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Winning the Tech Talent Competition

Without STEM Immigration Reforms, the United States Will Not Stay ahead of China

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Remco Zwetsloot

A Report of the CSIS Renewing American Innovation Project

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Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, D.C. 20036
202-887-0200 | www.csis.org

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Executive Summary

Talent is critical to innovation, and America's deep pool of skilled scientists and engineers is a key component of its technological primacy. But today, for the first time in decades, U.S. leadership is under serious threat. Reaping the fruits of significant long-term investments, China's supply of science, technology, engineering, and mathematics (STEM) talent now rivals that of the United States, both in terms of quantity and quality. Given current trends, it is inevitable that China will overtake the United States in purely domestic terms—if it has not done so already.

The most powerful—and perhaps only—lasting and asymmetric American advantage is its ability to attract and retain international talent, a feat China has not been able to replicate despite extensive efforts. But the U.S. government risks squandering that advantage through poor immigration policy. Without significant reforms to STEM immigration, the United States will struggle to maintain long-term competitiveness and achieve near-term technology priorities such as semiconductor supply chain security, leadership in artificial intelligence (AI), and clean energy innovation.

Part 1 of this paper provides data that supports these claims. Findings include:

- By 2025, China is projected to nearly double annual U.S. STEM PhD output (77,000 versus 40,000 graduates per year, respectively). Counting only domestic U.S. students, China would more than triple American numbers.
- China already far outpaces America in bachelor's and master's graduates; in 2019, China granted 1,886,000 bachelor's degrees and 326,000 master's degrees in STEM fields, compared to 445,000 and 171,000, respectively, for the United States.

- The quality of Chinese education has improved significantly over the last decade, especially at the PhD level. In 2020, 71 Chinese universities ranked in the top 500 globally, up from 23 in 2010. Even when quantity comparisons are limited to graduates from these higher-quality universities, China still graduates more STEM PhDs than the United States does today.
- America remains far more attractive to international scientists and engineers than China. While available data is imperfect, surveys suggest 60 percent of advanced STEM talent based abroad would consider moving to the United States, compared to around 10 percent for China. These figures have changed little over the past decade.
- Immigration policies are harming America's technology talent pool. Visa issues have contributed to a recent drop in international STEM enrollments. For instance, around 60 percent of U.S.-trained international AI PhDs who left the country after graduating said that immigration issues were relevant to their decision to leave.
- These realities are creating a budding bipartisan consensus that U.S. STEM immigration reform is "a national security imperative," as the National Security Commission on Artificial Intelligence recently put it. But this consensus has yet to be turned into action.

Part 2 of this report identifies three overarching policy priorities that should be at the center of a twenty-first-century international talent strategy and proposes several concrete legislative and executive policy options for pursuing these priorities (see table below). Along with much-needed domestic investments, these policies would go a long way toward maintaining and expanding America's technological superiority.

Policy Priorities	**Reforming STEM Immigration to Boost National Security**	**Ensuring Immigration Reforms Complement Domestic Workforce Investments**	**Safeguarding Research and Technology While Maintaining an Open System**
Legislative Policy Options	• Exempt advanced STEM graduates from green card caps. • Create a new green card category for workers in critical and emerging technology fields related to national security. • Create a dedicated and secure student-to-worker pathway.	• Create a dedicated entrepreneur ("start-up") visa. • Raise visa application fees to fund additional STEM training for domestic students and workers. • Prioritize visa applications in high-demand critical and emerging technology fields.	• Create a new public-private research security partnership. • Prioritize and fund open-source science and technology intelligence.
Executive Policy Options	• Recapture a large number of unused green cards. • Clarify and broaden the scope of the O-1 "extraordinary talent" visa. • Grant "National Interest Waivers" to workers in critical and emerging technology fields.	• Utilize the International Entrepreneur Rule. • Utilize existing immigration authorities related to labor shortages.	• Implement Presidential Proclamation 10043 in a targeted way. • Streamline information sharing across science agencies. • Engage with allies and partners on research security and technology transfer.

