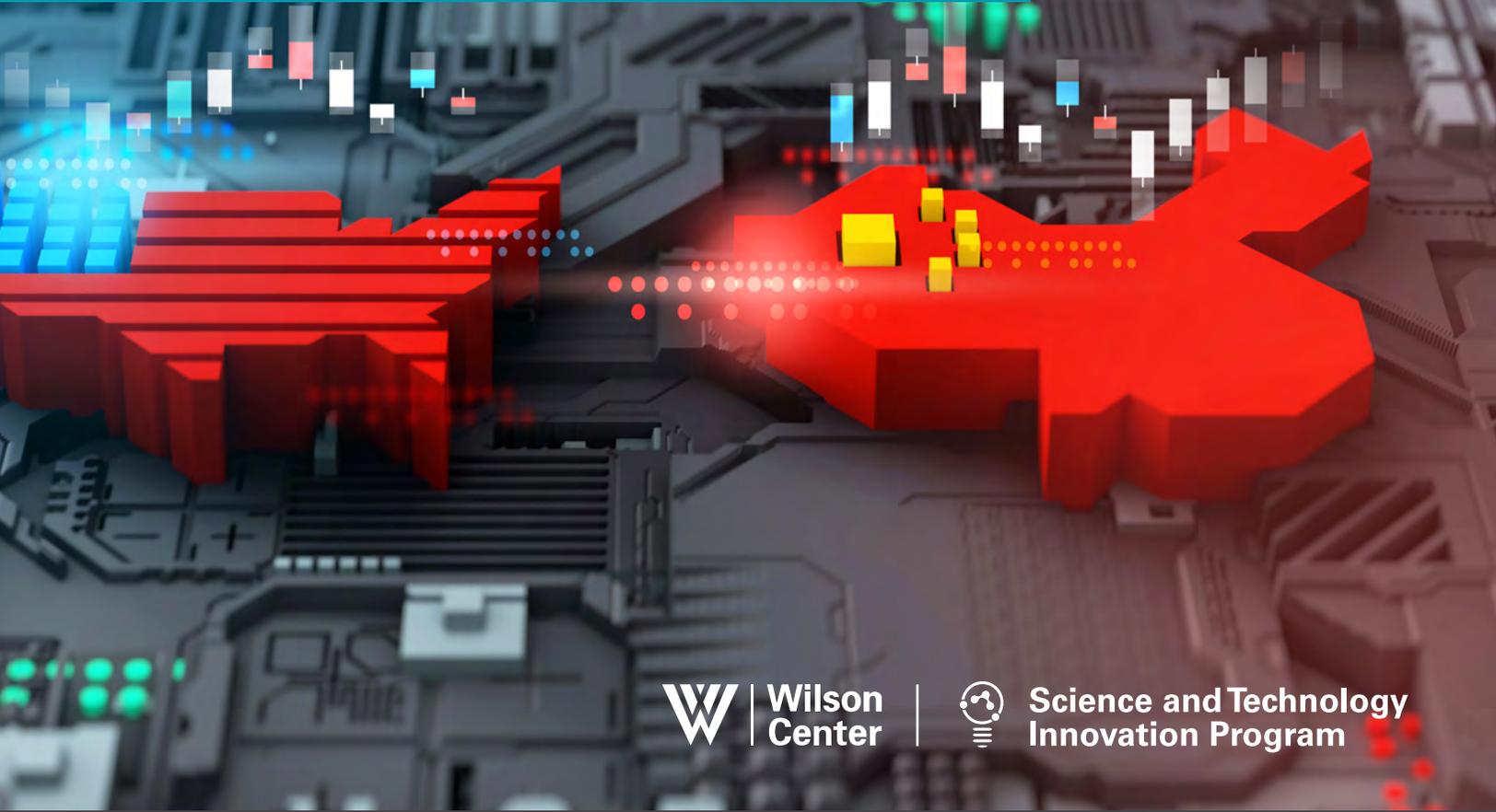


# Science and Technology Innovation Program



Wilson Center | Science and Technology Innovation Program



## Playing Offense in the Race for Technology Leadership: Priorities for Final Competitiveness Bill

### Author

Hon. Mark R. Kennedy,  
Global Fellow

April 2022





## Table of Contents

<b>Introduction</b>	<b>2</b>
<b>Defense Alone is Insufficient</b>	<b>2</b>
<b>The 4T Playbook: Proven Path to Competitive Advantage</b>	<b>4</b>
Great Britain’s 4T Rise to Leadership	5
The US’s 4T Rise to Leadership	5
China Embracing the 4T Playbook	6
America Neglecting The 4T Playbook	7
<b>Five Key 4T Plays to Preserve America’s Innovative Edge</b>	<b>8</b>
T1 Talent: Prepare the Nation for a Digital World	8
<i>Play #1 – Expanded Support for STEM Education</i>	9
<i>Play #2 – Continue as Magnet for Globe’s Best Talent with Improved Safeguards</i>	12
T2 Technology: Lead in Tomorrow’s Technologies	13
<i>Play #3 – Bolster Federal Research Funding with Priority to 4IR Technologies</i>	13
T3 Tilt-Free: Tilt only for Security, not Protectionism	14
<i>Play #4 – Minimize Tilting</i>	14
T4 Trade: Ensure Broad Market for America’s Innovative Products 1	15
<i>Play #5 – Lead in Setting Terms of Trade</i>	16
<b>Conclusion</b>	<b>17</b>
<b>About the Author</b>	<b>18</b>
<b>References</b>	<b>19</b>



## Introduction

America is finally poised to begin to go on offense in the contest for technology leadership in the future. Both federal chambers have passed a bill purportedly aimed at elevating the competitiveness of the United States. The United States House of Representatives passed the America COMPETES Act on February 4, 2022, that now must be reconciled with the bill's Senate counterpart, the United States Innovation and Competition Act of 2021 that passed on June 8, 2021. There is perhaps no greater priority facing the nation than to preserve its innovative edge upon which its prosperity and security depends. Playing defense is insufficient. The final bill has the potential to put America on offense.

Each bill includes a mixture of provisions not directly relevant to advancing America's competitiveness that are beyond the scope of this paper. They both include provisions vital to bolstering American innovation and sadly other provisions anathema to competitiveness. As the conference committee convenes it should retain those elements that will truly help American innovation stay a step ahead and steer clear of provisions harmful to competitiveness.

This paper seeks to state the case for action within the construct of a historical framework for elevating national innovation. It will identify categories of provisions to retain, perhaps even bolster and some provisions to jettison in the conference report for a competitiveness bill.

**Author's Note:** While America is in a contest for tech leadership with the People's Republic of China (MIT Technology Review, 2020) it is important to note that our efforts to preserve our edge implies no ill will towards the people of China. It will be important to continue to guard against and condemn any discrimination against Asian Americans. Attracting the best talent from around the world, including from China, and making them feel at home will continue to be a key factor in America's success. Yes, we must get better at protecting our discoveries, but this is not accomplished by abandoning a core competitive advantage—America's openness. Please read any references to China as referring to its policies as led by the Chinese government.

## Defense Alone is Insufficient

Benjamin Franklin warned that "If everyone is thinking alike, then no one is thinking." In today's highly divided civic life, Americans seem to disagree on everything other than to get tough with China (Kapur, 2021). Yet the similar approaches to getting tough by the administrations of both President Donald Trump and President Joe Biden do not fully address the difficult actions that must be taken for America to succeed in its intensifying rivalry with China. Both administrations have been relying to date almost exclusively on defensive measures—export controls, trade barriers, restricting access to financial markets. Recently the Biden Administration blacklisted another Chinese company—artificial intelligence giant SenseTime (Feng, 2021) as Didi, China's answer to Uber, delisted from the New York Stock Exchange amid regulatory pressure on Chinese listed companies (Yang, 2021).

America has tried the defensive prescriptions of export controls and financial restrictions against a rising Asian power before. Scholars believe that America's oil embargo and freezing assets of Japan helped lead to Pearl Harbor (History.com, 2022). Protecting American intellectual property is necessary but is no substitute for



innovating faster than others. For the United States to have the strength to deter rather than provoke another Pacific conflict, it must not just play defense, but also go on offense by investing in the talent and research necessary to keep its innovative edge, renewing leadership on trade to ensure markets for its innovative products, and accelerating the military embracing new technologies.

