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SCIENCE AND TECHNOLOGY NET ASSESSMENT AND COMPETITIVE STRATEGY

by Christopher A. Ford and Dawn Meyerriecks

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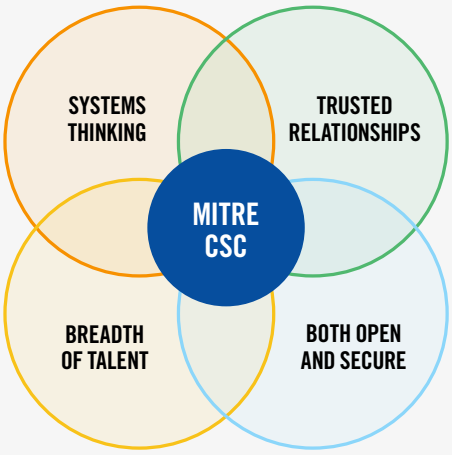

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EXECUTIVE SUMMARY

It is critical to U.S. national security and competitive strategy for our leaders to have a deep understanding of the science and technology dynamics that so powerfully shape the modern world. This makes the comparative assessments of trends, key competitions, risks, opportunities, and future prospects of national capabilities in the technology arena—that is, Science and Technology Net Assessment (S&TNA)—an essential tool of modern statecraft.

Technological revolutions can have earth-shaking implications in many dimensions, such as massive geopolitical payoffs akin to those won by Britain and then by the United States in the First, Second, and Third Industrial Revolutions. With this in mind, China hopes to seize "first mover" advantages in what it anticipates will be a *Fourth* Industrial Revolution. As the United States attempts to respond to these Science and Technology (S&T) challenges, our leaders will need to be much better equipped for sound decision-making in this arena. Hence the critical importance of S&TNA and Science and Technology Intelligence (S&TI).

If done right, S&TNA has many potential customers, both in the federal system and beyond, but the U.S. policy community is not yet getting the support it needs in terms of S&TNA collection and analysis for a number of reasons. In addition to the more specific challenges of mobilizing appropriate substantive expertise and resourcing, no single executive branch entity owns the responsibility for developing whole-of-nation "technosystem" understandings and for subsequent net assessment production. Nor is the U.S. Intelligence Community (IC) properly equipped to *support* S&TNA. It is not well staffed or resourced to do S&TI well, does not place much priority on relevant collection or analysis, and suffers from an instinctive prejudice against just the sort of *unclassified* information that can often be so crucial in S&TNI and S&TNA alike. In addition, the IC is generally prohibited from analyzing *U.S.* capabilities in the ways that would be needed for S&TNA. Adding to the challenge, U.S. institutions are not currently well prepared to *share* relevant insights across the range of key stakeholders.

A solid S&TNA system would need to draw heavily on contributions from Federally Funded Research and Development Centers (FFRDCs) as well as university research institutions, academic researchers, and commercial industry stakeholders. The United States should urgently take a number of basic initial steps to start building an effective S&TNA and S&TI system in support of its national competitive strategy, beginning with a pilot program to implement a set of S&TNA initiatives focused on current technology competitive challenges.

THE STAKES

It is critical to U.S. national security and competitive strategy for our leaders to have a deep understanding of the science and technology dynamics that so powerfully shape the modern world. This makes Science and Technology Net Assessment (S&TNA)—that is, the "comparative assessments of trends, key competitions, risks, opportunities, and future prospects"[1] of national capabilities in the technology arena—an essential tool of modern statecraft: one with which leaders can help assess their strategic environment and understand their competitive position and prospects therein. It also demonstrates the importance of Science and Technology Intelligence (S&TI) as a crucial input to S&TNA, without which leaders may lack critical information about adversary capabilities and intentions. This paper explores the challenges of S&TNA and S&TI, and of doing them both in the ways our nation requires in its technology-powered strategic competition with the People's Republic of China.

To really appreciate these dynamics, we must first set the context. It may seem obvious to a citizen of the modern world that S&T issues are important. Nevertheless, for present purposes, it's worth emphasizing—from a geopolitical and national security perspective—just *how* important they can be.

Technological revolutions, after all, can have earth-shaking implications in many dimensions. Two and a half centuries ago, steam-powered machines were beginning to revolutionize industry and productive activity in Britain and several countries in Western Europe as part of a dramatic process of change and advancement in which technology and industry evolved into a self-accelerating ecosystem of invention and innovation that reshaped virtually every existing sector of human activity. These advances—which we remember today as the Industrial Revolution—were themselves built on foundations laid during the Scientific Revolution of the 16th and 17th centuries, which saw dramatic leaps in scientific and material knowledge with the development of the modern scientific method, the advent of Newtonian mechanics, and huge strides in the emergence of modern fields such as physics, optics, chemistry, and metallurgy.

