MADE IN CHINA 2025

AND THE FUTURE OF AMERICAN INDUSTRY

PROJECT FOR STRONG LABOR MARKETS AND NATIONAL DEVELOPMENT

CHAIRMAN MARCO RUBIO

U.S. SENATE COMMITTEE ON
SMALL BUSINESS
& ENTREPRENEURSHIP

The Project for Strong Labor Markets and National Development is a project of the U.S. Senate Committee on Small Business and Entrepreneurship under Chairman Marco Rubio. It exists to build a hub for policy development oriented to the institutions of dignified work, strong families, thriving communities, and a unified nation. This includes strengthening small business and entrepreneurship, which are critical components to an agenda of national renewal.

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Praise for *Made in China 2025 and the Future of American Industry*

"The Rubio report…makes for compelling and fascinating reading: "This report's central conclusion is that the U.S. cannot escape or avoid decisions about industrial policy." – David Brooks, *The New York Times*

"The @marcorubio Made in China Report will be weekend reading. Thanks to the senator for his work on this critical subject as well as his willingness to question certain rigid 20th Century ideologies." – Joe Scarborough, co-host of *Morning Joe*

"On February 12, Sen. Marco Rubio issued the most important report yet seen in this new Congress—and it might possibly be the most important congressional document published this year." – James Pinkerton, Co-Chair of the RATE Coalition

"The report highlights the need for a wakeup call when it comes to understanding the nature of the threat from China." – Robert Atkinson, Founder and President of the Information Technology and Innovation Foundation

"…the Rubio report is one of the clearest and most coherent statements I've seen from either party of the need for a state strategy in an era of global supply chains + state capitalism." – Todd Tucker, Fellow at the Roosevelt Institute

"The China report… represents a new level of creative and forward thinking, from either party, on the China issue." – Jeff Ferry, Chief Economist at the Coalition for a Prosperous America

"Senator Rubio… absolutely nails it, and it's important that we listen to him when he says, 'Look, this is the most pervasive challenge. This is without precedent. This is the gravest threat to the American republic.'" – Gordon Chang, Author of *The Coming Collapse of China*

"I've been reading @marcorubio's "Made in China 2025 and the Future of American Industry." Every American needs to read it." – Rebecca Mansour, Senior Editor-at-Large at *Breitbart*

"A new report on China from the Senate Small Business Committee, now chaired by Senator Marco Rubio, is turning heads in the conservative policy world… what makes the report interesting, particularly from a Republican-chaired committee, is its suggestion that America shouldn't merely punish China for unfair trade practices, but also should pursue a national innovation strategy of similar ambition." – Samuel Hammond, Director of Poverty and Welfare Policy at Niskanen Center

"Rubio said something extraordinary: the United States needs an industrial policy. But to do any of these things, the United States will first have to admit to itself that industrial policies are possible in the land of the free. And that they sometimes actually work." – Brendan Greely, *Financial Times*

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INTRODUCTION

CHAIRMAN RUBIO: BUILDING THE FUTURE AMERICA

The 21st-century economy has brought great challenges to American workers. For many, the American Dream of earned happiness – the dream that my immigrant parents were able to pursue and achieve – feels increasingly out of reach.

The American people know something has gone wrong. Will our children inherit an America where stable, well-paying work is available only to the few, or to the many? Will our country look more like the land of shared opportunity that my parents found when they arrived, or will we become a stagnant nation fighting over how to divide up what little opportunity is left?

We must deal with the American people's concerns. The health of our nation rests on the foundation of dignified work, upon which we can build strong families, strong communities, and a unified and patriotic nation. Threats to American productivity, including threats to the jobs and wages of our workers and products of our small businesses, represent a threat to our national fabric. To restore faith in the American promise of earned success through dignified work, we must confront challenges to it directly.

It is for this reason I have long pushed for a policy agenda to meet the needs of working families. From expanding the per-child tax credit for low- and medium-income families and subsidizing the employment of low-skilled workers, many of whom who have dropped out of the labor force, to promoting changes to our business tax code that put dynamism and investment first, throughout my time in office I have sought to help Americans face the challenges of today.

That effort continues now. Confronting the great challenges of our time begins by understanding that many of the outcomes we hope to change are themselves consequences of our own choices, not the inevitable result of global or market forces. We live in the country and economy we, through our choices or unwillingness to choose, have built. We can decide to build something different.

An honest assessment of the state of American workers and small businesses should include the effects of our decision to expand trade with China at the beginning of the 21st century. The main commercial goal was to promote better access to China's consumer markets for American companies and small businesses. This has not happened, however.

High-end goods made by advanced manufacturing were the very products that America was supposed to make more of due to our competitive advantages in talent and capital. Instead, these products are increasingly being captured by China. The "Made in China 2025" industrial plan announced in 2015 by the

Chinese government makes their goal clear. China aims to become the global leader in innovation and manufacturing.

This would be an unacceptable outcome for American workers. To drive our own development in a competitive, global economy, we must prioritize the high-wage industries of the 21st century, to the benefit of American businesses, workers, and their families.

Our national debate for how to compete in the global economy, however, has too often been restricted by the assumption that the only possible route ahead requires doubling down on the status quo of free trade for its own sake.

In a globalized economy, high wages for American workers are not the natural outcome of expanding trade, especially when some trading partners do not abide by the rules that they've agreed to. Free markets can be an unparalleled force for the creation of prosperity and wealth, but they produce in response to the terms they've been given. Lately, success by these terms has been defined by the growth of financial services instead of applied research or advanced manufacturing. The conclusion we should draw from this evidence is that we have too often failed to make the well-being of working Americans the terms for market success.

Setting new terms for our economy will strengthen the American system against its rivals, including an emergent and increasingly aggressive Chinese government and Communist Party. Though the Chinese government's model of centralized economic planning presents a formidable challenge, it is fundamentally flawed. The Chinese government's authoritarian system prioritizes the protection of the Communist Party's power above all else and leaves little room for the freedom and competition from which real and sustainable innovation, prosperity, and human dignity emerge.

We must do the hard work of forging a new consensus based on the challenges and opportunities that lie ahead in order to build a better America for future generations. It is what Americans have always done.

The urgency of answering these questions is why I have formed the Project for Strong Labor Markets and National Development from my staff at the U.S. Senate Committee on Small Business and Entrepreneurship. My hope is this report may contribute to this critical discussion.

Sincerely,

Marco Rubio
Chairman
U.S. Senate Committee on Small Business and Entrepreneurship

EXECUTIVE SUMMARY

1. Nations desire high-value, high-labor content production, and compete for industries and innovations that drive it. In a world of state competition for valuable industries, a domestic policy of neutrality is itself a selection of priority. "Not choosing" is a choice, however it is made. The critical policy consideration, then, is not whether states should organize their economies, but how they should be organized.

2. The Chinese government's whole-of-state industrial planning provides an extreme example of the inevitability of economic decision-making. National priorities exist prior to international law. International organizations may provide a mechanism to limit the negative externalities of pursuing these priorities, but they do not eliminate their underlying cause.

3. Existing characterizations of "industrial policy" do not apply cleanly in the 21st century. Economic organization does not require picking "winners and losers" or protectionist self-sufficiency. Dynamism and exposure to the global economy can also be priorities of economic decision.

4. The goal of American economic policy should be to benefit working Americans and the families their earnings support. Taking this goal seriously requires making a priority of its secondary implications. For example: manufacturing generally provides more stable employment than services, and geographic proximity to large production facilities encourages small business dynamism.

5. The "Made in China 2025" industrial plan, which targets 10 high-value industrial sectors for global dominance, demonstrates that the Chinese government is doing more than merely "breaking the rules," it is seeking to set new terms for international economic competition.

6. Evaluating the "Made in China 2025" plan should contribute to the American economic policy framework in two main ways. First, assessing the plan's particular goals and progress toward them can identify areas for defensive action. Second, comparing areas of China's success to America's relative decline can help identify areas for creative reform.

7. A common defense of expanded trade with China is that the U.S. would maintain or increase its position on the high end of the value chain, while China would supply the U.S. with lower-value inputs. This has not happened for the U.S. economy as a whole. In important areas, China has moved up the value chain relative to the U.S.

8. China has made gains vs. the U.S. in high-value sectors by various measures. Importantly, this has occurred in global export markets, which involve large scale and competition. China has significantly increased its export share of global markets since 2001 and aims for continued growth by this measure in the "Made in China 2025" plan.

9. Though its goals and progress vary, China has demonstrated clear success in information technology, shipping, and energy and power generation, while investing in large-scale projects in aerospace, vehicles, and robotics.

10. U.S. policy should respond to the practical and political economy challenges of the "Made in China 2025" plan. This includes enacting strategic U.S.-China capital flow restrictions and corresponding defensive measures for domestic industries targeted by the plan. It also means prioritizing new economic development, including encouraging physical investment and discouraging un-productive arbitrage through the tax code, and utilizing development assistance like the Small Business Investment Company and Small Business Investment Research programs. Finally, it means considering labor market stabilization policies to support Americans' attachment to the labor force and accumulation of valuable skills.

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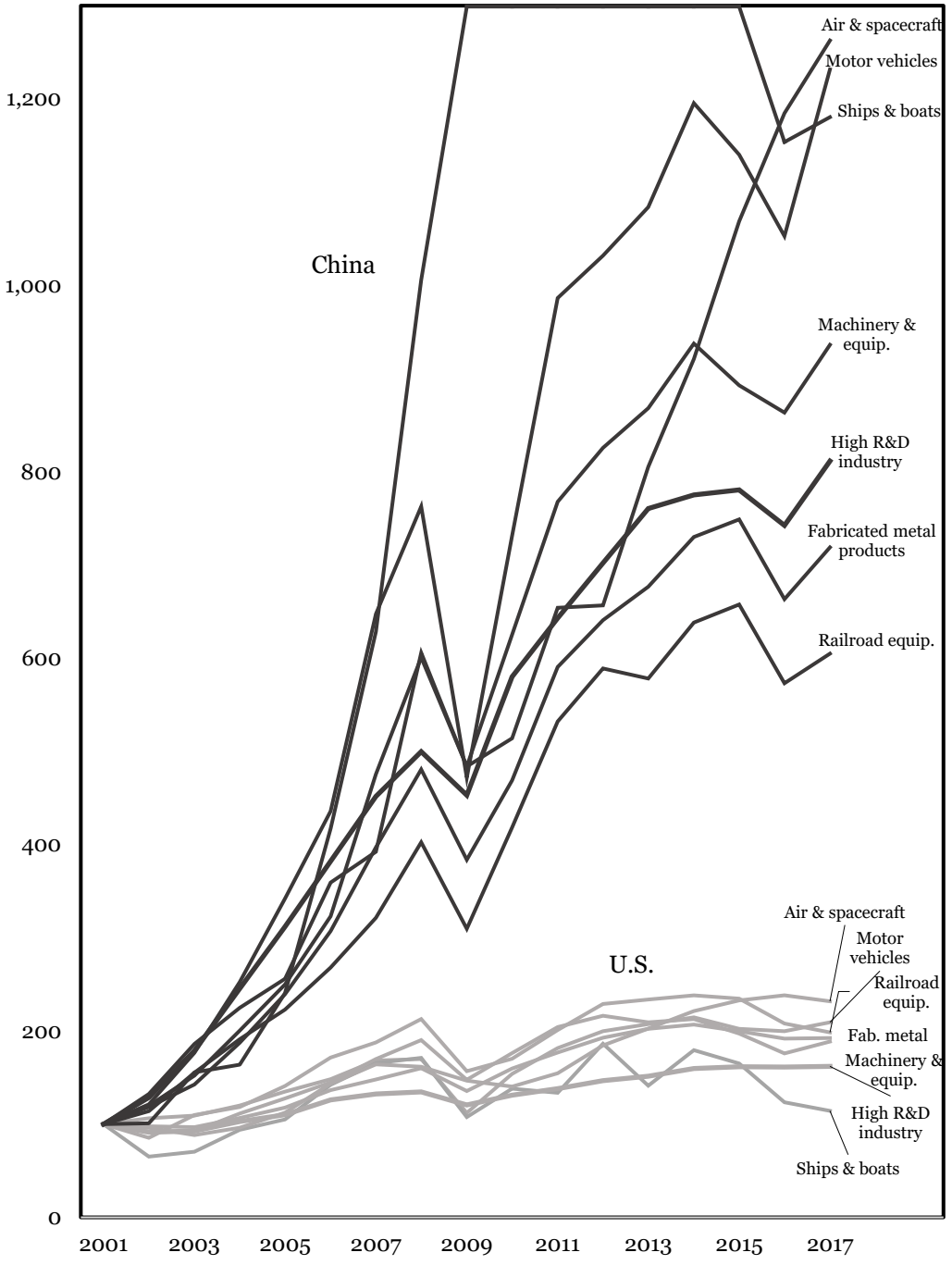
Figure 1.

Increase in global exports by heavy industry (OECD)
index, base year 2001 = 100

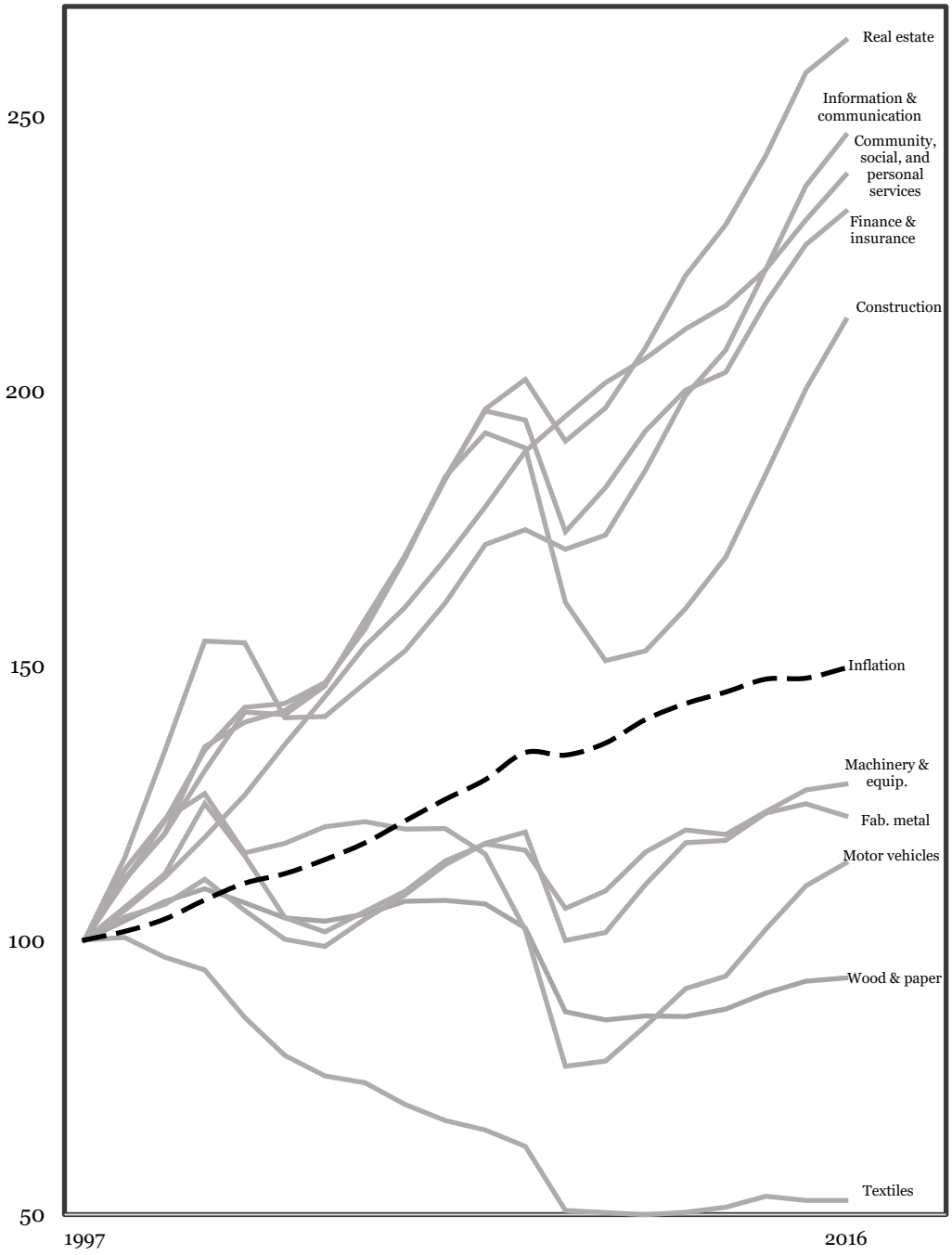


[1]

[1] OECD, STAN Bilateral Trade Database by Industry and End-use Category (BTDIxE). https://stats.oecd.org/, accessed January 4, 2019.

Figure 2.

U.S. total labor compensation by industry, 1997-2016 (OECD)
Five highest growth and five lowest growth two-digit industries
index, base year 1997 = 100



[2]

[2] OECD, STAN Industrial Analysis. https://stats.oecd.org/, accessed January 4, 2019.

THE POLITICAL ECONOMY OF PLANNING

"If the system of perfect liberty to industry and commerce were the prevailing system of nations, the arguments which dissuade a country in the predicament of the United States from the zealous pursuit of manufactures would doubtless have great force… But [this] system is far from characterizing the general policy of nations… The regulations of several countries with which we have the most extensive intercourse throw serious obstructions in the way of the principal staples of the United States… Remarks of this kind are not made in the spirit of complaint. It is for the nations whose regulations are alluded to, to judge for themselves whether, by aiming at too much, they do not lose more than they gain. It is for the United States to consider by what means they can render themselves least dependent on the combinations, right or wrong, of foreign policy…"

– Secretary of the U.S. Treasury Alexander Hamilton, Report on the Subject of Manufactures, submitted by the Treasury Department to the Congress December 5, 1791.[3]

"The health and vitality of the U.S. semiconductor industry are essential to America's future competitiveness. We cannot allow it to be jeopardized by unfair trading practices."

– President Ronald Reagan, Statement on Tariff Increases on Japanese Semiconductor Products, April 17, 1987.[4]

[3] Alexander Hamilton, "Report on the Subject of Manufactures," National Archives, December 5, 1791, https://founders.archives.gov/documents/Hamilton/01-10-02-0001-0007.
[4] President Ronald Reagan, "Statement on Tariff Increases on Japanese Semiconductor Products April 17, 1987," Ronald Reagan Presidential Library, https://www.reaganlibrary.gov/research/speeches/041787a.

In a world of state competition for valuable industries, a domestic policy of neutrality among activities is itself a selection of priority. "Not choosing" is a choice, however it is made. The relevant policy consideration, then, is not whether states should organize their economies, but how they should be organized. Total neutrality among interacting economic systems is impossible, but relative material decline is not.

States make decisions about economic value, and organize their economies around them. This reality does not presuppose the outcome or propriety of their choices. They may choose the wrong priorities. Their priorities may clash with others'. They may pursue their priorities effectively or ineffectively. Their choices might register as being more "free market" in some instances, or less in others, but they are not optional or avoidable.

This report's central conclusion is that the U.S. cannot escape or avoid decisions about industrial policy. States place great value on capturing high-productivity, high-labor content industries, or developing new ones. This is no new insight, for constraining the excessive possibilities of this behavior is arguably the orienting view of the World Trade Organization (WTO).[5] States can attempt to redirect this fundamental interest by agreeing to "not select" industries, or at least not do so outside the bounds of reasonable policy difference. But even here, distinctions between competing decisions of economic value must be made. The choices required to run a group true to the principle of fair and equal competition – like the kinds and degrees of enforcement of its rules, its dispute settlement system, the selection of states to its membership, and how states hold power within in it – are themselves decisions that necessarily involve a hierarchy of economic and political priorities.

Even among nations of similar circumstance, agreement to "play by the rules" in economic competition operates more in a state of contest than as a consensus. Robert Lighthizer, now the United States Trade Representative (USTR), noted in testimony before the U.S.-China Economic and Security Review Commission in 2010 that "WTO commitments are not religious obligations," and they are not necessarily based on full agreement to shared principle, but rather "upon the assumption of relatively equal costs and benefits."[6] As Harvard Kennedy School Professor Dani Rodrik has written, "the purpose of international rules should be not to impose common rules on countries with different regulatory systems, but to accept these differences and regulate the interface between them so as to reduce adverse spillovers."[7]

China's accession to the WTO is instructive for the inevitability of industrial policy. The admission of a state into a rules-based trade order against whom the rules cannot be fully enforced sets up a clarifying dilemma. Either exposure to the global system inevitably directs states' interests to the principles of the agreement, or the imputed universality of the rules is untrue, at least in their ability to describe how states operate under them. The 2018 USTR report on the

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[5] World Trade Organization, "WTO Trade Statistics," World Trade Statistical Review 2017, https://www.wto.org/english/thewto_e/whatis_e/what_stand_for_e.htm.
[6] Robert E. Lighthizer, Testimony Before the U.S.-China Economic and Security Review Commission, Evaluating China's Role in the World Trade Organization Over the Past Decade, June 9, 2010, https://www.uscc.gov/sites/default/files/6.9.10Lighthizer.pdf.
[7] Dani Rodrik, "Industrial Policy for the 21st Century," Harvard University, http://www.vedegylet.hu/fejkrit/szvggyujt/rodrik_industrial_policy.pdf.

Chinese government's compliance with WTO rules makes clear the immediate relevance of the scenario:

> *"It is simply unrealistic to believe that WTO enforcement actions alone can ever have a significant impact on an economy as large as China's economy… The notion that our problems with China can be solved by bringing more cases at the WTO alone is naïve at best, and at worst it distracts policymakers from facing the gravity of the challenge…"*[8]

Which from the following practices should count as "fair" in global trade? Technology transfer facilitated by the use of "junk patents" that are used to retaliate against foreign companies' intellectual property lawsuits? Certification standards that slow the approval of new foreign capital goods for import? Strong ties between government policy commissions and exporters? State-supported credit lines to industrial developers that, while theoretically neutral among sectors, in practice favors only export-heavy industries?[9]

The scope of these practices provides an example of how the Chinese government's whole-of-nation industrial planning simply does not fit into the categories currently given to trade enforcement. This not-so-hypothetical example might appear to present a broad choice to U.S. policymakers: either firmly insist that all partner states (including the U.S.) adopt universal market principles, or abandon these principles for a competitive system of deals forged by the leverage of raw economic power. To the list posed above: are all of these practices unfair, or none? The clash between these ends of the spectrum constitutes much of the underlying debate over China's challenge to the global economy.

The motivating factor to move out of this binary framing is that both ends of the spectrum no longer accomplish their stated goals. Reduced long-term economic growth fails the standards of those who prioritize global efficiency, manufacturing job loss fails the standards of those who prioritize national self-sufficiency, and low productivity growth fails the standards of both.

A new approach to the dilemma is required. Lost in the polarity of the discussion is a path forward that can resolve the concerns of both economic dynamism and efficiency for one, and national sovereignty and value-chain position for the other.

To identify such a path requires an imagination beyond the category choices of global market harmonization and protectionist retreat from trade, which are currently understood as the only options available. Dynamism can itself be a priority of industrial policy. Setting up competition for new fields, in which firms compete on the quality of their investment and on a global scale, make high-growth dynamism the terms for success, whether those terms are set by the state or the market. An economic agenda to effectively pursue dynamism in high value activities for its own sake might create an outcome with both the properties of

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[8] United States Trade Representative, 2017 Report to Congress on China's WTO Compliance, January 2018, https://ustr.gov/sites/default/files/files/Press/Reports/China%202017%20WTO%20Report.pdf.

[9] The hypotheticals of this list are drawn from the real examples from the work of James McGregor, "China's Drive for 'Indigenous Innovation'" U.S. Chamber of Commerce, https://www.uschamber.com/sites/default/files/documents/files/100728chinareport_0_0.pdf, and Mark Wu, "The 'China, Inc.' Challenge to Global Trade Governance." *Harvard International Law* Journal, Spring 2016, http://www.harvardilj.org/wp-content/uploads/HLI210_crop.pdf.

entrepreneurship and capital deployment attributed to a more free-market economy, and the stable, high-paying American manufacturing jobs attributed to an earlier, more regulated American economy.

Plainly stating a national priority for value chain progress and its attendant workforce benefits to skills and pay need not be objectionable to market principles. Rodrik's suggested principles for a 21st century industrial agenda, for example, include a preference for policy "in favor of more dynamic activities generally, regardless of whether those are located within industry or manufacturing per se," that "support must target activities, not sectors," and in which "incentives should be provided only to "new" activities."[10] [11] Such an approach would likely favor startups and small businesses with the ability to act anew in the application of new technology over more trenchant large firms. And far from embracing autarky, competition in goods exports makes market scale and international exposure essential to American firms' success.

The distinction between this model of development and a more strictly "rules-based" model is in its clarity of purpose. What are the rules oriented to? The goal of U.S. economic policy should be to benefit working Americans and the families their earnings support. In the abstract, this goal is mostly agreed upon. But giving the particular implications of this goal the weight of priority will draw a clear distinction between whether the goal should be pursued as an end unto itself, or merely by extension.

To that end, recent history delivers a few general lessons to help provide these implications. Manufacturing provides better and more stable employment for American workers than financial services. Physical capital development makes for more prosperous towns and communities than does digital capital. Knowing how to make a specialized product is a less replicable skill than marketing the product for sale. Research and development expenditures deliver greater benefits to the public than private cost alone justifies. Offshoring jobs to save on labor costs doesn't often create equivalent jobs for the workers displaced by it. Worker skills are not easily transferable across industries. Geographic proximity to productive assets like factories increases the prosperity of supplying and local small businesses. In sum, production matters.

In the pursuit of this goal, economic value can be defined prior to the value assigned by the market. How the U.S. economy lines up with the above concepts will be more descriptive of the status of American workers than more abstract criteria like the ideal ratio of taxes or spending, or whether or not trade agreements reduce barriers to international trade as a category. The initial decision to prioritize American workers and their families becomes clear in the definition of these implications and how they relate to regular workers.

Applying this framework to the U.S. policy response to China offers the opportunity to likewise disentangle knots of principle. On the one hand, it would require an expansive view of trade enforcement against violations of property rights as a way to faithfully contest challenges to our national priorities. On the other, it would entail a more expansive view of possible models of

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[10] Rodrik, "Industrial Policy for the 21st century."
[11] See also Niall Ferguson, "We're All State Capitalists Now," *Foreign Policy*, February 9, 2012, https://foreignpolicy.com/2012/02/09/were-all-state-capitalists-now/.

development, both in China and the U.S., keeping in mind that if trade enforcement is undertaken too lightly, or even if it is pursued effectively but fails to meaningfully rebalance the U.S.-China economic relationship, the American recourse will be our own commercial strength.