Many Americans believe and our actions to date reflect the belief that the solution is simply to keep China from taking our technology. This implies China does not have the ability to innovate on their own. They do. China's accessing American technology by acquisition, forced transfer or theft advanced them to their current position of sophistication much more quickly than they could have on their own (U.S. Embassy Tblisi, 2022). They are moving beyond catchup mode to in some cases leaping ahead. They have succeeded in moving from copycats to leaders on a global scale in key technologies. Americans must set their conceit aside, acknowledge that America has been overtaken in key technologies and will be in others unless it takes dramatic steps to keep its innovative edge. Underestimating the challenge will only accrue to China's advantage.

Consider the facts. Senior military officials acknowledge that China's advances in hypersonic missiles is worrisome (Hadley, 2021). China has 77% global market share in the production of lithium-ion batteries essential to electric cars (Sumangil, 2021). China leads significantly in digital payments and its lead in digital currency could threaten the global position of the United States Dollar (Rabouin, 2021). Despite significant pressure applied by the United States, China's Huawei continues to lead globally in fifth generation (5G) telecommunications infrastructure installations (Sacks, 2021). China is also making great strides in advancing in artificial intelligence, robotics, quantum information systems, and more.

America's response to date has relied heavily on unilateral sanctions (Adams, 2020), implying a view that either takes for granted that allies will follow America's lead or that allies' technology does not matter. The recent pulling back from trade leadership also reflects a diminished view of the importance of allied relationships. As trade restrictions force a bifurcation of the tech markets and nations are forced to choose between America and China, this cavalier neglect of global relations will prove increasingly detrimental.

As the military seeks to recapture ground lost during an extended period of preoccupation with anti-terrorism to prepare for intensified great power rivalry, Congress continues to prevent them from divesting platforms with little relevance to such contests. A couple of examples—the FY22 National Defense Authorization Act restricts the Air Force's planned reductions of A-10 Warthog (Insinna, 2021) and the full decommissioning of the Navy's aging cruisers (Eckstein, 2022). Such actions do not fully respect the rise in China's military power and the urgency for America to modernize.

Preserving an innovative edge is even more important today. In the past the United States Department of Defense's research regularly spawned technologies that could be applied commercially—touch screens, the Global Positioning System (GPS), and internet technologies central to the smartphone (Manyika, 2019). With the Department of Defense's research funding declining from 36% of global R&D in 1960 to merely 3% in 2019, (Gallo, 2021) it is more often adopting commercial technologies for defense applications. In that most of these technologies that have both commercial and military functionality are readily available to state rivals and non-state foes, security today rests more heavily on the military outpacing others in the adaptation of new technologies (Lewis, 2021).



For America to truly answer China’s challenge in the century ahead requires a radical change in mindset. The United States must respect China’s innovation capabilities and trajectory, the importance of allies and the rapidly growing capabilities of China.

No one alive today has experienced a world where the leading nation in innovation was not a democracy. This contributes to citizens’ inability to imagine the profound risks to their prosperity and security if America lost its innovative edge or to believe America could lose its edge. Many do not fully recognize how fast the pace of innovation is accelerating globally, and how disruptive and transformative it will be to industries, economies, societies, and the lives of individuals. Many do not recognize how China has taken the lead in key technologies. China could take the lead in other technologies before the average citizen even knew that America’s innovative edge upon which so much hinges was at risk.

## **The 4T Playbook: Proven Path to Competitive Advantage**

America assumed its innovation leadership position from the United Kingdom following World War II propelled by significant actions to advance four foundations for innovation—talent, technology, a tilt-free environment, and trade, each reinforcing the other. You cannot advance new technologies without talent. Innovation is more likely to be spawned in an environment where it is unfettered by highly prescriptive political tilting. Nations with the largest global markets for their innovations can afford to keep innovating and stay ahead.

The United Kingdom had earlier achieved its innovative leadership fueled by the same four T’s—talent, technology, tilt-free and trade. China is now following this same proven 4T Playbook to challenge American leadership



and global influence. The United States must stop neglecting the playbook's precepts and instead bolster its current efforts to stay a step ahead on innovation. This was the genesis for the competitiveness bill heading to conference and must remain its focus.

## Great Britain's 4T Rise to Leadership

By the mid 18<sup>th</sup> century, then-Great Britain had become the leading economy of its day as it led the first industrial revolution.

**Technology:** The industrial revolution was sparked by the advance of new mechanical technologies—power loom, cotton gin, steam engine, iron making and machine tools.

**Talent:** The new century also saw a rapid expansion of higher education to provide the talent its expanding economy demanded, including institutions that became today's polytechnics, medical schools, King's College, and the University College London (University College London, 2022).

**Trade:** Great Britain benefited initially from trade with its far-flung empire.

**Tilt-Free:** At beginning of the 19th century, innovation accelerated as Britain moved beyond mercantilism to embrace tilt-free trade at the encouragement of its merchants (UK Parliament, 2022). Great Britain's embrace of David Ricardo's theory of comparative advantage "that countries were better off specializing in what they enjoy a comparative advantage in and importing the goods in which they lack a comparative advantage" (Corporate Finance Institute, 2022) propelled their economic vitality.

***The 4T Playbook worked for Britain.***

## The US's 4T Rise to Leadership

The second industrial revolution fueled by electricity and the assembly line coincided with the founding of Johns Hopkins, as the world's first research university and the vanguard for the leading universities embracing a research mission. This accelerated the cultivation of both tech-savvy talent and discovery (Crow, 2020).

**Tilt-Free:** Being more market driven, more entrepreneurial than other nations has long been an American hallmark. America's rise to global leadership was in significant part due to its embrace of Ricardo's theory of comparative advantage.

It was three powerful post-World War II actions that really accelerated America's innovative leadership.

**Talent:** The G.I. Bill allowed millions of returning veterans to earn a college degree, providing the talent for an economic boom (Onion, 2019).

**Technology:** The federal government continued the significant increase of its investment in research that helped win the war spurred by the advocacy of Vannevar Bush, who "anticipated a new global competition of power, premised significantly on technologies, and he wanted the United States to invest in all the components to establish an innovative edge" (Zoellick R. B., 2020).



**Trade:** President Franklin D. Roosevelt and British Prime Minister Winston Churchill met in 1941 prior to America entering the war and issued the Atlantic Charter, a key plank of which was a commitment to open trade (U.S. Department of State, 2009). As the United States led the creation of the international order following the war, in addition to its embrace of democracy, human rights and the rule of law, it committed to the global advance of free markets (Goodman, 2018).

America's firm embrace of the 4T playbook allowed it to bolster its innovation leadership during the third industrial revolution based on semiconductors, computing, and the internet. America has been home to the most innovative technologies ever since due to its substantial investments in education and research to fuel discovery and a commitment to the global expansion of trade opening markets for its innovative products. These actions have propelled America's prosperity by making its products in high demand as its innovation spawned new markets, new industries, and new companies. These actions have also bolstered America's security by advancing new military capabilities that give it an advantage over any foe.

***The 4T Playbook worked for the United States.***

## China Embracing the 4T Playbook

Observing how industrial revolutions and the embrace of the 4T Playbook led to the rise of the United Kingdom and the United States, it is no wonder that China has such a keen and intense focus on leading the fourth industrial revolution (4IR), a fusion of advances in artificial intelligence (AI), robotics, the Internet of Things (IoT), 3D printing, genetic engineering, quantum computing, and more. The 4IR is disrupting and transforming every human activity and China is on a multi-decade concerted path to assume innovation leadership by leading in these key technologies of the future.

Xi Jinping became China's paramount leader in 2012 and in 2015 his government issued a bold national strategic plan to move China from being a manufacturer of low-tech goods to becoming a leader in technological industries. The plan's "Made in China 2025" goals included achieving leadership in key technologies of the future and to invest massively to accomplish this end. Xi's plan built on a long-term plan for science and technology issued in 2006 that for the first time devoted substantial resources to improving the country's technological infrastructure (Cong Cao, 2006) and a plan in 2010 to advance designated emerging industries (The US-China Business Council, 2013). But what sets Made in China 2025 apart is its specific targets to achieve "70% self-sufficiency in high-tech industries" by 2025 and "by 2049—the hundredth anniversary of the People's Republic of China...a dominant position in global markets" (Chatzky, 2019). Unlike America's erratic policy swings, China has sustained this focus.