NOR, AT THIS POINT, DO CCP LEADERS MAKE MUCH SECRET THE FACT THAT THEIR OBJECTIVE IS TO SECURE FOR THEMSELVES THE KIND OF DRAMATIC GEOPOLITICAL ADVANTAGES THAT THE FIRST THREE INDUSTRIAL REVOLUTIONS SUCCESSIVELY GAVE TO BRITAIN AND THEN TO THE UNITED STATES.

This scientific, technological, and industrial-economic effervescence turned the world upside down, letting loose powerful forces of productivity and industrialization that produced extraordinary change that was as profound as it was disorienting. This was, after all, the era that produced both Dickensian industrial squalor and the marvels of modern know-how showcased at the "Great Exhibition" in London's Crystal Palace in 1851. It produced the leaps of human progress represented by steamships and railways, the telegraph, antimalarial drugs, electric light, blood transfusion, undersea cables, photography, and the smallpox vaccine. But it also gave rise to the grimmer novelties of dynamite, long-range artillery, machine guns, and poison gas.

This surge of technological innovation and industrial power produced a geopolitical revolution as well, for the asymmetry of its arrival and the enormous advantages that accrued to "first movers" in the age of modern industrial production and military firepower helped supercharge imperial expansion by those European powers that led in the Industrial Revolution. The implications were stunning.

By the 1920s, for instance, Europeans had conquered nearly 85 percent of the planet, with the British Empire alone covering a quarter of the Earth's surface. Even tiny and relatively weak Belgium had seized for itself an overseas empire that included one colony—the Belgian Congo—about 76 times larger than Belgium itself.

And that was just the *first* Industrial Revolution. Today, commentators and scholars sometimes also refer to a Second and Third Industrial Revolution—comprising the explosion of industrialized mass production in the early 20th century and the information and communications technology revolution of the late 20th century, respectively—for which first mover advantages in many respects accrued to the United States. These two further revolutions ultimately left America geopolitically unchallenged in our "unipolar moment," as the "hyperpower" dominating the entire global economy and international system after the collapse of the Soviet Union. Whatever ingredients may be said to go into such a "Numbered Industrial Revolution," in other words, the geopolitical stakes of the game would appear to be world-historically high.

That, at least, is what China thinks—and such assumptions have made seizing first mover advantages in the *next* Industrial Revolution a cardinal objective of Beijing's science and technology strategy. Chinese Communist Party (CCP) officials believe that the world is on the verge of a Fourth Industrial Revolution, and they are determined to put China in the driver's seat. According to Xi Jinping, for instance,

> "The previous three industrial revolutions were all characterized by

> transformative advancement in science and technology: the rise of mechanization in the 18th century, the harnessing of electricity in the 19th century, and the advent of the Information Age in the 20th century. … Today, we are experiencing another revolution in science, technology and industry, which is greater in scope and depth. Breakthroughs are being made in quick succession in frontier technologies like big data and artificial intelligence."[2]

Moreover, whereas previous Industrial Revolutions might to some extent be said to have come about largely through a happy alchemy of happenstance and market creativity, CCP officials—rightly or wrongly, as the world will presumably eventually learn—think that the next one can be *planned*.[3] To this end, strategic guidance documents such as China's "Innovation-Driven Development Strategy"[4]—which has been called "the most high-level, authoritative, and comprehensive strategy that the Xi Jinping regime has ever issued on the role that science, technology, and innovation plays in China's development"[5]—seek to deploy all relevant levers of state power and industrial policy to seize the high ground for Beijing. To quote Xi again,

> "We should aim for the frontiers of science and technology, strengthen basic research, and make major breakthroughs in pioneering basic research and groundbreaking and original innovations. We will strengthen basic research in applied sciences, launch major national science and technology projects, and prioritize innovation in key generic technologies, cutting-edge frontier technologies, modern engineering technologies, and disruptive technologies. These efforts will provide powerful support for building China's strength in science and technology, product quality, aerospace, cyberspace, and transportation; and for building a digital China and a smart society."[6]

CCP leaders do not make secret the fact that their objective is to secure for themselves the kind of dramatic economic, military, and geopolitical advantages that the first three Industrial Revolutions successively gave to Britain and then to the United States. Chinese officials believe that "[i]nternational politics and the economic system have been dominated by Western powers since the First Industrial Revolution,"[7] but that if China leads the *next* such revolution, it will be able to turn the tables.[8] Xi has made clear that he believes "technology is the core combat capability" in the modern world, and that China must "secure a decisive victory" on this terrain and usher in a "New Era."[9]

This, then, is the context for understanding the importance of S&TNA and S&TI for the United States, and indeed for all countries that would not wish to live in the Sinocentric global order that it seems to be the CCP's ambition to create.[10] In responding to the challenges presented by Chinese

strategy, U.S. leaders clearly need to get technology right.

