all the various federal agency prize competitions and crowdsourcing efforts.[302] "Prizes allow many methods to be tested and compared in parallel—sometimes for less than the cost of hiring a traditional contractor to test a single method," notes Jason Matheny, who served as director of the Intelligence Advanced Research Projects Activity in the Obama administration. "This makes prizes particularly valuable when the research question is well-defined and focused, but there is no clear evidence supporting any single potential path to a solution."[303]

Private-sector-led prizes and competitions also incentivize R&D efforts. Starting in 2007, Netflix began the Netflix Prize, an open competition for the best collaborative filtering algorithm (for Netflix, this is a movie recommendation system) that could improve on Netflix's own algorithm, called Cinematch. Only two years into the competition, a team of scientists from AT&T had improved on the algorithm by over 10 percent, entitling them to the $1 million first-place prize.[304] Many other types of private-sector competitions are being developed within the field of "big bet philanthropy," where major foundations place huge bets on programs that serve pressing social needs.[305] These efforts are sometimes referred to as *moonshots*.

Competitions in the field of AI have became so competitive, lucrative, and career-boosting that some companies have tried to manipulate them. In 2015, a group of researchers from Baidu, a Chinese web services company, were barred from international competition for AI after the team cheated during the Large Scale Visual Recognition Challenge hosted by Stanford University, the University of North Carolina, and the University of Michigan. The Baidu researchers allegedly created multiple accounts that allowed them to train their algorithm more than their competitors could, which gave them an unfair edge. The Large Scale Visual Recognition Challenge is known around the AI world, and the teams that excel during it garner so much recognition and clout that teams of researchers are apparently willing to put their credibility on the line for a chance at success.[306]

Most recently, NASA created a competition to spur the development of urban air mobility (UAM),[307] essentially drones that can fly humans around as a taxi does. The UAM Grand Challenge seeks to increase innovation in the field by allowing select companies to test their technologies in urban environments under a variety of weather, traffic, and contingency conditions. The US Air Force has announced that it will allow UAM companies to test using Air Force facilities and airspace. While the challenge is nominally about finding military uses, officials are quite open about the fact that it is intended to also stimulate commercial development and certification and maintain American supply chains.[308]

To the extent that some industrial policy targeting proves inevitable, policymakers would be wise to consider competitions and even lottery-based systems when they award support to specific companies or institutions. While still imperfect, such systems at least avoid myriad public choice problems and other chronic government-contracting fiascos that have been associated with most industrial policy programs throughout American history.

11. CONCLUSION: GENERALITY IS BETTER THAN TARGETING

Most government leaders would like to expand innovation opportunities and thus economic growth in their nations, which explains the enduring appeal of industrial policy planning. In many ways, there are few issues as nonpartisan as industrial policy, and it is likely that both Republican and Democratic policymakers will continue to call for stepped-up efforts.[309]

But the problem with the modern debate over industrial policy is that it is informed less by history and more by a Cold War–esque mentality of "striking back" at China. As Congress debated its massive industrial policy spending bill this year, the *New York Times* put it best: "The debate, so far, has not dwelled on the lessons of past successes and failures in government efforts to back new technologies. Instead, it has been focused on not losing ground to Beijing."[310]

Simply pouring billions more into hardened bureaucracies cannot guarantee innovation outcomes, however. Forms of industrial policy spending that are more targeted always threaten to devolve into a game of picking technological winners and losers, because at some point governments must decide how to channel resources.[311] Policymakers need to understand that every dollar spent pursuing these bets represents a dollar that could have been invested differently, and potential better.

Of course, industrial policy isn't going away, and US policymakers will be under pressure to expand existing programs or create new ones to counter competition from other countries. In this paper we have argued that the planning models used in China and the European Union are not worth emulating because of the myriad costs and conditions associated with them. But clearly a lot of industrial policy efforts already exist in the United States and, assuming they are not eliminated, the question will be how to prioritize among them.