**Talent:** China began building the equivalent of almost one university per week (Schleicher, 2016), and today Peking University and Tsinghua University rank among the world's top twenty in some credible rankings (The University Rankings, 2022). China's graduates in science, technology, engineering, and math (STEM) fields have grown exponentially, significantly outpacing American graduates in these fields. The World Economic Forum reports that China has eight times more STEM graduates annually than the United States (McCarthy, 2017). While America prides itself in having the highest quality scientists and engineers, at some point quantity *becomes* quality. This is especially true with advances in machine learning that rely more on trained engineers than cutting edge scientists.



**Technology:** China became the top filer of international patents in 2019 (World Intellectual Property Organization, 2020). *R&D World* forecasts that China will lead the world in the amount of combined research and development investments by industry, government, and academia in 2021 (Heney, 2022). China toppling America's long-standing leadership in these two vital measures of innovation should be enough alone to spark significant action.

**Tilt-Free:** Some suggest that the inefficiencies of political direction of actions to drive China's technological advance may severely hamper its progress (Economist, 2022). In the most recent World Economic Forum Competitiveness Index, China ranks 34th out of 141 nations in Entrepreneurial Culture while America ranks 2nd (Schwab, 2019). To seek to remedy this deficit, China deliberately created "a system that, through various formal and informal channels, promotes connectivity between state-owned enterprises (SOEs) and nominally private Chinese enterprises" (Weinstein, 2022). These connections include government subsidies, purchases, loans, and investment through government guidance funds (GGFs). GGFs invest directly or indirectly in companies or specific projects and provide government support in a manner that leverages market discipline and expertise (Murphy, 2021).

**Trade:** The Regional Comprehensive Economic Partnership, or the RCEP, including China, Japan, South Korea, and Australia went in place at the beginning of this year (The Washington Post, 2022). America is not a part of the RCEP trade agreement or the Comprehensive and Progressive Agreement for Trans-Pacific from which President Donald Trump withdrew and to which China seeks to join (Reuters, 2021). With America not part of either of these trade architectures and China part of one and seeking to join the other one, the United States is on the outside looking in as China potentially has the upper hand in defining the rules for trade in the world's largest and fastest growing economic region. Further, China's major investment in its Belt and Road Initiative ties trade along this new Silk Road to itself, as Britain did with its colonies in the first industrial revolution (McBride, 2020).

## America Neglecting The 4T Playbook

As China has embraced the 4T Playbook with vigor, America seems to have lost its copy. It has neglected its 4Ts.

**Talent:** State funding for American universities has receded during recessions and never fully recovered, leading to a long-term trend of lower support (Aborn & Cahill, 2020).

**Technology:** Other nations, not just China, have outpaced the federal government's support for research (Sargent, Jr., 2021). American R&D spending as a percentage of GDP ranks 10th in the world, behind major competitors such as Taiwan, Japan, Germany, and South Korea which ranks at the top in this metric (Council on Competitiveness, 2020). Counterterrorism has preoccupied America's military, slowing its pivot to capabilities needed for great power conflict deterrence. Even the surge in United States private industry investment in R&D could not offset the stagnant federal funding to allow America to keep the global lead in total R&D spending. Private funding cannot take the place of government funding for strategic and social purposes, nor make the investments too big and risky for any one private entity.

**Trade:** Recent trade actions have alienated partners as we have applied tariffs not just to China, but traditional allies. Innovation is accelerated by a global technology ecosystem to create scale. As export and investment



restrictions force the world to divide between those aligning with American or Chinese technologies, America faces the added challenge of preserving the ecosystem with the most scale in order to create competitive advantage. America's protectionist turn risks narrowing the reach of its innovation ecosystems.

## Five Key 4T Plays to Preserve America's Innovative Edge

China is already ahead in key technologies and closing the gap with American in others. If the world no longer looks to America for original ideas and inspiration, if the world's leading companies in key technologies are not headquartered in the United States, don't you think that would impact the economic prospects of future generations, if not today's? When American security forces move from having a technological advantage to being a step behind, can you truly believe that America's families and freedom are secure?

History has shown that those nations that emerge in the lead from each wave of innovation, learn to neutralize its potential disruptions, and capitalize on its transformative power will gain economic and security advantages over their rivals. The U.K. emerging from the first industrial revolution in the lead did not guarantee they would in the second—they did not. Just because America emerged in the lead from the second and third industrial revolutions, it is not preordained to lead after the fourth. America must earn it.

America is at an inflection point. Depending on its response, it will keep its innovative edge or surrender it to an ascendant China at great risk to its future prosperity and national security. America needs to run five offensive plays from the 4T Playbook and avoid anti-competitive actions currently in both chambers' bill drafts to keep itself on a trajectory to stay ahead in innovation. America's actions to preserve its technological and innovation leadership must match the scale of impact that reduced prosperity and security will have on its way of life if it fails to act. When confronted with a threat to its economic wellbeing and national security, the United States has always responded. The United States must rise to the challenge today.

### T1 Talent: Prepare the Nation for a Digital World

In America's tech rivalry with China, the imperative to accelerate the cultivation of tech talent takes on at least two dimensions—how it impacts America's ability to stay ahead in technology innovation and how it impacts societal cohesion and therefore the functionality of the government. Both are important. As a shortage in tech talent limits economic growth, it also limits economic opportunities for citizens. As those prepared to contribute to the digital economy earn a premium due to the shortage of talent, while the automation of work hollows out the middle class, many without tech skills resent that they do not benefit from technology's advance. The underlying angst contributes to the dysfunction of America's democracy. Preparing a broader segment of society with the skills needed in today's increasingly digital economy helps address both matters.

The nation's prosperity hinges on more adults not just graduating from high school, but also attaining a college degree, certificate, industry-recognized certification, or other credential of value. Barely half of Americans have a post high school credential. Given the rapid advance in automation, a significant share of Americans will need reskilling. The Lumina Foundation believes, "Dramatic action is needed to meet the nation's need for talent and to



ensure that all Americans have real opportunity to learn, grow, and thrive” (The Lumina Foundation, 2021). They are right.

Therefore, as we consider how to encourage more tech talent, America should not neglect federal support provided for all academic fields through Pell Grants and other programs. Advancing STEM talent is especially important to America having the talent to keep its innovative edge.

A study by a leading search firm predicts that the global overall talent shortage will reach 85.2 million workers by 2030 and as a result, companies worldwide risk losing \$8.4 trillion in revenue because of the lack of skilled talent (Franzino, 2022). Just think about how many more people would have better economic conditions if they had the skills needed to capture that otherwise forfeited economic growth. Investing more to help citizens gain this talent that will lead to economic growth will increase the resources of both the citizens and the government, unlike many other competing policy proposals.

### *Play #1 – Expanded Support for STEM Education*

To deliver the talent the nation needs to preserve its innovative edge, America needs to duplicate the effort that President Dwight Eisenhower initiated at the beginning of the Cold War, a National Defense Education Act.

With concerns about America’s standing in technology sparked by the Soviet Union’s launch of Sputnik in 1957, Congress passed the National Defense Education Act in 1958. This landmark bill funded graduate fellowships in science and math, supported development of curriculum in science and math for K-12 education, funded training for science teachers and more. This funding resulted in a doubling of students attending college, from 3.6 million in 1960 to 7.5 million in 1970. It helped the United States win the space race and ultimately, to prevail in the Cold War (United States Senate, 2022).

Several actions to expand America’s STEM talent are urgently needed:

### *Scholarships / Fellowships*

America lags relative to its competition in the share of its graduates pursuing STEM fields. In the World Talent Rankings of 64 countries by the International Institute for Management Development (IMD), an independent Swiss business school, America ranks 14 overall. The ranking, an amalgamation of over 30 metrics, ranks America lowest on the measure of the percentage of graduates in STEM. The United States ranked 52 (of 64) (International Institute for Management Development, 2022).