A common defense of expanded trade with China is a claim of advantageous value chain position: in theory, the production of cheap mass-market consumer goods in China would produce an increase in the standard of living for American consumers and allow the U.S. to increase high-value exports to China and the rest of the world. But what happens if, in reality, China makes these high-value products instead? That is the future envisioned by the "Made in China 2025" plan (hereafter referred to in this report as "*MIC2025*") first promoted by the Chinese government in 2015.

The current U.S.-China trade conflict, which formally began in 2018, has revealed much and represents the most consequential action of economic re-balancing taken in recent history. With or without a formal end to this conflict,[12] however, an honest reckoning of the U.S.-China trade relationship and its fundamental drivers is needed, and should arrive at a familiar conclusion. There is no answer like domestic innovation. It is no law of nature that innovation in the U.S. be limited to more efficient delivery of services via digital technology, while China develops capital-intensive manufacturing capacity, or that the outcomes of median workers in each country diverge in the way they have recently. These outcomes are affected by national decisions.

The Chinese government is often described as "breaking the rules," or pursuing a model of "unfair competition" against the U.S.-led international system of trade. While these charges are true on their own terms, their descriptive shortfall of the bigger picture is instructive.[13] The Chinese government is doing more than breaking the formal rules of trade: it is seeking, through state policy and the power of its domestic market, to dictate the real terms for how global trade will proceed, and to whose benefit. As such, the China challenge to the international economic order does not represent an exception to the rule so much as it does a possible disproof of its governing political economy.

Assessing the Chinese government's industrial policy in the form of *MIC2025*, as this report does, is instructive for two main reasons:

1. Understanding which industries receive state support from *MIC2025*, and how this support translates into market outcomes, can provide a blueprint for effective defensive action. The Trump Administration's "Section 301" tariffs on goods supported by *MIC2025* have been consequential for this reason. Making China's growth in export share for high-end goods more costly would increase the need for internal reforms in China and strengthen U.S. leverage to secure real policy concessions.

2. Evaluating the particular policies and strategies that the Chinese government has employed to achieve its *MIC2025* goals, especially in

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[12] At the time of the publication of this report in February 2019, high-level talks between the U.S. and China are ongoing, with scheduled Section 301 tariff rate increases postponed until March 1, 2019. See also footnote #18 for a discussion of *C2025*'s relation to China's macroeconomic circumstance.
[13] Mark Wu, "The 'China Inc.' Challenge to Global Trade Governance," *Harvard International Law* Journal, Spring 2016, http://www.harvardilj.org/wp-content/uploads/HLI210_crop.pdf.

comparison to those of the U.S. in similar sectors, can provide useful contrast. That China is growing in areas the U.S. is not presents an opportunity for creative offense as well as a cause for defensive action. The policy blend of state priorities and market reforms the Chinese government has at times employed is not entirely new. Similar development strategies have been pursued by U.S. allies like Japan and South Korea, in addition to sharing traits of the U.S.'s own earlier approach to industrial development.[14] In areas of U.S. advantage like digital technology, the sum of American domestic policy has sometimes functioned as state prioritization of development through the use of markets.[15] [16] Though the Chinese government has consistently violated international trade laws, disregard for mutually-beneficial norms and international rules is not a necessary condition for industrial policy. Reversing the decline in American manufacturing production will require an honest assessment of what has worked, and what hasn't.

This perspective should not be misunderstood as an endorsement of the Chinese government's economic policies. Directing vast resources into debt-driven investment requires the possibility of credible returns, yet state-owned enterprises concerned with internal Communist Party politics are often ill-suited to identify profitable opportunities.[17] Financing the state's pursuit of economic goals through the suppression of household savings risks disconnecting the benefits of growth from the workers creating it. Central planning risks inefficiency and the creation of stagnant political interests that prevent future reform. Reliance on formal "plans" creates targets that cannot be met, or distract from underlying problems. These risks should be accounted for, but they do not make quantifiable effects on American industry less real. *MIC2025* provides a set of goals to measure policy against. The goal should be to understand the plan as policy category.

Contrary to the predictions of many, the last year of the U.S.-China trade conflict has shown there is an economic "life after tariffs."[18] Economic policymaking is

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[14] Officials throughout the development period of East Asia have openly made this claim, and the development theories of Americans like Alexander Hamilton, Friedrich List, and Henry Carey have likewise been cited by officials in Japan and South Korea. See "The Rise of China and the Fall of the 'Free Trade' Myth," by Pankaj Mishra, *The New York Times*, February 7, 2018, https://www.nytimes.com/2018/02/07/magazine/the-rise-of-china-and-the-fall-of-the-free-trade-myth.html. For a broader analysis of the role of List's thought in China's development model, see page 381 of "Friedrich List's Heart, Wit and Will: Mental Capital as the Productive Force of Progress" by Arno Mong Daastol, Erfurt University, November 2011. See also *How Asia Works: Success and Failure in the World's Most Dynamic Region* (2013) by Joe Studwell. The policy suite of infant industry protection, state-driven investment, and restricted credit has been called the "American school" of economics. See *Land of Promise: An Economic History of the United States* (2012) by Michael Lind.

[15] Robyn Klingler-Vidra, "Building the Venture Capital State," *American Affairs*, 2018, https://americanaffairsjournal.org/2018/08/building-the-venture-capital-state/.

[16] Mariana Mazzucato, "The State Behind the iPhone," in *The Entrepreneurial State*, 93-108. New York: Anthem, 2015.

[17] Robert J. Samuelson, "Why China clings to state capitalism," *Washington Post*, January 9, 2019, https://www.washingtonpost.com/opinions/why-china-clings-to-state-capitalism/2019/01/09/5137c6d4-141e-11e9-b6ad-9cfd62dbb0a8_story.html?utm_term=.5a320d98d437.

[18] A number of indicators at the time of this report's drafting in January 2019 suggest China's economy has slowed significantly. The report's argument occurs independent of this broader economic volatility. As the report discusses, *MIC2025* aims to boost high-value exports, and even its self-sufficiency targets are often aimed at developing the scale necessary to produce exports for global markets. While slower domestic growth constrains capital and other tools, demand for exports is external, that is, dependent upon economic conditions in other countries. By this line of reasoning, slower domestic growth in China could require increased priority on exports. Finally, the "export discipline" model may be assessed as its own economic institution, as the Studwell quote on page 20 describes. See comments on *MIC2025*'s relation to macroeconomics in "China's Growth Machine No Longer Looks Unstoppable," by Noah Smith, *Bloomberg*, January 15, 2019,

not an apolitical application of perfect theory to practice. It is the organization and execution of national priorities. America has historically prioritized the ability of American workers to support themselves and their families with their own wages, earned by their own labor. Free and healthy markets for Americans goods and services, both at home and abroad, have often advanced this priority. But aligning the interests of American institutions and people to this goal often elides questions of whether a given approach is for or against "the market," or "free trade." Markets respond to the priorities set for them through policy choices. The critical question is which policy choices are in the interests of the American people. This Project believes *MIC2025* and the opportunity for policy response that it demands are worth studying to better understand the answer.

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https://www.bloomberg.com/opinion/articles/2019-01-15/china-economy-now-slowed-by-stimulus-used-in-great-recession. See also Brad Setser, Twitter Post, https://twitter.com/Brad_Setser/status/1085247950052302848.

OVERVIEW

"No matter how we will open to the West, no matter how we will use the foreign capital, and whatever the proportion of the private investment will be, this will cover only a small percentage of the Chinese economy. It will by no means affect the socialist public ownership of the means of production. Even the fact that foreigners might build factories in China will play only a complementary role. A subsidiary role. Then of course, there will be some decadent influence of capitalism brought into China. We are aware of this, but I think that it is not so terrible and we are not afraid of it."

— Deng Xiaoping, August 31, 1980[19]

"On the traditional competition field of international development, the rules were set by other people… To seize the great opportunities in the new scientific-technological revolution and industrial transformation, we must enter early on while the new competition field is being built, and even dominate some of the competition field construction, so we become a major designer of the new rules of competition and a leader on the new field."

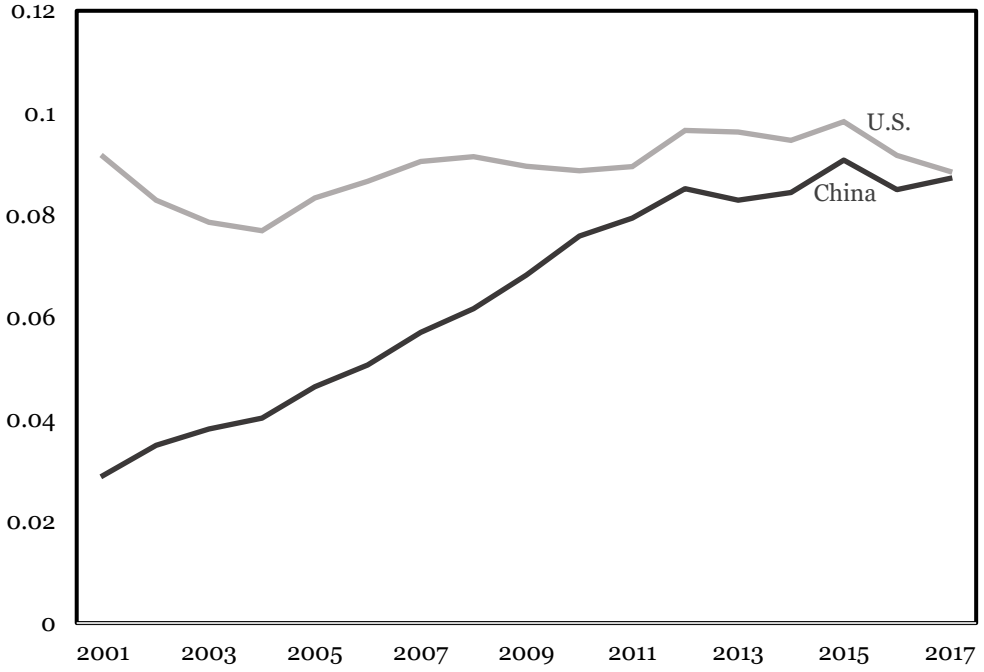
— Xi Jinping, June 10, 2014[20]

[19] Oriana Fallaci, "Deng: A Third World War Is Inevitable," *Washington Post*, https://www.washingtonpost.com/archive/politics/1980/09/01/deng-a-third-world-war-is-inevitable/a7222afa-3dfd-4169-b288-bdf34f942bfe/?utm_term=.d33fe69465bb, different translation found in "Answers to the Italian Journalist Oriana Fallaci," August 23, 1980, http://en.people.cn/dengxp/vol2/text/b1470.html.
[20] Chris Buckley, "Xi Urges Greater Innovation in 'Core Technologies,'" *New York Times*, June 10, 2014, https://sinosphere.blogs.nytimes.com/2014/06/10/xi-urges-greater-innovation-in-core-technologies/.

Figure 3.

Share of global export market in 32 selected high unit value capital goods (UN ITC and Census)

4-digit HS line in chapters 82 through 90, excluding aircraft, weighted by 2017 global export value



[21]

[21] Selected four-digit lines include: **8406** Steam turbines and other vapor turbines; **8408** Compression-ignition internal combustion piston engine; **8411** Turbojets, turbopropellers and other gas turbines; **8414** Air or vacuum pumps; **8426** Ships' derricks. cranes; **8429** Self-propelled bulldozers, angledozers, graders, levellers, scrapers, mechanical shovels, excavators, shovel loaders, tamping machines and roadrollers; **8430** Moving, grading, levelling, scraping, excavating, tamping, compacting, extracting or boring machinery; **8456** Machine tools for working any material by removal of material, by laser or other light or photon beam, ultrasonic, electro-discharge, electro-chemical, electron beam, ionic-beam or plasma arc processes; **8457** Machining centers, unit construction machines and transfer machines for working metal; **8458** Lathes for removing metal; **8459** Machine tools, incl. way-type unit head machines, for drilling, boring, milling, threading or tapping; **8460** Machine tools for deburring, sharpening, grinding, honing, lapping, polishing or otherwise finishing metal; **8461** Machine tools for planing, shaping, slotting, broaching, gear cutting, gear grinding or gear finishing, sawing, cutting-off; **8462** Machine tools, incl. presses, for working metal; **8479** Machines and mechanical appliances not specified or included elsewhere in this chapter; **8486** Machines and apparatus of a kind used solely or principally for the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays; **8501** Electric motors and generators; **8502** Electric generating sets and rotary converters; **8504** Electrical transformers, static converters, and inductors; **8543** Electrical machines and apparatus, having individual functions; **8601** Rail locomotives powered from an external source of electricity or by electric accumulators; **8602** Rail locomotives (excluding those powered from an external source of electricity or by accumulators), locomotive tenders; **8603** Self-propelled railway or tramway coaches, vans and trucks; **8605** Railway or tramway passenger coaches, luggage vans, post office coaches; **8701** Tractors; **8703** Motor cars and other motor vehicles principally designed for the transport of persons; **8704** Motor vehicles for the transport of goods; **8705** Special purpose motor vehicles e.g. breakdown lorries, crane lorries, fire fighting vehicles, lorries, mobile workshops and mobile radiological units; **8901** Cruise ships, excursion boats, ferry-boats, cargo ships, barges and similar vessels for the transport of persons or goods; **8902** Fishing vessels; **8904** Tugs and pusher craft; **8905** Light-vessels, fire-floats, dredgers, floating cranes, floating docks, floating or submersible drilling or production platforms; **8906** Vessels, incl. warships and lifeboats. Headings shortened for length. Data is from United Nations COMTRADE, compiled by the International Trade Center's "Trade Map," https://www.trademap.org/Index.aspx.

At the heart of trade conflict between the United States (U.S.) and the People's Republic of China (China) is a shift in relative economic position. Since its accession to the World Trade Organization (WTO) in 2001, China has increasingly captured leading positions in global economic standings previously held by the U.S., including total trade,[22] goods exports,[23] purchasing power,[24] and consecutive years of high growth.[25]

This shift has been felt in various ways in the U.S. The initial period following China's accession witnessed a large volume of low- to-medium value-added imports substituting for U.S. goods, displacing many American jobs in an effect now generally referred to as the "China shock."[26] In the years following the 2008 financial crisis and consequent economic recession, import substitution began to shift from consumer goods to capital goods.[27]

The Chinese government's export-led development policies have fueled large trade surpluses and formed manufacturing ecosystems that create the conditions for sizable investments in innovation in China. Increasingly moving beyond infant industry-level learning, Chinese government and industry leverage economic position to move up the value chain. China's arrival at the technological frontier in some industries has made its next stage of development something other than merely "catching up" to developed economies like the U.S. *MIC2025* can be understood as both a result and cause of this move. By one translation, the plan makes this priority clear in its own words:

> *"Manufacturing is the main pillar of the national economy, the foundation of the country, tool of transformation and basis of prosperity. Since the beginning of industrial civilization in the middle of the 18th century, it has been proven repeatedly by the rise and fall of world powers that without strong manufacturing, there is no national prosperity. Building internationally competitive manufacturing is the only way China can enhance its strength, protect state security and become a world power… China's manufacturing sector has maintained rapid development and has built an industrial system that is both comprehensive and independent. It has greatly supported China's industrialization and modernization and significantly enhanced the country's overall strength. It has supported China's position as a world power. However, compared with the advanced economies, China's manufacturing sector is large but not strong, with obvious gaps in innovation capacity, efficiency of resource utilization, quality of industrial infrastructure and degree of digitalization. The task of*

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[22] Malcolm Scott and Sam Cedric, "Here's How Fast China's Economy Is Catching Up to the U.S.," *Bloomberg*, May 24, 2018, https://www.bloomberg.com/graphics/2016-us-vs-china-economy/.
[23] World Trade Organization, "World Trade Statistical Review 2018," https://www.wto.org/english/res_e/statis_e/wts2018_e/wts2018_e.pdf.
[24] Noah Smith, "Who Has the World's No. 1 Economy? Not the U.S.," *Bloomberg*, October 18, 2017, https://www.bloomberg.com/opinion/articles/2017-10-18/who-has-the-world-s-no-1-economy-not-the-u-s.
[25] World Bank, Gross Domestic Product for China [MKTGDPCNA646NWDB], retrieved from FRED, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/MKTGDPCNA646NWDB.
[26] David H. Autor, David Dorn and Gordon H. Hanson, 2016, "The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade," Annual Review of Economics, vol 8(1), https://www.nber.org/papers/w2190.
[27] Brad Setser, "When Did the China Shock End?" Council on Foreign Relations, 2018, https://www.cfr.org/blog/when-did-china-shock-end.

upgrading and accelerating technological development is urgent… We will strive to transform China into the global manufacturing leader…"[28]

MIC2025 outlines the Chinese government's long-term aim to become the world's dominant manufacturer and innovation leader by 2049, its centennial celebration year.[29] Achieving this goal requires moving up the manufacturing value chain, developing innovation capacity, and solidifying domestic supply chains in order to compete globally. *MIC2025* accordingly sets explicit goals in export growth and national self-sufficiency in 10 advanced industries. If *MIC2025* is successful by these terms, what the "China shock" did to domestic U.S. production of electronics, furniture, plastics, metals, and vehicle parts could threaten to repeat itself in capital goods like machinery, automobiles, high-end computers, rail, and aerospace products.

American small businesses, which make up much of the domestic U.S. supply chain, would be especially exposed to future import competition. From producing aircraft and automobile parts to developing new technologies in robotics and agriculture, small businesses in the U.S. drive the production and innovation of critical components. A 2017 study conducted by Mercedes Delgado of the Massachusetts Institute of Technology's Sloan School of Management and former U.S. Small Business Administration (SBA) Administrator Karen Mills found the U.S. supply chain contains 37 percent of all jobs, employing 44 million people, including many small firms clustered around larger suppliers.[30] Research conducted by Edward L. Glaeser and William R. Kerr of Harvard University and Harvard Business School finds that significant sources of industrial dynamism comes from networks of supplier small businesses in close proximity to large goods production.[31]

Changes in value chain position for finished and capital goods have effects on supplying small businesses by changing demand for their products and affecting their connection, geographic or otherwise, to their large-firm customers. *MIC2025*'s emphasis on "self-sufficiency" in high-value sectors should be read in this context as a possible threat to the U.S. supply chain. Further analysis of this possible threat will be conducted in the sections below.

This report examines each of the 10 industrial sectors prioritized by *MIC2025* according to the findings of the USTR in its 2018 investigation of China's trade practices under Section 301 of the Trade Act of 1974.[32] It will focus on what the USTR has called the fourth stage of the Chinese government's National Medium- and Long-Term Science and Technology Development Plan Outline (MLP), which prioritizes the innovation of new products after the successful transfer of foreign technology to China:

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[28] State Council of the People's Republic of China, Made in China 2025: Charting the 10-Year Transformation of Chinese Industry, trans. IoT One (Beijing, China, 2015).
[29] Ibid.
[30] Mercedes Delgado and Karen Mills, A New Categorization of the U.S. Economy: The Role of Supply Chain Industries in Innovation and Economic Performance (October 9, 2017), MIT Sloan Research Paper No. 5241-16, Available at SSRN: https://ssrn.com/abstract=3050296 or http://dx.doi.org/10.2139/ssrn.3050296.
[31] Edward L. Glaeser and William R. Kerr, 2009, "Local Industrial Conditions and Entrepreneurship: How Much of the Spatial Distribution Can We Explain?," Journal of Economics & Management Strategy, Blackwell Publishing, vol. 18(3), pages 623-663, 09.
[32] Office of the United States Trade Representative, "Findings Of The Investigation Into China's Acts, Policies, and Practices Related To Technology Transfer, Intellectual Property, And Innovation Under Section 301 Of The Trade Act Of 1974, 2018," https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF.

> *"(4) Re-innovate: At this stage, Chinese companies should "re-innovate" and improve upon the foreign technology. The ultimate objective is to develop new, home-grown products that are competitive internationally, so as to "allow enterprises to possess more indigenous intellectual property for core products and core technologies."*[33]

The report builds upon the extensive work of government agencies, offices, and commissions such as the USTR, the Department of Commerce, the White House Office of Trade and Manufacturing Policy, and the U.S.-China Economic and Security Review Commission, as well as outside organizations such as the U.S. Chamber of Commerce and American Chamber of Commerce in the People's Republic of China, among others to understand and describe the *MIC2025* plan and its effect on the U.S. It seeks to contribute to this research by exploring the industrial policy of *MIC2025* and its outcomes on a sector-by-sector basis, comparing it to U.S. business progress in the same industries, and by drawing policy conclusions based on this evidence.

[33] Ibid.

DEFINITIONS AND METHODOLOGY

***MIC2025*:** The "Made in China 2025" plan, referred to in this report as *MIC2025*, is the Chinese government's industrial strategy aimed at making the nation the global leader in high-technology manufacturing, promulgated in 2015 by the State Council, the Chinese government's chief administrative authority. According to the report issued by the USTR in accordance with section 301 of the 1974 Trade Act, this 10-year plan targets ten specific strategic industries, including: (1) aerospace, (2) robotics, (3) new energy vehicles, (4) high-technology shipping, (5) artificial intelligence and next-generation information technology, (6) biotechnology, (7) energy and power generation, (8) advanced railway, (9) new materials, and (10) agricultural machinery.[34] *MIC2025* harnesses China's intertwined state-party-business ecosystem to support targeted sectors through a variety of means including large scale investments, subsidies, intellectual property acquisition, and other formal or informal policies.[35]

The USTR's Section 301 report notes *MIC2025* informs the Chinese government's three-step strategy in advanced manufacturing:

> *"Under the first step, by 2025, China should 'approach the level of manufacturing powers Germany and Japan during the period when they realized industrialization." In the second step, China should 'enter the front ranks of second tier manufacturing powers' by 2035. In the final step, China should 'enter the first tier of global manufacturing powers' by 2045, at which point China will have 'innovation-driving capabilities,' 'clear competitive advantages,' and "world-leading technology systems and industrial systems."*[36]

Included in *MIC2025* is the *Key Area Technology Roadmap*, which establishes clear targets for global and domestic market shares in the ten sectors. *MIC2025* is a blueprint for high-tech "self-sufficiency" and provides the foundation for a move up the industrial value chain to achieve competitiveness in global markets. As a result, China aims to enhance the quality of its local research, development, and manufacturing capabilities, while simultaneously leveraging its domestic market to access foreign technology, talent, and industrial know-how.[37]

Trade data methodology: The report employs the use of the Harmonized System (HS), North American Industry Classification System (NAICS), Structural Analysis (STAN) databases, and Trade in Value Added (TiVA) trade indicators. HS-level data was compiled using the International Trade Center (ITC) interface, which compiles trade indicators from the United Nations' (UN) COMTRADE database and its own calculations. The ITC is a joint agency of the WTO and UN. NAICS data was accessed using the U.S. Census Bureau's (Census) "USA Trade"

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[34] USTR, Section 301.
[35] James McBride, "Is 'Made in China 2025' a Threat to Global Trade?" Council on Foreign Relations, https://www.cfr.org/backgrounder/made-china-2025-threat-global-trade.
[36] USTR, Section 301.
[37] U.S.-China Economic and Security Review Commission, China's Technonationalism Toolbox: A Primer, March 28, 2018, https://www.uscc.gov/sites/default/files/Research/China%27s%20Technonationalism.pdf.

database. STAN and TiVA data was accessed from the Organization for Economic Cooperation and Development (OECD). Data sources for each chart are referenced in parentheses by source organization.

The report uses trade data to illustrate the export-driven growth goals of *MIC2025*, which in addition to having the most relevant impact on U.S. consumer markets and competing U.S. producers, provide a more objective standard against which the performance of *MIC2025* can be evaluated. This is true for a number of reasons. Export growth requires competing against the rest of the world. It is relatively straightforward for states to require their own citizens to purchase domestic goods, but not in competition on the global market. Moreover, due to the lack of reported data for China in some cases, and concern about data accuracy in China, measures of exports are more likely to be reliable because they are also reported by countries importing the relevant good or service. Finally, characterized by Joe Studwell in his 2013 book *How Asia Works* as "export discipline," relative export growth has proved a successful proxy for market performance in states seeking to leverage public investment to create high-growth firms. Studwell describes how export growth can serve as an effective benchmark for economic development priorities:

> *"…in East Asia successful governments pioneered new ways to promote accelerated technological upgrading in manufacturing through subsidies that were conditioned on export performance. This combination of subsidy and what I call 'export discipline' took the pace of industrialization to a level never before seen.*
>
> *"…This overcame the traditional problem with subsidy and protection policies, whereby entrepreneurs pocketed financial incentives but failed to do the hard work of producing competitive products. Firms were not able to hide behind tariff and other barriers and sell only to a protected domestic market because protection, subsidies and credit were conditioned on export growth. Firms that did not meet the export benchmark were cut off from state largesse, forced to merge with more successful companies, or occasionally even bankrupted. Governments thereby ended up with world-beating firms to justify their considerable investments of public funds."*[38]

Figure 3, titled "Share of global export market in 32 selected high unit value capital goods by 4-digit HS line in chapters 82 through 90, excluding aircraft, weighted by 2017 global export value (UN ITC and Census)," represents an example of this analysis. It creates a weighted average by total global exports in 2017 of the U.S. and China share of global export market share in 32 high unit-value four-digit HS codes. This shows that China has increased its global market share to nearly match the U.S. in some high-price, high-value products.

Because HS data does not break out the value of foreign-source components, the report makes use of TiVa data as well. Because HS data is not grouped by industry, the report uses U.S.-reported NAICS data, which is, using imports from China relative to total U.S. exports as a proxy for China exports as percent of competitor exports. Finally, the report also uses OECD Bilateral Trade in Goods

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[38] Studwell, *How Asia Works,* pp xiii- xiv, xvii- xviii.

by Industry and End-use (BTDIxE) data for industry-level analysis, including exports, capital goods, and intermediate goods.

Mode of analysis: The report discusses the commercial impact and implications of *MIC2025* for the U.S. Other issue sets often raised in discussions of the U.S.-China relationship, like national security and differences in political system, are beyond the scope of this report. They are mentioned insofar as they have commercial effect. Though this singular perspective is limiting – and especially so in the case of China where economic, security, and politics are often intertwined – a broader approach extends beyond the jurisdiction of the Committee. Congressional institutions such as the Congressional-Executive Commission on China and the U.S.-China Economic and Security Review Commission are well positioned to provide this comprehensive approach, and do so often in their reports and hearings. Finally, narrowing the focus to commercial impact allows for a clearer understanding of the status of *MIC2025* on its own terms – in its success for driving growth in market share and productivity – and by comparison, shifts in the composition of U.S. business output.