RESPONDING WISELY

To be sure, with a strong attachment to free market principles, the United States is traditionally leery of anything that feels or looks like "industrial policy"—that is, government involvement in the economy in order to promote particular sectors or generally guide developments in one direction or another. Yet, perhaps mindful of Adam Smith's admission that "defense" should take priority over "opulence,"[11] the U.S. government for many years *has* provided important support to key sectors and has engaged in de facto industrial policy in discrete areas of potential strategic significance, sometimes indeed catalyzing significant technical advances.[12]

In the face of geopolitical challenges from CCP revisionism that have been powerfully fueled by China's growing economic might and technological sophistication, the United States is today trying to step up federal efforts to catalyze S&T progress. The most significant single element of the U.S. effort to date is the recent passage of the bipartisan CHIPS and Science Act of 2022,[13] which the White House says will

> "mak[e] historic investments that will poise U.S. workers, communities, and businesses to win the race for the 21st century. It will strengthen American manufacturing, supply chains, and national security, and invest in research and development, science and technology, and the workforce of the future to keep the United States the leader in the industries of tomorrow, including nanotechnology, clean energy, quantum computing, and artificial intelligence. The CHIPS and Science Act makes the smart investments so that American [industries can] compete in and win the future."[14]

As such U.S. efforts to respond to S&T challenges continue, however—including, notably, in actually deciding how and where to *spend* the considerable sums of money appropriated by the CHIPS and Science Act—our leaders will need to be much better equipped for sound decision-making in this arena. Hence the critical importance of S&TNA and S&TI.

The Role and Challenges of S&TNA

Science and Technology Net Assessment, as noted, is the comparative assessment of trends, key competitions, risks, opportunities, and future prospects in the S&T environment. Concretely, this work inherently requires *comparing* an adversary's capabilities and trajectory with those of the United States and other relevant players in the international system in order to identify trends and *relative* points or aspects of advantage, thereby teasing out the implications of the *interaction* of various "them" and "us" factors. Thus, in this context, S&TNA is a critical element of wise decision-making in a competitive environment, for one can hardly expect

to make good decisions *about* S&T policy without being well informed about the S&T *environment*.

To unpack this commonsense notion into a more elaborate articulation of discrete elements, we here assume that effective policymaking involves the ability to:

1. See and understand the complexity of one's strategic and operational environment at a level of detail that is sufficient to inform decisions while remaining alive to nuance and potential second- and third-order effects, yet not so granular as to be overwhelming;

2. Discern the full scope, potential reach, and practical limitations of whatever levers of power and influence are available for acting in that environment;

3. Grasp the breadth of key stakeholder interests and equities—not merely one's own, but also those of allies, partners, friends, and third parties, as well as those of one's adversaries—that are likely to be affected by the use of such levers;

4. Evaluate potential alternative courses of action (COAs) against this rich informational background, assess the likely impact of such COAs on relevant interests and equities, and discern (in at least very general probabilistic terms) those steps that are (a) most likely to advance feasible objectives and broader values that have been prioritized as a matter of policy and strategy and/or (b) least likely to have adverse consequences;

5. Coordinate the employment of available levers of power and influence to implement those COAs one has decided to adopt; and

6. Observe and assess the impact of such moves on the operational and strategic environment, compare these effects to what had been anticipated, and feed *this* information, in turn, back into an ongoing cycle of iterated follow-on modeling and data collection, COA evaluation, and decision-making.

As applied to the arena of economic and technological competition, S&T Net Assessment is important in various ways to all of these elements, and in particular to the first and the sixth, both of which revolve around being able to see and understand the dynamism of the operational and strategic environment.