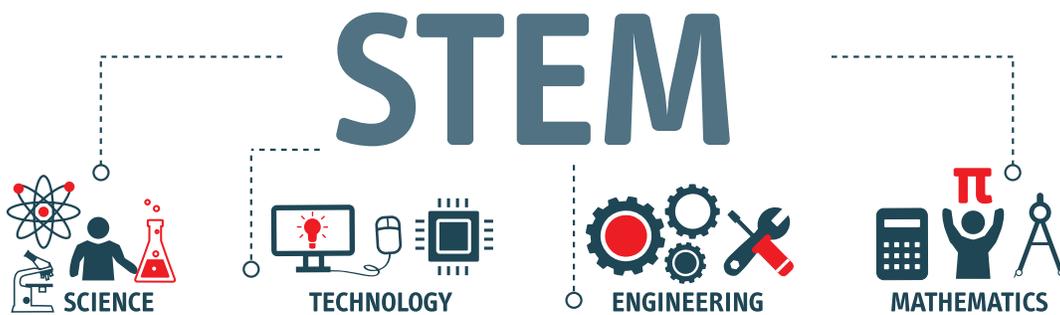
Why do so few Americans pursue STEM studies? A poll conducted by the Pew Research Center found that “about half of adults (52%) say the main reason young people don’t pursue STEM degrees is they think these subjects are too hard” (Kennedy, Hefferon, & Funk, 2018). There is not much we can do about that, though the broader public needs to understand it is as important as it is hard and to be more encouraging of those considering STEM degrees. The survey also found that of those with an interest in pursuing a STEM career who did not do so, “the most commonly cited reason for not pursuing a STEM career was cost and time barriers” (ibid.). This is something that additional financial support could help address.



Targeted funding should reverse the disincentive to pursue STEM degrees caused by their often costing up to twice as much to deliver as liberal arts degrees (Berman, 2019). Many universities pass higher costs on to the students through higher tuition rate for STEM degrees, thereby disincentivizing students to pursue them. This cost disincentive is further compounded by some degrees like engineering having so many requirements, they are more difficult to complete in four years, adding to their cost. Support should be provided in a way that instead provides an incentive for students to pursue STEM degrees.

Besides student hesitancy to pursue STEM degrees, a study of the AI workforce found that the “surge in demand for computer science courses at many American universities appears in some cases to be greater than their ability to supply them” (Perkins, 2021). Providing aid to encourage STEM degrees directly to students in the form of competitive scholarships will incentivize and reward universities that are responsive to the need for more such talent.

America significantly lags China in the number of STEM PhDs, important to both educating STEM talent and advancing research. American universities awarded twice as many doctorates in STEM fields as Chinese universities in 2000. But by 2007, the order had flipped, and China began outpacing American universities (Fedasiuk, 2021).



In 2019, a Council on Foreign Relations report called for urgent action and recommended 25,000 competitive undergraduate STEM scholarships and 5,000 graduate fellowships (Manyika, 2019). Last year, the National Security Commission on Artificial Intelligence called for 25,000 STEM undergraduate scholarships, 5,000 STEM PhD fellowships, and 500 postdoctoral positions over five years (NSCAI, 2021). Not only is a response of this scale highly beneficial to America economically, but it is also a geopolitical necessity.

The Senate bill authorizes \$5.2 billion from FY 2022–FY 2026 for STEM education and workforce development in the key technology focus areas. This is an important step but should be amplified. Such aid should seek to reverse the cost disincentive to students who pursue STEM degrees.

### *K-12 / Diversity of Tech Talent*

STEM fields lack diversity. Black and Hispanic workers remain underrepresented. Women make up a large majority of all workers in health-related jobs, but remain underrepresented in the physical sciences, computing, and engineering (Fry, Kennedy, & Funk, 2021). To make meaningful progress in diversifying the tech workforce, the K-12 system needs to produce a more robust pipeline of talent prepared for a tech career. Once they advance



to college, they should be supported through mentoring, training, research experience, and academic and career advising.

Significant current efforts by non-profits, universities, and industry to engage, attract, and equip today's youth to consider tech careers, should be encouraged and expanded. Such efforts need to reach out to youth, parents, educators, and counselors. They need to commence at latest in middle school and continue throughout a student's educational journey. These efforts are more productive in tandem with quality science and math instruction.

There is a "considerable shortage" in physics, chemistry, and math teachers at both the secondary and college levels (AAEE, 2020). Only 45.7% of chemistry teachers and 50.4% of physics teachers have a degree in their field (NSCRC, 2015). To both expand tech talent and its diversity, America must bolster efforts to ensure qualified science teachers and encourage more K-12 students to take higher math courses that prepare them for technical degrees.

It is important that federal legislation reflect states having the prime responsibility for K-12 education. Consistent with this division of roles, useful provisions in the Senate bill include establishing new competitive grant programs aimed at helping states increase the postsecondary STEM education for high school students and at increasing K-12 students' access to computer science education and opportunities to develop computational thinking skills, including students who are underrepresented in the computer science field. The House bill includes similar programs and calls on the NSF to support translational research and development to help scale up effective pre-K-12 STEM education innovations.





### *Innovation in Post-Secondary Offerings*

Besides encouraging the skills necessary to advance the 4IR technologies as scientists and engineers, it is important that Americans of all ages are prepared for the new world that these disruptive technologies are introducing. This will require meaningful innovation in post-secondary educational offerings.

Graduates in all fields of study will increasingly be called on to leverage the power of data and new technology. More analytics education in all university degrees should be encouraged. Those in non-STEM fields should be prepared to address the bias, governance, and ethics of the use of artificial intelligence and similar social implications of other technologies. All Americans would benefit from having greater tech literacy and being savvy consumers of products and services enabled by these new technologies.

To prepare a wider share of society for the digital world, new postsecondary credential offerings, whether certificates, badges, or other micro credentials must be encouraged. These can serve as a first step along a career, to facilitate pivoting to a new career and to help employees keep pace with rapidly advancing technology (Pancorbo, 2021).

Such provisions should be pursued by higher education and employers collaborating and should not require significant federal involvement.

### *Federal Tech Talent*

A key priority should be to ensure sufficient tech talent being available to the government and military. Suggested solutions have included the creation of a United States Digital Service Academy and/or a Digital Corps.

The Senate bill includes and scholarships to undergraduate and graduate students studying AI and related fields in exchange for service in the public sector equal to the period of time of their scholarship upon completion of their degree. Such a talent pool is vital for both the civil and military service. It should be embraced. The Senate also proposed a re-skilling program to provide federal employees with technical skills and a cyber workforce program for qualified federal employees to rotate among federal agencies that, properly structured, could be beneficial.

If the final competitiveness bill does not have sufficient support for bolstering America's tech talent, it should soon be followed by a bill addressing these concerns modeled on the National Defense Education Act.

### *Play #2 – Continue as Magnet for Globe's Best Talent with Improved Safeguards*

A key competitive advantage for America is its openness. Studies regularly affirm that American innovation and entrepreneurship activities are advanced by immigrants (Krol, 2021). If Jensen Huang had not immigrated from Taiwan to co-found NVIDIA (ILC, 2022), America's highest market value chip company (CMC.com, 2022), the United States would have even more concerns about access to chips. A recent study found that more than half of top-tier AI researchers worked outside their home countries. With about a third of the world's top AI talent coming from China, only a tenth works there (The Economist, 2022). It is in America's interest to continue to attract a significant share of that mobile talent.



Yes, higher education leaders must and do work in a concerted manner with government leaders to bolster the protocols necessary to ensure that the discoveries and intellectual property (IP) created in and for America are protected. Concerns about the loss of IP due to foreign students is best addressed through intelligence and research security reforms to reduce the risk of technology transfer, not by negating the significant advantage America gains by attracting the globe's best tech talent, including Chinese students and researchers, to study, research and hopefully remain in the United States.

The Senate bill includes several provisions targeted at protecting America's intellectual property (IP), including requiring the NSF director to work with institutions of higher education on initiatives to support IP protection, limit undue influence, and support domestic talent development. It also establishes a Research Security and Policy Office responsible for coordinating all research security policy issues and a Research Security and Integrity Information Sharing Analysis Organization. It limits participation in a foreign government talent recruitment program, expands background checks and requires a review of foreign gifts to universities.

