The World's Innovation *Fire-Breathing* Dragon

By Robert D. Atkinson

Forget the nonsense that China can't innovate. Beijing may well come out on top.

Perhaps the most critical question for the United States *vis-à-vis* the economic and technology challenge it faces from China is whether China can become a real innovator. If China remains largely a copier of others' innovations, and if the United States can maintain or increase its rate of innovation, the United States has a better chance of maintaining its lead over China. But if China can develop new-to-the-world innovations faster or even at the nearly the same rate as the United States and other allied nations, then it is much more likely that China will be able to take significant market share from OECD nations' technology companies. As things now stand, China is on course to achieve that ambition across a range of advanced technology industries, especially as Chinese firms benefit from a large protected domestic market and a vastly more supportive government.

For the most part, scholars studying the Chinese economy have argued that China is incapable of "true" innovation, at least at the global frontier of science and technology. The prevailing view is that China is constrained by an education system that encourages rote memorization and represses creative expression, a risk-averse culture centered around a reverence for authority, weak intellectual property protections, and inefficient state involvement in markets. Proponents of these arguments

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believe that while China's economic rise is impressive, it is bound to be at best a fast follower of Western innovators.

Examples of such arguments abound. Emblematic is an article in *Foreign Affairs* by China scholar George Magnus, who wrote in May 2024 that China

> *cannot create a true climate of economic innovation so long as its rigid politics and governance and exclusionary approach to institution building remain in place. In fact, an innovation-based industrial strategy may not be transformative if the government is unable to address basic systemic weaknesses such as youth unemployment, frailties in China's banking and financial systems, and weak consumer demand.*

These kinds of rationales for why China can't innovate repeat past assumptions about other Asian "tiger" economies, including South Korea, Taiwan, and Singapore. Moreover, they reflect a very narrow view of innovation—the archetype of the lone inventor working away in a garage until an aha! moment occurs, producing a new-to-the-world idea. But that is invention, something the United States is quite good at, not innovation. Innovation is the process of turning inventions into useful new products and commercializing them globally. And the rationales for why China can't innovate really do not hold water. They are based on an ideological assumption that only market capitalism, and not state capitalism, can produce leading firms in advanced industries.

In reality, China is proving it can innovate by making rapid progress in many industries, both advanced and emerging. The Chinese Communist Party began that process with its 2006 Medium and Long-Term Plan on Science and Technology, followed by the 2015 Made in China 2025 plan, released under President Xi Jinping. MIC2025 has been followed by many specific action plans directed at individual technologies and industries, including semiconductors and biotechnology. This all should serve as a wake-up call for the West, because were China to achieve these capabilities, combined with its lower costs, Chinese firms could dominate global markets in many if not most advanced industries. The implications for national economic and military power would be significant.

NEXT-GEN NUCLEAR STRATEGY

Take the nuclear power industry. There, "China is the *de facto* world leader," according to Jacopo Buongiorno, a professor of nuclear science and engineering at the Massachusetts Institute of Technology. Indeed, China likely stands ten to fifteen years ahead of the United States, especially in its ability to field fourth-generation nuclear reactors. China's government has made it a high priority to spur domestic nuclear reactor construction as part of Beijing's broader energy strategy. Looking ahead, China appears likely to use its burgeoning domestic capacity as a foundation for competitive reactor exports, much as it has previously pursued a "dual-circulation" strategy in areas such as electric vehicles and batteries.

China's nuclear industry currently has twenty-seven reactors under construction (more than two-and-a-half times more than any other country), on top of its existing fleet of fifty-six. Last year, China started operating the world's first fourth-generation nuclear plant, the 200 megawatt gas-cooled Shidaowan-1, in China's northern Shandong province. China's National Energy Administration has asserted that "90 percent of the technology in the new plant was developed within China." Meanwhile, China is also leading the development and deployment of a new fleet of cost-competitive small modular reactors.

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China has proved to be particularly adept in systemic and organizational nuclear innovation. This stems from its coherent national strategy for nuclear power, which entails a range of federal and provincial policies such as low-interest financing, feed-in tariffs, and other subsidies that make nuclear power generation cost-competitive; streamlined permitting and regulatory approval processes (such as for safety and environmental impact assessments); and coordinating supply chains effectively. Indeed, as industry analyst Kenneth Luongo commented, "They don't have any secret sauce other than state financing, state-supported

supply chain, and a state commitment to build the technology." That said, China's rapid deployment of leading-edge nuclear power plants produces significant scale economies and learning-by-doing effects, and this suggests that Chinese enterprises will gain an advantage at incremental innovation in this sector going forward.