If done right, S&TNA has many potential customers, both in the federal system and beyond, ranging from the big security- and economic-related departments and agencies (e.g., the Departments of Defense, State, Commerce, Treasury, and Homeland Security, as well as various components

of the Executive Office of the President) to stakeholders in the private and academic sectors. Good S&TNA could, for instance, help enrich alliance and partner relationships, permit early responses to the emergence of key threats and opportunities, support diplomatic negotiations, facilitate the development of improved analytical models, identify good (or bad) S&T-related investment opportunities, and help avoid strategic surprise, among other benefits.

Yet the U.S. policy community is not getting the support it needs in terms of S&TNA collection and analysis. S&TNA is difficult for our government to do for a number of reasons. For one thing, S&TNA—both in collection targeting and in analysis—needs to be able to draw on deep technical expertise as well as excellent S&TI (see below). It requires expertise, moreover, not merely about S&T topics that are fairly obviously important today or are likely to be so in the years ahead, but also about the "ragged edge" of a range of emerging technology areas that do *not* necessarily seem important today, as well as about the potential *intersections* between areas that could emerge as future use cases are developed.

It is difficult for the government—even as a whole—to provide such broad and deep know-how by simply drawing on federal employees, most of whom, by definition, are *neither* full-time scientists nor technicians. Language barriers can arise here, too, because whereas S&TNA is inherently *relational*—in the sense that it requires comparing one's *own* position and prospects to those of other players in the international arena—most analysts asked to perform net assessment functions lack the language training needed to swim effectively in a sea of scientific terminology, technical jargon, or commercial market phraseology, even in a foreign language they otherwise understand well (assuming that they know one at all).

Deep S&T expertise is also not enough, for good S&TNA needs to concern itself not merely with science and technology, but also with the broader "technosystem" in which technology is embedded[15]—and that can be so crucial in determining which and how innovative technologies actually transition to real-world application in specific use cases. Here, business (e.g., in technology commercialization) and applied science expertise are also needed. A workforce of analysts who are "thinkers" and "book smart" in S&T issues, in other words, may need leavening with "doers" familiar with the challenges of moving something clever from basic research and development (R&D) all the way through to production and operational employment. (After all, "technology lists" don't tell the policymaker what he or she needs to know; one has to get past mere enumeration into issues of real capabilities.) Practical insights into workforce and human capital issues will also be critical, for these, too, are variables that powerfully affect what can and is likely to be done with S&T innovations.

Finally, a key inhibitor of good S&TNA is that no one executive branch entity owns the responsibility for net assessment construction. To be sure, multiple entities have contributing roles and responsibilities, but no single body is held accountable for developing whole-of-nation technosystem understandings and for subsequent net assessment production.

Prioritizing and Enabling S&TI

At present, we do not believe the U.S. Intelligence Community (IC) is properly able to *support* S&TNA. As a result, America's leaders lack the help they need in understanding foreign S&T capabilities—and especially adversary capabilities—and therefore also in understanding (in a net assessment sense) how others' capabilities stack up against our own. This is not entirely the IC's fault, of course, because there is no single S&TNA orchestration entity and S&TI is not specifically called out as a priority area for IC collection and analysis in support of national strategy. In the heat of day-to-day events, moreover, policymakers (i.e., intelligence consumers) unsurprisingly tend to demand and reward collection and analysis that supports immediate operational needs rather than chasing long-term, nuanced insight into technical topics that most laypeople would find difficult to understand in the first place.

Even with these caveats, however, the IC is not particularly well staffed or resourced to do S&TI well. Nor, unfortunately, does it place much priority on the collection or analysis of information on basic research, commercial competitive dynamics, business- or commerce-related issues, or international standards bodies, nor on capital markets, venture capital, and corporate R&D questions—all of which are of considerable relevance to technology development and national competitive trajectories.

Another deficiency lies in the classification-prioritizing "psychic DNA" of the IC's analytical community, which often tends to assume about information that "if we haven't stolen it, it can't be that important." This attitude is perhaps forgivable when it comes to understanding our adversaries' military plans or intelligence operations. (After all, one would expect an opponent to keep this information secret for good reason, as the effectiveness of such plans and intelligence depends in large part on our not knowing what they are in advance.)

As applied to S&TI, however, an instinctive prejudice against *unclassified* information often gets things rather backward. In understanding issues of competitive posture and relative overall advantage in economic and technological competition, open-source information about the S&T environment is likely to provide a more solid foundation for subsequent clandestine intelligence collection and analytical exploration than simply building out one's unclassified inquiries in concentric circles around whatever data one

already happens to have collected through intelligence means.