INDUSTRY ANALYSIS

AEROSPACE

> *"We are embarked as pioneers upon a new science and industry in which our problems are so new and unusual that it behooves no one to dismiss any novel idea with the statement that 'it can't be done!'"*
>
> – William E. Boeing, founder of The Boeing Company.[39]

- The development of indigenous passenger aircraft is among the Chinese government's top industrial priorities. While to date it has been unsuccessful in creating a competitor against current industry leaders, China is now testing its latest model and claims a number of advance orders.
- The American aircraft industry represents the top of the U.S. value chain in manufacturing and exports, and enjoys strong public policy support.
- At least 10 U.S. firms have established joint ventures in China through its aircraft development program, sharing knowledge and technical expertise in an undertaking to create a Chinese state-backed competitor to one of America's most productive sectors.

If one were to imagine the ideal sectoral outcome of expanded trade with China, it would be difficult to describe a result better than that of the U.S. aircraft industry. As China's consumer markets became wealthier from foreign trade, a larger middle class increased demand for consumer goods and services like air travel. American producers, well-positioned from years of competition with other large firms in the global market, sold more passenger aircraft – a capital-intensive, advanced manufacturing job-creating finished good – directly from U.S. factories to China's market. In 2017, the top export from the U.S. to China was civilian aircraft, with a value of $16.3 billion.[40]

That China has singled out the most successful American industrial product in its markets for competition, then, is notable. Air and spacecraft, and the related technologies required to mass-produce them, represent perhaps the highest end of the value chain in exportable goods in the global economy in terms of value and scale required for production. If the Chinese government can use its tools of state to weaken the U.S. position in the highest part of the value chain, without corresponding U.S. innovations, then even the most basic case for mutual benefit based on comparative advantage has been undermined. The potential

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[39] Mike Lombardi, "50 Years at the Leading Edge," The Boeing Company, August 2009, https://www.boeing.com/news/frontiers/archive/2009/august/i_history.pdf.
[40] Subhayu Bandyopadhya, Asha Bharadwaj, and Suryadipta Roy, "Taking a Closer Look at U.S. Exports to China," Federal Reserve Bank of St. Louis, https://www.stlouisfed.org/publications/regional-economist/third-quarter-2018/closer-look-exports-china.

consequence of *MIC2025's* goals for civilian aircraft, then, should be clearly understood.

After failed attempts to create its own industry in the 1970s, in 2008 China formed the Commercial Aircraft Corporation of China (COMAC) to develop the C-919, an indigenous large passenger aircraft.[41] *MIC2025* sets a goal for domestic commercial aircraft to supply 20 percent of the global market and regional delivery planes to capture 40 percent of the global market by 2025.[42] The implication of this goal is clear: Boeing and Airbus currently occupy the vast majority of the market, so meeting *MIC2025*'s targets requires reducing their market share.[43] *MIC2025* also sets goals for high-end aircraft parts, including the completion of the CJ-1000A turbofan by 2020 and commercial use by 2025, and a 30 percent market share for domestically-produced regional aircraft components by 2025.

While still in its testing stage, and despite suffering significant setbacks in timeline, the C-919 reportedly has more than 1,000 orders and commitments, nearly all from domestic airlines except for an order from the U.S. firm General Electric (G.E.) Capital Aviation Services.[44] By comparison, Airbus delivered its 1,000th plane in 2013, after nearly 20 years in the market.[45] Though the order sheet's quantity is ill-defined (the timeframe for more formal commitments and delivery remains unclear), the figure serves as a signal of China's commitment to using its domestic market to service the goals of *MIC2025*.

An order for the plane by an American firm is worth noting in its context. This future demand by a U.S. company for the plane intended to be a competitor to a significant U.S. export sector appears to be driven, at least in part, by the use of G.E. parts in the C-919. As Brad Setser of the Council on Foreign Relations commented, it is "striking that GE's [joint venture] to supply avionics to the C-919 is used as an example of successful collaboration" because "the C-919 is meant to displace Boeing 737s from China's market – and civil aircraft are currently America's leading export to China (and the world)."[46]

G.E. is not alone among Western firms in supplying the development of the C-919. Evidence from other suppliers suggests China requires joint ventures for various kinds of aircraft supply products, and even for some finished goods.[47] For example, the American company Honeywell provides support systems for the C-919, and has a joint venture with the largest aircraft manufacturer in the country, the state-owned Aviation Industry Corporation of China (AVIC).[48]

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[41] Derek A. Levine, *The Dragon Takes Flight*, Brill, 2015.
[42] Amanda Lee, "China's Aviation Industry has a Steep Climb to 'Made in China 2025' Goals," *South China Morning Post*, October 29, 2018, https://www.scmp.com/business/article/2170746/chinas-aviation-industry-has-steep-climb-made-china-2025-goals.
[43] Jon Sindreu, "How China Could Challenge the Boeing-Airbus Duopoly," *Wall Street Journal*, January 6, 2019, https://www.wsj.com/articles/how-china-could-challenge-the-boeing-airbus-duopoly-11546786800.
[44] Brenda Goh and Tim Hepher, "Ready for take-off? China's answer to Boeing now just needs to sell," *Reuters*, April 24, 2017, https://www.reuters.com/article/us-china-aviation-comac-analysis/ready-for-take-off-chinas-answer-to-boeing-now-just-needs-to-sell-idUSKBN17Q2F8.
[45] Airbus, "Airbus in China," https://www.airbus.com/company/worldwide-presence/china.html.
[46] Brad Setser, Twitter Post, https://twitter.com/Brad_Setser/status/1045026757437517826.
[47] Lingling Wei and Bob Davis, "How China Systematically Pries Technology From U.S. Companies," *Wall Street Journal,* September 26, 2018, https://www.wsj.com/articles/how-china-systematically-pries-technology-from-u-s-companies-1537972066.
[48] Xinhua, "Honeywell, AVIC to extend cooperation in flight control systems," December 9, 2018, http://www.china.org.cn/business/2018-12/09/content_74255399.htm.

Boeing opened its first 737 finishing plant in China last year,[49] and Airbus has operated a joint venture with a Chinese firm since 2008, an operation that was expanded in 2017.[50]

The bilateral U.S.-China relationship in aircraft represents an example of how a purely firm-centric trade policy, in which the framework is characterized mostly by the reaction and interests of U.S. firms, could present situations that have the potential to counteract the national interest. At least 10 U.S. suppliers to the C-919 program have joint ventures partnerships in China, according to the RAND Corporation,[51] even though the future end product is intended to be a competitor to the largest U.S. export to China. Are increased exports of supply parts in the present worth reduced exports of the finished good in the future? The immediate term does not demand an answer. The arrangement will hold for all U.S. partners so long as the C-919 poses little threat to U.S. aircraft exports, allowing U.S. firms to sell supplying goods or assemble aircraft more cheaply for China's airlines. While the description may match reality now, this waypoint is not the goal of *MIC2025*.

Interviews conducted by the RAND Corporation[52] suggest U.S. firms are aware of this tension, and understand that as China's market develops, aircraft industry leaders are at risk of investing in a potential competitor. But this awareness does not yet appear to bear impact on discrete production decisions, at least relative to the benefits to firms listed. According to the RAND study, U.S. firms note the benefits of participation as "a marketing tool" or to "enhance the company's image in China" – the goal being, of course, increased sales there. Though increased sales in the medium-term increase firms' growth and extends profit time horizons in the event of a prolonged transition to the C-919, little is said of long-term competitive advantage in this market. One of the more revealing findings of the RAND Corporation report is that U.S. firms did not openly oppose the C-919 joint venture requirement, "rather, they sought assistance from the U.S. government in crafting a winning bid, including the creation of a joint venture."[53]

Though a very sizable gap remains between China's industry and its U.S. and E.U. competition in aircraft, the future demand of what is expected to become the world's largest airline travel market, and maintenance of industrial policy (like required joint ventures) successful in other industries have put in place the structural elements for catching up. Setser estimates the current level of orders for the C-919, if fulfilled, would represent up to 500 fewer exports of Boeing 737 aircraft,[54] or about 25 percent of all aircraft Boeing has exported to China so far.[55]

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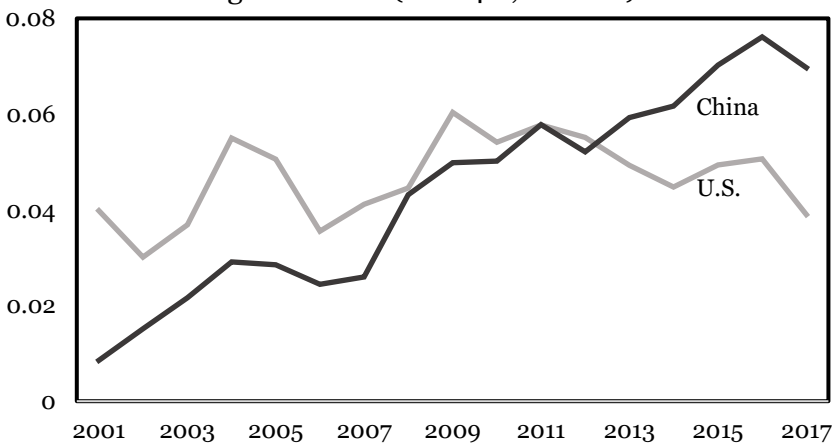
[49] Bloomberg News, "Boeing to Open Its First 737 Plant in China Under Shadow of a Trade War," *Bloomberg*, December 13, 2018, https://www.bloomberg.com/news/articles/2018-12-13/boeing-s-first-china-737-plant-to-open-in-shadow-of-trade-war.
[50] "Airbus in China."
[51] Keith Crane, Jill E. Luoto, Scott Warren Harold, et. al., "The Effectiveness of China's Industrial Policies in Commercial Aviation Manufacturing," RAND Corporation, 2014, https://www.rand.org/content/dam/rand/pubs/research_reports/RR200/RR245/RAND_RR245.pdf.
[52] Ibid.
[53] Ibid.
[54] Brad Setser, Twitter Post, "China - because of its domestic market structure - doesn't have to produce a technological competitor to the latest 737s and A320s to substantially cut into U.S. exports. 1000 orders for C919 to the first order approximation = 500 fewer 737s. https://twitter.com/Brad_Setser/status/1082328476848455680.
[55] Simple Flying, "Boeing Delivers Its 2000th Jet To China – Is This Boeing's Biggest Market?" https://simpleflying.com/boeing-delivers-its-2000th-jet-to-china-is-this-boeings-biggest-market/.

While industry opinion for the C-919's ability to develop as quickly leans skeptical, even a subpar passenger aircraft may pose a threat due to the Chinese government's control over its domestic airlines and ability to provide sizable export financing.

China has moved up the value chain quickly in other elements of the aircraft industry. For example, since 2001 China has increased its global market share of the four-digit HS line for turbojets, turbopropellers, and other gas turbines six fold, while the U.S. share has remained roughly constant. While trade data at levels of great detail can have high levels of variance, the comparison of at least one part of the supply chain paints a picture of development.

Figure 4.

Share of export market in turbojets, turbopropellers, and other gas turbines (HS 8411, UN ITC)



[56]

The Chinese government likely places great priority on producing passenger aircraft for the same reasons the U.S. does: large global markets for goods yields domestic employment and productivity. The U.S. aircraft industry's 2017 trade surplus was the largest of any domestic manufacturing industry, and aircraft production directly employs nearly 500,000 workers in scientific and technical jobs, and over 700,000 in related fields.[57] American airlines occupied the second, third, fourth, and eighth positions among global competitors for revenue in 2017 – and all were above Chinese firms.

The U.S. aircraft industry represents one of the most successful examples of industrial management in terms of global market share, at least compared to other industries targeted by *MIC2025*. It occupies the highest position on the value chain, with finished aircraft occupying the highest average per-unit value of all significant U.S. exports from 1998 to 2017,[58] and its U.S. makers have maintained high and constant position in the global marketplace.

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[56] United Nations COMTRADE, compiled by the International Trade Center's "Trade Map," https://www.trademap.org/Index.aspx.
[57] Select USA, "The Aerospace Industry in the United States," https://www.selectusa.gov/aerospace-industry-united-states.
[58] Staff calculation from U.S. Census Bureau.

It is no coincidence that American dominance in the global aircraft industry has occurred in conjunction with significant (though international trade-law compliant)[59] policy priority. Large export margins in civil aircraft are not simply the natural outcome of market forces set loose by expanded trade with China, but are the product of consistent and strategic maintenance. Government contracts, export financing,[60] and priority of dispute settlement cases are just a few examples of how the U.S makes a priority of aircraft manufacturing. This selection of priority is not unique to the U.S. That the WTO has ruled against the E.U. for subsidies to Airbus should indicate state priority for aircraft production is common to countries with the capacity to make them, likely due to aircraft's high position on the value chain.[61]

Given uncertainty for the long-term availability of Chinese consumer demand for foreign aircraft, the risk-beating value may be found in future innovation. Boeing has begun the development of the 737 Max, its latest large passenger aircraft model, which some observers expect to render the C-919 obsolete. If this is the case, either for the 737 Max or for other innovation in aircraft, and the Chinese government carries through on its promise of corralling its own airlines to buy only C-919s, China's airlines will face considerable cost pressure relative to its global competitors. If recent history is an indicator, domestic innovation in the U.S. at the moment of ambition in the Chinese aerospace industry would significantly set back the time horizon for developing a competitive passenger aircraft.

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[59] This has been proved by the outcomes of numerous dispute settlement cases at the WTO. See "US victory as WTO overturns Boeing state aid ruling," by Peggy Hollinger and Jim Brunsden, *Financial Times*, September 4, 2017, https://www.ft.com/content/861449ae-918e-11e7-bdfa-eda243196c2c.

[60] This is not an endorsement of any particular set of policies, but instead a recognition that they exist, and exist downstream from a prior commitment to the existence of such production in the United States. Whether government export financing for aircraft is necessary in a low-interest rate, cash-flush capital market is beyond the scope of this report. For context, see "Boeing *loves* the Export-Import Bank, but Boeing doesn't *need* the Export-Import Bank" by Tim Carney, *Washington Examiner*, February 17, 2017, https://www.washingtonexaminer.com/boeing-loves-the-export-import-bank-but-boeing-doesnt-need-the-export-import-bank.

[61] As one Canadian trade attorney put it, "The aerospace industry – I don't care what country you're in – is highly, highly subsidized by domestic governments." https://globalnews.ca/news/3773916/bombardier-boeing-subsidies/.

NEW ENERGY VEHICLES

> *"The automotive industry faces disruptive change on multiple fronts… The trap arises from the fact that compared to investing for the future, focusing entirely on the near-term wins— until it doesn't."*
>
> – Robert C. Wolcott, Clinical Professor of Innovation and Entrepreneurship in Executive Education, Kellogg School of Management, Northwestern University, 2017[62]

- *MIC2025* sets ambitious production targets for New Energy Vehicles (NEVs) and provides funding for research and development, subsidies to manufacturers, and technology transfer policies in order to meet these goals.
- The extent of China's bet on NEVs characterizes the risks associated with economic planning, given current consumer market preferences, while also presenting possible future risks to U.S. industry.
- In the U.S., car manufacturers are independently investing in NEVs, with limited policy support.

The inclusion of New Energy Vehicles (NEV)[63] as a target industry in the *MIC2025* roadmap is unsurprising. The Chinese government has made the development of its NEV sector an official priority since at least 2010,[64] and it has yielded results. In 2017, China's passenger car sales reached 25 million, which represented 35 percent of the global market. That same year, the U.S. passenger car market accounted for 8.6 percent.[65] In addition to having the largest general passenger car market in the world, China has the largest NEV market, with an estimated one million NEV vehicles sold in 2018.[66]

China aims to put 2 million domestically-made NEVs on the road per year by 2020 – twenty times the number predicted in the US for the same year – and three million per year by 2025. *MIC2025* also sets ambitious goals for indigenous technological capacity growth, as well as for global brand-name leadership, aiming to place two Chinese NEV companies in the top 10 global passenger car companies in global sales by 2025, and ensuring at least 10 percent of China's NEV sales are in foreign markets.[67]

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[62] Robert C. Wolcott, "Lead Change Or Decline: The Future Of The Automotive Industry – And Every Industry," *Forbes*, December 14, 2017, https://www.forbes.com/sites/robertwolcott/2017/12/14/lead-change-or-decline-the-future-of-the-automotive-industry-and-every-industry/#7b07df1511e4.
[63] In its 2010 designation of NEVs as a Strategic Emerging Industry, the Chinese government used the term "New Energy Vehicle" to mean both hybrid vehicles and pure-electric vehicles. However the Chinese government's strong preference for promoting the development of the full-electric vehicle market over the hybrid market has become clear in recent years, and is reflected in the distribution: of the more than 1 million new NEVs in 2018, three out of every four were battery-powered pure-electric vehicles. See Scott Kennedy, *China's Risky Drive into New-Energy Vehicles*, Report, Center for Strategic and International Studies.
[64] In 2010, the Chinese government designated NEVs as one of seven "strategic emerging industries."
[65] Ibid.
[66] "China Is About to Shake Up the World of Electric Cars," *Bloomberg.com,* https://www.bloomberg.com/news/articles/2018-11-14/china-is-about-to-shake-up-the-world-of-electric-cars-quicktake.
[67] U.S. Chamber of Commerce, "Made in China 2025: Global Ambitions Built on Local Protections," 2017, https://www.uschamber.com/sites/default/files/final_made_in_china_2025_report_full.pdf.

The general direction of these goals is clear: the creation of a self-sufficient, thriving, technologically-superior domestic NEV market to compete in the global market. Automobiles are currently the U.S.' second-largest finished goods export to China. In addition to cutting reliance on foreign automakers, the achievement of this goal has the potential to solve several strategic problems for China, including its reliance on foreign oil[68] and its well-known challenges with air pollution.

Notably, NEV goals are in line with what researchers Llewelyn Hughes and Jonas Meckling have called the "innovating up" strategy, in which "follower" countries in technological innovation like China "adopt policies that support research and development to develop differentiated high-tech products for export," instead of directly competing with incumbent producers abroad.[69] By this strategy, the development of an indigenous NEV industry represents a potential competitive advantage in the global automobile industry. The Chinese automobile industry has never managed to fully compete on the quality of its internal combustion engine vehicles (ICV), as American and European automobile firms have maintained consistent market shares by relation, and despite including target goals for hybrid vehicles in *MIC2025,* the party-state also appears to have calculated Japan and others will maintain a lead in hybrid technology superiority.[70]

Leadership in the NEV market represents an opportunity for the Chinese domestic sector to compete and win in a key segment of the auto market – not just in consumer market size, which it already leads, but in technological and brand leadership as well.[71] With only 106 cars per 1,000 people (versus 800 per 1,000 in the US), China's domestic automobile market presents a significant growth opportunity.[72] Developing globally competitive name-brand vehicles was an essential component of both Japan's and South Korea's economic development, a fact not lost on the Chinese government.

Aggressive state action has driven both the supply and demand for NEVs. The extent of the support is significant. Between 2009 and 2017, these efforts cumulatively represented $58.8 billion in government support for the NEV industry, equal to approximately 42 percent of the value of all NEV sales.[73]

On the supply side, the Chinese government has heavily funded research and development into NEV component technologies, especially batteries, established emission guidelines to incentivize domestic NEV production, and forced technology transfers from foreign participants in NEV joint ventures.[74] The

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[68] China eclipsed the U.S. as the largest net importer in 2013.
[69] Llewelyn Hughes and Jonas Meckling, "Policy competition in clean technology: Scaling up or innovating up?" *Business and Politics*, 20(4), 2018 588-614, doi:10.1017/bap.2018.20.
[70] Scott Kennedy, *China's Risky Drive into New-Energy Vehicles*, Report, Center for Strategic and International Studies.
[71] Case in point: Only four of the top ten best-selling auto brands in China are domestically produced, and two of those four are joint ventures that rely heavily on foreign know-how. All of the 15 top-selling NEV brands in China, by contrast, are domestically produced, and *C2025* aims to place at least two domestic NEV companies in the top ten car companies as measured by global sales.
[72] Kennedy, China's Risky Drive.
[73] Ibid.
[74]Prior to 2017, China required any joint venture to lead to China's mastery of at least one of the three technologies essential to NEVs. In 2017, China began requiring NEV joint ventures to lead to China's mastery of all three, as well as mandating that joint ventures must produce new brands not affiliated with the foreign partner. In 2018 China began to phase out the forced technology transfer requirements, but the hunger for core technical mastery is clear.

Chinese government has also largely banned foreign-made batteries from the market and created a "dual credit" system in which automobile manufacturers receive credits for NEV vehicles and are responsible for meeting a minimum threshold of credits, creating a production market within the industry.

On the demand side, the Chinese government heavily subsidizes NEV manufacturers to help drive down sales prices, exempts NEV purchases from sales tax, and restricts the issuance of license plates to traditional ICVs (especially in urban areas) but not to NEVs. The nation has invested heavily in electric car charging infrastructure and uses its procurement policy to act as a major buyer of NEVs.[75]

This systematic promotion of the industry appears to have yielded strong growth. NEV passenger car sales grew from 600,000 in 2017 to 1 million in 2018, and despite a leveling-off of automobile sales generally in China, continue to grow at a pace that puts it on track to reach its goal of NEVs accounting for 20 percent of all automobile sales by 2020.[76] In 2018, Ford[77] and General Motors[78] announced new electric car model production in China, and Tesla announced it would build its "Gigafactory 3" in Shanghai.[79] The Chinese firm Qiantu Motor announced last year its intent to sell the first Chinese automobile company-produced car, a luxury electric sedan, in the U.S.[80]

This growth does not come without some instability, however. The NEV sector is not yet profitable and has yet to indicate it can survive without government support. China's leading NEV manufacturer, BYD, posted a 72 percent drop in 2018 first-half profits due to reduced state subsidies; profitability is expected to improve again with the institution of new subsidies.[81] Despite this lack of independent viability, there more than 100 NEV makers in China. As with much of China's investment-driven growth, oversupply is the open question. Without the heavy incentives provided by the government, demand remains weak among the Chinese consumer base, and NEVs do not yet compare with ICVs concerning quality, range, reliability, and other consumer concerns. Further hits to consumer demand due to a domestic economic slowdown have left expensive automobile factories sitting idle.[82]

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[75] Other policies prop up the domestic industry and discourage foreign market entry as well. For example, China deliberately builds its electric car charging infrastructure to its own standards, and insists that all electric vehicles submit continual, real-time position information to the government (another form of potential forced technology transfer). This list does not mention the general 15 percent tariff imposed on imported automobiles (down temporarily from 25 percent), and extensive global efforts to secure an independent supply chain of critical component materials (e.g. cobalt in the Democratic Republic of the Congo).
[76] Kennedy, China's Risky Drive.
[77] Tom Hancock, "Ford to launch electric vehicles in China," *Financial Times*, December 5, 2017, https://www.ft.com/content/3fe38e12-d9c9-11e7-a039-c64b1c09b482.
[78] Steve Hanley, "GM Boosting Number Of Electric Car Models In China To 20," *Clean Technica,* June 6, 2018, https://cleantechnica.com/2018/06/06/gm-boosting-number-of-electric-car-models-in-china-to-20/.
[79] Sean O'Kane, "Tesla signs agreement to build cars in China," *The Verge,* July 10, 2018, https://www.theverge.com/2018/7/10/17553094/tesla-china-gigafactory-cars-deal-agreement.
[80] Michael J. Coren, "For the first time, a Chinese car is coming to the US—and it's electric," *Quartz*, December 18, 2018, https://qz.com/1500303/chinas-qiantu-will-be-first-chinese-electric-carmaker-to-challenge-tesla-in-the-us/.
[81] "BYD Posts 72.2 Percent Fall in First-half Profit as Beijing Cuts…" *Reuters*, August 29, 2018, https://www.reuters.com/article/us-byd-results/byd-posts-72-2-percent-fall-in-first-half-profit-as-beijing-cuts-subsidies-idUSKCN1LE1JM.
[82] Trefor Moss, "China's Car Slump Leaves Foreign Auto Makers With Idle Factories," *Wall Street Journal,* December 25, 2018, https://www.wsj.com/articles/idle-hands-in-china-workshops-as-foreign-car-makers-struggle-with-zombie-factories-11545750002.

While this outcome indicates a partial weakness of development model, the long-term risk to U.S. industry remains real. Overcapacity combined with slow consumer demand inside China may drive a renewed focus on exports, though there is much room for U.S. makers to absorb. While there are now approximately one million plug-in cars on the road in the U.S.,[83] the American electric car market's growth does not compare to China's. Only 0.2 percent of vehicles on the road in the U.S. are electric. There were 361,307 electric cars sold in the U.S. in 2018, up sharply from 199,826 in 2017 due almost entirely to Tesla, which sold 139,782 Model 3s in 2018. Tesla alone accounts for over half of all U.S. plug-in vehicle sales. The second-bestselling electric vehicle was the Toyota Prius Prime, which sold less than 30,000.[84] The U.S. electric vehicle supply-chain is not primarily domestic-sourced, with the most critical element (the lithium-ion cells that form the basis of EV batteries) coming primarily from Japan and South Korea. Furthermore, China already controls some key elements of the electric vehicle supply chain – for example the capacity to refine cobalt (a critical component in the production of lithium-ion batteries), ninety percent of which is controlled by China.[85]

U.S. policy support is much more limited compared to China's program. While the U.S. provides some general support in the form of the federal tax credit for research and development, some support to the battery industry, and some sales tax relief for purchases, the truly aggressive efforts have largely been undertaken by states (notably California, with strict emission standards, a long-term commitment to zero-emissions, and its own buyer subsidies).[86]

The ultimate impact of the U.S. and China approaches remains to be seen. The risk China faces is an outcome in which it does not ultimately have the power to shape global consumer demand for vehicles. If electric vehicle efficiency and quality don't reach the necessary levels, it is not clear domestic or global consumer demand is sufficient to justify China's investment levels.[87] It is notable that Tesla, the most successful American entrant into the electric vehicle market, succeeded with the help of a $451.8 billion 2010 loan from the U.S. Department of Energy's Advanced Technology Vehicle Manufacturing program, a loan it repaid ahead of schedule in 2013.[88]

The potential threat to the U.S. is long-term: should China have bet correctly on electric vehicles, and should global demand begin to shift away from internal combustion to electric vehicles on a large scale, the U.S. industry may be unable to meet demand. If so, China may be poised to overtake the U.S. Even if most of the firms producing the Chinese economy's exports in the sector are American and European, their productive capacity for NEVs is being built in China, within

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[83] "Plug-In Electric Cars Sales In U.S. Surpass 1 Million," Inside EVs 81 of Electric Vehicle Charging Is Done at Home Comments, October 8, 2018, https://insideevs.com/1-million-electric-cars-sold-us/.
[84] Julia Pyper, "US Electric Vehicle Sales Increased by 81% in 2018," *Greentech Media*, https://www.greentechmedia.com/articles/read/us-electric-vehicle-sales-increase-by-81-in-2018#gs.7fGS9wyV.
[85] "Global EV Outlook 2018: Towards cross-modal electrification," OECD/IEA, 2018, www.iea.org.
[86] It should be noted that even the limited federal efforts to promote the EV market are the subject of serious debate and disagreement.
[87] The Chinese government has recently started investing heavily in fuel cell vehicles, perhaps realizing the danger of putting all its eggs in one basket. See: Henry Sanderson, "Hydrogen power: China backs fuel cell technology," *Financial Times*, January 1, 2019, https://www.ft.com/content/27ccfc90-fa49-11e8-af46-2022a0b02a6c.
[88] "Tesla Repays Department of Energy Loan Nine Years Early." Tesla, May 22, 2013, https://www.tesla.com/blog/tesla-repays-department-energy-loan-nine-years-early.

the sphere of influence of the Chinese government and its priority of developing indigenous competitors.