Nuclear fusion has also become a national priority for China. That is important because if fusion can work and be reasonably cost-effective, it will become the power source for the entire world. Indeed, China's State Council made it clear in a recent meeting that "controlled nuclear fusion is the only direction for future energy." In January, the Chinese government launched a new national industrial consortium, led by China National Nuclear Corporation, to promote the development and advancement of nuclear fusion technology. The consortium will include twenty-five primarily government-owned companies, four universities, and one private company, with much of the technological know-how for the project derived from research conducted at the CNNC-affiliated Southwestern Institute of Physics and the Chinese Academy of Sciences-affiliated Institute of Plasma Physics. The Chinese government also announced that it will create a new enterprise, the China Fusion Corporation, in an attempt to lead the industry's development. China also participates as a member of the thirty-five–nation $25 billion nuclear fusion power research project, the International Thermonuclear Experimental Reactor.

Until now, the main locus of China's government-funded fusion research has been based at the Institute of Plasma Physics at the Hefei Institute of Physical Science, where scientists operate the $900 million Experimental Advanced Superconducting Tokamak (EAST). In 2021, EAST achieved several world records, including maintaining a plasma temperature of 120 million degrees Celsius for 101 seconds and 160 million degrees Celsius for twenty seconds. Following on EAST, in 2017 China commenced engineering design on the China Fusion Engineering Test Reactor, a magnetic confinement fusion device, construction of which is planned for the late 2020s as a demonstration of the feasibility of large-scale fusion power generation. The Chinese government has also launched new fusion education programs in China, with a goal of training one thousand new plasma physicists to support these initiatives.

The OECD nations won the last innovation war. They may lose the current innovation war unless they prepare to fight it, and that includes close allied technology cooperation.

China today has much more in common with the Asian Tigers in recent decades—Hong Kong, Korea, Singapore, and Taiwan—except that the better analogy for China is a fire-breathing dragon.

China appears to be roughly on par today with U.S. (and other foreign) efforts to develop nuclear fusion technologies. But the Chinese government has set an ambitious goal of building the first industrial prototype fusion reactor, which it has dubbed an "artificial sun," by 2035, and officials hope to begin large-scale commercial production of fusion energy by 2050.

BEYOND NUCLEAR

We see similar kinds of rapid progress in other industries. Robotics promises to be one of the most important technologies of the next quarter-century, powering not only a host of productivity-enhancing processes but also military capabilities. While China lags behind the leaders, especially Japanese, Swiss, and German firms, it is making extremely rapid progress. Since 2017, thanks to a national "100,000 Robot Program," there have been more than 3,400 robotics start-ups in China—focusing not just on industrial robots, but also on autonomous mobile robots. In just the last year, Tracxn lists 188 Chinese robotics start-ups. Eight of the largest ten have venture investors from outside China, indicating their innovative potential. Many of these start-ups are from Songshan Lake, a government-backed industrial

development zone south of Dongguan, China, that has hundreds of robotics companies, both start-ups and established firms. One Hong Kong professor stated that "people here [at Dongguan] can develop a new tech product five to ten times faster than in Silicon Valley or Europe, at one-fifth or one-fourth the cost."

On the whole, it appears that China and Chinese robotic companies recognize that they need to pivot from being fast followers to being innovators. Moreover, the government is forcing robotics researchers at universities to rub shoulders with companies.

As one study of Chinese robotics argues:

> *This upgrading trajectory of industrial robots … is similar to the development of the mobile phone sector in China: at first, the domestic firms provided slightly lower quality but much cheaper alternatives to foreign produced high-end phones; and later on, when the domestic firms accumulated enough resources, they could make significant technological breakthroughs and become internationally competitive.*

Another industry where China is making rapid progress is chemicals. To date, China's success has been mostly in basic, commodity chemicals where it dominates global production. However, the Chinese government is seeking to achieve the same success in more innovation-based specialty chemicals. For example, the government's 2023 "Guiding Catalog for Industrial Structure Adjustment" advocates for the development of a number of new materials related to the chemical industry, including low-VOC adhesives, water treatment agents, catalysts, electronic chemicals, silicone materials, and fluorine materials. The government has also set a goal that the fine chemicals as a share of total chemical production reach at least 50 percent. To those ends, the central and provincial governments in China provide significant direct and indirect subsidies to chemical firms. Chinese governments also provide a range of other financial incentives, including low-interest loans. In addition, Chinese governments are upgrading chemical parks. Under this effort, ten or so leading companies are to be cultivated as national champions. This focus on chemical innovation is one reason why of the top ten metropolitan areas in the world to locate chemicals industry research and development facilities ranked in terms of quality of the research, three were Chinese (Guangzhou first, Shanghai third, and Beijing sixth).