Today, the United States still has a tech talent advantage vis-à-vis China; whether it will a decade from now depends, in large part, on U.S. policymakers.

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Part 1. The Problem

Technology Competition Is Talent Competition

Technology competition with China is among the central strategic issues facing the U.S. government today. A critical component of this competition involves "talent"—the scientists and engineers working at the frontiers of science and technology.

Talent is core to China's technological ambitions. Xi Jinping has called talent "the first resource" in China's drive for "independent innovation," and Chinese leaders see shortages of high-skilled labor as a key obstacle to their technological ambitions in areas such as semiconductors, AI, and biotechnology.[1] The Chinese Communist Party (CCP) Central Committee wrote in its 2016 National Innovation-Driven Development Strategy that "the essence of being innovation-driven is being talent-driven."[2] Huawei founder Ren Zhengfei explains how his strategic priorities are informed by U.S. history: "The strength of the United States as a nation is not land, it's the talent. What can we learn from the U.S.? Attract talent."[3]

Scholars agree with this diagnosis. In a recent review of research on innovation, two prominent economists concluded that "increasing the supply of human capital" is the single best policy tool governments have to sustainably boost technological advancement.[4] Talent has always played a large role in spurring progress, but it has become especially central since society's transition toward a "knowledge economy," where competitiveness depends largely on high-end research and development (R&D) and innovation clusters rather than low-skilled labor and physical production: "Today, the knowledge economy vaults talented individuals to the center of economic performance and the achievement of global prosperity."[5]

Talent is also critical to the U.S. government's near-term technological goals. For instance, boosting semiconductor leadership and securing supply chains have been top priorities for both the Trump

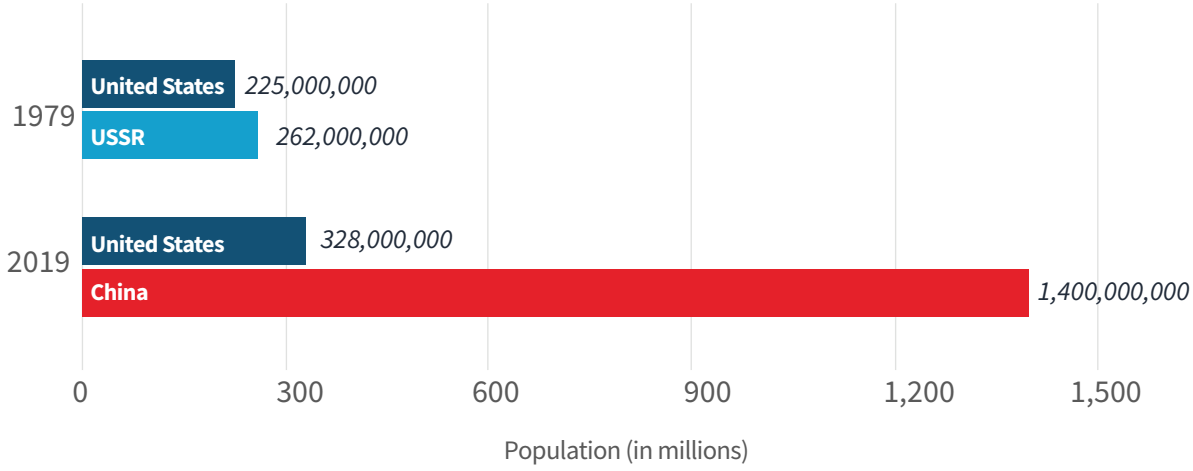
and Biden administrations. Current plans to expand domestic U.S. semiconductor manufacturing capacity, backed by billions in funding, will require tens of thousands of new workers. Semiconductor companies report that labor shortages play a critical role in the current chip shortage and identify workforce investments and immigration reforms as the "number one [policy] change that would help the industry in the near term."[6] It is no coincidence that a senior microelectronics professor at Tsinghua, a top Chinese university that recently established a college dedicated to semiconductors, said that "the competition between China and the U.S. is essentially the competition of talent."[7]

The Talent Dimensions of the China Challenge

In the realm of technology and talent, China is the fiercest challenger the United States has faced since its ascent to great power status. There are two main reasons for this.

