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China Is Rapidly Becoming a Leading Innovator in Advanced Industries: Executive Summary

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There may be no more important question for the West's competitive position in advanced industries than whether China is becoming a rival innovator. While the evidence suggests it hasn't yet taken the overall lead, it has pulled ahead in certain areas, and in many others Chinese firms will likely equal or surpass Western firms within a decade or so.

OVERVIEW

The most critical question for Western economies vis-à-vis China's economic and technology challenge is whether and when China can become a real innovator. If China remains largely a copier, then the threat to the U.S. and other Western economies is less. However, if China can develop new-to-the-world innovations ahead of or around the same time as Western nations, its potential to supplant Western technology-based companies becomes much more likely.

To date, this issue has been widely discussed but not rigorously examined. To remedy that, the Information Technology and Innovation Foundation (ITIF) has conducted an in-depth analysis of the extent to which Chinese companies are innovating.

Overall, we find that for the most part, Chinese firms and industries are not as innovative as the global leaders in Western nations. However, they are catching up, in many cases at an extremely rapid pace—and the scale of their efforts, backed by the Chinese Communist Party (CCP), is astounding. As an analogy, it is as if we were to look at the ocean and see calm waves, but over the horizon is a tsunami of hundreds of strong, innovative, and lower-cost Chinese firms in dozens of industries seeking to seize Western leaders' global market share.

As such, it is time to reject the prevailing view that "China can't innovate." While China is ruled by an avowed Marxist-Leninist party, China is not the Soviet Union, and its firms have considerable degrees of freedom to act in largely free markets. The reality is China is much more akin to the Asian Tigers (Hong Kong, South Korea, Singapore, and Taiwan) 20 years ago, only in this case, China is not a tiger, but rather a fire-breathing dragon on government-provided steroids. Only the bipartisan embrace of a new national economic doctrine—national security capitalism—supported by tens of billions of dollars in U.S. public investment annually (direct

and via tax expenditures) can stem the eventual loss of U.S. technology leadership and the consequential loss of military and national power.

WHY THIS MATTERS

The last decade has shown that China can be a globally competitive producer of technologically complex goods, including telecom equipment, machine tools, computers, solar panels, high-speed rail, ships, drones, electric vehicles, bulk chemicals, LCD displays, satellites, heavy equipment, and pharmaceuticals. In these industries, China has been able to gain market share through the advantages of scale economies in its protected home market, complemented by often massive subsidies to Chinese firms coupled with a litany of other unfair practices.

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However, if China can combine its cost advantage with an innovation advantage, or at least innovation parity, the challenge to advanced technology industries in Western nations will become much more significant. As such, a key question for Western nations is to what extent China has become or soon will become an innovation leader, or at least on par with Western innovation leaders. If China can innovate on par with the leaders, the result will be a significant diminution of Western firms' market share, including widespread and highly visible corporate bankruptcies, as China will be able to combine quality, innovation, and price.

The result would mean a China that is much more self-sufficient in advanced industries. Therefore, Western sanctions and other trade tools to discipline it would have little effect and, moreover, China could become the one with sanction power, threatening to cut off supplies of needed goods if the United States and other Western nations do not do what it wants. Its military capabilities would increase even further. Its foreign power and influence over other nations, especially in the developing world but also in regions such as Europe, would increase even more.

At the same time, because global markets for advanced industries are largely fixed, at least in the short-run, China's gain will inevitably come at Western loss. This means Western advanced industry capabilities would shrink, and in the case of some already weak nations such as the United Kingdom and Australia, virtually evaporate. The United States' economy could see itself looking like that of the United Kingdom in several decades, with a dramatically hollowed out technology production base. This, of course, would have severe consequences for U.S. military capabilities, with military spending having to increase massively if most weapons systems and parts are made only for the Defense Department, as opposed to being dual use. Because the U.S. trade deficit would likely increase even more, a significant devaluation of the dollar would be likely, lowering U.S. living standards.