With the proliferation of assignments to various agencies to address unwanted tech transfer, it is necessary to ensure that the resulting efforts at protection are not so cumbersome that they stifle more innovation than they prevent being inappropriately transferred. To be effective, universities need consistent, transparent guidelines governing such things as disclosure of foreign ties by researchers and when collaboration with universities and other partners in "at risk" countries is permitted. Such guidelines should balance the benefits received from scientific exchange and attracting needed talent (Chang, 2021). Thoughtful reforms and continued collaboration amongst academia and supporting government agencies can ensure that the costs of illegal tech transfer remains well below the benefits from the brain gain America receives by remaining open.

The House bill exempts foreign recipients of doctoral STEM degrees from the visa cap, creates new visas for entrepreneurs and provides special immigrant status admission for priority highly skilled Hong Kong residents. Such provisions and more should be considered in tandem with those strengthening safeguards against illegal tech transfer. It is important to recognize the significant net benefit America receives from continuing to attract the talent that creates a steady stream of new breakthroughs that keep American innovation ahead.

## **T2 Technology: Lead in Tomorrow's Technologies**

America has long had an entrepreneurial ecosystem that is the envy of the world. The Triple Helix partnership amongst government research funding, corporations and universities has led to great success and America's current leadership position. The United States emerged after World War II as the global leader in science and technology propelled by its investment in research and development (R&D). In 1960, the United States accounted for approximately 69% of the world's R&D funding. By 2019, however, its share of global R&D expenditures had fallen to about 30% (Sargent, Jr., 2021).

### *Play #3 – Bolster Federal Research Funding with Priority to 4IR Technologies*

America's federal funding for research has fallen over time, declining seven straight years in real terms, from 2009 to 2016, by a total 16.8% (Sargent Jr., 2021). China increased its research funding by an average of 17% per year from 2000 to 2017 (McCarthy, 2020). These divergent trends now leave America behind China in total



R&D expenditures, in international patent applications, and scientific papers (National Institute of Science and Technology Policy, 2020). With all these quantity measures, America today still looks more favorable when measures of quality are applied. Nevertheless, there is legitimate cause for concern about the trajectory.

Government, industry, and academia must recommit to reinvigorating our investment in research and growing the resulting discoveries into new ventures. We must reverse the decline in federal research funding. Research collaborations between government, corporate and university players must increase. With the federal share of America's R&D expenditures declining from 31.1% to 21.2% between 2010 and 2019 (Sargent Jr., 2021), a first step needs to be the federal government's renewed commitment to research funding.

Federal investment in R&D as a % of GDP has steadily declined from a 1964 high of 1.86% of GDP to 0.62% of GDP in 2018. If today's federal R&D investment as a % of GDP matched this 1964 height, the investment would be nearly \$400 billion (Council on Competitiveness, 2020), but was estimated to be \$157.8 billion in FY 2021 (Sargent Jr., 2021). The House or Senate versions increase research funding by tens of billions, not the hundreds of billions necessary to achieve the historic high as a percentage of GDP.

It is imperative that the final competitiveness bill includes research directed towards regaining and retaining leadership in the new technologies of the 4IR at or above the amounts currently contemplated. Such an incremental investment in research should not just be authorized but amply appropriated in successive years.

While not a focus of the current bill, efforts to enhance research into and adoption of new technologies in the military also need to be bolstered.

### **T3 Tilt-Free: Tilt only for Security, not Protectionism**

A recent article in *The Economist* expresses skepticism that China will indeed take the lead in technology from the United States in great part due to the significant investments it is making towards this end not being allocated efficiently (The Economist, 2022). This highlights the advantage of the Tilt-Free approach, an advantage America should guard carefully.

#### *Play #4 – Minimize Tilting*

Most of the significant investments in both bills related to semiconductors is not directed towards preserving the significant innovative edge that America currently possesses, but instead is focused on offsetting tilts caused by the subsidies of other nations that have reduced the amount of chip fabrication occurring in the United States. As the America joins in subsidizing (instead of seeking to limit subsidies by other nations), it must recognize that there is a slippery slope from supply chain "resilience" to "protectionism."

Every tilt away from comparative advantage means a step down the competitiveness ladder and due to higher costs, a step up the inflation ladder. As an example, a recent study by the Boston Consulting Group and the Semiconductor Industry Association suggests that achieving semiconductor "self-sufficiency" or technology "independence" / "sovereignty" would require "\$900 to 1,225 billion in upfront investment to cover each region's 2019 consumption levels" and would result in "\$45 to \$125 billion in incremental recurrent annual operational costs" (Varas, 2021).



The same report suggests the scale of support in both bills as part of the Creating Helpful Incentives to Produce Semiconductors (CHIPS) for America Act is in line with the self-sufficiency required for defense and critical infrastructure purposes. Though the bill has broad bi-partisan support, there are many who fear that it will lead to oversupply and waste. They argue that the semiconductor market has always been cyclical, that a chip shortage during a pandemic that elevated demand for all things digital is not unexpected and that the market can respond to this shortage without subsidies (The Economist, 2021). In any event, care should be given to implementing any such subsidies with as few tilts, picking winners or losers, either by industry or geography, as possible if the aim is truly to elevate American competitiveness (Wu, 2021).

The House's \$45 billion fund to provide grants and loans to more broadly strengthen American supply chains and manufacturing (Swanson, 2021), is particularly ripe for politically favored allocation. Prior to implementing any such "United States only" efforts to achieve targeted resilience objectives, it would be preferential from a competitiveness perspective to assess whether ally-shoring or friend-shoring would be more efficient than on-shoring (Coy, 2021).

As to research funding, there are versions of tilts in both bills (McKinnon, Andrews, & Hayashi, 2022). While the House bill allows federal science officials more flexibility in allocating funds provided to the National Science Foundation (NSF), at the same time it targets long-term funding towards issues, however worthy, that are unrelated to global competitiveness.

The annual "China Power" report by the Department of Defense specifically identifies that China "seeks to dominate technologies associated with the Fourth Industrial Revolution" (DoD, 2021). The Senate bill focusing its additional funding to the NSF substantially towards 4IR technologies is perhaps excusable given the importance of emerging ahead in the transformative technologies of the current industrial revolution to preserve America's lead. Even so, legislatively prescribing lists of long-term priorities may limit the ability to follow the best opportunities that emerge in fast moving technologies.

An annual White House memoranda already establishes real-time government R&D priorities, providing top-down direction. America's secret sauce has been leaving room for the bottom-up direction of research investment, allowing researchers and funding agency leaders to constantly scan for promising emerging technologies and to adjust investments to reflect unfolding opportunities (Patrick Windham, 2020). The final bill should seek to preserve this real time responsiveness.

## **T4 Trade: Ensure Broad Market for America's Innovative Products**

A half century of America engaging internationally to create rules, arrangements, and institutions aligned with American values and interests buttressed its position as the world's leading economy as it expanded mutual prosperity and security. Not only has rising domestic resistance caused America under Presidents Trump and Biden to pull back from negotiating new agreements and standards, but to instead implement protectionist measures.

To sustain a position as the most innovative nation requires not only cultivating the market access necessary for scaling to achieve financial viability when commercializing technologies, but ideally having the largest global



demand for new innovative offerings. With economic decoupling selectively occurring as America implements export controls and China pushes to become self-reliant in key technologies, not only will currently dominant American tech suppliers lose out on the Chinese market, but Chinese competitors will emerge to challenge them globally. Which countries will align with China and who will choose America? Will the part that choose America be the bigger half? With a divided market, will American companies be able to retain the lead?

While steel tariffs have recently thankfully been relaxed on our allies—Europe and Japan (CNA, 2022), President Biden has continued President Trump’s tariffs that most economists believe are undermining American competitiveness and are being paid for by American consumers (CNBC, 2019). These tariffs do nothing to address the primary concern of forced tech transfer. As the United States reduces its focus on international institutions that will play key roles in shaping the 21st century economy, China has moved aggressively to assert itself, assume leadership roles, and shape international standards from the inside in ways that undermine American values and competitiveness.

Battling China’s mercantilism in like kind plays to China’s strengths, not America’s. As America sits on the trade sidelines and is a party to neither of the two trade architectures currently in place in Asia, America risks letting others write the rules it must follow, including in the growing digital economy.