A further challenge lies in *sharing* relevant insights across the range of key stakeholders—including those in commercial industry and the research and academic communities—whose involvement will be needed in developing and implementing effective and genuinely whole-of-nation *responses* to contemporary challenges of S&T innovation competition. Even within the U.S. government, and notwithstanding growing awareness that technology competition *is* critical to future prosperity and national security, shared awareness of capabilities, intentions, and threats associated with foreign technology production is surprisingly poor. Particularly given the degree to which it is in fact possible to call attention to such matters quite well without drawing on classified information, too little is currently done to raise general awareness of the breadth and gravity of the challenges we face.

RECOMMENDATIONS

Since S&TNA is crucial to our leaders' ability to make effective decisions in a technology-competitive strategic environment, it follows that while we need to build and resource effective technology net assessment capabilities, we should house them where resident expertise exists or can be built out quickly and within a fully chartered entity. Given the aforementioned challenges of providing the requisite depth and range of relevant S&T and technosystem expertise solely through government personnel, moreover, a solid S&TNA system—wherever it happens to be located in bureaucratic terms—would also need to draw heavily on contributions from national laboratories and Federally Funded Research and Development Centers (FFRDCs), as well as academic researchers, university research institutions, and commercial industry stakeholders.

Doing this properly, and at scale, will be a huge task, and one that it would be unreasonable to expect our government to be able to quickly provide. But we *do* need to develop much better S&TNA capabilities, and the time to start building them is, as it were, "yesterday."

To this end, we recommend that the United States start by taking the following basic steps to get this country started along the road to having an effective S&TNA and S&TI system in support of its national competitive strategy:

1. We should immediately develop and implement a pilot program to implement a set of S&TNA initiatives focused on current technology competitive challenges. There is nothing wrong with learning to walk before we try to run, and these initiatives should be limited enough in scope to be bureaucratically and operationally feasible as first endeavors, informed by relevant best practices used in what is already done today in performing competitive analysis in the private sector and in comparing weapons capabilities, and chosen in order to have high

odds of initial success in demonstrating S&TNA value. Nevertheless, the initiatives must also be of real substantive importance, as well as methodologically challenging enough to provide us with valuable lessons that can inform follow-on efforts to refine *and scale* these initial efforts into what will eventually become a full-fledged United States S&TNA enterprise.

2. We should immediately begin to develop, implement, and mature a national S&TNA program to absorb these pilot activities and, thereafter, institutionalize and systematize technical and commercialization community-wide practices, roles, and responsibilities. This effort would repurpose existing budget and full-time employee resources from various parts of the government, with a special emphasis on finding staff who have clear technical and/or business acumen, along with the ability to foster cross-government and cross-technology commercial and academic relationships. Developing appropriate S&TNA tradecraft, including S&TI taskings, via the U.S. technical community should be the priority, with net assessment product assessment performed—and informed—by key policy stakeholders.

3. We should charter and establish a national S&TNA support entity of some sort, to help this national program by drawing creatively on extra-governmental resources, including FFRDC, university research institutions, and private industry support and talent.

4. In the IC, we should define and prioritize S&TI collection and "red" analysis activities (i.e., of adversary capabilities and intent) as an essential enabling component of S&TNA.

Much more will ultimately be needed, of course, beyond simply developing such capabilities as a proof-of-concept exercise or pilot program, identifying and ensuring access to the data streams needed to do such work properly, and putting in place procedures and analytical methods that are both scalable and methodologically rigorous. But even these modest initial steps would at least be a start—and the need is acute.

CONCLUSION

In a strategic competition with an increasingly adversarial China that sees itself as being in a zero-sum competition with the United States and that wishes to reshape the international system around itself, it is essential to U.S. national security and competitive strategy for our leaders to have a deep understanding of the science and technology dynamics that so powerfully shape the modern world. They need sophisticated S&TNA—supported by

robust S&TI capabilities—in order to acquire and maintain this understanding, so that critically important national decisions can be made more quickly.

U.S. leaders are not yet getting the S&TI and S&TNA support that they need for national success in these endeavors, but we can meet these challenges with a resolute and focused national S&TNA effort. It is time to begin developing this capability.

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ENDNOTES

1 U.S. Department of Defense, Office of Net Assessment, "Office of Net Assessment (ONA)" (undated), *available at* https://www.defense.gov/About/office-of-the-secretary-of-defense/office-of-net-assessment/.