Overall, if China succeeds in being the global innovation leader, the result would be a shift in the center of global economic power and innovation from a geopoint somewhere in the Atlantic Ocean to China. Should that happen, geopolitics would fundamentally change, America would lose its status as the most powerful nation on earth, and the West would be reliant on China and likely having to kowtow to Beijing, as was true in ancient times.

CAN CHINA INNOVATE?

The question of whether China can innovate is longstanding, with analysts coming down on both sides. Most still argue that China cannot be innovative because its system is deficient, as it has weak intellectual property (IP) protection, is too state directed, and has too little creativity. And many have latched onto the comforting narrative of "peak China": a China now in long-term decline.

However, in the face of almost daily news from China on innovation, a growing number of analysts reject this largely ideological framing based on the belief that only the American model can generate innovation. Indeed, some argue that in certain industries China is even more innovative than the United States.

METHODOLOGY

This study assesses the innovative capabilities of Chinese-owned companies. Unfortunately, except for drug approvals for the biopharmaceutical industry, there is no readily available data assessing Chinese firm innovations. As a result, we use three methods to assess Chinese firm innovation: data analysis, firm analysis, and, most importantly, industry analysis.

Data Analysis

Data suggests that in some areas and industries, China appears to be ahead, and in many other areas it is rapidly catching up. China exceeds the United States in the number of researchers, scientific articles, top-ranked scientific articles, and global innovation clusters. Its expenditures on research and development (R&D) and venture capital are about equivalent to U.S. levels, and the number of firms in the top 2,500 R&D spenders is about 80 percent of the U.S. level.

Firm Analysis

From 679 Chinese firms listed on the EU R&D 2,500 list, we randomly selected 44 firms for deeper analysis. Few were at the global leading edge of innovation, although most appeared to be catching up to the leaders and making rapid progress. On a scale of 1 to 10, where one is completely a copier with no real original innovation and 10 means the firm is moderately to significantly ahead of the global leading edge of innovation, the mean score was 6: lagging, perhaps two years behind, with some original innovation. The highest-ranking firms were Chinese National Nuclear Power (score of 9), drone maker DJI (8.75), QuantumCTek (8.25), electric Vehicle (EV) maker BYD (8), and AI company Zhipu (8).

Industry Analysis

Finally, we examined 10 key industries and technologies, both critical and emerging: artificial intelligence, biotechnology, chemicals, displays, electric vehicles, robotics, machine tools, nuclear power, quantum computing, and semiconductors. We relied on both scholarly and industry literature and discussions with industry experts.

All but machine tools were published as full reports. Table 1 provides an overall summary. Of the 10 industries, we assessed that China is ahead or at par in two, near the lead in four, and lagging behind in four. With the exception of semiconductors, where progress has been somewhat frustrated by export controls on equipment, and quantum, China's rate of progress is striking.

Table 1: Summary of industry studies' results

Industry	Position vs. World Leaders	Pace of Progress
Robotics	Near	Rapid
Chemicals	Lagging	Rapid
Nuclear Power	Ahead	Rapid
Electric Vehicles/Batteries	At Par	Rapid
Machine Tools	Lagging	Rapid
Biopharmaceuticals	Lagging	Rapid
Electronic Displays	Near	Rapid
Semiconductors	Lagging	Modest
Artificial Intelligence	Near	Rapid
Quantum	Near	Modest
Display Technology	Near	Rapid

Striking Factoids About Chinese Innovation

- China installed more industrial robots than did rest of the world in 2023.
- In 2013, the U.S. share of chemical industry R&D spending was 30 percent, while China's was 1 percent. By 2022, China's was 16.8 percent and America's 18.6 percent.
- China has more nuclear power plants under constuction than does the rest of the world combined.
- China will add more chip-making capacity than will the rest of the world combined in 2024.
- China accounts for 62 percent of global EV production.
- From 2017 to 2021, Chinese new drug clinical trials grew faster than any nation's.
- China has the world's first long-distance quantum-secured communications route.