### *Play #5 – Lead in Setting Terms of Trade*

America cannot afford to turn inward, no matter the domestic sentiment. To strengthen America’s standing relative to China, it must unite allies in common cause to define the terms of trade. As America’s hard power advantages lessen, its soft power will be more important. Trade is the most potent soft power. Of vital importance is defining rules for the fast-growing digital economy—data protection, e-commerce, free flow of information, limits on localization requirements, privacy, limits on censorship, cyber security, and central bank



digital currency (Zoellick, 2022). The Senate version encourages the United States Trade Representative to pursue such agreements with “like-minded countries”

As China now seeks to enter the Comprehensive and Progressive Trans-Pacific Partnership (CPTPP) (Reuters, 2021), it is even more urgent that America reconsiders joining this agreement it once promoted to ensure access to Asian markets and the maintenance of high standards. The Biden Administration’s Indo-Pacific Strategy to work more closely with Asian nations on trade issues (Hayashi, 2022) is welcome though insufficient as it precludes actions that would provide mutual market access, as with the CPTPP.

Leading the reform of the World Trade Organization offers an opportunity to address abuses like state subsidies and forced tech transfer (Tippett, 2021). Both the House and Senate versions of the bill endorse the United States taking the leading in advancing such reforms.

America must step up its engagement in scientific bodies given that China now leads four of the of the 15 UN specialized scientific committees compared to one led by America. It is important to avert China from assuming leadership of the World Intellectual Property Organization and to counter its well-resourced and state led engagement in international standards technical institutes (Yang T. C., 2020).

American should not abandon the international order it spawned. It should double down on strengthening it to withstand the challenges it now faces.

The House and Senate drafts include little to encourage the United States to lead in setting the terms of trade. The House bill includes protectionist measures that would hamper competitiveness (Bradley, 2022), and as such are not appropriate in a bill to elevate America’s ability to compete. It is worth noting that the Senate trade title passed as its own amendment by an overwhelming bipartisan majority of 91-4 while the House trade title passed by a narrow party line vote and never received a hearing or vote in committee (Gump, 2022).

## Conclusion

The 4T playbook is a proven path to technological leadership. Given that America’s innovative edge underwrites its prosperity and security, there arguably is no higher priority. A bill by Congress in line with efforts to genuinely bolster and avoid actions that hamper America’s competitiveness as outlined above is worthy of support and should be considered a priority. America should approach the task of preserving its innovative edge with a view to not only strengthen its own innovative engine but to also align its efforts more closely with democratic allies. A concerted and collaborative sustained effort can allow America and its allies to enjoy the benefits of innovative leadership for decades to come.



## About the Author



### **Hon. Mark Kennedy, Global Fellow, The Wilson Center's Science and Technology Innovation Program**

A first-generation college graduate, Kennedy has led at the highest levels of academia, government, and business. He served as President of the University of Colorado and President of the University of North Dakota. Mark was a graduate school director at George Washington University, taught at Johns Hopkins University and authored *Shapeholders: Business Success in the Age of Activism*, published by Columbia University. Kennedy served as a United States Congressman (Minnesota) and as a presidentially appointed trade advisor under both President George W. Bush and President Barack Obama. Mark was treasurer of the company known today as Macy's, helped Pillsbury buy and expand Häagen-Dazs and served in a global role for Accenture. Kennedy founded the Economic Club of Minnesota and is a member of the Council on Foreign Relations. He earned a bachelor's degree from St. John's University and a Master's in Business Administration with distinction from the University of Michigan.

*The opinions expressed here are those of the author and do not represent the Wilson Center.*



## References

- AAEE. (2020). *Educator Supply and Demand Report 2019-20*. Retrieved from American Association for Employment in Education: [https://aaee.org/sites/default/files/content-files/AAEE%20Report2019\\_2020.pdf](https://aaee.org/sites/default/files/content-files/AAEE%20Report2019_2020.pdf)
- Aborn, M., & Cahill, N. (2020, October 27). *Higher Education Funding Takes a Hit During Recessions. But It Doesn't Have To*. Retrieved from Bipartisan Policy Center: <https://bipartisanpolicy.org/blog/higher-education-funding-takes-a-hit-during-recessions-but-it-doesnt-have-to/>
- Adams, H. S. (2020, January 8). *Key Takeaways from the First Unilateral Controls Issued Pursuant to the Export Control Reform Act*. Retrieved from Ropes & Gray: <https://www.ropesgray.com/en/newsroom/alerts/2020/01/Key-Takeaways-from-the-First-Unilateral-Controls-Issued-Pursuant-to-the-Export-Control-Reform-Act>
- Berlitz. (2021, May 31). *The most spoken languages in the world*. Retrieved from Berlitz: <https://www.berlitz.com/en-uy/blog/most-spoken-languages-world>
- Berman, J. (2019, February 13). *Why it costs colleges far more to educate a physicist or teacher than an English major*. Retrieved from Market Watch: <https://www.marketwatch.com/story/why-it-costs-colleges-far-more-to-educate-a-physicist-or-teacher-than-an-english-major-2019-02-13>
- Bradley, N. L. (2022, February 2). *U.S. Chamber Letter on H.R. 4521, the "America COMPETES Act"*. Retrieved from U.S. Chamber: <https://www.uschamber.com/international/trade-agreements/u-s-chamber-letter-on-h-r-4521-the-america-competes-act>
- Brian Kennedy, M. H. (2018, January 17). *Half of Americans think young people don't pursue STEM because it is too hard*. Retrieved from Pew Research Center: <https://www.pewresearch.org/fact-tank/2018/01/17/half-of-americans-think-young-people-dont-pursue-stem-because-it-is-too-hard/>
- Chang, W. H.-M. (2021, September 10). *Unwanted Foreign Transfers of U.S. Technology: Proposed Prevention Strategies*. Retrieved from George University Center for Security and Emerging Technology: <https://cset.georgetown.edu/article/unwanted-foreign-transfers-of-u-s-technology-proposed-prevention-strategies/>
- Chatzky, J. M. (2019, May 13). *Is 'Made in China 2025' a Threat to Global Trade?* Retrieved from Council on Foreign Relations: <https://www.cfr.org/background/made-china-2025-threat-global-trade>
- CMC.com. (2022, February 8). *Largest semiconductor companies by market cap*. Retrieved from CompaniesMarketCap.com: <https://companiesmarketcap.com/semiconductors/largest-semiconductor-companies-by-market-cap/>
- CNA. (2022, February 7). *US, Japan reach deal to cut tariffs on Japanese steel, fight excess output*. Retrieved from Channel News Asia: <https://www.channelnewsasia.com/business/us-japan-reach-deal-cut-tariffs-japanese-steel-fight-excess-output-2484541>
- CNBC. (2019, August 2). *Here's why US importers and consumers pay Trump's tariffs, not China*. Retrieved from CNBC: <https://www.cnbc.com/2019/08/02/heres-why-us-importers-and-consumers-pay-trumps-tariffs-not-china.html>
- Cong Cao, R. S. (2006, December). *China's 15 Year Science and Technology Plan*. Retrieved from Physics Today: <https://china-us.uoregon.edu/pdf/final%20print%20version.pdf>
- Corporate Finance Institute. (2022, February 8). *Comparative Advantage*. Retrieved from Corporate Finance Institute: <https://corporatefinanceinstitute.com/resources/knowledge/economics/comparative-advantage/>