At the same time, leading American car manufacturers like GM[89] and Ford[90] are investing in electric vehicles. The question is whether U.S. policy will concern itself with these long-term strategic concerns, not simply as a matter of competing with China's policy offerings for NEVs, but for innovation in automobile production more generally, including autonomous vehicles and cheaper production of existing models. Should global demand shift and the U.S. automobile industry not be prepared to meet it with growth areas of its own, the industry as a whole – including the many small businesses which supply and service it – is at risk.

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[89] "General Motors Calls for National Zero Emissions Vehicle (NZEV) Program," General Motors, October 26, 2018, https://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2018/oct/1026-emissions.html.

[90] Keith Naughton, Ryan Beene and Gabrielle Coppola, "Ford Goes 'All In' on Electric Cars," *Bloomberg*, January 14, 2018, https://www.bloomberg.com/news/articles/2018-01-14/ford-doubling-electric-vehicle-spending-to-11-billion-by-2022.

NEXT-GENERATION INFORMATION TECHNOLOGY

> *"The inventor … looks upon the world and is not contented with things as they are. He wants to improve whatever he sees, he wants to benefit the world; he is haunted by an idea. The spirit of invention possesses him, seeking materialization."*
>
> – Alexander Graham Bell to the Patent Congress, 1891[91]
>
> "*…if you control the code, you control the world."*
>
> – Marc Goodman, *Future Crimes*, 2015[92]

- Next generation information technology goals in *MIC2025* include the development of domestic capabilities in semiconductor production and information technologies, as well as forward-looking innovations such as artificial intelligence and 5G.
- Chinese technology companies not only receive large amounts of government support but are also increasingly intertwined with the party-state.
- American technology companies retain their positions as industry leaders, though digital firms face headwinds.

MIC2025 consistently places next-generation information technology (IT) first in its list of critical strategic industries. The centrality of next-generation IT to China's economic thinking is not a recent development. In 2010, the Chinese government's State Council designated next-generation information technology as one of its seven "strategic emerging industries,"[93] and the sector remains fundamental to China's industrial policy. The first sentence of the first section of one translation of the State Council's *MIC2025* document begins with an expansive view: "The deep integration of next generation IT into manufacturing is triggering far-reaching industrial transformation… China's manufacturing sector is facing a great opportunity,"[94] China's assessment appears to be that next-generation IT leadership will be critical to advancing its value chain position.

MIC2025 frames its ambition in the terms of development of component IT technologies (specifically semiconductors) and information technology and telecommunications.[95] China's race for global dominance in next-generation IT represents the leading edge of global industrial competition, a reality reflected by the growth of state-supported IT companies like Huawei, ZTE, Alibaba, and Tencent. This is reflected in *MIC2025*, which states that IT advancement is central to the realization of its goals in other industries (like robotics and

[91] Jennifer Groundwater, *Alexander Graham Bell: The Spirit of Innovation* (2018), James Lorimer & Company.
[92] Marc Goodman, *Future Crimes* (Random House, 2015).
[93] The US-China Business Council, "China's Strategic Emerging Industries: Policy, Implementation, Challenges, & Recommendations," March 2013, https://www.uschina.org/sites/default/files/sei-report.pdf.
[94] State Council, Made in China 2025.
[95] Ibid.

aerospace equipment), and which expresses urgency in other priority industries (like new advanced materials) due to their position in the IT supply chain.[96]

MIC2025's stated goals are ambitious. The plan aims for an annual growth rate of 20 percent per year in the integrated circuit (IC) industry, and an IC supply chain on par with "advanced international levels" by 2030. This would represent significant advancement. China is highly dependent on foreign industry for its chips, with more than 90 percent of its supply coming from foreign sources in 2017.[97] China's dependence on foreign industry is not primarily in chip design or testing but production, which requires highly specialized equipment Chinese industry has not yet mastered. According to the *Financial Times*, China is currently only capable of producing what Dutch semiconductor company ASML could do fifteen years ago. Brett Simpson of Arete Research sums it up: "You cannot build a semiconductor facility without using the big major equipment companies, none of which are Chinese. If you fight a war with no guns you're going to lose. And they don't have the guns." This reality underlies *MIC2025's* sense of urgency to develop China's own domestic chip capacity and supply chain, and the level of resource China is willing to commit to achieving it. *MIC2025* calls for growing the scale of the National IC Industry Investment Fund,[98] and President Xi Jinping has recently pledged $150 billion to support the sector.[99]

The Chinese government's goals concerning telecommunications and information technology are similarly lofty. *MIC2025* calls for China's leadership in mobile communications, internet technology, and advanced computers and servers. The Chinese government wants Chinese industry to lead in mobile communications, including the development of 5G technology and standards, and aims for China-produced mobile telecommunications equipment, mobile terminals, and mobile terminal chips to reach 40, 45, and 20 percent of global market share by 2025, respectively.[100] Similar targets are set for the global market share of next-generation internet routers and switches (25 percent by 2025) and advanced computers and servers (40 percent by 2025).[101]

The scale of these goals should be appreciated. The global technology market was predicted to reach $3 trillion in 2018, by one estimate.[102] The 2018 *Forbes* Global 2000 lists 54 telecommunications companies, which together claim over $3.4 trillion in assets.[103] Success by the terms of *MIC2025* would mean record performance.

China's national champion companies in telecommunications and information technology are highly visible and subjects of international scrutiny, making clear

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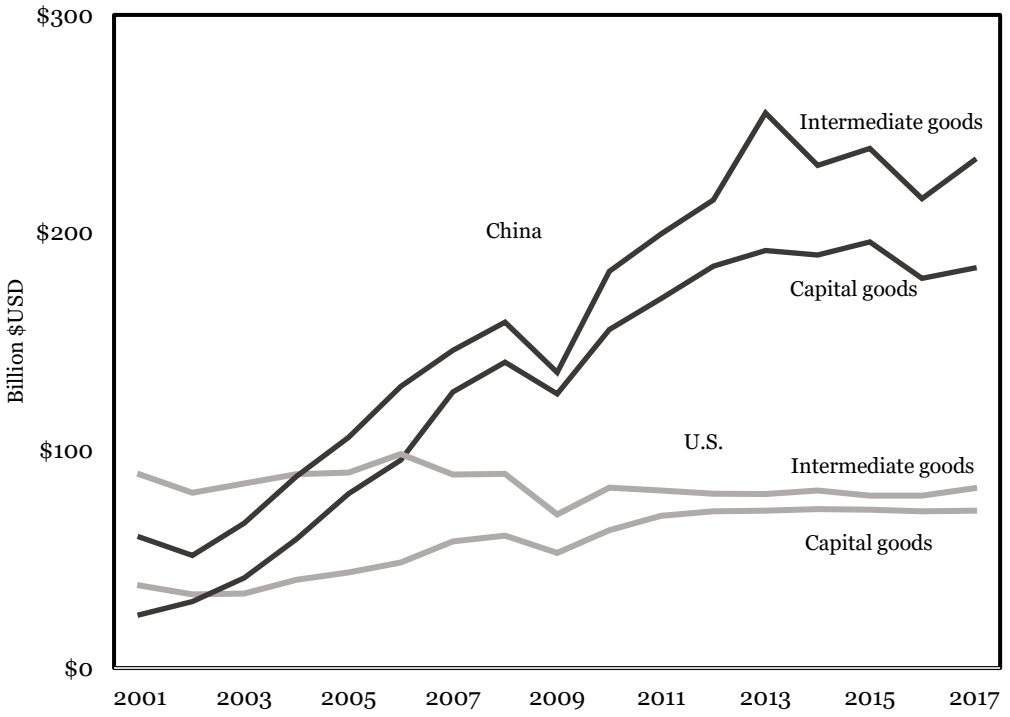
[96] Ibid.
[97] "The US Government Announced a Deal Thursday to Lift a Ban on ZTE (ZTCOF) from Buying Parts," "China Is Trying to Kick Its Dependence on Foreign Computer Chips," CNNMoney, https://money.cnn.com/2018/06/08/technology/china-computer-chips-foreign-reliance/index.html.
[98] U.S. Chamber.
[99] Emily Feng and Kathrin Hille, "China Vulnerable in War with US over Computer Chips," *Financial Times,* December 03, 2018, https://www.ft.com/content/4a8553a6-f3b2-11e8-ae55-df4bf40f9d0d.
[100] U.S. Chamber.
[101] Ibid.
[102] Andrew Bartels, "Global Tech Market Will Grow By 4% In 2018, Reaching $3 Trillion," *Forbes,* October 18, 2017, https://www.forbes.com/sites/forrester/2017/10/18/global-tech-market-will-grow-by-4-in-2018-reaching-3-trillion.
[103] Jonathan Ponciano, "The World's Largest Telecom Companies 2018: AT&T, Verizon Remain On Top As Sector Struggles," *Forbes*, June 6, 2018, https://www.forbes.com/sites/jonathanponciano/2018/06/06/worlds-largest-telecom-companies-2018.

how China and international actors understand these firms to represent the possibility, or threat, of China's IT dominance. Nine of the world's twenty largest technology companies in the world are from China.[104] Huawei Technologies is the world's largest producer of telecommunications equipment[105] and in 2018 became the world's second-largest producer of smartphones (after Samsung, displacing Apple), with stated aims to become number one by 2020.[106] A 2018 report by Bloomberg found that private equity and venture capital investment in China's technology companies grew from $14 billion to $120 billion in five years (2012-2017); 34 Chinese start-ups were valued at over $1 billion in 2017, and Alibaba predicted 55 percent growth in 2018.[107] In the period since joining the WTO, China went from lagging the U.S. in both intermediate and capital ICT goods exports, to leading with advantages of $151 billion and $111 billion, respectively (depicted in Figure 5).

Figure 5.

Global information communication technology (ICT) manufacturing exports, 2001-2017 (OECD)



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[104] Sally French, "China Has 9 of the World's 20 Biggest Tech Companies," *MarketWatch*, May 31, 2018, https://www.marketwatch.com/story/china-has-9-of-the-worlds-20-biggest-tech-companies-2018-05-31.
[105] "Who's Afraid of Huawei?" *The Economist*, August 04, 2012, https://www.economist.com/leaders/2012/08/04/whos-afraid-of-huawei.
[106] Arjun Kharpal,"After Overtaking Apple in Smartphones, Huawei Is Aiming for No. 1 by 2020," *CNBC,* November 21, 2018, https://www.cnbc.com/2018/11/16/huawei-aims-to-overtake-samsung-as-no-1-smartphone-player-by-2020.html.
[107]Christopher Balding, "China Is Nationalizing Its Tech Sector," *Bloomberg.com*, https://www.bloomberg.com/opinion/articles/2018-04-12/china-is-nationalizing-its-tech-sector.
[108] OECD, STAN Bilateral Trade Database by Industry and End-use Category (BTDIxE), Goods by Industry and End-use, ISIC Rev.4. https://stats.oecd.org/.

China's technology companies are increasingly entangled with the party-state. According to the 2018 Annual Report of the Congressional-Executive Commission on China, proposed revisions to guidelines issued in June 2018 by the China Securities Regulatory Commission would require all listed companies to establish Chinese Communist Party groups.[109] Reports indicate many technology companies have already instituted Party committees.[110] Furthermore, China's authorities have contemplated taking ownership stakes in private technology firms, with board seats and direct Communist Party input into firm management.[111] The distinction between China's state-owned enterprises and its ostensibly private sector technology champion firms is increasingly blurry. In these ways and more, China's government utilizes the technology sector as an arm of the state's national apparatus. Wang Xiaochuan, the CEO of a Chinese search engine company, reportedly expressed the dynamic bluntly:

> *"We're entering an era in which we'll be fused together. It might be that there will be a request to establish a Party committee within your company, or that you should let state investors take a stake, you know, as a form of mixed ownership. If you think clearly about this, you really can resonate together with the state. You can receive massive support. But if it's your nature to want to go your own way, to think that your interests differ from what the state is advocating, then you'll probably find that things are painful, more painful than in the past."*[112]

This state of business contrasts with the U.S., in which the relationship between American technology firms and American policymakers have become more fraught as firms have grown in size. Recent concerns about privacy and the integrity of the use of individuals' personal data represent just the latest development in possible U.S. policy shift relating to its large technology firms, which remain the most profitable in the world.

China's firms have sought to use the American sector's relative market openness to their advantage, making large investments in U.S. startups in Silicon Valley,[113] listing on U.S stock exchanges, and selling to the American market, while simultaneously blocking in either absolute or conditional terms American technology companies from market access in China.[114] Moreover, Chinese technology firms have engaged in a different capital strategy than their U.S. counterparts. As Sequoia Capital partner Michael Moritz writes in the *Financial Times*, "[between] 2015 and 2017, the five biggest US tech groups (especially Apple and Microsoft) spent $228 [billion] on stock buybacks and dividends, Bloomberg data shows. During the same period, the top five Chinese technology

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[109] Congressional-Executive Commission on China, "2018 Annual Report," https://www.cecc.gov/publications/annual-reports/2018-annual-report.
[110] Emily Feng, "Chinese Tech Groups Display Closer Ties with Communist Party," *Financial Times,* October 10, 2017, https://www.ft.com/content/6bc839c0-ace6-11e7-aab9-abaa44b1e130.
[111] Li Yuan, "Beijing Pushes for a Direct Hand in China's Big Tech Firms," *The Wall Street Journal*, October 11, 2017, https://www.wsj.com/articles/beijing-pushes-for-a-direct-hand-in-chinas-big-tech-firms-1507758314.
[112] Balding, "China is Nationalizing."
[113] Michael Moritz, "China is winning the global tech race," June 17, 2018, https://www.ft.com/content/3530f178-6e50-11e8-8863-a9bb262c5f53.
[114] For a good example of this argument, see, "Tech Platforms: The New Battleground in the U.S.-China Strategic Competition," Report, Baron Public Affairs, LLC.

companies spent just $10.7 [billion] and ploughed the rest of their excess cash into investments that broaden their footprint and influence."[115]

The goals of *MIC2025* also extend into technologies which are not yet commercially viable. China's heavy investment in artificial intelligence (AI) and quantum computing make the point clearly. China's AI industry has grown 67 percent over the past year and produced more patents and research papers than its U.S. counterparts.[116] By one estimate, China currently has more than 30 times more capital invested in quantum research than the U.S. [117] Like in robotics, China has sunk considerable physical capital into this project, building a $10 billion National Laboratory for Quantum Information Sciences, set open in 2020. The sum of these efforts contrasts with a total U.S. investment of about $200 million a year into quantum research.[118]

As Chinese policymakers seek to draw level with the world in semiconductor production and dominate global telecommunications, it is also looking ahead to the next frontiers of technological innovation. The question for the U.S. is whether it can adequately respond not just to the immediate threats posed by individual Chinese technology companies, but to the long-term threats China's policy poses to the American technology sector. To quote testimony from James Lewis of the Center for Strategic and International Studies to the U.S. Trade Representative:

> *"What is new is that unfair trade, security and industrial policies, tolerable in a smaller developing economy, are now combined with China's immense, government-directed investment and regulatory policies to put foreign firms at a disadvantage…China now has the wealth, commercial sophistication and technical expertise to make its pursuit of technological leadership work. The fundamental issue for the U.S. and other western nations, and the IT sector is how to respond to a managed economy with a well-financed strategy to create a domestic industry intended to displace foreign suppliers."*[119]

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[115] Mortiz, China Tech Race.
[116] Pablo Robles, "China Plans to Be a World Leader in Artificial Intelligence by 2030," *South China Morning Post,* https://multimedia.scmp.com/news/china/article/2166148/china-2025-artificial-intelligence/index.html.
[117] Barb Darrow, "Alibaba's Cloud Unit Teams with Chinese Researchers on Quantum Computing," *Fortune*, July 30, 2015.
[118] Stephen Chen, "China Building World's Biggest Quantum Research Facility," *South China Morning Post*, September 11, 2017, https://www.scmp.com/news/china/society/article/2110563/china-building-worlds-biggest-quantum-research-facility.
[119] USTR 301 Report.

ADVANCED RAILWAY

> *"So far, 83% of all rail products in the world are operated by #CRRC or are CRRC ones. How long will it take for us conquering the remaining 17%?"*
>
> – China Railroad Rolling Stock Corporation (CRRC), @CRRC_global, Tweet on Twitter.[120]

- Like other sectors in *MIC2025*, advanced railway represents high-value capital goods production that also serves China's international economic aspirations.
- China has poured significant resources into its state-owned railway firms, which are expanding in countries across the world, including the U.S.
- Though the U.S. has implemented laws to require some domestic sourcing for rail transportation, China's firms continue in high export and revenue growth.

MIC2025's targets for advanced railway aim to increase production of a capital good to service China's internal economy and international shipping, while playing a role in China's attempts to expand its zone of economic influence, the primary example being the formation of a transcontinental railroad to service partner nations of the Belt and Road Initiative economic group, an international development plan to expand trade and investment infrastructure from China through Asia, Africa, and Europe.[121]

MIC2025's primary target for railway products, including rolling stock and locomotives, is 30 percent of the global market by 2020 and 45 percent by 2025 for rail transit equipment, and eventually occupation of the highest end of the global value chain in the industry. The China Railroad Rolling Stock Corporation (CRRC), the state-owned enterprise leading this production, reported revenues of more than $37 billion in 2015[122] — significantly outpacing the entire U.S. railcar market, which had $22 billion of output during the same year.[123]

China has utilized its large internal consumer market to quickly scale up its railway production firms. Benefiting from relatively-low rates of car ownership and the need for infrastructure to facilitate rapidly-growing trade volume, the Chinese railroad industry has grown quickly, and China is now home to the world's largest high-speed rail network, at over 15,000 miles. Chinese firms have built more than two-thirds of the world's entire high-speed rail in just over the last decade.[124] China is also the world's largest urban rail market and is expected

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[120] Erik Olson, "Securing America's critical infrastructure," *Washington Times*, January 16, 2018, https://m.washingtontimes.com/news/2018/jan/16/donald-trump-has-the-opportunity-to-outpace-chinas/.
[121] Brenda Goh and Marcin Goettig, "In Europe's east, a border town strains under China's Silk Road train boom," *Reuters*, June 26, 2018, https://www.reuters.com/article/us-china-europe-silkroad-insight/in-europes-east-a-border-town-strains-under-chinas-silk-road-train-boom-idUSKBN1JM34M.
[122] Macquarie Research, CRRC Corp Ltd, Too Big to Roll Too Fast (May 20, 2016), p. 3.
[123] Oxford Economics, Will We Derail US Freight Rolling Stock Production? (May 2017), p. 24.
[124] Tom Mitchell and Xinning Liu, "China's high-speed rail and fears of fast track to debt," *Financial Times*, August 13, 2018, https://www.ft.com/content/ca28f58a-955d-11e8-b747-fb1e803ee64e.

to increase its total railway freight volume to 4.2 billion tons by the end of the decade.[125]

With domestic market dominance achieved, China's export goals for rail in *MIC2025* are notable. Analysis by McKinsey & Company finds CRRC to be the clear market leader in railway manufacturing, capturing nearly one-third of the market for new vehicles in addition to standing as the top firm in market share for high-speed trains and metro cars.[126] A since-deleted tweet by a Twitter account affiliated with CRRC even claimed progress in excess of some stated goals, saying "So far, 83% of all rail products in the world are operated by #CRRC or are CRRC ones. How long will it take for us conquering the remaining 17%?"[127]

China depends on highly-leveraged export financing to underprice its exports of rail stock, guaranteeing it with government debt and relying on future income streams for repayment over a decades-long period. While this model increases total debt figures, for now, export growth has risen in tandem, with China eclipsing the U.S. export market share in rolling stock and closing the gap in rail locomotives.

Evidence suggests the Chinese government now seeks growth by tapping into the world's largest freight market: the U.S. According to testimony by the Rail Security Alliance, China is rapidly increasing its market presence in the U.S., including with local and state government partners. [128] This growth is corroborated by rapid growth in imports of rolling stock from China as a percent of total U.S. exports of the product, as rough proxy for comparing relative exports by China and the U.S. by end-use, which rose to nearly 20 percent before declining to a level in 2017 still nearly quadruple what it was in 2002 (depicted in Figure 6 on the following page).

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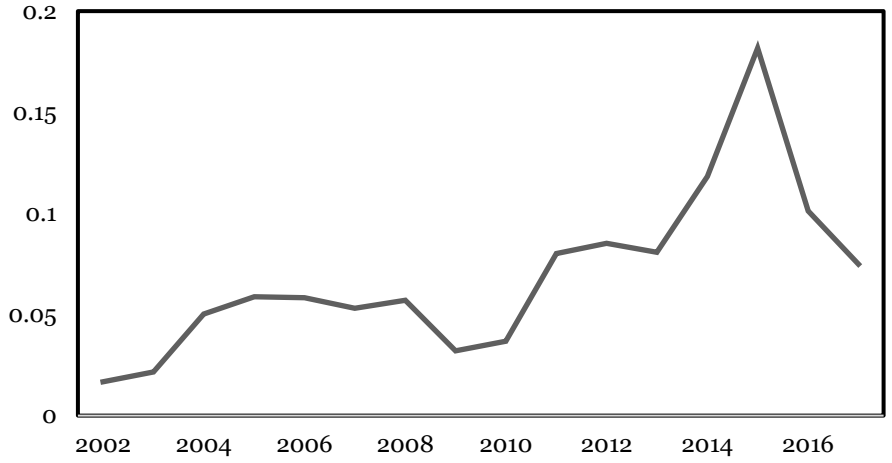
[125] "Due to the Lapse in Government Funding," Korea - Distribution and Sales Channels, https://www.export.gov/article?id=China-Rail-and-Urban-Rail.
[126] "Huge value pool shifts ahead – how rolling stock manufacturers can lay track for profitable growth," (McKinsey & Company, September 2016), https://www.mckinsey.com/~/media/McKinsey/Industries/Automotive%20and%20Assembly/Our%20Insights/How%20rolling%20stock%20manufacturers%20can%20lay%20track%20for%20profitable%20growth/How-rolling-stock-manufacturers-can-lay-track-for-profitable-growth.ashx.
[127] Erik Olson, "Securing America's critical infrastructure," *Washington Times*, January 16, 2018, https://m.washingtontimes.com/news/2018/jan/16/donald-trump-has-the-opportunity-to-outpace-chinas/.
[128] U.S. Congress, Committee on Banking, Housing, and Urban Affairs, *CFIUS Reform: Examining the Essential Elements,* January 18, 2018, http://railsecurity.org/wp-content/uploads/2018/01/RSA-CFIUS-Statement-for-the-Record.pdf.

Figure 6.

U.S. imports of China-source railroad rolling stock (NAICS 336510) as a percent of total U.S. exports in the same category (Census)



[129]

Recent action by the U.S. has influenced these developments. The Fixing America's Surface Transportation (FAST) Act (P.L. 114-94), enacted in 2015 (perhaps explaining some reduction in the level of China-source stock imports beginning in that year) increased the share of public transit rolling stock components and subcomponents that must be produced in the U.S. from 60 percent in fiscal year 2017 to 70 percent for years 2020 and beyond.[130]

While China's growth in the industry has been rapid, the U.S. remains home to large producers, and profitable freight and passenger rail networks. For example, the American company Union Pacific reported a 2017 revenue figure of $21.2 billion,[131] while the state-owned China Railway Corporation (CRC) reported $283 million in the same year.[132] So while U.S. firms continue high performance in freight services, growth in this particular segment of the industry can occur as a complement to greater import volume in addition to exports. In the manufacture of rolling stock, it is difficult to overstate the CRRC advantage over other firms. Research conducted by the European firm SCI Verkehr GmbH[133] displays the size of CRRC relative to the rest of the top 10 global manufacturers.

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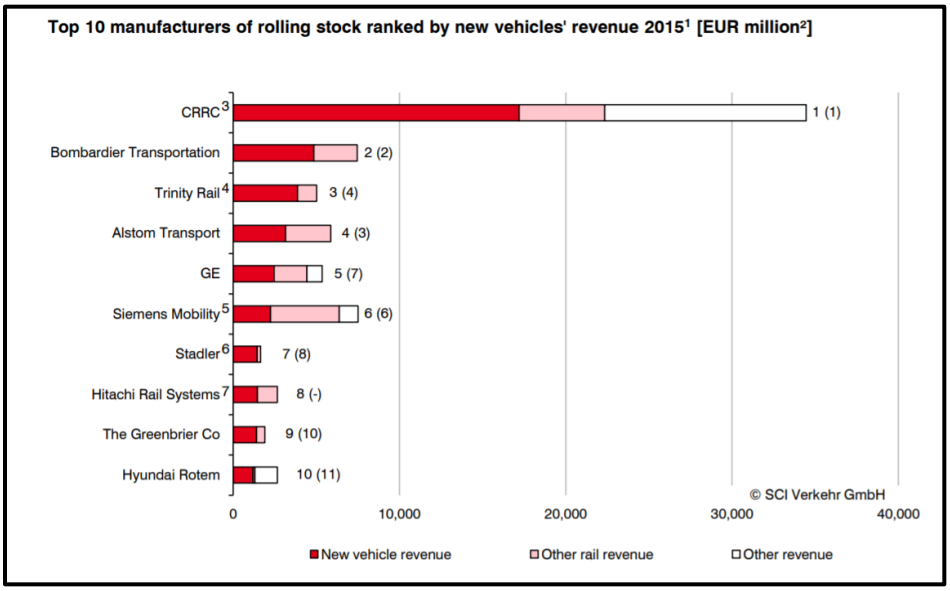
[129] U.S. Census Bureau, NAICS District-level Data, https://usatrade.census.gov.
[130] Michaela D Platzer and William J. Mallett, "Effects of buy America on Transportation Infrastructure and U.S. Manufacturing: Policy Options," (*Congressional Research Service,* 2017).
[131] "Union Pacific Reports Fourth Quarter and Full Year 2017 Results," Union Pacific, https://www.up.com/media/releases/180125-4q-earnings.htm.
[132] "China Railway Corp Announces Record 2017 Results," *CGTN,* https://news.cgtn.com/news/3d3d674d7a6b6a4d77457a6333566d54/share_p.html.
[133]Worldwide Rolling Stock Manufacturers Market Insights and Factsheets for Top 50 Manufactures and Overview of 180 companies and 330 Production Sites, (SCI Verkehr GmbH, 2016), https://www.sci.de/fileadmin/user_upload/Flyer_Hersteller_Schienenfahrzeuge.pdf.