There are several reasons why China has made and continues to make such progress. After all, China is vastly more innovative than other middle-income countries, which typically lag behind on innovation and focus more on routinized production. One reason, described ahead, is that China has developed the most ambitious science and technology policy system in the world. The second, however, is that, like other fast followers, China is competing from the bottom and moving up the value chain to attack the leaders. As such, innovation at the lower levels of the value chain is often invisible to the leaders focused on end-product competition, and is easier because it builds on a robust base of suppliers and accumulated experience. The West's problem, especially the United States', is that it is trying to innovate with a significantly hollowed out production system, something scholars have long recognized as difficult.

CHINA'S DREAM: TECHNO-ECONOMIC LEADERSHIP

The question of "is China innovative?" must be seen in the context of CCP goals. China's economic, trade, and technology policy is all about winning the war for global techno-economic power. The CCP's overarching focus—indeed, one might say "obsession"—is innovation in advanced industries. Unlike the United States', Chinese economic policy does not privilege consumer, worker, or even investor welfare, nor is efficiency or even innovation in non-traded sectors its top goal. For the CCP, economics, trade, and technology are a battlefield on which they fight for advanced industry dominance. For U.S. policymakers, markets should be largely left alone to generate their own optimal outcomes.

American Neglect

Few acknowledge that the United States is even in such a competition—or if they do, they think a U.S. victory is inevitable. To the extent U.S. leaders pay attention, the focus is principally on limiting Chinese military capabilities. And leaders in Europe are even farther behind in recognizing the China challenge, with most focused only on replacing U.S. sales to China with European sales.

Even if some recognize China's distinctive goals, many fail to take China seriously because they believe that China's goal is only to achieve self-sufficiency in the face of U.S technology restrictions. Of course, China is seeking to reduce dependence, but its goal to be the global leader in advanced industries predated by recent export controls.

Failing to recognize the existence of two completely different economic systems with different rules is the core problem for the United States and most Western nations. Most experts see national economies as not in conflict, with specialization based on comparative advantage generating win-win outcomes. China sees competition as akin to war. As Xi Jinping has stated, "Technological innovation has become the main battleground of the global playing field, and competition for tech dominance will grow unprecedentedly fierce." Moreover, many in the United States see free-market economic systems as superior. Lethargy vis-à-vis China is the result.

Chinese and U.S. Economic Systems

The U.S. and Chinese systems are fundamentally different:

- The United States seeks comparative advantage based on market forces; China seeks to win the global war for advanced technology leadership.
- The United States seeks to maximize consumer, taxpayer, and worker welfare; China wants advanced industry competitiveness, even if consumers, workers, and taxpayers pay a price.
- In America, free trade is ideal; China practices "power trade" to strengthen its own producers, weaken foreign ones, and create dependencies on China.
- America's innovation model is linear, wherein the main role for government is investing in basic research; China's is circular, funding applied R&D to help Chinese firms gain competitive advantage that becomes self-reinforcing.
- America's economic system is built around consumption; China's is built around investment.

- The U.S. innovation system is oriented to higher-value end products and the customer experience/demand, not lower and less-profitable parts of the value chain; China's is oriented to moving up the innovation value chain, while retaining dominance at the lower levels of the value chain.
- American policymakers long ago abandoned having a direction for the U.S. economy, other than growth, or, increasingly, "equity"; China is teleological—it relentlessly pursues a greater global share of advanced technology industry production.
- In America, potato chips, computer chips: what's the difference? In China, computer chips matter, "potato chips" are either ignored or suppressed.
- The U.S. model is to not invest unless the net present value return exceeds the short-term cost of capital; China views investing in technology the way America views funding weapons systems: Economic returns are not central, power and security are.

IMPLICATIONS FOR U.S. POLICY

To achieve its goal of techno-economic power, China has built a fundamentally different kind of innovation system, the first of its kind. Most in the United States remain in denial of this reality. However, just as the United States put in place a new innovation system in the late 1940s (and adapted it in the 1980s to respond to the Japanese challenge), it is time to transform again, this time adopting a "national power capitalism" doctrine wherein the state sets goals and takes concerted action, with the private sector empowered to achieve them.