- Council on Competitiveness. (2020, December 7). *Competing in the Next Economy*. Retrieved from Council on Competitiveness: [https://www.compete.org/storage/documents/documents/CoC\\_Commission\\_NextE-con\\_121620\\_FINAL.pdf](https://www.compete.org/storage/documents/documents/CoC_Commission_NextE-con_121620_FINAL.pdf)
- Coy, P. (2021, June 24). 'Onshoring' Is So Last Year. The New Lingo Is 'Friend-Shoring'. Retrieved from Bloomberg: <https://www.bloomberg.com/news/articles/2021-06-24/-onshoring-is-so-last-year-the-new-lingo-is-friend-shoring>
- Crow, M. (2020, April 14). *ASU Office of the President*. Retrieved from Arizona State University: <https://president.asu.edu/read/the-emergence-of-the-fifth-wave-in-american-higher-education>
- DoD. (2021, May). *DoD Base Realignment and Closure*. Retrieved from Department of Defense: [https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2022/budget\\_justification/pdfs/05\\_BRAC/FY2022\\_BRAC\\_Overview.pdf](https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2022/budget_justification/pdfs/05_BRAC/FY2022_BRAC_Overview.pdf)
- DoE. (2021, September 15). *HOW DID U.S. STUDENTS PERFORM ON THE MOST RECENT ASSESSMENTS?* Retrieved from Nation's Report Card: <https://www.nationsreportcard.gov>
- Fedasiuk, R. Z. (2021, August). *China is Fast Outpacing U.S. STEM PhD Growth*. Retrieved from Center for Security and Emerging Technology: <https://cset.georgetown.edu/publication/china-is-fast-outpacing-u-s-stem-phd-growth/>
- Feng, R. F. (2021, December 19). *SenseTime Revives IPO Days After U.S. Investment Blacklist Forced Delay*. Retrieved from Wall Street Journal: <https://www.wsj.com/articles/sensetime-revives-ipo-days-after-u-s-investment-blacklist-forced-delay-11639968854>
- Franzino, M. (2022, January 20). *The \$8.5 Trillion Talent Shortage*. Retrieved from Korn Ferry: <https://www.kornferry.com/insights/this-week-in-leadership/talent-crunch-future-of-work>
- Fry, R., Kennedy, B., & Funk, C. (2021, April 1). *STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity*. Retrieved from Pew Research: <https://www.pewresearch.org/science/2021/04/01/stem-jobs-see-uneven-progress-in-increasing-gender-racial-and-ethnic-diversity/>
- Goodman, P. S. (2018, March 26). *The Post-World War II Order Is Under Assault From the Powers That Built It*. Retrieved from New York Times: <https://www.nytimes.com/2018/03/26/business/nato-european-union.html>
- Hadley, G. (2021, November 22). *US Has 'a Lot of Catching Up to Do' in Hypersonics, Space Force's No. 2 Says*. Retrieved from Air Force Magazine: <https://www.airforcemag.com/us-catching-up-to-do-hypersonic-missile-space-force/>
- Hayashi, Y. (2022, February 6). *U.S. Readies New Asia-Pacific Economic Strategy to Counter China*. Retrieved from Wall Street Journal: [https://www.wsj.com/articles/u-s-readies-new-asia-pacific-economic-strategy-to-counter-china-11644148801?st=kn37hqm5x0drthb&reflink=article\\_email\\_share](https://www.wsj.com/articles/u-s-readies-new-asia-pacific-economic-strategy-to-counter-china-11644148801?st=kn37hqm5x0drthb&reflink=article_email_share)
- Heney, P. (2022, February 22). *2021 Global R&D Funding Forecast released*. Retrieved from R&D World: <https://www.rdworldonline.com/2021-global-rd-funding-forecast-released/>
- History.com. (2022, January 18). *United States freezes Japanese assets*. Retrieved from History Channel: <https://www.history.com/this-day-in-history/united-states-freezes-japanese-assets>
- ILC. (2022, February 8). *Jensen Huang*. Retrieved from The Immigrant Learning Center: <https://www.ilctr.org/entrepreneur-hof/jen-hsun-huang/>
- Insinna, V. (2021, December 7). *Congress approves retirement of 160+ Air Force planes – with one notable exception*. Retrieved from Breaking Defense: <https://breakingdefense.com/2021/12/congress-approves-retirement-of-160-air-force-planes-with-one-notable-exception/>
- International Institute for Management Development. (2022, January 19). *World Talent Rankings*. Retrieved from IMD: <https://www.imd.org/centers/world-competitiveness-center/rankings/world-talent-competitiveness/>



- Kampfner, J. (2022, January 12). *Big power rivalry: Who is winning the popularity wars?* Retrieved from Chatham House: <https://www.chathamhouse.org/2022/01/big-power-rivalry-who-winning-popularity-wars>
- Kapur, B. S. (2021, March 21). *Why China may be the last bipartisan issue left in Washington.* Retrieved from NBC News: <https://www.nbcnews.com/politics/congress/why-china-may-be-last-bipartisan-issue-left-washing-ton-n1261407>
- Kennedy, B., Hefferon, M., & Funk, C. (2018, January 17). *Half of Americans think young people don't pursue STEM because it is too hard.* Retrieved from Pew Research Center: <https://www.pewresearch.org/fact-tank/2018/01/17/half-of-americans-think-young-people-dont-pursue-stem-because-it-is-too-hard/>
- Krol, R. (2021, Fall). *Effects of Immigration on Entrepreneurship and Innovation.* Retrieved from CATO Journal: <https://www.cato.org/cato-journal/fall-2021/effects-immigration-entrepreneurship-innovation>
- Laura Silver, K. D. (2020, October 6). *Unfavorable Views of China Reach Historic Highs in Many Countries.* Retrieved from Pew Research: <https://www.pewresearch.org/global/2020/10/06/unfavorable-views-of-china-reach-historic-highs-in-many-countries/>
- Manyika, W. H. (2019, September). *Innovation and National Security Keeping Our Edge.* Retrieved from Council on Foreign Relations: <https://www.cfr.org/report/keeping-our-edge/>
- McBride, A. C. (2020, January 28). *China's Massive Belt and Road Initiative.* Retrieved from Council on Foreign Relation: <https://www.cfr.org/backgrounder/chinas-massive-belt-and-road-initiative>
- McCarthy, N. (2017, February 6). *The Countries With The Most STEM Graduates.* Retrieved from Industry Week: <https://www.industryweek.com/talent/article/21998889/the-countries-with-the-most-stem-graduates>
- McCarthy, N. (2020, January 20). *China Is Closing The Gap With The U.S. In R&D Expenditure.* Retrieved from Forbes: <https://www.forbes.com/sites/niallmccarthy/2020/01/20/china-is-closing-the-gap-with-the-us-in-rd-expenditure-infographic/?sh=46cce01f5832>
- McKinnon, J. D., Andrews, N., & Hayashi, Y. (2022, February 4). *House Passes \$350 Billion Competitiveness Bill, but Senate Fight Looms.* Retrieved from The Wall Street Journal: <https://www.wsj.com/articles/house-expected-to-pass-350-billion-bill-to-help-u-s-compete-globally-11643972401>
- MIT Technology Review. (2020, October 29). *America's technological leadership is at stake in this election.* Retrieved from MIT Technology Review: <https://www.technologyreview.com/2020/10/29/1011375/america-technological-leadership-is-at-stake-in-this-election/>
- Murphy, N. L. (2021, March). *Understanding Chinese Government Guidance Funds.* Retrieved from Georgetown University Center for Security and Emerging Technology: <https://cset.georgetown.edu/publication/understanding-chinese-government-guidance-funds/>
- National Institute of Science and Technology Policy. (2020, September 14). *China Overtakes US to Rank Top for Science Papers: Japan in Fourth Place.* Retrieved from Nippon.com: <https://www.nippon.com/en/japan-data/h00809/>
- NSCAI. (2021, March). *National Security Commission on Artificial Intelligence.* Retrieved from National Security Commission on Artificial Intelligence: <https://www.nscai.gov/2021-final-report/>
- NSCRC. (2015). *Education and Certification Qualifications of Departmentalized Public High School-Level Teachers of Selected Subjects.* Retrieved from National Student Clearinghouse Research Center: <https://nces.ed.gov/pubs2015/2015814.pdf>
- Onion, S. a. (2019, June 7). *G.I. Bill.* Retrieved from History.com: <https://www.history.com/topics/world-war-ii/gi-bill>