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Chemical industry expert Kai Pflug summarized where China stands as follows:

> *What is new about the current wave of Chinese domestic investments in chemicals is that these now target precisely the chemical segments that are the most innovative, which tend to also be the fastest growing ones. So far, Western chemical companies survived by out-innovating the Chinese—the latest developments show that this approach is far from certain to work in the future. In a worst-case scenario, this would only leave Western companies with smaller-volume chemicals, in which the scale-oriented Chinese players typically are less interested.*

China is making similar advances in many other industries and technologies, too, including space, supercomputers, quantum communications, and of course, electric vehicles. Given all this, it's time to reject the often ideologically based view that "China can't innovate." While it is still true that China is ruled by a communist party, it is not the Soviet Union, where market forces were never allowed to prevail. Chinese firms have considerable freedom to act, as long as they are working to achieve the goal of making China the world innovation leader and staying out of politics. Moreover, Chinese culture is highly entrepreneurial, unlike Japan for example. The reality is that China today has much more in common with the Asian

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The implications of China reaching the global innovation frontier in many foundational and emerging industries cannot be overstated. If it can combine lower costs (in part through government supports) with strong innovation, then build out from its own closed market, extending its dominance through the Belt and Road markets, it has the potential to gain significant global market share in a range of key industries. China has already done this in industries like commercial drones, batteries, telecommunications equipment, steel, and solar panels.

HOW SHOULD THE OECD NATIONS RESPOND?

It is beyond the scope of this article to lay out a free-world agenda for responding to the Chinese Dragon. However, the most important step OECD nations can take is to recognize the challenge for what it is. Continuing to deny the nature of the challenge by entertaining false narratives that contend China's economy is weakening or even facing a long decline is certainly comforting, and takes away the need for fiscally expensive and disruptive policy changes. The same goes for arguments that the OECD nations, and in particular the United States, are destined to lead in emerging technologies, like quantum, artificial intelligence, and semiconductors. Even if that were true, which is a very risky assumption, it would ignore the fact that advanced economies cannot thrive on a narrow set of technologies, no matter how cutting-edge they are.

Finally, it should go without saying that the prevailing view that a nation's industry mix does not matter—a view that is especially prevalent in the United States and most Commonwealth nations—must be jettisoned as ideological morphine if allied nations are to respond effectively. The idea that the OECD nations could have adequate global power in the face of the Chinese technology dragon if they become "hewers of wood and drawers of water" is the worst kind of head-in-the-sand thinking.

More specifically, as the U.S. government considers its possible responses to the Chinese tech dragon, one necessity will be much closer economic and technology cooperation with our core allies. For example, for the nuclear industry, the United States needs to be working more closely with nations such as France, Germany, Japan, and South Korea to collaborate on research and development for advanced nuclear technologies and to help promote nuclear exports from techno-democracies to third-party markets. Indeed, considerable collaboration could be achieved in the regulatory, procurement, and contracting spaces. For instance, the United States could allow companies based in allied countries to own reactor licenses in the United States in order to promote foreign investment and accelerate domestic deployment. Further, the United States could lean into international efforts to standardize and harmonize design and testing standards, such as those embodied in the International Atomic Energy Agency's SMR Platform and Nuclear Harmonization and Standardization Initiative.

The United States could further relax import or export control of non-fuel or non-nuclear safety-related components (such as vessels, piping, and testing services) when they are traded among allied nations. This could include limited authorizations to be exempt from domestic sourcing on the procurement of systems, subsystems, and components related to advanced reactors from specific allied countries. Further, the U.S. Department of Energy could forge more bilateral agreements with allied research and development centers such as the UK Atomic Energy Authority and the Korea Atomic Energy Research Institute to provide funding to advance joint small research and development projects and data sharing. The United States also could explore joint financing of projects among allies. For instance, a foreign firm might be the prime contractor on a project, but firms from other countries could be involved too. Such deep collaborations are likely to be fruitful in a host of other industries and technologies.

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French Prime Minister Georges Clemenceau complained that "generals always prepare to fight the last war, especially if they won it." The OECD nations won the last innovation war. They may lose the current innovation war unless they prepare to fight it, and that includes close allied technology cooperation. ◆