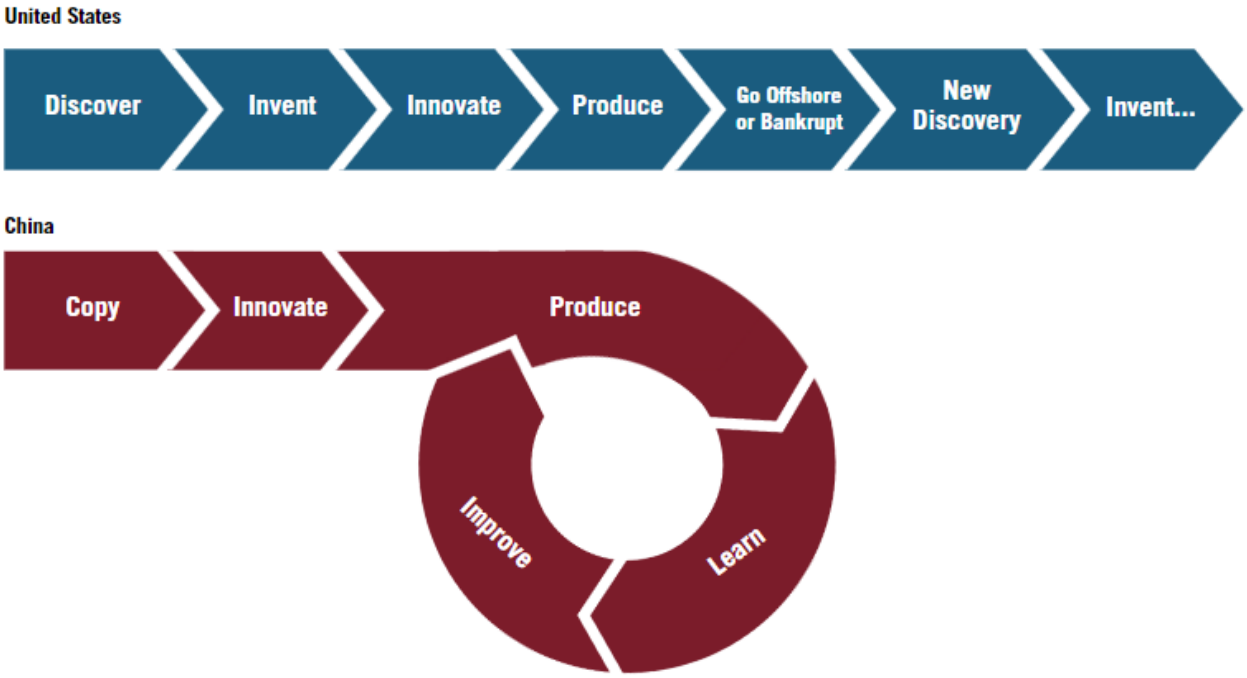
The U.S. Innovation Model

The U.S. model of innovation has the following attributes:

- Government invests in basic science with the projects selected by principal investigators or by agencies pursuing mission interests such as defense, space, health, or energy. (See figure 1.) But science is a public good that is easily copied by China.
- Entrepreneurs use the generated knowledge. Because of free markets, limited taxation, and robust IP protection, they can reap the rewards of their innovations. But these incentives to get rich cut both ways: The strongest incentives are for the best and brightest to become financial traders, not deep tech entrepreneurs.
- The United States focuses on invention, not on innovation and production—but the latter is the source of power.
- The U.S. system is process based: fund research, support antitrust, reduce regulation, limit taxes, increase immigration, etc. But even the best processes are unlikely to lead to advanced industry leadership.
- Even in the face of Chinese competition, the focus is on improving, not changing, this system. Not enough discovery, fund more science. Too much failure in the first "valley of death," provide incentives to commercialize research. Not enough venture funding, cut capital gains taxes.