Figure 7.



Research compiled by the Congressional Research Service indicates the U.S. domestic market for railroad rolling stock totaled $19 billion in 2016, and directly employed about 30,000 manufacturing workers. The American firms GE and Electro Motive Diesel (EMD) make up the U.S. share of global competitiveness in diesel locomotive production, though CRRC is also growing in the U.S., with production facilities in Massachusetts and Illinois.[134]

That this increase in CRRC's U.S. presence has occurred during the implementation of the FAST Act's "Buy America" rule should be instructive, as it demonstrates the limited effectiveness of production-sourcing law in a global economy. Dominant firms will source production where they need to, and though the location of production in America creates good-paying American jobs, the practice does not ultimately contribute to advancing America's position in global industrial competition.

In its own way, China has understood this in other industries. U.S.-based multinationals sourcing production facilities in China have created millions of good jobs in China, but this on its own is not a strategy for development. The Chinese government's joint venture and technology transfer requirements for foreign firms represent an admission that neither a production-location-centric, nor a firm-centric development model is sufficient for movement up the value chain. China has employed strategies of both in its development.

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[134] Heather Timmons and Echo Huang, "The Chinese Company Making Boston and Chicago's New Subway Cars Has Big Problems in Singapore," *Quartz*, July 6, 2016, https://qz.com/724156/the-chinese-company-making-boston-and-chicagos-new-subway-cars-has-big-problems-in-singapore/.

HIGH-TECHNOLOGY SHIPPING

> *"If sea power be really based upon a peaceful and extensive commerce, aptitude for commercial pursuits must be a distinguishing feature of the nations that have at one time or another been great upon the sea… it is the wish of every nation that this shipping business should be done by its own vessels."*
>
> – Alfred Thayer Mahan, *The Influence of Sea Power Upon History, 1660-1783* (1890).[135]
>
> *"Today, the biggest mover in the international shipbuilding market is China. China already had an active shipbuilding industry, but growth resulted from the country's industrial expansion strategy in conjunction with strong rising demand as a result of China's economic boom… A coordinated effort and commitment on the part of government and industry led to rapid growth and dominance in a competitive market."*
>
> – Dwight D. Eisenhower School for National Security and Resource Strategy, "Shipbuilding Industry 2015."[136]

- China devotes significant resources to developing the technological sophistication of its commercial shipbuilding industry through subsidies, export financing, and joint ventures with advanced foreign firms.
- Once the world's foremost shipbuilding economy, the U.S. now produces less than one percent of the global supply of commercial ships, due in part to past inaction in the face of government-subsidized foreign competition.

The ocean-based economy has long been an element of China's commercial and industrial policy. In 2003, the State Council issued the "Outline of the National Ocean Economy Development Plan," the country's first modern maritime economic strategy.[137] The State Council has continued this emphasis by designating high-technology shipping and marine engineering equipment a critical sector in *MIC2025*. The plan highlights shipbuilding, maritime resource extraction, and a variety of other sea-based industries for development.

Though China is already among the global leaders in shipbuilding, *MIC2025* emphasizes a move up the production value chain to develop and manufacture high-technology ships and advanced maritime equipment.[138] While China's commercial shipbuilding advantage has traditionally come from its ability to produce large quantities of low-cost ships since the government traditionally

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[135] Alfred Thayer Mahan, "The Influence of Sea Power Upon History, 1660-1783," Project Gutenburg, http://www.gutenberg.org/files/13529/13529-h/13529-h.htm#Page_25.
[136] Dwight D. Eisenhower School for National Security and Resource Strategy, "Shipbuilding Industry 2015," https://es.ndu.edu/Portals/75/Documents/industry-study/reports/2015/es-is-report-shipbuilding-2015.pdf.
[137] Tabitha Mallory, Preparing for the Ocean Century: China's Changing Political Institutions for Ocean Governance and Maritime Development, Issues & studies, 51. 111-138, 2015.
[138] U.S. Chamber of Commerce, "Made in China 2025: Global Ambitions Built on Local Protections," 2017, https://www.uschamber.com/sites/default/files/final_made_in_china_2025_report_full.pdf.

relegated superior resources to military shipbuilding,[139] it now focuses on increasing civil-military cooperation and creating higher value commercial ships, such as liquefied natural gas (LNG) carriers and autonomous vessels.[140]

In 2017, the state-owned China State Shipbuilding Corporation (CSSC) produced its first ever "smart ship," a bulk carrier called *Great Intelligence*. State media reports Dalian Shipbuilding Industry Company, a subsidiary of state-owned China Shipbuilding Industry Corporation (CSIC), has begun production on the first smart crude oil carrier, with the aim to launch the vessel in 2020.[141] China is also developing the world's largest autonomous ship testing site.[142] China has proven its ability to build large quantities of lower-end vessels to take a significant share of the global market for ships, and now aims for higher-value production.

Targets for advanced marine resource extraction capabilities in *MIC2025* include stated goals to create a strong domestic research and development base by 2020, and develop increasingly sophisticated deepwater engineering systems by 2025. To this end, the China National Offshore Oil Corporation (CNOOC) has begun development and construction of the nation's first deep-water self-operated gas field, Lingshui 17-2. In keeping with these goals, Chinese shipbuilder Fujian Mawei Shipbuilding Ltd. launched a deep sea mining ship capable of working at a depth of 2,500 meters.[143]

Shipping facilitates other objectives. The development of high-technology ships more efficiently moves goods across the world, assisting China's export-driven growth model, while dual-use technologies help to protect the nation's industrial and economic investments and provide the country with a massive ocean-based militia.[144] China pursues oil and gas exploration, mineral resource extraction, and desalination efforts to match both current and foreseen scarcity. Additionally, China creates national champion companies and benefit from economies of scale by merging its state-owned enterprises in shipping[145] and shipbuilding.[146]

The Chinese government provides its shipbuilders a variety of advantages, including subsidies and discounted financing for foreign purchases. A 2018 study conducted by Myrto Kalouptsidi of Harvard University indicates China's government subsidies lowered shipyard costs between 13 and 20 percent from

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[139] Shannon Tiezzi, "Chinese Naval Shipbuilding: Measuring the Waves," *The Diplomat*, April 25, 2017, https://thediplomat.com/2017/04/chinese-naval-shipbuilding-measuring-the-waves/.
[140] Andrew Erickson, "Chinese Shipbuilding and Seapower: Full Steam Ahead, Destination Uncharted," Center for International Maritime Security, January 09, 2019, http://cimsec.org/chinese-shipbuilding-and-seapower-full-steam-ahead-destination-uncharted/39383.
[141] 陈子琰, "China Developing First Smart Oil Carrier," *Chinadaily.com.cn*, Dcember 27, 2018, http://www.chinadaily.com.cn/a/201712/27/WS5a42d91aa31008cf16da3999.htm.
[142] Jeffrey Lin and P.W. Singer, "China Is Building the World's Largest Facility for Robot Ship Research," *Popular Science*, February 20, 2018, https://www.popsci.com/china-world-largest-facility-robot-ship-research.
[143] 郭凯, "Deep Sea Mining Ship Launched in East China," *Chinadaily.com.cn*, April 1, 2018, http://www.chinadaily.com.cn/a/201804/01/WS5ac0107ea3105cdcf651589a_1.html.
[144] WSJ Staff, "Meet the Chinese Maritime Militia Waging a 'People's War at Sea'," *The Wall Street Journal*, April 01, 2015, https://blogs.wsj.com/chinarealtime/2015/03/31/meet-the-chinese-maritime-militia-waging-a-peoples-war-at-sea/.
[145] "China's Cabinet Approves Merger of Cosco Group, China Shipping," *Bloomberg.com*, December 11, 2015, https://www.bloomberg.com/news/articles/2015-12-11/china-s-cabinet-approves-merger-of-cosco-group-china-shipping.
[146] "China Plans Merger of Shipbuilders to Create Behemoth," *Bloomberg.com*, March 29, 2018, https://www.bloomberg.com/news/articles/2018-03-30/china-is-said-to-plan-merger-of-shipbuilders-to-create-behemoth.

2006 to 2012, before the announcement of *MIC2025*.[147] Additionally, China encourages high amounts of civil-military cooperation in the maritime sector as it races towards naval primacy.[148] Finally, in areas of this sector in which China does not yet have sufficient technical expertise, its government encourages foreign companies to enter joint ventures with domestic industry to gain market access.

The decline in American shipbuilding and maritime-related industries predates *MIC2025* and provides a compelling lesson. Once the leader in commercial shipbuilding, the U.S. now accounts for less than one percent of the global market.[149] In 1981, as competition from government-subsidized foreign companies in Europe, Japan, and Korea grew, the U.S. ended sector supports known as construction differential subsidies. American policymakers took little action when faced with foreign industrial policies similar to those currently employed by the Chinese government, and American commercial maritime industries declined in global share as a result.[150]

While the Chinese government's support for shipbuilding contributes to the U.S.' inability to regain market share, the original cause for the decline is industrial competition from other foreign actors. For example, last year the E.U. and Japan filed a formal complaint with the WTO against South Korea's shipbuilding subsidies.[151] Future gains by Chinese industry would have to come at the expense of other countries that have likewise made the industry of priority.

In the U.S., however, it appears unlikely that domestic shipbuilders will make gains in market share absent external actions. The harmful impacts of competing foreign states on the U.S. shipbuilding industry have been undeniable. As Maritime Administrator Mark Buzby told Congress in January 2018, "over the last few decades, the U.S. Maritime industry has suffered losses as companies, ships, and jobs moved overseas."[152]

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[147] Myrto Kalouptsidi, "Detection and Impact of Industrial Subsidies: The Case of Chinese Shipbuilding," *The Review of Economic Studies*, Volume 85, Issue 2, 1 April 2018, Pages 1111–1158, https://doi.org/10.1093/restud/rdx050.
[148] China Power Team, "How is China modernizing its Navy?" *China Power*, December 17, 2018, Updated January 9, 2019, https://chinapower.csis.org/china-naval-modernization/.
[149] Aaron Klein, "Decline in U.S. Shipbuilding Industry: A Cautionary Tale of Foreign Subsidies Destroying U.S. Jobs," http://www.openandfairskies.com/wp-content/uploads/2015/07/Cautionary-Tale-Foreign-Subsidies-Destroying-U.S.-Jobs.pdf.
[150] Ibid.
[151] Maritime Executive, "EU Joins Complaint Over S. Korean Shipbuilding Subsidies," *The Maritime Executive*, November 26, 2018, https://www.maritime-executive.com/article/eu-joins-complaint-over-s-korean-shipbuilding-subsidies.
[152] U.S. Congress, House, Committee on Transportation and Infrastructure, The State of the U.S.-flag Maritime Industry: Hearing before the Subcommittee on Coast Guard and Maritime Transportation of the Committee on Transportation and Infrastructure, House of Representatives, One Hundred Fifteenth Congress, Second Session, January 17, 2018.

BIOTECHNOLOGY

> *"We documented that within a couple of years of [the opening of free trade with China]… the United States shut its last penicillin fermentation plant up in New York. And that was after Chinese companies dumped product on the U.S. and global markets at below market prices and drove everybody out – the U.S., the Europeans and even the Indian penicillin fermentation plants. Drove them out. And then they increased the price. This is the playbook of China…"*
>
> – Rosemary Gibson, co-author of *China Rx: Exposing the Risks of America's Dependence on China for Medicine*, 2018.[153]

- China plays a significant role in the biotechnology industry as a manufacturer of active pharmaceutical ingredients and lower-end drugs. As with many other sectors in *MIC2025,* policymakers aim to shift the industry up the value chain.
- Although American pharmaceutical firms face short-term commercial opportunities in China, the U.S. runs the risk of losing important components of its medical supply chain to China's government-backed industry.

Chinese policymakers aim to make China's domestic biotechnology industry the medicine cabinet of the world. To a large extent, they have already succeeded in achieving dominance in the lower end of the pharmaceutical and medical technology value chain. 80 percent of the active pharmaceutical ingredients (API) of drugs in the American market come from overseas, primarily from China and India. In older drugs with low profit margins, Chinese drugmakers have often taken over production entirely from Western companies. Chinese manufacturers are already the sole suppliers of many API and lower-end drugs. Additionally, the American medical device sector is somewhat dependent on parts imported from China.[154]

China has not historically been as competitive in creating new commercial drugs, however. Foreign companies have long done well in China by selling off-patent branded drugs, against which the domestic sector could not compete on quality.[155] *MIC2025* indicates a desire to change this. Mirroring the Chinese government's ambitions in the other critical industries, *MIC2025* spells out China's intention for competing at the higher end of the value chain by innovating new drugs, increasing the quality of its products, achieving self-sufficiency in the domestic market, and increasing exports. Earlier attempts by Chinese policymakers to move China's medical device sector to the higher end of the value chain have seen success: therapeutic devices replaced disposables as

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[153] "Rosemary Gibson on America's Dependence On China for Medicine," *Corporate Crime Reporter*, August 28, 2018, https://www.corporatecrimereporter.com/news/200/rosemary-gibson-americas-dependence-china-medicine/.
[154] Ibid.
[155] Tom Hancock, "China Health Reforms Help Global Pharma Groups despite Price Cuts," *Financial Times*, August 26, 2018, https://www.ft.com/content/5aef7218-a50f-11e8-8ecf-a7ae1beff35b.

China's largest medical device export in 2012, and the bulk of China's medical device exports are already now mid- to high-technology.[156]

China's domestic pharmaceutical sector presents an object lesson in the government's industrial policy. At first glance, China appears to be normalizing its market in the interests of the sector's long-term health. Since 2015, the Chinese Drug Administration (CDA) has undertaken a series of reforms meant to address challenges that have plagued its drug industry, including streamlining the approval processes for new drugs, bringing China into better alignment with international drug assessment standards and clinical data collection,[157] [158] and raising production standards.[159] In May 2018, China cut tariffs on imported cancer drugs and reduced them for other drugs.[160]

These efforts have made what was already the world's second-largest drug market even more attractive to foreign pharmaceuticals. In addition to the favorable consumer market conditions of a large, aging, and increasingly affluent population, new drugs are easier to get approved than they historically have been. The Chinese government has also made it harder for some domestic firms to survive in light of its new, stricter standards, especially generic drug manufacturers.[161] In the short-term, it may seem as if China is interested in deliberately letting market forces weed out weaker domestic firms in order to strengthen the domestic industry in the long-term.[162] As a result, foreign firms see opportunity in the current state of the Chinese market.[163]

However, the apparent boom for foreign companies and culling of domestic firms is likely to be short-lived. *MIC2025* makes clear China's goal is not to build a thriving market without regard for whether producers are foreign or domestic, but to build its own domestic industry as a global competitor in high-end biomedicine similar to its current position at the lower end of the value chain.[164]

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[156] Mihir Toreskar, *China's Changing Medical Device Exports,* Journal of International Commerce and Economics (USTR), January 2018. See also Toreskar, Mihar, *China Claims the Global Value Chain for Medical Devices,* Journal of International Commerce and Economics (USTR), January 2018.

[157] Clinical data standards are no small matter in a nation in which, even as recently as 2016, 80% of domestic clinical trials contained falsified data. See for example: "Re: 80% of China's Clinical Trial Data Are Fraudulent, Investigation Finds," *The BMJ,* January 14, 2019, https://www.bmj.com/content/355/bmj.i5396/rr-1.

[158] It is also worth noting, however, that it was the Chinese drug regulatory agency itself that brought this concern to light – a notable act that demonstrates how serious Chinese authorities, which are traditionally reluctant to reveal damaging information, are about signaling to domestic pharmaceutical manufacturers that they must improve their standards. For a discussion on this point, see Benjamin Shobert, "Note To The Chinese FDA: When 80% Of Your Data Is Bad, How Trustworthy Is The Other 20%?" *Forbes*, October 18, 2016, https://www.forbes.com/sites/benjaminshobert/2016/10/11/note-to-the-cfda-when-80-of-your-data-is-bad-how-trustworthy-is-the-other-20/#2114de0320cd.

[159] "China Is Sprucing up Its Pharma Sector," *The Economist*, August 30, 2018, https://www.economist.com/business/2018/08/30/china-is-sprucing-up-its-pharma-sector.

[160] Ibid.

[161] As many as half of China's smaller domestic drug manufacturers could fold as a result of these changes. See: Eric Ng, "Why most small players may not survive China's pharmaceutical industry consolidation," *South China Morning Post*, January 31, 2018.

[162] Lu Xianping, the CEO of Chinese biotech company Chipscreen Biosciences, has suggested that over fifty percent of Chinese pharmaceutical companies could shutter as a result of these reforms.

[163] Ibid. It is hard to overstate how significant an opportunity China's massive population, which is both aging and increasingly affluent, presents to pharmaceutical companies. See also: Tom Hancock, "China Health Reforms Help Global Pharma Groups despite Price Cuts," *Financial Times,* August 26, 2018, https://www.ft.com/content/5aef7218-a50f-11e8-8ecf-a7ae1beff35b., for a discussion of the optimism of American and European pharmaceutical industries on their prospects in the China market.

[164] U.S. Chamber of Commerce, "Made in China 2025: Global Ambitions Built on Local Protections," 2017, https://www.uschamber.com/sites/default/files/final_made_in_china_2025_report_full.pdf.

This long-term strategic goal is implemented in policy through subsidies to domestic firms and forced mergers to create greater scale. Should the current "thinning of the herd" drive domestic industry to the strong position the Chinese government intends, foreign pharmaceutical and medical device manufacturers may find themselves in an off-brand market which no longer requires nor favors their products, and a high-end market which can compete on quality in China and abroad.

The U.S.-China pharmaceutical and medical technology trade relationship represents short-term opportunities for American businesses and long-term vulnerabilities for the American public. China's control over global API and U.S. dependence on imported generics present risks to the safety and stability of the American drug supply. While the U.S. Food and Drug Administration (FDA) is responsible for the approval of all drugs and ingredients in the American market, regardless of source, the reality of American quality control over foreign producers is decidedly less clear. A report by the U.S. Government Accountability Office (GAO) estimates that of 535 of China's facilities subject to FDA monitoring, as many as 243 – almost half – may have never been inspected between 2010 and 2016. Moreover, according to the GAO, "the fact remains that FDA does not know whether or for how long these establishments have or may have supplied drugs to the U.S. market, and has little other information about them."[165] With China's flawed domestic regulation, and the new reforms discussed above far from complete, the safety of the American drug supply is in question.[166]

The concentration of critical drug production in one country presents a threat to supply stability as well. For example, in 2016 a factory owned by the Chinese drug company Qilu exploded and triggered a global shortage of the drug piperacillin, an essential antibiotic for which the affected facility was the sole producer.[167] In some cases, the Chinese government's level of control over the supply chain already has resulted in direct leverage over trading partners.[168]

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[165] The GAO report on FDA foreign inspections is deeply concerning on numerous fronts. See: "Drug Safety: FDA Has Improved Its Foreign Drug Inspection Program, but Needs to Assess the Effectiveness and Staffing of Its Foreign Offices," United States Government Accountability Office Report, December 2016, https://www.gao.gov/assets/690/681689.pdf. Other concerns are also germane, including the number of inspections that have been conducted and found questionable conditions, but resulted in little or no substantive action.

[166] Take for example the recent recall of multiple batches of valsartan, a common blood pressure medication, which were found to be contaminated with the cancer-causing substance NDMA. The contamination was traced to Zhejiang Huahai Pharmaceuticals in China. See: "Many U.S. Drugs Are Made Far from Home. That Scares These Experts," *NBCNews.com*, https://www.nbcnews.com/health/health-news/fda-recalls-are-reminder-china-controls-much-world-s-drug-n900716.; Ben Westcott, "Chinese Company Recalls Tainted Heart Medicine from Stores Worldwide," *CNN*, July 30, 2018, https://www.cnn.com/2018/07/30/health/china-heart-medicine-vaccine-intl/index.html. Recent (and ongoing) recalls of heart medication have since expanded to other drugs traceable to the same Chinese supplier, well as others traceable to India. See also: Jen Christensen, "Heart Drug Recall Expanded Again," *CNN*, January 04, 2019, https://www.cnn.com/2019/01/04/health/valsartan-recall-fda-expands/index.html.

[167] Judy Stone, "Fragile Antibiotic Supply Chain Causes Shortages And Is A National Security Threat," *Forbes,* June 01, 2018, https://www.forbes.com/sites/judystone/2018/06/01/fragile-antibiotic-supply-chain-causes-shortages-and-is-a-national-security-threat/#66c2269dadf3 ; ECA Academy. "Explosion of an API Manufacturing Site: Supply of Medicinal Products Endangered," *ECA Academy*, February 08, 2017, https://www.gmp-compliance.org/gmp-news/explosion-of-an-api-manufacturing-site-supply-of-medicinal-products-endangered.

[168] Take, for example, the case of Chinese drug manufacturer Zhejiang Novus Pharmaceuticals. In 2018, Zhejiang successfully argued before the USTR 301 Committee that its version of vancomycin hydrochloride (an antibiotic) should be removed from the tariff list, by pointing out (accurately) that to impose tariffs on its product would threaten the American supply of a critical drug. See: U.S. Trade International Commission, 301

China has a long way to go before its internal reforms and market supports produce a domestic sector capable of either meeting internal demand or presenting a serious market threat to high-end pharmaceutical and medical technology leaders. The U.S. remains the largest pharmaceutical consumer base in the world, and due to the U.S.' own policy priority of the pharmaceutical industry, China lags far behind the U.S. in the development and innovation of new drugs and devices. American pharmaceutical companies generally seem unworried by *MIC2025* goals, as the market reforms necessary to achieve those goals increase opportunity for foreign firms, at least in the short-term.

While current positions on the value chain seem clear, long-term trends could be of concern. About 90 percent of all prescriptions written in the United States are for generics,[169] which are a portion of the industry in which Chinese firms already exert outsized control. As Chinese pharmaceutical manufacturers improve the quality of their APIs and generics, the costs for those products may rise even while maintaining their positions as the cheapest drugs on the market. As costs for inputs and alternatives rise, generics in the U.S. may face greater pressure, potentially making the U.S. drug supply even more dependent on Chinese suppliers. As the Chinese government pursues its *MIC2025* plan to innovate, develop, and manufacture new products that can then be exported back to the U.S., the future of American jobs in the higher-end of the U.S. pharmaceutical and medical device value chain remains a matter for attention.

Committee, Section 301 Tariffs Public Hearing, May 17, 2018, https://ustr.gov/sites/default/files/enforcement/301Investigations/Hearing%20Transcript%2C%20Proposed%20Tariffs%20Day%203.pdf. China state television took note and celebrated the victory: Wu Lei, Tu Ting, Zhang Jiaying, "How Zhejiang Medicine was able to avoid U.S. tariffs," August 22, 2018, https://news.cgtn.com/news/3d3d414e33596a4e79457a6333566d54/share_p.html.

[169] "Generic Drug Access & Savings in the U.S.: Access in Jeopardy," *Association for Accessible Medicines*, 2018, https://accessiblemeds.org/sites/default/files/ 2018_aam_generic_drug_access_and_savings_report.pdf.

ROBOTICS

"Man minus the Machine is a slave; Man plus the Machine is a freeman."

– Henry Ford, founder of the Ford Motor Company, 1925.[170]

"There are two kinds of technologically driven productivity. The first is when technology replaces workers (e.g., automatic elevators replacing elevator operators). The second is when technology makes workers more productive (e.g., carpenters using pneumatic nail guns instead of hammers). Both are good, and both boost productivity and per-capita GDP."

– Robert Atkinson, "Robots, Automation, and Jobs: A Primer for Policymakers," 2017.[171]

- Policymakers in China are heavily investing in the adoption and production of robots as a critical sector for economic development.
- In sharp contrast with China's priority of robotics, American policymakers and the public generally balk at the priority of increased robotics development and adoption.
- The contrast in robotics provides a useful proxy for understanding *MIC2025*'s model of development relative to the U.S. more generally.

MIC2025 reserves ambitious treatment for robotics and automated machinery. Unlike its goals for other sectors, *MIC2025* does not set export market targets for robotics, opting instead for increase to domestic market presence. In the plan's timeframe, the number of industrial automations is expected to increase tenfold to 1.8 million units, and have a 70 percent share of the domestic market – an amount up from the current 30 percent.[172] A report by the International Federation of Robotics finds a growth rate in recent years suggesting this target is not out of reach, with a yearly growth rate in robotics sales of 27 percent in 2016, and further increases of 20 percent possible through the year 2020.[173]

As the Information Technology and Innovation Foundation (ITIF) report on industrial robot adoption puts it, "China appears to be in a class of its own," in its priority of robotics, providing "greater subsidies for robot adoption than any other nation, both in absolute terms and per-robot."[174] Though China lags behind

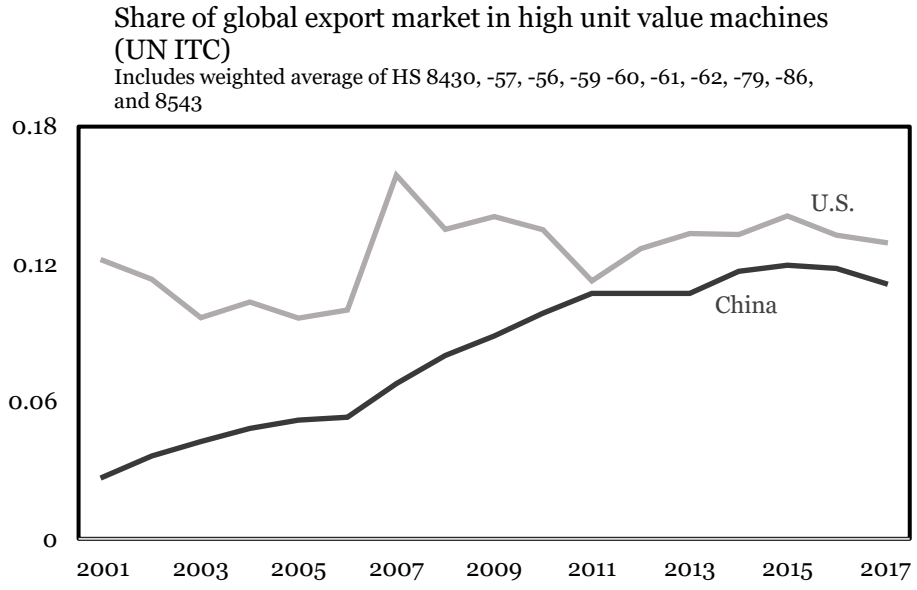
[170] Henry Ford, *Ford News* August 1, 1925, https://www.thehenryford.org/collections-and-research/digital-resources/popular-topics/henry-ford-quotes/.
[171] Robert Atkinson, "Robots, Automation, and Jobs: A Primer for Policymakers," Information Technology & Innovation Foundation, May 8, 2017, https://itif.org/publications/2017/05/08/robots-automation-and-jobs-primer-policymakers.
[172] "Guangdong's US$65bn Plan to Move up the Hi-tech Industry Chain," *South China Morning Post,* August 19, 2018, https://www.scmp.com/news/china/economy/article/2160361/guangdongs-us65-billion-plan-help-move-china-hi-tech-industry.
[173] International Federation of Robotics, "China breaks historic records in automation," https://ifr.org/news/robots-china-breaks-historic-records-in-automation/.
[174] Robert D. Atkinson, "Which Nations Really Lead in Industrial Robot Adoption?" *Information Technology and Innovation Foundation*, November 2018, http://www2.itif.org/2018-industrial-robot-adoption.pdf.

most developed countries in robots per-worker in the ITIF report, it is ranked third when accounting for relative compensation levels. If its robot adoption rate continues at this level, China would overtake South Korea as the world leader in robot adoption by 2026.[175] Consider the following: in 2017 China installed 138,000 robotic units, the highest in the world for that year. Japan, the second highest, installed 46,000 units, and the U.S. 34,000.[176]

The particular methods employed to accomplish this priority are worth mentioning, both for the size of financing and the scale of physical capital committed. The Chinese province Guangdong has announced plans to invest more than $65.5 billion in strategic and emerging industries, including robotics, through 2020.[177] The creation of a $17.5 million, 430,000 square foot factory in the city of Foshan is expected to triple Chinese robotics company Jaten Robot & Automation's annual production to 10,000 robots a year.[178] The Chinese appliance maker Midea and German robotics firm Kuka have begun building an 8.6 million square foot, $10.5 billion industrial estate to house three industrial automation ventures, with the expected annual capacity to produce 75,000 industrial robots by 2024.