The first is China's sheer scale. America's last major geopolitical and technological challenger—the Soviet Union—had roughly the same population. China, however, has a population four times the size of the United States (Figure 1). Given this disparity—and the recent successes of China's educational investments—it is clear that America's Cold War-era talent strategy, which was centered on domestic workforce investments, is insufficient to meet today's challenges.

Figure 1: China's scale means the U.S. government Cold War-era talent strategy is insufficient for today's context



Source: Census for U.S. data, Demoscope Weekly for USSR data, and National Bureau of Statistics for Chinese data.

The second main reason that today's talent competition poses an unprecedented challenge for the United States is the increasingly diffuse and competitive nature of the international science and technology ecosystem. The United States dominated global R&D and innovation during much of the Cold War, making it the natural destination for those at the top of their field. Today, it is not nearly as dominant; China alone is projected to exceed U.S. R&D expenditures in 2021.[8]

The United States competes for technical talent not only with China but also with U.S. allies and partners, many of which have recently reformed their immigration systems specifically to attract top technical talent.[9] Several indicators (reviewed below) suggest that other countries are successfully

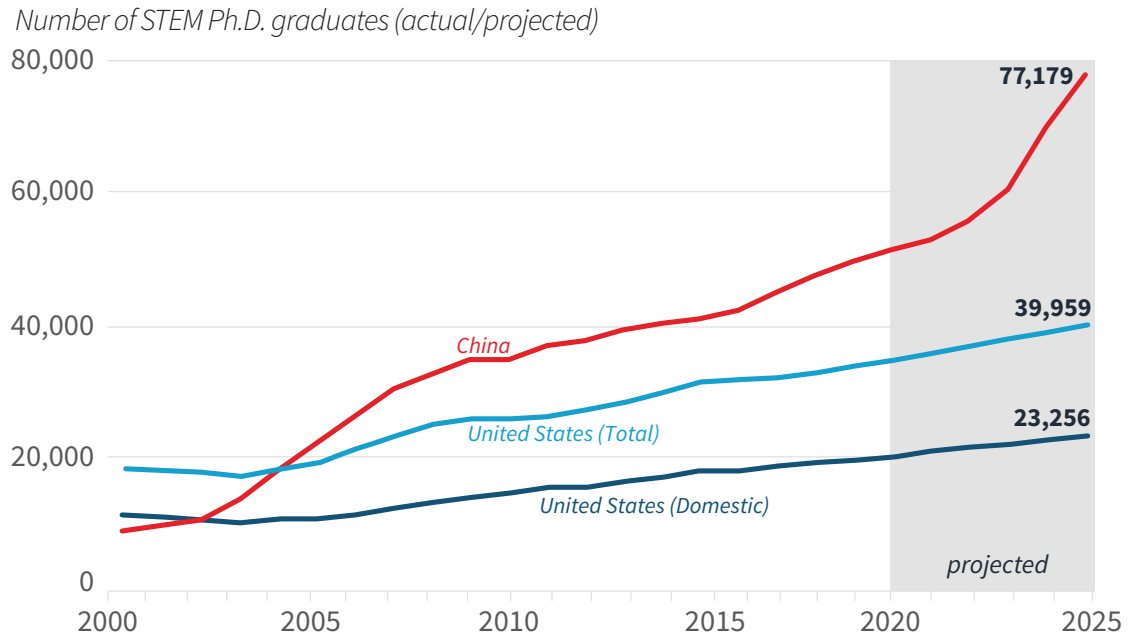
poaching large numbers of high-skilled workers who would have otherwise gone to, or stayed in, the United States. America is no longer the default destination for the world's best scientists and engineers.