If invention is the goal, the U.S. innovation system might indeed be the superior system. But if innovation and domestic production is the goal, the system fails.

Figure 1: The U.S. and Chinese innovation systems



The Chinese Innovation Model

China seeks to attain advanced industry dominance with a more circular innovation model:

- Tech advancement starts with an injection of an innovation from an established source.
- Once that technology enters the system, a positive cycle begins with Chinese companies starting to produce the innovation, and using the profits to reinvest in more.
- Because of robust levels of state support, as well as a protected domestic market, at least some of the many supported firms survive and expand.
- The more successful firms usually engage in rigorous, continuous incremental product improvement and deep process innovation, again often supported by government.
- As sales of the leaders expand, weaker firms go out of business, leading to more-concentrated industries.
- Profits (and subsidies) in the stronger firms are reinvested in R&D to help the companies attack Western market segments.
- Chinese entrants erode foreign sales, leading the latter to cut back on R&D or simply exit certain segments in favor of more profitable segments.

While this model of innovation might not as often get to radical "Schumpeterian" inventions, it can get to industry leadership in innovation and continuous improvement and increased global market share. China is focused on what Clay Christensen has termed "low-end disruption," where it seeks to disrupt from the bottom. This bottom-up, supply-side approach is why Chinese innovation and dependencies now occur at every level of the value chain.

The Chinese circular model of innovation involves the following 10 key factors of success (the "10 S's"):

1. **Science and engineering capabilities.** Having a massive number of scientists and engineers enables Chinese companies to throw low-cost talent at the problem of continuous improvement and innovation.
2. **Head Start**. China has achieved a head start in certain industries, and this has helped tip the balance decisively in favor of its companies that are far down industry learning curves. This enables them to maintain their lead against later Western entrants.
3. **Market Size**: In many industries, China either has gained market share through significant economies of scale, which means the marginal cost of every additional unit is lower than the prior unit. Not only is China's market size enormous, but in most key industries, foreign companies are precluded from gaining significant market access. On top of that, the Chinese government is aggressively "buying" market share outside China, especially in fast-growing developing nations.
4. **Speed.** The Chinese innovation system is centered not so much in laboratories, but rather in production systems. Constant feedback and learning from the market are incorporated as quickly as possible into product design and production systems. This enables competitors to constantly bring improvements to market.
5. **Local Suppliers.** Since China is a low-cost production system, most Chinese suppliers are still in China, often in the same region as original equipment manufacturers (OEMs). And because China specializes so much in manufacturing, it enjoys rich and deep local production agglomerations, which in turn supports innovation.
6. **Subsidies and other protections**. China's subsidies are still on steroids, in part because of the intense competition between cities and provinces, which shell out massive funds to support local champions. In 2022, 99 percent of listed firms in China received direct government subsidies.
7. **Firm Size with competition**. China understands that large firms are key to global success and has adopted a strategy of consolidation, the opposite of aggressive antitrust.
8. **Specialization**. China goes deep to specialize. Unlike the United States, where a research university may have just a few professors working on a particular area, China has established research institutes with hundreds of researchers working on the same topic.
9. **Space.** China gives innovators ample space to take risks and test technologies. China's innovators not only face few barriers than do Western innovators, they are often encouraged and supported by the government to take such risks.
10. **Strategy.** Chinese government actions are guided by a regularly evolving strategy that focuses governments and companies around one key direction. At least at the national level, there is widespread alignment in government on the strategy. Moreover, Chinese officials have a deep and sophisticated understanding of the long-standing discipline of competitiveness-focused science and technology policy.

Implications for the United States

While the Chinese innovation model is similar to what Japan and the Asian Tigers relied on to become innovation leaders, it is different in fundamental ways, including the massive size of the Chinese economy, the level of control by the government, and the level of commitment to dominate most advanced industries.

What are the implications of this "Asian Tiger on Steroids" model for the United States and Western economies? First, it means policymakers need to recognize the nature of the challenge. Most remain in denial, arguing that China is a paper tiger. Others deny that we are even in competition with other countries. Others focus only on derisking, particularly a few key products, such as rare earths. Still others focus just on limiting military advancement.