- Pancorbo, D. G. (2021, June). *U.S. Demand for AI Certifications*. Retrieved from Georgetown University's Center for Security and Emerging Technology: <https://cset.georgetown.edu/wp-content/uploads/CSET-U.S.-Demand-for-AI-Certifications.pdf>
- Perkins, D. G. (2021, October). *U.S. AI Workforce: Policy Recommendations*. Retrieved from Georgetown University's Center for Security and Emerging Technology: <https://cset.georgetown.edu/publication/u-s-ai-workforce-policy-recommendations/>
- Rabouin, D. (2021, September 21). *The U.S. Is Losing the Global Race to Decide the Future of Money—and It Could Doom the Almighty Dollar*. Retrieved from Time: <https://time.com/6099105/us-china-digital-currency-central-bank/>
- Reuters. (2021, September 21). *China applies to join Pacific trade pact to boost economic clout*. Retrieved from Reuters: <https://www.reuters.com/world/china/china-officially-applies-join-cptpp-trade-pact-2021-09-16/>
- Sacks, D. (2021, March 29). *China's Huawei Is Winning the 5G Race. Here's What the United States Should Do To Respond*. Retrieved from Council on Foreign Relations: <https://www.cfr.org/blog/china-huawei-5g>
- Sargent Jr., J. F. (2021, October 4). *U.S. Research and Development Funding and Performance: Fact Sheet*. Retrieved from Congressional Research Service: <https://sgp.fas.org/crs/misc/R44307.pdf>
- Sargent, Jr., J. F. (2021, September 27). *Global Research and Development Expenditures: Fact Sheet*. Retrieved from Congressional Research Service: <https://sgp.fas.org/crs/misc/R44283.pdf>
- Schleicher, A. (2016, March 16). *China opens a new university every week*. Retrieved from BBC: <https://www.bbc.com/news/business-35776555>
- Schwab, K. (2019). *The Global Competitiveness Report 2019*. Retrieved from World Economic Forum: [https://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf)
- Sumangil, A. Y. (2021, February 16). *Top electric vehicle markets dominate lithium-ion battery capacity growth*. Retrieved from S&P Global: <https://www.spglobal.com/marketintelligence/en/news-insights/blog/top-electric-vehicle-markets-dominate-lithium-ion-battery-capacity-growth>
- Swanson, C. E. (2021, February 4). *House Passes Bill Adding Billions to Research to Compete With China*. Retrieved from New York Times: <https://www.nytimes.com/2022/02/04/us/politics/house-china-competitive-bill.html>
- The Economist. (2021, August 7). *The chip shortage is a self-solving problem*. Retrieved from The Economist: <https://www.economist.com/leaders/2021/08/07/the-chip-shortage-is-a-self-solving-problem>
- The Economist. (2022, January 22). *Can China create a world-beating AI industry?* Retrieved from Economist: <https://www.economist.com/business/2022/01/22/can-china-create-a-world-beating-ai-industry>
- The University Rankings. (2022, January 13). *World University Rankings*. Retrieved from Times Higher Education: [https://www.timeshighereducation.com/world-university-rankings/2022/world-ranking#!page/0/length/25/locations/CHN/sort\\_by/rank/sort\\_order/asc/cols/stats](https://www.timeshighereducation.com/world-university-rankings/2022/world-ranking#!page/0/length/25/locations/CHN/sort_by/rank/sort_order/asc/cols/stats)
- The US-China Business Council. (2013, March). *China's Strategic Emerging Industries: Policy, Implementation, Challenges, & Recommendations*. Retrieved from The US-China Business Council: <https://www.uschina.org/sites/default/files/sei-report.pdf>
- The Washington Post. (2022, January 4). *In Asia, China fills an economic void the United States left*. Retrieved from Washington Post: <https://www.washingtonpost.com/opinions/2022/01/04/rcep-trade-agreement-china/>
- Tippett, J. H. (2021, March 10). *Europe and the Prospects for WTO Reform*. Retrieved from Council on Foreign Relations: <https://www.cfr.org/blog/europe-and-prospects-wto-reform>



- U.S. Department of State. (2009, January 20). *The Bretton Woods Conference, 1944*. Retrieved from U.S. Department of State Archive: <https://2001-2009.state.gov/r/pa/ho/time/wwii/98681.htm>
- U.S. Embassy Tblisi. (2022, January 21). *How the Chinese Communist Party steals science*. Retrieved from U.S. Embassy in Georgia: <https://ge.usembassy.gov/how-the-chinese-communist-party-steals-science/>
- UK Parliament. (2022, January 14). *Free Trade and Protection*. Retrieved from UK Parliament: <https://www.parliament.uk/about/living-heritage/transformingsociety/tradeindustry/importexport/overview/freetrade/>
- United States Senate. (2022, January 20). *Sputnik Spurs Passage of the National Defense Education Act*. Retrieved from United States Senate: [https://www.senate.gov/artandhistory/history/minute/Sputnik\\_Spurs\\_Passage\\_of\\_National\\_Defense\\_Education\\_Act.htm](https://www.senate.gov/artandhistory/history/minute/Sputnik_Spurs_Passage_of_National_Defense_Education_Act.htm)
- University College London. (2022, January 14). *The history behind UCL*. Retrieved from University College London: <https://www.ucl.ac.uk/students/news/2020/dec/history-behind-ucl>
- Varas, R. V. (2021, April). *Strengthening the Global Semiconductor Supply Chain in an Uncertain Era*. Retrieved from BCG-SIA: <https://web-assets.bcg.com/9d/64/367c63094411b6e9e1407bec0dcc/bcgxsia-strengthening-the-global-semiconductor-value-chain-april-2021.pdf>
- Weinstein, E. (2022, January 6). *Beijing's 're-innovation' strategy is key element of U.S.-China competition*. Retrieved from Brookings: <https://www.brookings.edu/techstream/beijings-re-innovation-strategy-is-key-element-of-u-s-china-competition/>
- World International Property Organization. (2020, April 7). *China Becomes Top Filer of International Patents in 2019 Amid Robust Growth for WIPO's IP Services, Treaties and Finances*. Retrieved from World International Property Organization: [https://www.wipo.int/pressroom/en/articles/2020/article\\_0005.html](https://www.wipo.int/pressroom/en/articles/2020/article_0005.html)
- Wu, A. E. (2021, April 13). *U.S. Chips Act Shouldn't Favor Certain Sectors, Tech Groups Warn*. Retrieved from Bloomberg: <https://www.bloomberg.com/news/articles/2021-04-14/u-s-chips-act-shouldn-t-favor-certain-sectors-tech-groups-warn>
- Yang, J. (2021, December 3). *Didi Global Plans to Delist From New York Stock Exchange*. Retrieved from Wall Street Journal: <https://www.wsj.com/articles/didi-global-plans-to-delist-from-new-york-stock-exchange-11638495158>
- Yang, T. C. (2020, April 9). *How China Is Remaking the UN In Its Own Image*. Retrieved from The Diplomat: <https://thediplomat.com/2020/04/how-china-is-remaking-the-un-in-its-own-image/>
- Zoellick. (2022, February 1). *If America Doesn't Set the Digital Trade Agenda, China Will*. Retrieved from Wall Street Journal: <https://www.wsj.com/articles/if-the-u-s-doesnt-set-the-digital-trade-agenda-china-will-economy-cloud-computing-globalization-data-11643755347>
- Zoellick, R. B. (2020). *America in the World, A History of U.S. Diplomacy and Foreign Policy*. New York, Boston: Twelve.



## WOODROW WILSON INTERNATIONAL CENTER FOR SCHOLARS

The Wilson Center, chartered by Congress in 1968 as the official memorial to President Woodrow Wilson, is the nation's key non-partisan policy forum for tackling global issues through independent research and open dialogue to inform actionable ideas for the policy community.

## THE SCIENCE AND TECHNOLOGY INNOVATION PROGRAM (STIP)

The Science and Technology Innovation Program (STIP) brings foresight to the frontier. Our experts explore emerging technologies through vital conversations, making science policy accessible to everyone.

Woodrow Wilson International Center for Scholars  
One Woodrow Wilson Plaza  
1300 Pennsylvania Avenue NW  
Washington, DC 20004-3027

### The Wilson Center

-  [www.wilsoncenter.org](http://www.wilsoncenter.org)
-  [wwics@wilsoncenter.org](mailto:wwics@wilsoncenter.org)
-  [facebook.com/woodrowwilsoncenter](https://facebook.com/woodrowwilsoncenter)
-  [@thewilsoncenter](https://twitter.com/thewilsoncenter)
-  202.691.4000



### Science and Technology Innovation Program

-  [www.wilsoncenter.org/program/science-and-technology-innovation-program](http://www.wilsoncenter.org/program/science-and-technology-innovation-program)
-  [stip@wilsoncenter.org](mailto:stip@wilsoncenter.org)
-  [@WilsonSTIP](https://twitter.com/WilsonSTIP)
-  202.691.4321