China's Domestic Talent Investments Are Paying Off

Recognizing the importance of talent to technological innovation and independence, China has long prioritized domestic workforce and education investments.[10] A succession of plans—including Project 985, Project 211, and the Double First Class University Plan—have sought to vault Chinese universities into "world-class" status.[11] These plans are supported by significant investment; for instance, the budget of the Chinese Ministry of Education doubled between 2012 and 2021.[12]

China's initial development strategy took advantage of the country's large numbers of low-skilled laborers. Today, by contrast, the CCP's policies are focused on converting the country's demographic assets into a high-tech talent advantage. Studies suggest China is succeeding at increasing the quantity and quality of its STEM graduates. In 2019, China graduated 50,000 STEM PhDs, compared to 34,000 in the United States (Figure 2). Based on recent enrollment trends, China is projected to nearly double annual U.S. STEM PhD graduate counts by 2025, with 77,000 compared to 40,000; counting only domestic students, China would more than triple America's projected 23,000 graduates.[13]

Figure 2: China is projected to nearly double U.S. STEM PhD graduates by 2025

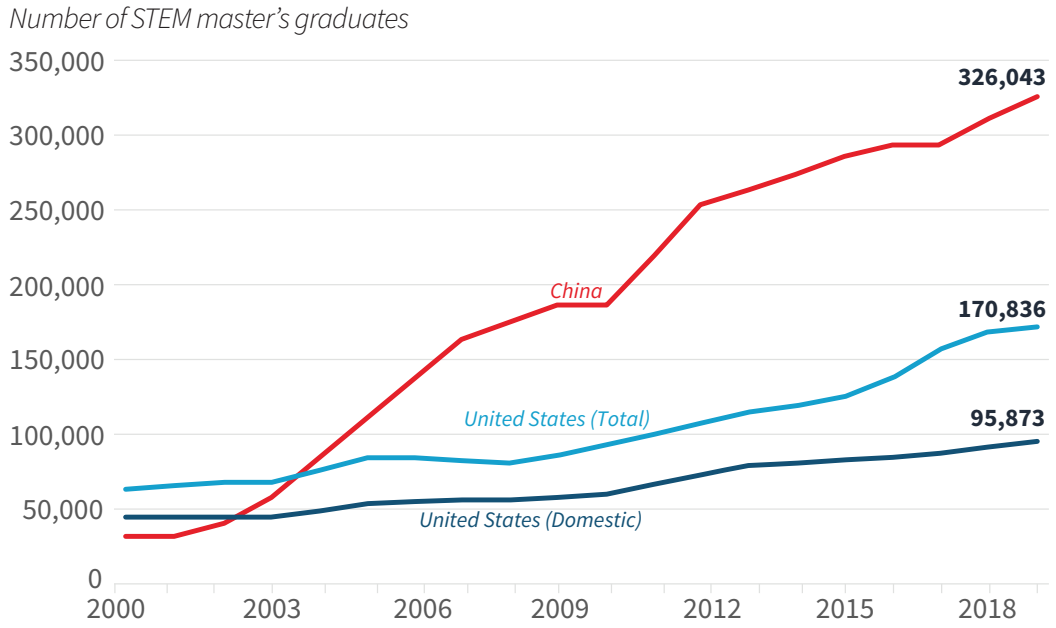


Source: Remco Zwetsloot et al., *China Is Fast Outpacing US STEM PhD Growth* (Washington, DC: Center for Security and Emerging Technology, August 2021), https://cset.georgetown.edu/publication/china-is-fast-outpacing-u-s-stem-phd-growth/.

Similar forecasts are not possible for STEM bachelor's and master's graduates due to lack of available data, but past trends show China has already surpassed U.S. universities at these levels as well. In 2019, China graduated 1,886,000 bachelor's students and 326,000 master's students with STEM degrees, compared to 445,000 and 171,000, respectively, in the United States (Figures