To the extent experts worry about the ability of the United States to effectively compete, the dictate is to do what we have been doing—just a bit more of it and a bit better. The reality is if the United States is to avoid becoming a second-rate technology economy, it is time to "break glass" and craft a completely new national innovation and economic policy system.

America's Challenge: Ideological Divergence

That transformation depends on rejecting the four major visions for U.S. capitalism now vying for control—market global capitalism, ingredient capitalism, anti-corporate capitalism, and worker capitalism—and instead coalescing around a bipartisan vision of "national power capitalism."

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Market Global Capitalism

Although weakening, market capitalism remains the dominant U.S. doctrine. In this view, free markets and unfettered globalization are the best way to drive growth, and any alterations, especially anything that limits globalization or imposes industrial policy, do harm. Even if market capitalism produced optimal results in a world without China, it fails in a world with China. The reason is simple: China overinvests in industries deemed critical. As a result, firms in market capitalist nations reduce investment in these sectors because they cannot earn optimal returns. Market capitalism has never conceived of such a system and has no answer to it.

Ingredient Capitalism

As the limitations of market capitalism have become clearer, many have embraced a variant: ingredient capitalism. Global free trade and free markets are still the goal, but government plays a stronger role in supporting key innovation ingredients: R&D, education, skills (including immigration), entrepreneurship, infrastructure, and tech transfer initiatives. Ingredient capitalism is based on the belief that America can succeed by having lots of the right inputs. But it is not just the quantity of ingredients, it is using the right ingredients to make the right recipes. If China is seeking to dominate key industries, any policy that does not respond with recipes focused on these industries will fail.

Anti-corporate Capitalism

As the flaws of market capitalism have become more widely accepted, progressives have used those flaws to advance a counter-doctrine of anti-corporate capitalism. For them, corporate

capitalism is the source of climate disaster, racial and gender oppression, inequality, the breakdown of democracy, worker victimization, and every other ill that can be imagined. They want small and mid-sized enterprises (SMEs) to dominate, or in industries where scale economies or technological complexity makes that impossible, heavy regulation or government ownership. They oppose investing in advanced industries because the money goes to corporations, and instead call for massive government spending (or tax breaks) for childcare, housing, education, mass transit, distributed energy, universal basic income, and retirement security, all of which they portray as investments and even industrial policy. For them, the China challenge is irrelevant, and the people who call it out are labeled racists. Anti-corporate capitalism paves the road not only to the United States losing to China but also to U.S. de-technologization.

Worker Capitalism

An emerging contender is "worker capitalism," which holds that since market capitalism privileged capital, it is now time to put workers, especially blue-collar workers, first. In some ways, worker capitalism helps address the China challenge because of its focus on government policy, including trade and industrial policy, to create more blue-collar jobs. But being good at making potato chips is not the same as being good at making computer chips. And some, in their quest to create good manufacturing jobs, oppose automation. As such, their go-to solutions, such as Buy America and widespread tariffs, would fail against the China threat because it would not focus enough on key sectors. We need to privilege the nation, not workers (or capitalists).

National Power Capitalism

American needs to copy key elements of the China model and embrace "national power capitalism." This is premised on the reality of states competing for techno-economic power. Like defense policy, it is goal oriented. America needs a globally dominant biopharma industry, chip industry, aerospace industry, AI industry, etc. And therefore, we need policies to enable that.

National power capitalism rejects both the market idolatry of free-market capitalism and the anti-business ideology of anti-capitalism. And it is more activist than "ingredient capitalism," and more strategic than worker capitalism.