While advanced robotics remains in its developing stage, China has proved successful in growing its global market share in other forms of advanced machinery, including laser technology, computers, physical environment-shaping equipment, and other forms of industrial machines, as depicted by Figure 8.

Figure 8.



[179]

[175] Ibid.
[176] Marco Hernandez, "How China Aims to Dominate the World of Robotics," *South China Morning Post,* https://multimedia.scmp.com/news/china/article/2164290/china-2025-robotics/index.html.
[177] Ibid.
[178] "A Robot Revolution Is under Way at the 'World's Factory'. Here's Why," *South China Morning Post*, October 25, 2018, https://www.scmp.com/economy/china-economy/article/2164103/made-china-2025-peek-robot-revolution-under-way-hub-worlds.
[179] Selected four-digit lines include: **8430** Moving, grading, levelling, scraping, excavating, tamping, compacting, extracting or boring machinery, for earth, minerals or ores; pile-drivers and pile-extractors; snowploughs and snowblowers, **8457** Machining centres, unit construction machines "single station" and

Robotics facilitates the development of capital goods in other areas of economic importance, including electronics and motor vehicles. The automotive industry represents the largest global industry demand for robotics,[180] and *MIC2025*'s goals for development in the sector appear to drive much of the deployment expected by *MIC2025*. A May 2017 report by the *New York Times* quoted the then-chief executive officer of Ford Motor Company in describing the extent of the commitment, saying "[we're] basically building an R&D center here in China," and the director of China manufacturing at General Motors as saying "Robots aren't the threat… The threat is not being able to run your business with products that people want to buy."[181]

Questions over quality and efficiency of indigenous production remain, and structural factors like a decline in working-age population[182] may also drive the prioritization of labor-saving technology. Even so, China's express goal of development in robotics makes for a contrast with the U.S., where policymakers and opinion leaders often blame automation for a loss of manufacturing jobs rather than viewing it as an essential component of their formation. President Barack Obama summed up this view in his 2017 farewell address, saying "The next wave of economic dislocations won't come from overseas… It will come from the relentless pace of automation that makes a lot of good middle-class jobs obsolete."[183] A 2016 article titled "The Long-Term Jobs Killer is Not China. It's Automation," quoted Harvard University economist Lawrence Katz on the economic consensus for whether off-shoring or automation led to manufacturing job loss: "Over the long haul, clearly automation's been much more important—it's not even close."[184]

Perhaps unsurprisingly given this consensus, U.S. development and adoption of industrial robots lags the rest of the world. According to the ITIF report, the U.S. ranks 7th in the world in adoption per worker and 16th in the world when adjusted for wage levels.[185] On the other hand, this relative slowness in robot production

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multi-station transfer machines for working metal, **8456** Machine tools for working any material by removal of material, by laser or other light or photon beam, ultrasonic, electro-discharge, electro-chemical, electron beam, ionic-beam or plasma arc processes; water-jet cutting machines, **8459** Machine tools, incl. way-type unit head machines, for drilling, boring, milling, threading or tapping, **8460** Machine tools for deburring, sharpening, grinding, honing, lapping, polishing or otherwise finishing metal, metal carbides or cermets by means of grinding stones, abrasives or polishing products, **8461** Machine tools for planing, shaping, slotting, broaching, gear cutting, gear grinding or gear finishing, sawing, cutting-off and other machine tools working by removing metal, sintered metal carbides or cermets, n.e.s., **8462** Machine tools, incl. presses, for working metal by forging, hammering or die-stamping; machine tools, incl. presses, for working metal by bending, folding, straightening, flattening, shearing, punching or notching; presses for working metal or metal carbides, **8479** Machines and mechanical appliances having individual functions, not specified or included elsewhere in this chapter; parts thereof; **8486** Machines and apparatus of a kind used solely or principally for the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays; and **8453** Electrical machines and apparatus, having individual functions. United Nations COMTRADE, compiled the International Trade Centre's "Trade Map," https://www.trademap.org/Index.aspx.

[180] Mark Muro, "Where the Robots Are," *The Brookings Institution*, August 14, 2017, https://www.brookings.edu/blog/the-avenue/2017/08/14/where-the-robots-are/.

[181] Keith Bradsher, "A Robot Revolution, This Time in China," *The New York Times*, May 14, 2017, https://www.nytimes.com/2017/05/12/business/a-robot-revolution-this-time-in-china.html.

[182] Congressional-Executive Commission on China, "2018 Annual Report," page 6, https://www.cecc.gov/publications/annual-reports/2018-annual-report.

[183] Claire Cain Miller, "A Darker Theme in Obama's Farewell: Automation Can Divide Us," *The New York Times*, January 12, 2017.

[184] Claire Cain Miller, "The Long-Term Jobs Killer is Not China. It's Automation," *The New York Times*, December 21, 2016, https://www.nytimes.com/2016/12/21/upshot/the-long-term-jobs-killer-is-not-china-its-automation.html.

[185] "Which Nations Really Lead in Industrial Robot Adoption?" *Information Technology and Innovation Foundation*.

belies the claims of economic harms to manufacturing jobs attributed to it. How can the U.S. be on the leading edge of a robot-induced "world without work"[186] if other countries have surpassed its levels of robot development and have increased manufacturing employment instead? Moreover, the defining characteristic of rising automation – producing greater output with fewer workers – can be quantified by the indicator of productivity growth, a measure which has slowed in the U.S. If robots were taking jobs, then by definition the rate at which the American economy produces more per worker would be growing, but it is not. In an essay titled "Is Technology Destroying the Labor Market?" Manhattan Institute senior fellow Oren Cass explains this paradox of simultaneous increase in output per worker and increase in employment:

> *"The crucial question is what happens to output as productivity rises. If we achieve the 2.8 percent annual productivity growth that translates to a 100 percent increase after 25 years—the typical worker producing twice as much as a generation earlier—this also means, using the language of the automation debate, that every 25 years, we will destroy half of the economy's jobs. And that would indeed be the result, if output remained at its initial level. But if output also doubles, then everyone remains working and material living standards can double, too. This is precisely what happened from 1947 to 1972, widely seen as the golden age for American manufacturing and the nation's middle class. Economy-wide productivity increased by 99 percent; only 50 workers were needed by the end of the Vietnam War to do the work that 100 could complete at the end of World War II. The result was not mass unemployment. Instead, America produced more stuff. The same share of the population was working in 1972 as in 1947, and men's median income was 86 percent higher."*[187]

A significant difference between China and the U.S. in the proper attitude of the state toward robotics provides an object lesson in economic development. As *MIC2025* prioritizes thousand percent increases in robot production, *The Atlantic* runs a cover story[188] on the threat of robots' to Americans' well-being – during the middle of a historic domestic productivity slowdown. While the potential effects of particular forms of automation on closely-impacted occupations are worth understanding for the sake of maintaining labor market stability, this is a categorically different concern than understanding automation as a central threat to employment.

The contrast is influential not only because the American consensus absolves policy decisions from responsibility in the loss of manufacturing jobs, but that in doing so it denies the possibility of building a more productive future. Automation is not an external force that moves by its own cause or logic, but an active process of economic development that can either enhance or detract from human labor content based on human decision. China's economic model has at least recognized productivity-increasing goods are a priority of development.

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[186]Derek Thompson, "A World Without Work," *The Atlantic*, November 6, 2017, https://www.theatlantic.com/magazine/archive/2015/07/world-without-work/395294/.
[187] Oren Cass, "Is Technology Destroying the Labor Market?" *City Journal*, Spring 2018, https://www.city-journal.org/html/technology-destroying-labor-market-15829.html.
[188] Thompson, "A World Without Work."

There are deeper questions posed by what has been called the "mirage of progress and the reality of stagnation."[189] Robotics is especially instructive, because it represents a capital good produced with the direct intent of becoming labor-saving technology – automation in its most direct form. As such, robotics is a useful proxy for productivity more broadly. Short of policy prescription, however, the U.S. might consider the framework of friendly nations like South Korea, which has embraced the role of automation to the great benefit of its economic and national development.[190] It is also worth considering how policy priority of the automotive sector might represent investment in robotics in downstream production decisions, as the sector deployed 60,000 robots in 2016 and remained a net job-creator.[191]

In the absence of political or cultural consensus, the development of robotics remain essential to many businesses across the U.S. The 2017 labor market, which reached levels of unemployment below four percent, created the conditions for businesses facing a labor shortage to invest in labor-saving technology. From burger-flipping robots to automating the production of store labels, small businesses and franchises have often responded to these conditions by making their existing employees more productive.[192] And while the extent to which the tight labor market has made permanent improvements to productivity remains to be seen, it also clearly increased demand for some robotics production. A 2018 study by the Boston Consulting Group[193] lists a "shortage of labor" as the top driver of firms' needs for robotics, and a report by Richard Florida of CityLab notes increased robotics growth in industrial areas of the country, including Detroit and Chicago.[194] Applying these industry-level insights and experience with robotics to policy might produce a framework more conducive to productivity growth.

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[189] Russell Berman and Peter Thiel, "German 270: Sovereignty and the Limits of Globalization and Technology," Syllabus from seminar at Stanford University, https://www.documentcloud.org/documents/5677718-Thiel-German-270-Syllabus.html.
[190] Robert Atkinson, "Which Nations Really Lead in Industrial Robot Adoption?" November 2018, https://itif.org/publications/2018/11/19/which-nations-really-lead-industrial-robot-adoption.
[191] Chris Middleton, "South Korea most automated nation on earth, says report. The UK? Going nowhere." *Internet of Business,* February 14, 2018, https://internetofbusiness.com/south-korea-automated-nation-earth-says-report-uk-nowhere-robotics/.
[192] Julie Jargon and Eric Morath, "Short of Workers, Fast-Food Restaurants Turn to Robots," *Wall Street Journal*, June 24, 2018, https://www.wsj.com/articles/short-of-workers-fast-food-restaurants-turn-to-robots-1529868693.
[193] Justin Rose, Vladimir Lukic, et al. "Advancing Robotics to Boost US Manufacturing Competitiveness," Boston Consulting Group, October 25, 2018, https://www.bcg.com/en-us/publications/2018/advancing-robotics-boost-us-manufacturing-competitiveness.aspx.
[194] Richard Florida, "America's Robot Geography," *CityLab*, July 12, 2018, https://www.citylab.com/life/2018/07/americas-new-robot-geography/564155/.

ENERGY AND POWER GENERATION

> *"China is at the center of a global energy transformation, which is being driven by technological change and the falling cost of renewables. But China is not just investing in renewables and phasing out coal. It also accounts for a growing share of global energy demand, meaning that its economy… will reshape the resource sector worldwide."*
>
> – Jonathan Woetzel, senior partner, and director of the McKinsey Global Institute, and Jiang Kejun, senior researcher at the Energy Research Institute of China's National Development and Reform Commission, 2017.[195]

- To meet China's increasing energy needs and reduce its dependency on foreign energy, *MIC2025* outlines robust development and production goals for a range of energy sources including carbon-based fuels, renewables, and nuclear energy.
- China's solar energy industrial policy, which saw state-supported domestic production flood global markets and undercut international competition, provides an instructive example for how the nation's economic planners successfully leverage state resources to boost domestic firms at the expense of competition.
- The American energy sector remains strong, with forecasts predicting the U.S. will be a net energy exporter on an annual basis by 2020.

China is the world's largest consumer of energy, due to its rapid industrialization and vast population.[196] Since the year 2000, China's demand for energy has quadrupled.[197] In order to satisfy domestic demand for energy and cut its reliance on imports, the State Council identified energy and power generation as a critical sector in *MIC2025*.

In part, *MIC2025* calls for the development of renewable energy technologies, which serve as both a solution to the nation's pollution problems as well as its reliance on foreign energy sources. This need is underscored by China's dependence on imported oil, which at times originates from politically-unstable nations and is transported through disputed areas.[198] With the help of large-scale government support, Chinese industry has already made substantial headway in green energy development. In 2017, China was responsible for almost half of the world's new renewable energy capacity.[199]

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[195] Jonathan Woetzel and Jiang Kejun, "China's renewable energy revolution," McKinsey and Company, August 2017, https://www.mckinsey.com/mgi/overview/in-the-news/china-renewable-energy-revolution.
[196] "How Is China's Energy Footprint Changing?" *ChinaPower Project*, August 13, 2018, https://chinapower.csis.org/energy-footprint/.
[197] Nick Butler, "China's Promised Energy Revolution," *Financial Times*, November 20, 2017, https://www.ft.com/content/0094d3c3-405b-3966-a088-1060fa2cdc2e.
[198] ChinaPower Project.
[199] Staff Writer, "China's Renewable Energy Surges after State Backing," *Nikkei Asian Review,* November 21, 2018, https://asia.nikkei.com/Spotlight/Cover-Story/China-s-renewable-energy-surges-after-state-backing.

While nuclear energy production has stalled in OECD countries, China has taken a different approach. Through state financing, subsidies, and other forms of government support, China is investing in a robust nuclear strategy, including the development of its domestic capabilities and pursuit of global nuclear exports.[200] As one Bloomberg report notes, "[China]'s ambitions to build out its nuclear power industry at home, and sell its technology abroad, is beginning to overcome cost overruns and tighter regulations."[201] Its export base for nuclear energy is likely to include partner states of the Belt and Road Initiative.[202] [203]

The legacy of China's solar industry provides a clear example of energy-related industrial policy and its impacts on the American economy. China has used industrial policies including subsidies and technological support to prop up its domestic solar industry and flood global markets with artificially low-cost goods.[204] In the five years between 2008 and 2013, cut-rate China-sourced solar panels caused prices to plummet by 80 percent.[205] After an initial policy response by the International Trade Commission (ITC) in 2012, the ITC concluded an investigation in 2017 under Section 201 of the Trade Act of 1974, which determined China had caused trade-related injuries and recommended the implementation of tariffs.[206] President Trump has announced 30 percent tariffs on solar panels, with a five percent decrease each year for four years.[207] In August 2018, solar panels became subject to an additional 25 percent tariff, placing their effective rate at 55 percent.[208]

In the aftermath of the Section 201 tariff implementation, foreign and domestic firms announced building and expansion plans in the U.S. worth approximately $1 billion.[209] However, the long-term trajectory for domestic production in this sector remains unclear. In the U.S., there are twice as many workers in solar installation jobs than in solar manufacturing, and industry groups representing the installers have voiced opposition to the tariffs.

Since the implementation of the Section 201 tariffs, the Chinese government has cut subsidies and other forms of support to its solar industry, in large part due to

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[200] "America Risks Missing Out On A Global Nuclear Power Revival," Council on Foreign Relations, https://www.cfr.org/blog/america-risks-missing-out-global-nuclear-power-revival.
[201] "Russia Joins China's Race for Next-Generation Nuclear Reactors," *Bloomberg.com,* https://www.bloomberg.com/news/articles/2018-06-08/russia-joins-china-s-race-for-next-generation-nuclear-reactors.
[202] Butler, Energy Revolution.
[203] Madison Freeman, How Russia, China Use Nuclear Reactors To Win Global Influence, *Defense One,* July 13, 2018, https://www.defenseone.com/ideas/2018/07/china-and-russia-look-dominate-global-nuclear-power/149642/.
[204]Chen Gang, "Chinas Solar PV Manufacturing and Subsidies from the Perspective of State Capitalism," *The Copenhagen Journal of Asian Studies* 33, no. 1 (2015): 90, doi:10.22439/cjas.v33i1.4813.
[205] John Fialka, "Why China Is Dominating the Solar Industry," *Scientific American*, December 19, 2016, https://www.scientificamerican.com/article/why-china-is-dominating-the-solar-industry/.
[206] Caitlain Devereaux Lewis, "Shining a Light on the Solar Trade: Investigation Leads to Tariffs on Solar Energy-Related Imports," *Congressional Research Service,* 2018, http://www.crs.gov/Reports/LSB10066?source=search&guid=9a045be734e34e6689a3b5b8e7c2642c&index=2.
[207] Timothy Cama, "Trump Imposes 30 Percent Tariff on Solar Panel Imports," *The Hill,* January 23, 2018, https://thehill.com/policy/energy-environment/370171-trump-imposes-30-tariffs-on-solar-panel-imports.
[208] Kelly Pickerel and George Hahn, "It's Official: Chinese Solar Cells and Modules Hit with Additional 25% Tariff," *Solar Power World,* August 08, 2018, https://www.solarpowerworldonline.com/2018/08/its-official-chinese-solar-cells-and-modules-hit-with-additional-25-tariff/.
[209] Nichola Groom, "Billions in U.S. Solar Projects Shelved after Trump Panel Tariff," *Reuters*, June 07, 2018, https://www.reuters.com/article/us-trump-effect-solar-insight/billions-in-u-s-solar-projects-shelved-after-trump-panel-tariff-idUSKCN1J30CT.

oversupply.[210] The Chinese government has brought its complaints on the subject to the WTO, claiming the U.S. is in violation of international trade rules.[211]

The Chinese government's solar energy industrial policies achieved their short-term goals. Through the use of subsidies and other market manipulations, it advanced domestic manufacturing, increased the nation's exports, and artificially drove down prices for solar panels across the globe. Nonetheless, U.S. use of Section 201 tariffs demonstrates it is not defenseless against China's industrial policy in this sector.

Energy sectors in the U.S. employed more than 1.9 million workers in 2017, an increase of 15,000 from the previous year. Of this number, nearly 800,000 workers were employed in nuclear energy, renewables, and low-carbon emission energy sectors. Energy products make up the fastest growing export sector in the U.S. economy[212] – including the largest export growth industry from the U.S. to China by far – and the U.S. Department of Energy now forecasts the U.S. will be a net exporter of energy in 2020.[213]

Until recently, China was noted for their exports of low-cost oil and gas equipment inputs, while the U.S., Japan, and Germany dominated high-technology components and advanced manufacturing.[214] China has now overtaken the U.S. in oil and gas equipment exports, while also directly investing in its nuclear companies, seeking contracts for its firms across the world.[215] Some reports indicate China will overtake the U.S. in nuclear production by 2030.[216]

The American energy industry is robust and diverse. However, as Chinese policymakers discovered in the solar industry, U.S. firms have their vulnerabilities. American firms have at times been unable to withstand challenge when confronted by heavily subsidized, state-backed foreign competitors. The selection for energy as a priority industry in *MIC2025* suggests emerging technologies in the sector will remain contested.

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[210] Jill Baker, "Solar Leader China Is Slashing Its Subsidies On Solar Power – What You Need To Know." *Forbes,* June 19, 2018, https://www.forbes.com/sites/jillbaker/2018/06/18/solar-leader-china-is-slashing-its-subsidies-on-solar-power-what-you-need-to-know/#458f0f9a2f9a.
[211] David Stanway, "China Says U.S. Solar Tariffs Violate Trade Rules, Lodges WTO..." *Reuters,* August 15, 2018, https://www.reuters.com/article/us-usa-trade-china-solar/china-says-u-s-solar-tariffs-violate-trade-rules-lodges-wto-complaint-idUSKBN1L001K.
[212] Drew DeSilver, "With Trade on Congress' Agenda, Just What Does the U.S. Import and Export?" *Pew Research Center,* May 18, 2015, http://www.pewresearch.org/fact-tank/2015/05/18/just-what-does-the-u-s-import-and-export/.
[213]Tom DiChristopher, "US to become a net energy exporter in 2020 for first time in nearly 70 years, Energy Dept says," *CNBC*, January 24, 2019, https://www.cnbc.com/2019/01/24/us-becomes-a-net-energy-exporter-in-2020-energy-dept-says.html.
[214]International Trade Administration, "2017 Top Markets Report Upstream Oil and Gas Equipment: A Market Assessment Tool for U.S. Exporters," May 2017, https://www.trade.gov/topmarkets/pdf/Oil_and_Gas_Top_Markets_Report.pdf.
[215] "America Risks Missing Out On A Global Nuclear Power Revival," Council on Foreign Relations, https://www.cfr.org/blog/america-risks-missing-out-global-nuclear-power-revival.
[216] "The Future of Nuclear Power in China: Introduction – The Future of Nuclear Power in China," Carnegie Endowment for International Peace, https://carnegieendowment.org/2018/05/14/future-of-nuclear-power-in-china-introduction-pub-76312.

NEW MATERIALS

> *"New materials are not only one of ten major key fields of development, but also the foundation and support of the other nine fields."*
>
> – Pan Aikua, Director-General of the Raw Material Division at China's Ministry of Industry and Information Technology, 2018 [217]

- China lists the production of new materials both as a discrete sector of *MIC2025* and as a necessary input for upgrading many of the plan's other industries.
- China has succeeded in obtaining control of the extraction and processing of many of the natural materials used in high-technology production, including rare earth elements, lithium, and cobalt, and has emphasized the development of advanced synthetics, such as nanomaterials.
- The U.S. government has implemented plans focused on both securing sources of critical minerals and leading the production of high-performance composites and synthetics.

Advanced materials provide the building blocks to China's technological ambitions. A key element of *MIC2025*'s development goals is self-sufficiency: to move up the value chain, China must be able to develop on its own what it currently imports from abroad. But more than just substituting China's production for imports, to develop new technologies *MIC2025* places great emphasis on self-sufficiency throughout the supply chain in certain sectors. To that end, the Chinese government has emphasized developing and producing advanced synthetic materials, as well as securing the mining and processing capacity of critical resources. As Pan Aikua, Director-General of the Raw Material Division at China's Ministry of Industry and Information Technology stated, "new materials are not only one of ten major key fields of development, but also the foundation and support of the other nine fields."[218]

China takes advantage of its natural endowment of rare earth elements, producing approximately 90 percent of the world's supply.[219] This group of elements is critical to avionics, satellites, clean energy machinery, and other prominent advanced technologies.[220] China maintains export quotas on rare

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[217] Pan Aihua, "What Made-in-China 2025 Means for Petrochemicals and Chemicals," *CPECN,* October 21, 2018, https://www.cpecn.com/features/what-made-in-china-2025-means-for-petrochemicals-and-chemicals/.
[218] Ibid.
[219] "The rare earths are a relatively abundant group of 17 elements composed of scandium, yttrium, and the lanthanides. The elements range in crustal abundance from cerium, the 25th most abundant element of the 78 common elements in the Earth's crust at 60 parts per million, to thulium and lutetium, the least abundant rare-earth elements at about 0.5 part per million. The elemental forms of rare earths are iron gray to silvery lustrous metals that are typically soft, malleable, and ductile and usually reactive, especially at elevated temperatures or when finely divided. The rare earths' unique properties are used in a wide variety of applications." from "Rare Earths Statistics and Information," USGS Minerals Information: Mineral Commodity Summaries, December 21, 2018, https://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/.
[220] Lee Simmons, "Rare-Earth Market," *Foreign Policy*, July 12, 2016, https://foreignpolicy.com/2016/07/12/decoder-rare-earth-market-tech-defense-clean-energy-china-trade/.

earth elements and levies export taxes at rates between 15 and 25 percent. As a result, the price of these critical high-technology inputs has gone up in the rest of the world.[221] The Chinese government is more focused on securing rare earth elements to support domestic industry than on exports. China's control over these essential components cuts two ways: not only does it advantage domestic industry, it also provides a financial incentive for foreign entities, particularly in high-technology sectors, to produce in China where these inputs are readily available and less expensive.[222]

China's efforts to dominate inputs for high-technology manufacturing are not limited to elements where China enjoys a natural monopoly. Cobalt is a central component in lithium-ion batteries that power electronic devices and vehicles. While most of the world's cobalt comes from mines in the Democratic Republic of the Congo, China's companies control virtually all of the extraction and refining. In response, technology companies are developing batteries with less reliance on cobalt, but these efforts are still in their early stages, and Chinese technology firms maintain a strong advantage from their nation's grip on the global cobalt supply chain.[223] In the market for Lithium, another battery component, the formerly state-owned Chinese firm Tianqi Lithium now controls over half of the world's supply.[224]

Naturally-occurring rare earth elements may eventually lose their strategic importance as scientists race to develop nanomaterials and nanocomposites superior to natural rare earth elements in strength, flexibility, and electrical conductivity. However, rather than lose its dominant position to engineered substitutes, the 2017 Annual Report of the U.S.-China Economic and Security Review Commission points out, "China has become the fastest-growing country for nanotechnology publications and industrialization, particularly in nanomaterials and nanocomposites."[225] China currently accounts for 45 percent of the world's nanotechnology-related patent applications.[226]

China's research, development, and production of new materials take place along an "industry-university-research" axis. [227] To this end, the Chinese government has established multiple National Key Laboratories which focus on engineering and producing a wide array of new materials.[228] In 2011, the government founded the country's first state research lab dedicated to metamaterials, which are synthetic composite materials that possess desirable physical properties not

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[221] United States Government Accountability Office, "Rare Earth Materials in the Defense Supply Chain," April 14, 2010, https://www.gao.gov/new.items/d10617r.pdf.
[222] Ibid.
[223] Jack Farchy and Hayley Warren, "China Has a Secret Weapon in the Race to Dominate Electric Cars." *Bloomberg.com,* December 2, 2018, https://www.bloomberg.com/graphics/2018-china-cobalt/.
[224] Askhat Rathi, 2018. "One Chinese Company Now Controls Half the World's Lithium Production," *Quartz,* July 9, 2018, https://qz.com/1292202/china-now-effectively-controls-half-the-worlds-lithium-production/.
[225] *2017 Report to Congress of the U.S.-China economic and Security Review Commission,* 115th Congress, First Session, November 2017, 527 https://www.uscc.gov/sites/default/files/Annual_Report/Chapters/Chapter%204%2C%20Section%201%20-%20China%27s%20Pursuit%20of%20Dominance%20in%20Computing%2C%20Robotics%2C%20and%20Biotechnology.pdf.
[226] "China Focus: China Aims High in Nanotechnology," 2017, Xinhua, *Xinhua Net*, August 30, 2017, http://www.xinhuanet.com//english/2017-08/30/c_136568055.htm.
[227] Pan, What Made in China 2025 Means for Petrochemicals
[228] "Smart Materials China Landscape Report," Innovation China UK, July, 2015, http://www.icukonline.org/download/Smart%20material%20landscape%20report_270715.pdf.

found in nature.[229] According to reports, this laboratory now produces over 100,000 square feet of metamaterials annually.[230] China's state media reports that output from the nation's new materials industry more than doubled, from 1 trillion yuan ($150 billion in 2019 USD) in 2012 to 2.65 trillion yuan ($395 billion in 2019 USD) in 2016.[231] In addition to establishing and supporting research institutes, the Chinese government provides research and development tax incentives under the research and development "Super Deduction" and High New Technology Enterprise research and development programs, among other forms of financial support.[232]

In 2017, President Trump issued the *Presidential Executive Order on a Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*. This order highlights the nation's dependence on foreign sources of minerals vital to American economic prosperity and national defense. The order directs federal agencies to identify materials considered "critical," and declares the policy of the federal government to find alternative sources for such material, and strengthening domestic production activity.[233] Following the order, the Department of the Interior issued a notice identifying 35 critical minerals, including the rare earth elements, cobalt, and lithium.[234]

A 2018 report by the U.S. Geological Survey shows the U.S. no longer mines any rare earth material domestically. At the same time, the value of American imports of rare earth elements is increasing. Between 2013 and 2016, 78 percent of American rare earth imports came from China.[235] In 2018, the White House Office of Science and Technology Policy issued a report titled, "Strategy for American Leadership in Manufacturing." This plan identifies three main areas of federal priority relating to new materials: high-performance materials, such as lightweight and composite metals, additive manufacturing, including 3-D printing, and critical materials, like rare earth metals. The report highlights these components for many of the same reasons as the Chinese government, and it identifies the federal programs working on their development.[236]

The U.S. is not alone in its concern over reliance on China-sourced materials. In Japan, researchers are identifying new deposits of rare earth elements, and automakers are developing new technologies to reduce or eliminate the need for

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[229] 【华仕尊城】设计, http://www.kuang-chi.com/en/index.php?ac=article&at=list&tid=289.