2 Xi Jinping, remarks at the Plenary Session, BRICS Johannesburg Summit (July 26, 2018), *available at* https://www.fmprc.gov.cn/mfa_eng/gjhdq_665435/2913_665441/3094_664214/3096_664218/201807/t20180727_547056.html.

3 Assuming this to be the case, the CCP feels that its totalitarian model of governance offers significant advantages. According to China's "Innovation-Driven Development Strategy," "[t]he system of socialism with Chinese characteristics can combine the advantages of concentrating power for major undertakings with the market allocation of resources, and has provided basic safeguards for achieving innovation-driven development." Communist Party of China Central Committee and State Council, *Outline of the National Innovation-Driven Development Strategy* (May 19, 2016) [hereinafter "IDDS"], at 2, *available at* https://cset.georgetown.edu/publication/outline-of-the-national-innovation-driven-development-strategy/ [Chinese source: http://www.xinhuanet.com/politics/2016-05/19/c_1118898033.htm]. The CCP's 14th Five-Year Plan also claims that China has "many advantages for further development," including "remarkable institutional superiority, [and] improved administrative efficiency." National People's Congress, *Outline of the People's Republic of China 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives for 2035*, published by *Xinhua News Agency* (March 12, 2021), at 3, *available at* https://cset.georgetown.edu/wp-content/uploads/t0284_14th_Five_Year_Plan_EN.pdf [Chinese source: https://perma.cc/73AK-BUW2].

4 IDDS, *supra*.

5 MITRE Corporation, "China's National Development Strategy and Industrial Policy: A Path to Comprehensive National Power," paper prepared for the U.S. Air Force Office of Commercial and Economic Analysis (January 2022), at 8.

6 Xi Jinping, "Secure a Decisive Victory in Building a Moderately Prosperous Society in All Respects and Strive for the Great Success of Socialism with Chinese Characteristics for a New Era, remarks to the 19th Party Congress of the Chinese Communist Party" (October 18, 2017), published by *Xinhua News Agency* (November 4, 2017), *available at* https://www.chinadaily.com.cn/china/19thcpcnationalcongress/2017-11/04/content_34115212.html.

7 State Council Information Office of the People's Republic of China, "China and the World in the New Era (September 27, 2019), at 28, *available at*

https://english.www.gov.cn/archive/whitepaper/201909/27/content_WS5d8d80f9c6d0bcf8c4c142ef.html.

[8] See, e.g., Assistant Secretary of State Christopher Ford, "Why Chinese Technology Transfer Threats Matter," remarks at the U.S. Naval Academy (October 24, 2018) ("China is determined not to be left behind in the *next* RMA, which Chinese officials believe to be already underway. According to Xi Jinping, a new scientific and technological industrial revolution is now in progress, and the new Revolution in Military Affairs will be intertwined with this S&T revolution …."), *available at* https://www.newparadigmsforum.com/p2279.

[9] *See* Xi Jinping, "Secure a Decisive Victory," *supra*.

[10] See, e.g., Christopher Ford, "China's Strategic Vision: Part Three – Envisioning a Sinocentric World," MITRE Center for Strategic Competition, *Occasional Papers*, vol. 1, no. 3 (June 27, 2022), *available at* https://www.mitre.org/sites/default/files/2022-09/pr-21-02877-7-chinas-strategic-vision-part-three-envisioning-a-sinocentric-world.pdf.

[11] Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776), at Book IV, Chapter II, *available at* https://www.gutenberg.org/files/3300/3300-h/3300-h.htm.

[12] See, e.g., Christopher Ford, Charles Clancy, & Duane Blackburn, *A "Horizon Strategy" Framework for Science and Technology Policy for the U.S. Innovation Economy and America's Competitive Success*, MITRE Corporation (May 12, 2021), at 6, *available at* https://www.mitre.org/sites/default/files/2021-11/prs-21-1440-horizon-strategy-framework-science-technology-policy.pdf.

[13] P.L. 117-167 (August 9, 2022).

[14] White House Fact Sheet, "CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China" (August 9, 2022) (typographic error corrected from original), *available at* https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/. The acronym CHIPS stands for "creating helpful incentives to produce semiconductors." *See* Public Law 117-167 (August 9, 2022), *available at* https://www.congress.gov/bill/117th-congress/house-bill/4346/text.

[15] See, e.g., Ford, Clancy, & Blackburn, *supra*, at I (describing the "technosystem" as the broad range of factors affecting "how new insights are carried forward to full deployment across a range of novel and evolved use cases," including "technology governance questions and the interaction of new technologies with broader societal, legal-regulatory, and policy dynamics").

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