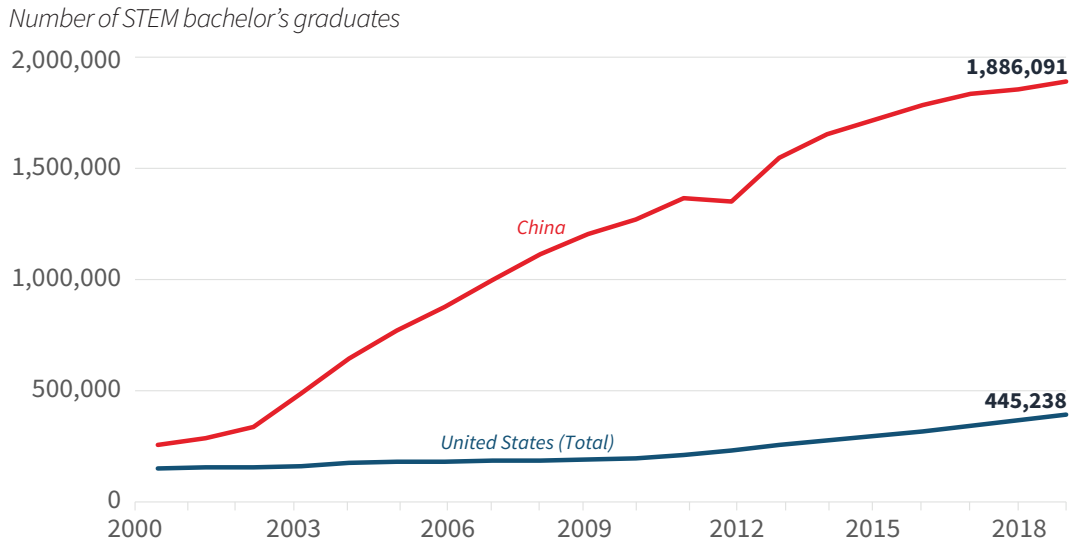
3 and 4). Around 45 percent (75,000) of U.S. STEM master's graduates were international students, compared to only 7 percent (31,000) at the bachelor's level; a domestic breakdown is therefore omitted from Figure 4.

Figure 3: China in 2019 already nearly doubled U.S. STEM master's graduates



Source: Department of Education IPEDS for U.S. data, Ministry of Education for Chinese data.

Figure 4: China had more than four times as many STEM bachelor's graduates in 2019



Source: Department of Education IPEDS for U.S. data, Ministry of Education for Chinese data.

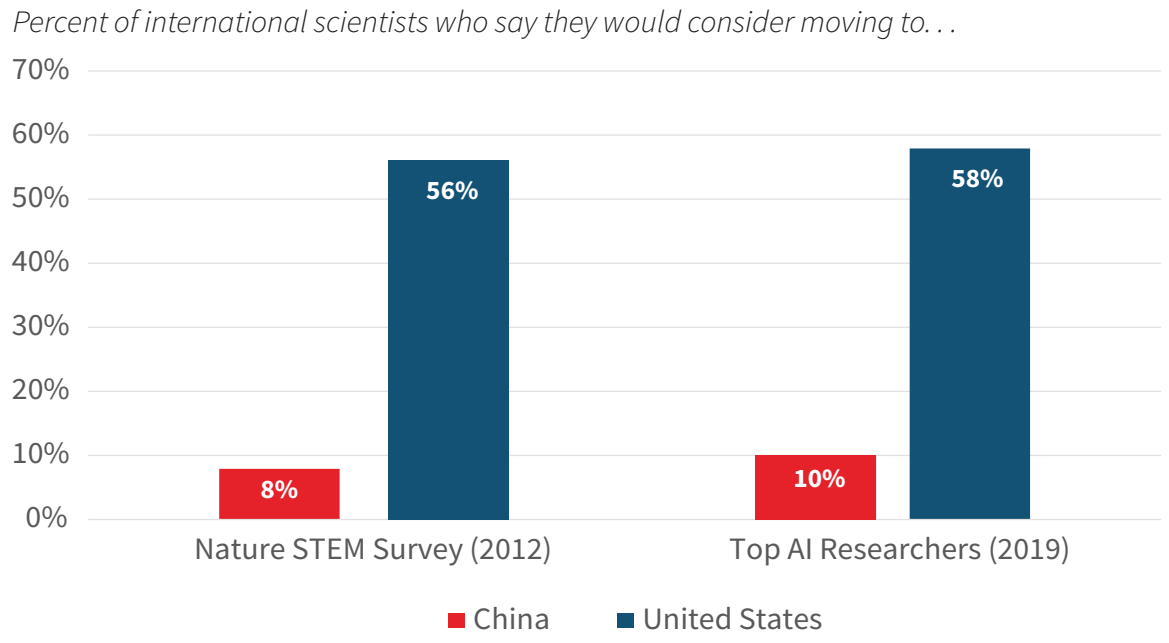
The quality of Chinese education has also increased, especially at the PhD level. In 2020, 71 Chinese universities ranked in the top 500 globally, up from 23 in 2010. These top-ranked universities graduated an estimated 26,500 STEM PhDs in 2019 (54 percent of all Chinese STEM PhDs), compared to 22,000 STEM PhD graduates from similarly ranked U.S. universities. In other words, even when the comparison is limited to high-quality institutions, China still outproduces the United States in STEM PhD graduates. By contrast, a large majority of China's master's and bachelor's graduates come from lower-quality institutions.[14]