[230] Jeffrey Lin and P.W. Singer, "China's New Stealth Fighter Uses Powerful Materials with Geometry Not Found in Nature," *Popular Science,* March 22, 2018, https://www.popsci.com/chinas-new-stealth-fighter-uses-metamaterials.

[231] Zhu Lingqing, "New Material Industry Expected to Create 10t Yuan by 2025," *China Daily,* February 12, 2018, http://www.chinadaily.com.cn/a/201802/12/WS5a812e48a3106e7dcc13c47e.html.

[232] Innovation China UK, Smart Materials China Landscape Report.

[233] "Executive Order 13817 of December 20, 2017, A Federal Strategy To Ensure Secure and Reliable Supplies of Critical Minerals," 82 FR 60835, https://www.gpo.gov/fdsys/granule/FR-2017-12-26/2017-27899.

[234] "Final List of Critical Minerals 2018," 83 Federal Register 97 (18 May 2018), pp. 23295- 23296, https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018.

[235] "U.S. Geological Survey, Mineral Commodity Summaries, January 2018," U.S. Geological Survey, U.S. Department of the Interior, https://minerals.usgs.gov/minerals/pubs/commodity/rare_earths/mcs-2018-raree.pdf.

[236] "Strategy for American Leadership in Advanced Manufacturing," National Science & Technology Council, Committee on Technology, Subcommittee on Advanced Manufacturing, October 2018, https://www.whitehouse.gov/wp-content/uploads/2018/10/Advanced-Manufacturing-Strategic-Plan-2018.pdf.

rare earth inputs.[237] In 2017, the U.S. Department of Energy Office of Fossil Energy and the National Energy Technology Laboratory presented to Congress an assessment of the feasibility of extracting rare earth elements from coal and coal products. This report highlights the large international demand for rare earth elements, both present and projected, and points out many projects created to address supply issues were abandoned due to economic considerations. The report notes additional sources of supply explain just one segment of the chain, as rare earth elements need to be processed, refined, and manufactured.[238]

On the research and development side, the U.S. has invested in programs such as the National Nanotechnology Initiative and the Critical Materials Institute. The U.S. has a critical advantage in its system of university laboratories and private research facilities. While research and development investment has risen steadily over the last four decades, as a percent of GDP those numbers have been relatively constant,[239] and according to the OECD, China is poised to overtake the U.S. in R&D spending.[240] On the other hand, the U.S. faces a relative supply gap for critical minerals and elements due to environmental regulations, arduous permitting processes, and lack of natural deposits of certain minerals.

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[237] Mayuko Yatsu, "Revisiting Rare Earths: The Ongoing Efforts to Challenge China's Monopoly," *The Diplomat,* August 29, 2017, https://thediplomat.com/2017/08/revisiting-rare-earths-the-ongoing-efforts-to-challenge-chinas-monopoly/.
[238] "Report on Rare Earth Elements from Coal and Coal Byproducts," U.S. Department of Energy, January 2017, https://www.energy.gov/sites/prod/files/2018/01/f47/EXEC-2014-000442%20-%20for%20Conrad%20Regis%202.2.17.pdf.
[239] J. John Wu, *Why U.S. Business R&D Is Not as Strong as It Appears*, Information Technology and Innovation Foundation, June 2018, http://www2.itif.org/2018-us-business-rd.pdf.
[240] "China Headed to Overtake EU, US in Science & Technology Spending, OECD Says," Estadísticas – OECD, December 11, 2014, http://www.oecd.org/newsroom/china-headed-to-overtake-eu-us-in-science-technology-spending.htm.

AGRICULTURAL MACHINERY

> *"…the place of the United States is at the head of the poll. Where, out of America, shall we get a pistol like Mr. Colt's, to kill our eight enemies in a second, or a reaping machine like Mr. McCormick's, to clear out twenty acres of wheat in a day?"*
>
> – Sir Henry Lytton Bulwer, British ambassador to the United States, 1851.[241]
>
> *"The future of China's agriculture sector lies in agricultural modernization, and the key to advancing agricultural modernization lies in the development of technology."*
>
> – Xu Nanping, State Council Vice Minister of science and technology, 2018.[242]

- *MIC2025's* agricultural machinery targets aim to resolve food security challenges and promote a high value-added export for China's economic sphere of influence.
- The U.S. is losing global market share relative to China in this sector.

China faces a complex set of agricultural challenges. Although it has one-fifth of the world's population, it has less than one-tenth of the world's farmland. In addition, an estimated 90 percent of China's farms are less than 2.5 acres in size. China's agricultural needs are shifting with the changing diets and lifestyles of its increasingly urban and affluent population.[243] Food supply issues are becoming increasingly pressing due to the scarcity of natural resources, such as water and arable land, and the presence of pollution in the water supply and soil.[244] As a critical sector in *MIC2025,* China's agricultural equipment manufacturers receive significant state support, including subsidies and research and development funding.[245]

China leads the world in total production of agricultural equipment, but the nation's manufacturing capabilities are primarily relegated to low-technology machines.[246] *MIC2025* plans to change this by attaining 90 percent self-sufficiency in agricultural machinery manufacturing and by developing a number

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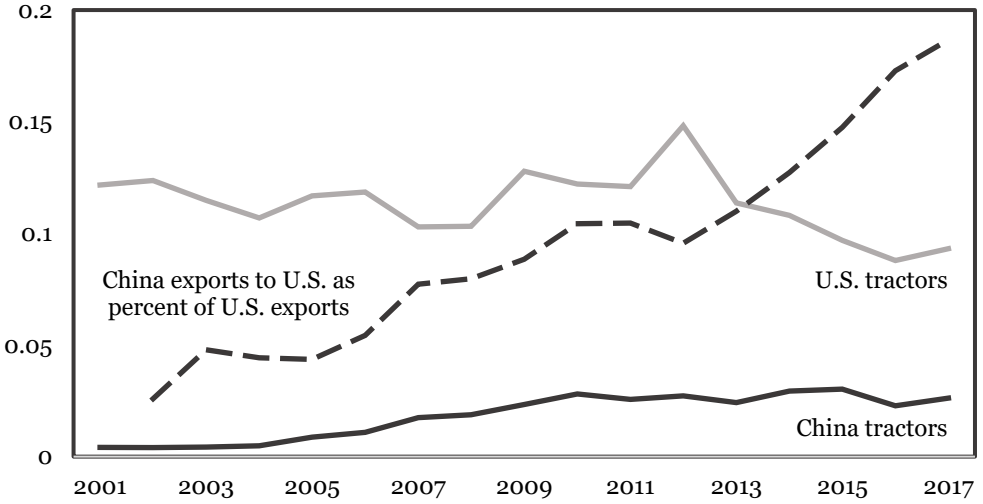
[241] Hebert Newton Casson, *Cyrus Hall McCormick: His Life and Work*, Chicago, Project Gutenburg, p. 130, http://www.gutenberg.org/ebooks/41953.
[242] Xinhua. "China pushes technology development to modernize agriculture," Xinhua, January 29, 2018, http://www.xinhuanet.com/english/2018-01/29/c_136934072.htm.
[243] Tracie McMillan and Tracie George Steinmetz, "How China Plans to Feed 1.4 Billion Growing Appetites," *National Geographic,* February 02, 2018, https://www.nationalgeographic.com/magazine/2018/02/feeding-china-growing-appetite-food-industry-agriculture/.
[244]Tianzhi Ren, "*China Agriculture: Challenge & Countermeasures*," (Chinese Academy of Agricultural Sciences), https://sustainabledevelopment.un.org/content/documents/ren_5may_agriculture.pdf.
[245] Chamber of Commerce of the United States of America, "Made in China 2025: Global Ambitions Built on Local Protections."
[246] United States Department of Commerce, International Trade Administration, U.S. Commercial Service, A Guide for U.S. Exporters 2017, 2017, https://build.export.gov/build/groups/public/@eg_cn/documents/webcontent/eg_cn_109546.pdf.

of internationally recognized brands by 2025.[247] Currently, China exports its agricultural machinery mainly to Africa and other parts of Asia, and especially to countries participating in the Belt and Road Initiative, which places a significant emphasis on agricultural trade. [248] [249] Its exports to the U.S. in the sector are also rising. Since 2001, U.S. imports of agricultural implements from China have grown from 2 percent of total U.S. exports of the same in 2002, to 18 percent in 2017, while China's growth in the share of global exports in tractors has outpaced the U.S. over the same period, though a sizable gap remains.

Figure 9.

Share of global export market in HS 8701, tractors (UN ITC); China exports to U.S. of NAICS 33311 Agricultural Implements as a percent of U.S. exports (Census)



[250]

As in the case of other *MIC2025* industries, China often relies on foreign technology and technical expertise to leap from producing low-end to high-technology goods. To accomplish this, China allows foreign companies to be eligible for subsidies if they manufacture agricultural equipment within China,[251] and as with other industries, to gain market access, foreign firms in agricultural aviation, surveying mapping, manufacture of special vehicles, among other industries must enter into joint venture firms with local companies that often appropriate their intellectual property and trade secrets.[252]

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[247] Chamber of Commerce.
[248] Wei Fang, Current Status and Development Trends of China's Agriculture Machinery Industry, LOVOL, July 2015, http://www.un-csam.org/ppta/2015distr/4.pdf.
[249] Erin Ennis, China's Belt and Road Initiative: Opportunities and Challenges for US Agriculture, Report, The US.- China Business Council, February 23, 2018, https://www.usda.gov/oce/forum/2018/speeches/Erin_Ennis.pdf.
[250] United Nations COMTRADE, compiled the International Trade Centre's "Trade Map," https://www.trademap.org/Index.aspx and U.S. Census Bureau, NAICS District-level Data, https://usatrade.census.gov.
[251] Olga Chilat, Briefing on the Machinery Sector in China 2018, *Cecimo*, 2018, https://www.agoria.be/www1.wsc/webextra/prg/nwAttach?appl=enewsv7&enewsdetid=213458&attach=Attach123854001.pdf&BodyPreview=no.
[252] Office of the United States Trade Representative, Findings of the Investigation into China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation Under Section 301 of the Trade Act of 1974, March 22, 2018, https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF.

As China upgrades its capacity to develop and produce increasingly high-value agriculture equipment, it is also expanding international agricultural collaboration through the Belt and Road Initiative. In doing so, China aims not only to improve its own efficiency in farming but also to expand the international market for its higher-value agricultural equipment. Between 2006 and 2016, China's agricultural foreign direct investment skyrocketed from $190 million to $3.29 billion.[253] As of 2016, the Chinese government maintained 23 business-focused Agricultural Technology Demonstration Centers (ATDC) in Africa.[254] A quote by the former vice minister of the Chinese Ministry of Commerce underscores the role of Chinese technologies and business in the nation's agricultural FDI: "Alternatively, I am assuming the ATDC is the best model to deliver Chinese agricultural technology to stimulate the local development."[255] China's government is actively promoting engagement between domestic agricultural companies and Belt and Road Initiative partner countries.[256]

While Chinese agricultural manufacturing has made significant advances over the last ten years, some institutional and technological barriers prevent the nation from advancing at the rate policymakers hoped to achieve. One major obstacle to agricultural modernization is the small size of China's farms. Small acreage units across large land masses are less adaptive to new technologies and large capital goods in agriculture.[257] In response to these problems, the government has attempted to consolidate holdings so high-technology and automated machines become easier to adopt and more efficient to use. Agriculture and farming are a $3 trillion industry in the United States, yet a mere two percent of Americans hold a farm-oriented job.[258] A swing towards larger, more mechanized farms has led to an increase in the adaptation of technology such as drones, smart irrigation and fertilization, and self-driving, GPS enabled tractors.[259]

According to the United States Department of Commerce, there are over 1,000 companies that manufacture agricultural equipment in the U.S., employing more than 60,000 American workers as of 2016.[260] The Department of Commerce further notes that exports from the U.S. to China have dropped as a direct result of the Chinese government's policies. The future of this industry is likely to be determined by the impact of trade decisions on demand for agricultural products and China's success in developing its own markets.

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[253] Xiaoyu Jiang, Yangfen Chen, and Lijuan Wang, "Can China's Agricultural FDI in Developing Countries Achieve a Win-Win Goal?" Enlightenment from the Liturature, *Sustainability,* 2018, https://www.mdpi.com/2071-1050/11/1/41.
[254] Xiuli Xu, Xiaoyun Li, Gubo Qi, Lixia Tang, Langton Mukwereza, Science, Technology, and the Politics of Knowledge: The Case of China's Agricultural Technology Demonstration Centers in Africa, *El Sevier,* May 2016, https://www.sciencedirect.com/science/article/pii/S0305750X15301509#b0205.
[255] Ibid.
[256] Li Binian and Liu Jinhui, Across China: Chinese agricultural firms expand along belt and road, *XinhauNet*, March 20, 2018, http://www.xinhuanet.com/english/2018-03/20/c_137053168.htm.
[257] Ibid.
[258] Chloe Sorvino, "The 25 Most Innovative Ag-Tech Startups," *Forbes,* July 05, 2017, https://www.forbes.com/sites/maggiemcgrath/2017/06/28/the-25-most-innovative-ag-tech-startups/#7f2eb9fa4883.
[259] Association of Equipment Manufacturers, "3 Trends Agriculture Equipment Manufacturers Should Be Ready For," Association of Equipment Manufacturers, July 05, 2018, https://www.aem.org/news/3-trends-agriculture-equipment-manufacturers-should-be-ready-for/.
[260] International Trade Administration, 2017 Top Markets Report: Agricultural Equipment, February 2017, https://www.trade.gov/topmarkets/pdf/Ag_Equipment_Top_Markets_Report.pdf.

POLICY IMPLICATIONS

"Commercial war, or competition, is a struggle between the capitalists themselves… The method of fighting is to undersell each other, in order to exhaust the weaker rivals so that the victor may control the market alone and dictate terms to the consuming public as long as possible… [Our laborers] are living from hand to mouth and will therefore only be too glad to welcome any capitalist who would even put up a sweat shop to exploit them. The capitalist is a rare specimen in China and is only beginning to make his appearance in the treaty ports. However, China must develop her industries by all means. Shall we follow the old path of western civilization? The goal of material civilization is not private profit but public profit."

– Sun Yat-Sen, *The International Development of China*, 1920.[261]

"A government can try to circumvent the private sector by running every firm itself. But such an approach is not recommended by history. Instead, governments must use their power… to make private entrepreneurs do what industrial development requires. In so doing, governments need to take a realistic view of entrepreneurs. Rather than plead with them to move voluntarily to some higher moral plane, it is better to accept the existence of the entrepreneur's 'animal spirits,' and use his desire to make as much money as possible to control him. The entrepreneur seeks to 'get in and grab,' as the term indicates. The state has to force him to fulfill developmental objectives while this is going on. Development is therefore a thoroughly political undertaking."

– Joe Studwell, *How Asia Works*, 2013.[262]

[261] Sun Yat-sen, The International Development of China, (Shanghai, Commercial Press, 1920), pp. 231-237.
[262] Studwell, *How Asia Works*, pp 107-108.

Corresponding response. The most straightforward response to *MIC2025*'s explicit selection of products and export goals is to respond in kind, based on the tools provided the U.S. by its membership in the WTO and reliance of China's exports on U.S. consumers. Because *MIC2025*, in effect, provides a roadmap for industrial competition in the next half decade, U.S. policy can use it in designing a response. Legislation introduced in the 116th Congress by Senators Marco Rubio (R-FL) and Tammy Baldwin (D-WI), titled the *Fair Trade with China Enforcement Act* (S.2),[263] would direct the USTR to develop and maintain a list of industries and corresponding finished goods receiving state support from China, and require countervailing action by relevant agencies throughout the U.S. government. This would include the following actions:

- Export controls enacted by the Department of Commerce on national security-sensitive technology and intellectual property related to the supply of *MIC2025* finished goods;
- Prohibition of majority-stake acquisitions by China resident investors of U.S. companies in supply industries for *MIC2025*; and
- Definition of *MIC2025* as a countervailable subsidy and declaration of suits relating to material injury or prevention of industry establishment by reason of imports of merchandise being produced by a *MIC2025* sector.

Enacting these policies would represent a continuation of the approach taken by the USTR to target imports from China receiving state support from *MIC2025* with Section 301 tariffs.[264] Further actions might also be taken. The work of threat definition amidst shifting state priorities and plans requires a whole-of-government approach. Legislation introduced in the 116th Congress by Senators Mark Warner (D-VA) and Rubio, *A bill to establish the Office of Critical Technologies and Security* (S.29), would create such an office in the Executive Office of the President to streamline efforts across the government to guard against threats to critical technologies.

Capital flows. China's currency, which is called the *renminbi* (RMB) in formal terms, and the *yuan* (CNY) as a unit of account, has a managed exchange rate.[265] China has demonstrated a willingness to strategically hold the value of the RMB below what it would otherwise be relative to the U.S. dollar (USD), and more recently it has propped up the RMB against downward pressure. Often known as currency devaluation or manipulation, China can manage its currency to provide an in-kind subsidy to U.S.-bound China-source goods and services by reducing relative cost. The practice was employed more commonly in the early- to mid-2000s, and in recent years changes to China's balance of payments have weakened the case for a formal designation of China as a currency

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[263] Senator Marco Rubio, "S.2, 116th Congress (2019-2020): Fair Trade with China Enforcement Act," Congress.gov, January 3, 2019, https://www.congress.gov/bill/116th-congress/senate-bill/2.
[264] Office of the United States Trade Representative, Request for Comments Concerning Proposed Modification of Action Pursuant to Section 301: China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation, June 20, 2018, https://ustr.gov/sites/default/files/301/2018-0026%20China%20FRN%207-10-2018_0.pdf.
[265] John Clark, "China's Evolving Managed Float: An Exploration of the Roles of the Fix and Broad Dollar Movements in Explaining Daily Exchange Rate Changes," Federal Reserve Bank of New York, November 2017, https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr828.pdf.

manipulator.[266] However, the possibility for targeted currency devaluation remains,[267] making necessary the use of U.S. tools as guards against it.

S.2, *the Fair Trade with China Enforcement Act*, proposes two policy changes toward this end. First, the legislation would cancel the 1984 U.S.-China bilateral tax treaty, which reduces investment income rates of China-source investment in the U.S. beyond what current statute would otherwise allow. Secondly, the legislation would remove the tax exemption for China's government income received from investments in the United States, including stocks, bonds, interest on deposits, other financial instruments held in the execution of government financial or monetary policy. The combined effect would be to make more expensive China's currency intervention, in addition to reducing extranormal upward pressure on the USD due to China-source investment, which as discussed in this report, is often not market-based.

The openness of U.S. financial markets to Chinese companies incurs further risk. U.S. stock exchanges list over 125 Chinese companies, which are largely shielded by China from the full oversight of American financial regulators.[268] [269] Furthermore, China's national security laws blur lines between private and state-controlled commercial entities.[270] Absent enforcement and accountability, Chinese companies run greater risks to U.S. investors.[271] As of 2017, these companies had a market capitalization of approximately $960 billion – including over $120 billion in pension funds, retirement plans, mutual funds, and exchange-traded funds.[272] Aside from the risks posed to American investors and financial markets, outflows of capital from the U.S. to China help manage Chinese firms' capital financing needs, including firms involved in *MIC2025*. Legislation introduced in the 115th Congress by Representative Michael Conaway (R-TX), titled the *Holding Foreign Companies Accountable Act* (H.R. 7234),[273] would require certain issuers to disclose to the Securities and Exchange Commission (SEC) information regarding foreign jurisdictions that prevent the Public Company Accounting Oversight Board (PCAOB) from performing inspections. If the SEC determines a company has three consecutive non-inspection years, it would prohibit the securities of the covered issuer from being traded on a U.S. securities exchange. This approach, among other methods to appropriately sanction Chinese listings for a disparity in accounting practices, should be considered.

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[266] Colby Smith, "If the Treasury names China a currency manipulator, it's purely political," *Financial Times*, October 12, 2018, https://ftalphaville.ft.com/2018/10/12/1539331846000/If-the-Treasury-names-China-a-currency-manipulator--it-s-purely-political/.
[267] See China's 2015 CNY devaluation for a recent example.
[268] U.S.-China Economic and Security Review Commission, 2017 Report to Congress, November 2017, https://www.uscc.gov/sites/default/files/annual_reports/2017_Annual_Report_to_Congress.pdf.
[269] Paul Gillis, "Public Company Accounting Oversight Board Enlists In The Trade War," *Seeking Alpha,* December 11, 2018, https://seekingalpha.com/article/4227643-public-company-accounting-oversight-board-enlists-trade-war.
[270] "Australia Says No Such Thing as Private Chinese Company, Will Guard National Interest," *Epoch Times*, January 17, 2019, https://www.theepochtimes.com/australia-steps-up-scrutiny-on-chinese-investment-to-guard-national-interest_2769320.html.
[271] Josh Rogin, "It's Time to End the 'China Hustle' on U.S. Stock Exchanges," *The Washington Post*, August 30, 2018, https://www.washingtonpost.com/opinions/global-opinions/its-time-to-end-the-china-hustle-on-us-stock-exchanges/2018/08/30/50137c1a-ac8d-11e8-8a0c-70b618c98d3c_story.html?utm_term=.9f6b0c9b86df.
[272] U.S.-China Economic and Security Review Commission, 2017 Report to Congress.
[273] Conaway, "Text - H.R.7234: Holding Foreign Companies Accountable Act," Congress.gov, December 10, 2018, https://www.congress.gov/bill/115th-congress/house-bill/7234/text?format=txt.

Trade. The current trade conflict with China suggests the discussion of a host of trade policies. In 2018, the USTR utilized its authority under Section 301 of the Trade Act of 1974 to impose tariffs on China-source goods related to the theft of intellectual property and *MIC2025*. It also utilized authority under Section 201 of the same Act to impose safeguard tariffs on imported residential washing machines and solar cells and modules.[274] The USTR, also in 2018, concluded negotiations for the U.S.-Mexico-Canada Agreement (USMCA), with regional content requirements for automobile production among other items, including a provision that would allow for withdrawal and other actions in the event a partner state makes a free-trade agreement with a non-market economy, including China.[275] Also in 2018, the Department of Commerce enacted tariffs on steel and aluminum under Section 232 of the Trade Expansion Act of 1962, and the Department is currently investigating the national security implications of foreign automobile production under the same authority.

Supplemented by China's retaliation, the sum effect has been to impose material changes to U.S.-China trade policies. At the same time, the U.S. trade deficit with China hit an all-time high in September 2018.[276] This does not mean the trade actions have been inconsequential (there is also evidence the tariffs have had greater macroeconomic effect in the period since), but instead that contests of trade law occur, rightly, in a track at least partly removed from economic development. U.S. trade law grants the executive the power to, in the words of the Trade Act of 1974, take action in the case when "the rights of the United States under any trade agreement are being denied; or an act, policy, or practice of a foreign country violates, or is inconsistent with, the provisions of, or otherwise denies benefits to the United States under, any trade agreement." It is a tool of enforcement. Congress should consider actions where necessary to supplement the depth and scope of such enforcement, as discussed above. Additionally, Congress should look for all available opportunities to reduce the burden on private American firms, including small businesses, to petition the federal government for such enforcement actions as necessary to mitigate and prevent demonstrable injury from dumping tied to China trade policies.

Development. Just as U.S. policymakers have proved willing to use American leverage to enforce international trade law and norms, the U.S. Congress should consider actions to leverage the American economy to increase domestic productivity. The growth rate of this statistic, which is a measure of output per-person, has fallen in the period since China's WTO accession, as depicted by figure 10.