The priority should be generalized economic development over targeted development efforts. The most important thing that policymakers can do to boost economic opportunities is to create a legal and regulatory environment that is conducive to entrepreneurship, investment, innovation, and free trade.[312] "Often, in their eagerness to get to the 'fun stuff' of handing out money, public leaders neglect the importance of setting the table, or creating a favorable environment," Josh Lerner warns. While he remains supportive of other government efforts to promote innovation, he stresses the importance of first creating what he calls "the right climate for entrepreneurialism."[313]

The analogy to climate is appropriate and often used by other economists and economic historians. The Nobel Prize–winning economist F. A. Hayek once suggested that policymakers should aim to "cultivate a growth by providing the appropriate environment, in the manner in which the gardener does this for his plants."[314]

The economic historian Joel Mokyr has noted how "technological progress requires above all tolerance toward the unfamiliar and the eccentric" and argues that the innovation that undergirds economic growth is best viewed as "a fragile and vulnerable plant" that "is highly sensitive to the social and economic environment and can easily be arrested by relatively small external changes."[315] Specifically, societal and political attitudes toward growth, risk-taking, and entrepreneurial activities (and failures) are important to the competitive standing of nations and the possibility of long-term prosperity.[316]

In other words, government should focus on setting the table for entrepreneurial activity instead of trying to determine everything on the plate. To put this differently, policymakers need to avoid the "fun stuff" and focus on "boring" issues that often get neglected.[317] These include a classic mix: simplified and equally applied taxes, streamlined permitting processes and sensible regulations,[318] limits on frivolous lawsuits, and clear protection for contracts and property rights.

Some government targeting is inevitable given the massive scale of government spending. But federal contracting and grant-making is not a frictionless nirvana where money seamlessly flows to the best projects and immediately gets put into action. In reality, bureaucracy slows things down and adds costs. A 2014 report sponsored by the National Academies of Sciences, Engineering, and Medicine examined the administrative burdens associated with federal research grants and contracts. The report surveyed over 13,000 leaders of federally funded projects and revealed that "an average of 42% of their research time associated with federally-funded projects was spent on meeting requirements rather than conducting active research." These findings were consistent with a previous survey the National Academies conducted in 2005.[319]

Even the most basic forms of government-sponsored research and development assistance are riddled with various knowledge shortfalls in terms of predicting future economic or technological needs. One 2006 survey concluded that many federal R&D subsidies can be "an effective public policy instrument when knowledge spillovers exist, yet *ex ante* it is difficult to identify projects that have the greatest potential to increase innovation and economic growth."[320] Again, this reflects the crapshoot nature of so much government R&D: some bets are bound to pay off, but they will likely be very difficult to foresee in advance. It often remains unclear how much public money was squandered on all the bad bets governments made.

For these reasons, government-sponsored competitions and prizes likely offer a much greater "bang for the buck" compared with other applied industrial policy programs,[321] which are often little better than the "raid on the Treasury" that William Niskanen warned against. Government should look to tap the benefits of competitions and offer general R&D assistance for universities and government labs before gambling taxpayer resources on more risky applied industrial policy efforts.

The worst form of industrial policy, one that should always be avoided, is complete nationalization of a sector, such that all the country's innovation hopes are placed on one massive and enormously expensive state-owned enterprise. Luckily, a growing number of scholars—including many who support lesser industrial policy efforts—are pointing out the many downsides to nationalization solutions for 5G networks and other supposedly critical systems.[322]

In sum, targeted industrial policy programs cannot magically bring about innovation or economic growth, and government efforts to plan economies from the top down have never had an encouraging track record.[323] As Aaron Chatterji, Edward Glaeser, and William Kerr conclude, "It is not obvious that government policy can create entrepreneurship," and "it is hard to see exactly how the government has any comparative advantage as a venture capitalist."[324] This has been true historically, and it is probably even more true today. "To believe that the United States can pursue a high-caliber industrial policy, however, requires assuming a more competent state than I have seen in the past decade," writes Daniel W. Drezner of the Fletcher School of Law and Diplomacy at Tufts University.[325] Mike Watson concurs: "Given the nature of industrial policymaking in the United States, there's little reason to believe future attempts at industrial planning will result in a more coherent, rational, or strategic allocation of resources than they have in the past."[326]

All the tax incentives and spending programs in the world will not matter much if aggregate tax or regulatory burdens significantly raise the cost of innovating and forming new businesses.[327] A positive innovation culture demands that a wide variety of cultural and economic factors and institutions be conducive to free enterprise and experimentation, not artificial inducements that distort markets.[328]

Finally, and most importantly, the many misguided industrial policy interventions governments have made in the past do not justify engaging in even more interventions today. Writing in 1983, economist Paul Krugman observed that there is "a familiar proposition from the literature on economic development that distortions due to government action may make other offsetting government actions desirable." To the contrary, he argued, "the appropriate response to government-induced distortions is to try to minimize them, not to target particular industries in which the country underinvests."[329] As the old adage goes, if you find yourself in a hole, the best advice is to stop digging. Constantly doubling down on industrial policy planning efforts is not going to help governments escape the problems created by their earlier mistakes.

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