A U.S. "10 S's" System

A national power capitalist system would mean adapting China's "10 S's" to the U.S. context:

1. **Science and engineering talent.** Having strong scientific and engineering talent is key, but that talent should be aligned with the key technologies and industries. It also means supporting applied research and engineering and establishing a National Technology Foundation that supports technology development instead of science for the world.
2. **Head Start.** The United States needs to regain a global head start in many industries, such as weapons systems, machine tools, autonomous systems, and quantum computing. This means selecting key technologies and industries for support, with incentives for R&D and U.S. production facilities.
3. **Market Size:** Winning requires limiting Chinese market access to Western nations for goods and services produced unfairly, as well as fighting for market access in unaligned nations.

4. **Speed.** Congress and the next administration need to tear down many of the massive speed bumps—if not outright roadblocks—that keep enterprises from acting with speed. This means smarter regulation, more test-beds for new technologies, and rejecting paranoid narratives around AI and other new technologies.
5. **Local Suppliers.** America needs to recreate deeper national supplier systems. A weaker dollar would help, as would a border-adjustable value-added tax and stronger support for SME manufacturers.
6. **Investment, Subsidies, and other protections.** The United States will not be competitive in a range of advanced industries if the federal government does do not significantly boost industrial subsidies, along with direct spending and tax incentives.
7. **Firm Size.** U.S. antitrust officials should assess antitrust actions affecting firms in globally traded sectors on whether those actions help or hurt America's ability to be a global leader.
8. **Specialization.** China has built large and specialized industry-focused research institutes that concentrate on key technologies. Congress needs to provide funding to do the same.
9. **Space**. America needs to give space to innovators to innovate, not tie them up in Gulliver-like restrictions.
10. **Strategy.** The United States needs an all-of-government strategy to stop the erosion of its techno-economy lead over China. And it needs to elevate the discipline of competitiveness-based science and technology policy above economics.

What To Do?

It is beyond the scope of this report to lay out a full China agenda. However, we do lay out five ambitious proposals:

1. **Triple the research and experimentation tax credit.** The Chinese R&D credit is at least three times more generous than America's, while China's R&D labor costs are less than half. Congress should triple the Alternative Simplified Credit to 42 percent and allow expenditures on global standard setting to qualify.
2. **Institute a seven-year, 25 percent investment tax credit for all new machinery and capital equipment.** America is "capital equipment lite"; China is heavy.
3. **Establish five national industrial research institutes focused on key industries and technologies,** modeled on entities such as Taiwan's ITRI.
4. **Establish a "Competitiveness DARPA"** to co-invest with industry on research and application of key technologies needed for dual-use national security leadership in the commercial sector.
5. **Establish a national industrial development bank** to provide low-interest patient capital for domestic manufacturing investment.

Conclusion

Over the previous 100 years, America never faced an adversary that could outproduce it. Now it does. And it will likely soon be facing one that can out-innovate it. While China has not caught up to the world's innovation leaders, it is making extremely rapid strides, and absent some kind of external or internal shocks, it is likely to be at or close to the global innovation frontier in most advanced industries in the next 10–20 years. Unless the United States embraces "national security capitalism," it is unlikely that it will be able to maintain a strong competitive position in a broad array of advanced industries. If the West loses advanced industry share, Western power will wither and China's will rise. As such, America and other Western nations need to embrace national power capitalism in order to "run" much faster.

Read the Full Report on itif.org

Robert D. Atkinson, "China Is Rapidly Becoming a Leading Innovator in Advanced Industries" (ITIF, September 2024), https://itif.org/publications/2024/09/16/china-is-rapidly-becoming-a-leading-innovator-in-advanced-industries/.

Acknowledgments

ITIF wishes to thank the Smith Richardson Foundation for supporting research on the question, "Can China Innovate?" To read the whole series, search for #ChinaInnovationSeries on itif.org.

The author would like to thank Randolph Court, Rush Doshi, Stephen Ezell, Michael Lind, and David Moschella for editorial comments, and Meghan Ostertag, Alma Merchant, and Nicole Duca for editorial assistance. He would also like to thank Sandra Barbosu for her analysis of China's biopharma industry, Hodan Omaar for her analysis of China's AI and quantum industries, and Stephen Ezell for his analysis of China's EV, semiconductor, nuclear power, and display industries.

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