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[274] United States Trade Representative, "Fact Sheet: Section 201 Cases: Imported Large Residential Washing Machines and Imported Solar Cells and Modules," Executive Office of the President of the United States. https://ustr.gov/sites/default/files/files/Press/fs/201%20Cases%20Fact%20Sheet.pdf

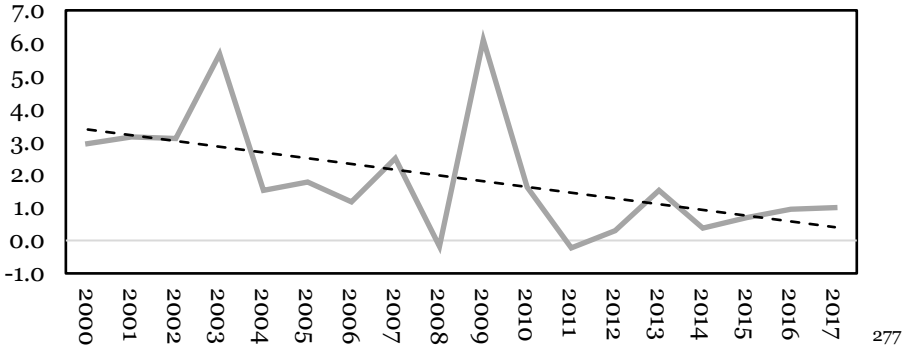
[275] "NAFTA's China Clause Is Latest Blow to Trudeau's Asia Ambitions," *Bloomberg.com,* https://www.bloomberg.com/news/articles/2018-10-04/nafta-s-china-clause-is-latest-blow-to-trudeau-s-asia-ambitions.

[276] "U.S. Trade Gap Widens; Deficit with China Rises to Record High," *Reuters,* November 02, 2018, https://www.reuters.com/article/us-usa-economy-tradefigures/u-s-trade-gap-widens-deficit-with-china-rises-to-record-high-idUSKCN1N71DL.

Figure 10.

U.S. nonfarm business sector: real output per hour of all persons

U.S. Bureau of Labor Statistics



[277]

The sources of the slowdown have been widely debated. It is generally agreed, though, that the decline has yielded worse outcomes for American workers and for the long-term growth potential of the U.S. economy. In one way or another, this is the macroeconomic background that many policy proposals, from tax cuts to skills training, subsidized employment, and infrastructure spending, implicitly aim to change.

Tax. As the largest recent policy undertaking of this kind and an example of how one paradigm of economic development might be understood in a policy context, the 2017 reform of the U.S. tax code is worth analysis. The *Tax Cuts and Jobs Act* (P.L. 115-97) reduced the U.S. corporate income tax rate from its previous level of 35 percent, the highest in the OECD, to 21 percent, a rate more in line with the OECD average.[278] The 14-percentage point reduction in the statutory corporate income rate significantly altered corporate incentives away from international tax arbitrage. To understand why this change – and not productivity-driven wage growth – is the most compelling argument for the law, and so why the law might fairly be called a missed opportunity for further development, requires a slightly different understanding of the current political economy.

It is instructive that the reduction in the corporate income tax rate was often advocated for as a way to compete with other developed countries for firm and investment location. It was a hallmark of President Trump's advocacy for the law, a point underscored by his reported initial intent to have the corporate income tax rate reduced to 15 percent, instead of 20, or 21 percent.[279] The strongest case for the law's expected increase in capital investment and workers' wages, made by the White House Council of Economic Advisers, cites research suggesting the same has occurred elsewhere, driven by cross-state firm and investment decisions.[280] Framing the rate reduction as beneficial by cause of international

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[277] U.S. Bureau of Labor Statistics, Nonfarm Business Sector: Real Output Per Hour of All Persons [OPHNFB], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/OPHNFB, January 11, 2019.

[278] Kyle Pomerleau, "The United States' Corporate Income Tax Rate is Now More in Line with Those Levied by Other Major Nations," Tax Foundation, February 12, 2018, https://taxfoundation.org/us-corporate-income-tax-more-competitive/.

[279] Ben White and Nancy Cook, "Trump still pushing for a 15 percent corporate rate," *Politico*, September 5, 2017. https://www.politico.com/story/2017/09/05/trump-corporate-tax-rate-cut-242354.

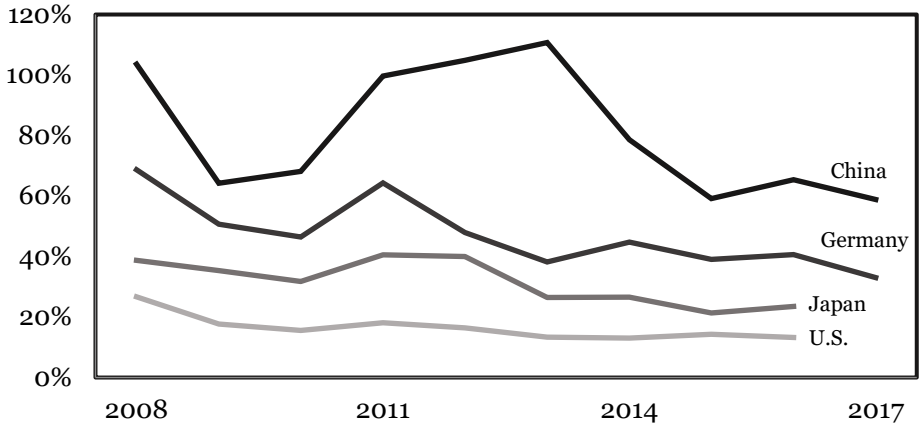
[280] The Council of Economic Advisers, "The Growth Effects of Corporate Tax Reform and Implications for Wages," White House Executive Office of the President, October 2017,

competition grasped an essential understanding of economic policy as choice more of structure than efficiency, though the two were often conflated.

It is an important distinction. Comparative differences in the tax rate on capital can be expected to influence capital behavior, but this is no guarantee of effective capital deployment. Capital investment is not the only possible use of new cash flows. Cash can be used for shareholder return without requisite increases in investment. For example, see the U.S.'s position among its industrial competitors for gross fixed capital formation as a percent of total market capitalization. Reducing the cost of capital equally across all kinds of assets is alone unlikely to yield movement equal to a doubling, or tripling of current levels.

Figure 11.

Gross fixed capital formation as a percent of total market capitalization, post-financial crisis (World Bank)



[281]

That a reduction in the U.S. tax burden on capital is likely a necessary but not sufficient condition for significant economic development is an insight which can be applied more broadly. In a globalized economy, U.S. firms that expand production in China, or in any other country, most often do so in response to profit motives. In the case of production location, the firm's market information has determined that particular location, whatever the reasons, to be the best place for production for the firm's overall strategy and growth. If there is a problem with a firm making this decision to invest outside the U.S. rather than inside the U.S., it is not attributable to an improper choice by the firm in response to the market, but rather the terms upon which the market is set. Likewise, when the structure of corporate governance prioritizes shareholder interests, corporate participation in the market is generally interpreted through the lens of return to shareholders. If there is a problem with the raising and deploying of capital, then, it is not attributable to the firm's response to its governors, but rather the terms upon which governance is set.

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https://www.whitehouse.gov/sites/whitehouse.gov/files/images/Corporate%20Tax%20Reform%20and%20Growth%20Final.pdf.

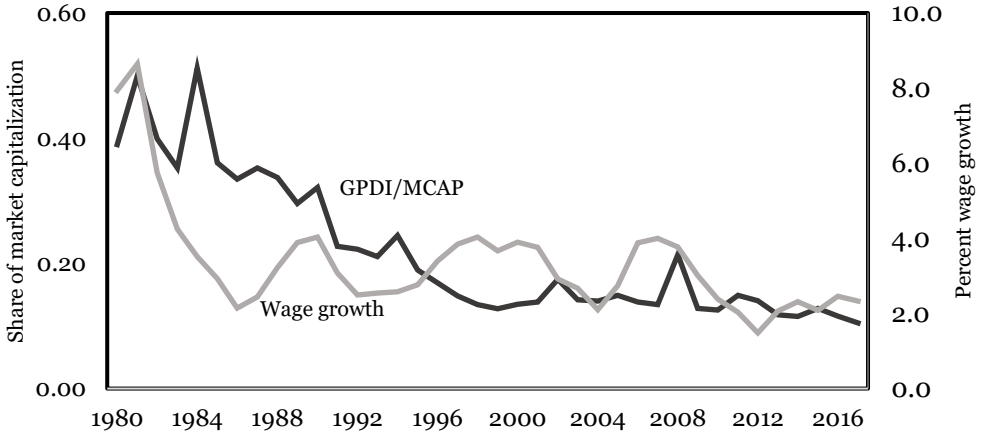
[281] World Federation of Exchanges database, Market capitalization of listed domestic companies (current US$) [CM.MKT.LCAP.CD], data retrieved from World Bank Data, The World Bank; https://data.worldbank.org/indicator/CM.MKT.LCAP.CD?locations=US, January 11, 2019.

Properly aligned with national priorities, markets in trade and finance can drive tremendous economic progress. Left to their own devices, expanding for expansion's sake, however, they provide market actors the framework to endlessly seek out new efficiencies, regardless of whether such efficiencies are in the national interest, or in some cases even in the interests of the firm's own product value.

The root cause of the problems plaguing the free market, then, might be understood not as valuing profit too much, but too little – or more precisely, in the wrong way. For example, increasing profit margins by developing new products to outcompete others takes risk, but saving on labor costs by off-shoring employment is more often safe. Highly-leveraged investments in technological discovery offer unknown outcomes, but distributions to shareholders are quantifiable. The existence of non-productive alternatives to capital investment, as a result, makes the product of the firm's American workers less valuable while at the same time increasing profits, making possible a world of higher asset prices, lower investment in the economy, and lower worker pay.

Figure 12.

Gross private domestic investment as a percent of market capitalization vs. wage growth (Federal Reserve Economic Data and World Bank)



[282]

The stated goals of the *Tax Cuts and Jobs Act* indicated many share the above understanding of the problem. Characteristics of the law's most central supporting arguments, like the frame of international competition and theory of investment-driven wage growth, understand the goal of helping American workers as one to promote domestic productivity. Successful development policies would mostly aim to achieve this goal to a greater extent.

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[282] U.S. Bureau of Labor Statistics, Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private [AHETPI], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/AHETPI, January 11, 2019, U.S. Bureau of Economic Analysis, Gross Private Domestic Investment [GPDI], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/GPDI, January 11, 2019, and World Federation of Exchanges database, Market capitalization of listed domestic companies (current US$) [CM.MKT.LCAP.CD], data retrieved from World Bank Data, The World Bank; https://data.worldbank.org/indicator/CM.MKT.LCAP.CD?locations=US, January 11, 2019.

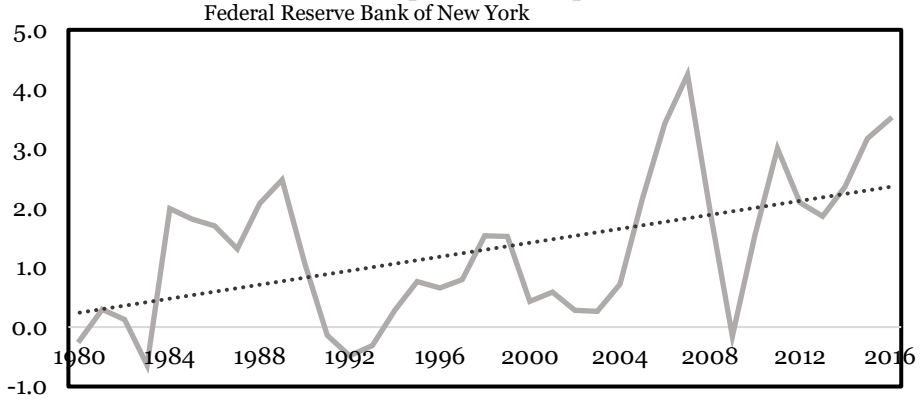
First among them should be the expansion and permanency of the immediate deduction for capital expenses, often called "full expensing." Prior to the *Tax Cuts and Jobs Act*, when firms purchased capital assets they could only write off the costs of depreciation based on a percentage schedule for the class of the asset. The *Tax Cuts and Jobs Act* enacted 100 percent bonus depreciation for assets with cost recovery lives of 20 or fewer years through the year 2022, after which it is reduced by 20 percent each year until expiring in 2026. Moreover, business investment in long-life assets like structures did not receive enhanced depreciation treatment at all.[283] Compounding the problem of expiration is a provision in the law effective in 2022 which requires companies to deduct their research and development expenses over a period of five years, compared to the immediate deduction given to R&D costs today.[284]

Building a more productive industrial base will require more investment in tangible assets. Congress should prioritize expanding enhanced depreciation to long-life capital assets, making the enhanced treatment of asset classes permanent, and eliminating the limitation of the deductibility of research and development costs in order to encourage such investment.

Continuing reforms in this direction should also address the increasing prevalence of share repurchases, often called stock buybacks.

Figure 13.

U.S. net share repurchases as percent of GDP
Federal Reserve Bank of New York



[285]

Though there is considerable debate over the extent to which firms have used asset windfalls and increased after-tax returns resulting specifically from the *Tax Cuts and Jobs Act* for capital investment, it is clear as a general matter that share repurchases have grown dramatically in the same period as falling investment and rising prices of less-productive assets. The relative newness of share repurchases as a tool for capital return suggests a number of policy options to channel the capital they represent more productively. Cash spent on share repurchases is not cash spent on capital investment, though the degree to which a

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[283] Scott Greenberg, "Tax Reform Isn't Done," Tax Foundation, March 8, 2018, https://taxfoundation.org/tax-reform-isnt-done/.
[284] Ibid.
[285] Joseph W. Gruber and and Steven Kamin (2017). "Corporate Buybacks and Capital Investment: An International Perspective," IFDP Notes. Washington: Board of Governors of the Federal Reserve System, April 11, 2017, https://doi.org/10.17016/2573-2129.30.

relationship exists may vary by sector and firm type. [286] Finally, share repurchases are tax-advantaged over dividends, due to the structure of capital gains taxes.[287] Tax policy changes to end this preference might, on their own, increase investment by shifting shareholder appetite for capital return. To the extent structural incentives remain for capital return, an increased tax rate on repurchases might raise revenue to finance other incentives for capital investment like full expensing.[288]

The *Tax Cuts and Jobs Act* also made fundamental reforms of the U.S. international tax system. In addition to allowing the domestic return of foreign cash holdings at a reduced tax rate, the law exempted foreign earnings from tax. Previously, U.S. tax law imposed full corporate tax, minus some credits for foreign taxes paid, on profits earned outside the U.S. upon their repatriation. The change enacted by the tax law practically eliminates inversion incentives, for U.S. firms can now bring back profits freely from operation anywhere in the world under this new structure, often called a "territorial system." While the change is consistent with a value chain position improvement – U.S. firms overseas create the opportunity for cheaper supply to domestic production, or increase foreign demand for U.S. products – on its own it would also create new opportunities for tax arbitrage. High-return assets like intellectual property and financial services could now face very little tax at all if moved offshore to low-tax jurisdictions. For this reason, the tax law also enacted an element of "worldwide" taxation by creating a tax on "global intangible low-tax income," or GILTI. The tax is imposed on earnings derived from assets earning supernormal returns, regardless of where in the world they are earned. The level of tax is based on a formula that scales with the tax rate the asset faces abroad. The law also offers a deduction for foreign-derived intangible income (FDII) exported abroad. Related measures include the "base erosion and anti-abuse tax," or BEAT, which limits the deductibility of intercompany debt in order to reduce incentives for tax reduction with related foreign companies.

The total effect of these changes will take time to assess, though in structure they are sound. The ability to increase profit margins by moving economically identical assets and processes to lower-tax jurisdictions has in the past reduced U.S. firms' incentives to become more productive, in addition to lowering tax revenue that might be used for competitiveness reforms mentioned elsewhere. The prevalence of these strategies might affect the U.S. trade deficit by encouraging the reimportation of high-value goods and assets from abroad, and reducing the U.S. export of the same.[289] The *Tax Cuts and Jobs Act* created new tools to address such practices. Policy efforts in this area should build on their

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[286] For a discussion of the relationship between the two, and relevant market structures and incentives that affect it, see "Share Buybacks and the Contradictions of "Shareholder Capitalism" by Julius Krein in *American Affairs*, https://americanaffairsjournal.org/2018/12/share-buybacks-and-the-contradictions-of-shareholder-capitalism/.

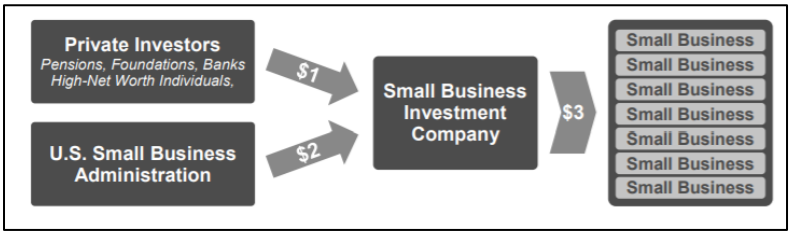
[287] Marvin Chirelstein, "Optional Redemptions and Optional Dividends: Taxing the Repurchase of Common Shares," *Yale Law Journal*, Vol. 78, No. 5, April 1969, https://digitalcommons.law.yale.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=5826&context=fss_papers.

[288] For a broader discussion, see Senator Marco Rubio, "America Needs to Restore the Dignity of Work," *The Atlantic,* December 13, 2018, https://www.theatlantic.com/ideas/archive/2018/12/help-working-class-voters-us-must-value-work/578032/.

goals to balance the competitiveness of U.S. firms with the need to reduce foreign arbitrage.

Small business. Ensuring the productive use of capital for American domestic production entails an agenda of economic restructuring. Creating new ecosystems of innovators and promoting the dynamism of new businesses entails an agenda of rejuvenation. Uniquely positioned among government agencies in this regard is the U.S. Small Business Administration, which operates a number of programs to service new and small businesses. Among these is the Small Business Investment Company (SBIC) program, which provides licenses to private equity firms to make equity and debt investments in qualifying small businesses, using their own capital plus funds borrowed with an SBA guarantee. Since the SBIC program's inception in 1958 through December 2017, SBICs have invested approximately $91.5 billion in capital through approximately 178,175 financings.[290] Globally competitive firms that received early funding supported by the SBIC program include Apple, Intel, Amgen, FedEx, and Tesla.[291]

Figure 14.



Source: U.S. Small Business Administration.[292]

In fiscal year 2017, the SBA committed to guarantee $1.96 billion in SBIC small business investments. SBICs invested another $3.77 billion from full private capital for a total of $5.73 billion in financing for 1,077 small businesses. Recent action to further strengthen the program includes P.L. 115-187, the *Small Business Investment Opportunity Act*, introduced in the 115th Congress by Senators Benjamin Cardin (D-MD), James Risch (R-ID), and John Kennedy (R-LA). Signed into law in 2018, the legislation increased the maximum amount of outstanding leverage made available to any licensed small business investment company from $150 million to $175 million. Also enacted in 2018 was P.L. 115-333, the *Spurring Business Investment in Communities Act* originally introduced by Senators Rubio, Baldwin, and Kennedy. The legislation addresses the geographic concentration of SBICs, with 72 percent of SBICs located in just ten states, by giving first priority to Small Business Investment Company (SBIC) program applicants located in underlicensed and under-financed states and expands a provision in the *Small Business Investment Act of 1958* providing certain exemptions from full private capital requirements to include applicants

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[290] Dilger, Robert Jay. 2018. "SBA Small Business Investment Company Program," *Congressional Research Service*, December 2018: 1-38. http://www.crs.gov/reports/pdf/R41456

[291] "Risch and Cardin, "Direct More Investment Capital to Innovative, High-Growth Small Businesses," U.S. Committee on Small Business & Entrepreneurship, https://www.sbc.senate.gov/public/index.cfm/pressreleases?ID=B9F5D82A-00F9-4068-ADE8-072555CA31C2.

[292] John Pagila, Ph.D, and David Robinson, Ph.D., "Measuring the Role of the SBIC Program in Small Business Job Creation," United States Small Business Committee, https://www.sba.gov/sites/default/files/files/SBA_SBIC_Jobs_Report_0.pdf.

from underlicensed states, among other reforms. Combined, the new laws provide an opportunity for the program to expand into new areas of the country in order to finance innovative products. Policymakers should consider building upon this success.

Policymakers should also consider the implications of expanding investments in higher growth companies that are creating the highest number of jobs. The SBIC program was responsible for the creation of nearly three million jobs between October 1995 and December 2014,[293] and while the aforementioned legislation bolsters the program, policymakers should consider building upon the program's success. For example, equity financing, while higher risk, is known to result in the highest job creation rates due to the correlation between higher risk investments and higher growth companies.[294]

The SBA also administers two programs that uniquely serve the nexus of small businesses and innovation: the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. The SBIR program requires federal agencies with extramural research and development budgets of $100 million or more to allocate at least 3.2 percent of their extramural funds for research awards to small businesses, while the STTR program requires federal agencies with an extramural research and development budget of $1 billion or more to allocate at least 0.45 percent of their extramural funds for STTR awards. Currently, 11 federal agencies participate in the SBIR program and five federal agencies participate in the STTR program. Through a highly competitive, merit-based system, awards are given to small businesses that have proposals or technology that could benefit the awarding agency. Built on a tiered system, an agency may award a Phase I award to determine feasibility, a Phase II award for demonstration and further development, and Phase III awards, which allows the business to pursue commercialization objectives. Across agencies, approximately $2.5 billion is awarded annually through federal SBIR and STTR programs. [295]

The Navy commissioned an independent study of the Naval SBIR and STTR programs to measure the commercialization and economic impacts of the programs between fiscal year (FY) 2000 and FY 2013.[296] The report found that nearly 65 percent of the Navy Phase II contracts reached the commercialization marketplace with the average contract selling $5.5 million in products, which is approximately seven times the average amount of the initial investment. Additionally, the commercialization of SBIR technologies resulted in $14.2 billion in sales of new products and services and $7 billion in sales of new capabilities and products to the U.S. military from the Navy alone.

The economic impacts of the Navy programs provide similar metrics: of a nearly $2.3 billion investment from FY 2000- FY 2013, the SBIR and STTR programs provided a 19:1 return on investment with an economic output of $44.3 billion.[297] The economic impact also includes the creation of nearly 200,000 jobs with an

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[293] John Paglia, John and David Robinson, "Measuring the Role of the SBIC Program in Small Business Job Creation," *Federal Research Division, Library of Congress*, January 2017: 1-29, https://www.sba.gov/sites/default/files/files/SBA_SBIC_Jobs_Report_0.pdf.
[294] Paglia and Robinson, Measuring the Role of the SBIC Program, 14.
[295] "National Economic Impact of the Dept. of the Navy SBIR/STTR Prgram, Fiscal Years 2000- 2013," https://www.navysbir.com/docs/Navy_SBIR_Economic_Impacts-2000-2013.pdf.
[296] Ibid.
[297] Ibid.

average wage of approximately $69,000, which is 42 percent higher than the average U.S. wage.[298]

Labor market stabilization. Labor market stability is essential to the creation of a high-investment, high-dynamism American economy because it keeps workers attached to the labor force during periods of upheaval and builds valuable skills. While value-chain progress creates new industries and productive jobs, it does not guarantee smooth transition from old industries and skills. In the developmental framework, this effect is notably distinct from the broader effort to "re-train" workers displaced by off-shoring that has occurred in recent years, insofar as the relevant training facilitates a shift to lower-paid service-sector employment. Rather than providing for labor market stability as an *ex post facto*[299] effort to reduce workers' "adjustment costs" to exogenous shifts in labor demand, a developmental approach would create sources of new demand for high-productivity activities and proactively support workers' attachment to them. This would suggest reforms to increase labor-force participation, especially in new industries, and focus training efforts on high-skill production.

A number of policy proposals might fit this framework.[300] Public and private resources, and cultural backing, could be shifted from a more traditional four-year higher education model to one more focused on labor market-driven skills development and process knowledge. For example, legislation introduced in the 115th Congress by Senators Michael Bennet (D-CO) and Rubio titled the *Higher Education Innovation Act*[301] proposes an alternative accreditation system that would allow institutions to meet students' needs with innovative educational products. As Cass has proposed in his book, *The Once and Future Worker*, allowing new forms of labor organization, perhaps like co-ops, could make for more effective skills-building and draw workers to new industries.[302] Subsidizing employment, perhaps in the form of a larger and transparent version of the Earned Income Tax Credit could increase the labor force participation of prime-aged Americans, attaching them jobs that teach basic skills and provide opportunities for upward movement. Prohibiting restrictive labor market practices like non-compete clauses, which often prevent workers from accepting new employment at competing firms, would relatedly increase worker flexibility to move to more productive, well-paying jobs. Policy proposed to this end includes legislation introduced in the 116th Congress by Senator Rubio, titled the *Freedom to Compete Act*, which would prohibit employers from entering into or enforcing non-compete agreements with most workers.[303]

Conclusion. *MIC2025* should help focus future policy efforts. Though some policies are worth doing for their own sake, the existence of value chain position

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[298] Ibid.
[299] For a broader discussion of the role *ex ante* social insurance plays in fostering a high-dynamism economy, see "The Free-Market Welfare State: Preserving Dynamism in a Volatile World" by Samuel Hammond of the *Niskanen Center*, May 2018. https://niskanencenter.org/wp-content/uploads/2018/04/Final_Free-Market-Welfare-State.pdf
[300] Proposals relating to higher education reform and worker representation are discussed further in "America Needs to Restore Dignity of Work," by Senator Marco Rubio, *The Atlantic*, December 13, 2018. https://www.theatlantic.com/ideas/archive/2018/12/help-working-class-voters-us-must-value-work/578032/
[301] U.S. Congress, Senate. *Higher Education Innovation Act*. S.615. 115th Cong., 1st sess. Introduced in Senate March 13, 2017, https://www.congress.gov/bill/115th-congress/senate-bill/615.
[302] Oren Cass, "The Once and Future Worker."
[303] U.S. Congress, Senate. *Freedom to Compete Act*. S. 124. 116th Cong., 1st sess. Introduced in Senate January 15th, 2019, https://www.congress.gov/bill/116th-congress/senate-bill/124?q=%7B%22search%22%3A%22freedom+to+compete+act%22%7D&s=1&r=1.

goals and international competition for them can usefully structure the many decisions made in any significant policy undertaking. Applying the framework of economic policy as one of priority-setting and execution should create greater clarity for debate over what those priorities should be, and how they should be executed.

The ultimate winners of such an approach should be the American workers who have lost out under an old consensus, which obfuscated priority interests for the sake of ambiguous, abstract ends. Though *MIC2025* is a foreign actor's plan for the domination of critical commercial sectors at the expense of American industries, the U.S. should not miss the opportunity the plan's prominence provides. *MIC2025*'s driving claim is that "without strong manufacturing, there is no national prosperity."[304] This should be a wake-up call for American political economy as much as a cause for scrutiny of the plan's methods and impacts.

[304] IoT, "Made in China 2025"

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