Immigration Is America's Key Asymmetric Talent Advantage

While China has successfully boosted its domestic STEM output, America remains a far more attractive destination for international STEM talent. In this domain of talent competition, China—despite big ambitions and significant investments—has not yet made large-scale gains.

International scientists consistently rate the United States as much more appealing than China. Figure 5 presents the results from two surveys that asked international scientists and engineers where they would consider moving in the near future. Although the surveys were held years apart (2012 versus 2019) and involved different fields (STEM broadly versus AI specifically), the results are consistent: only about 10 percent of international scientists and engineers seemed open to moving to China, compared to nearly 60 percent for the United States.

Figure 5: The United States is much more attractive to international scientists than China



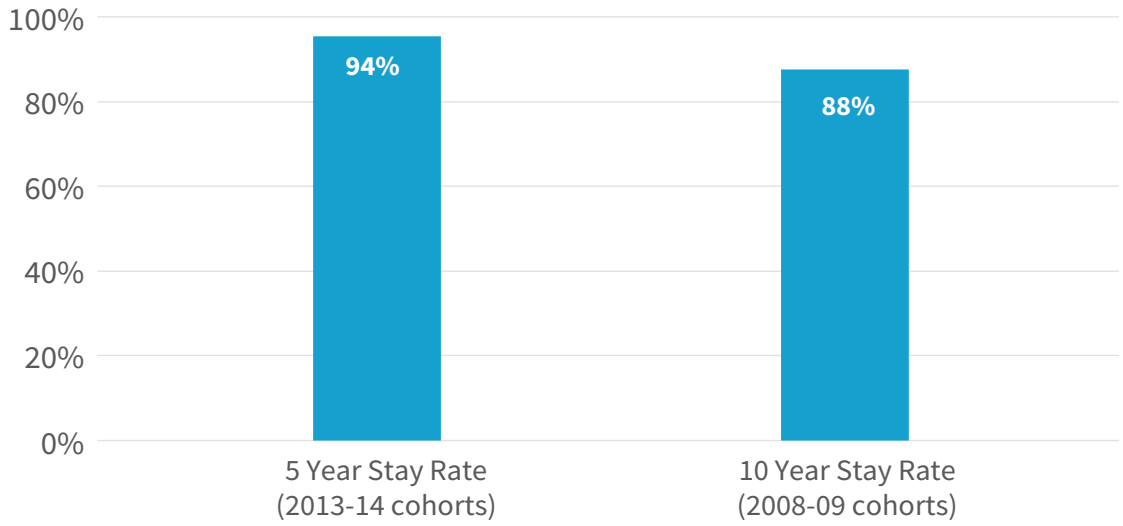
Source: Richard Van Noorden, "Global Mobility: Science on the Move," *Nature*, October 17, 2012, https://www.nature.com/articles/490326a; and Remco Zwetsloot et al., "Skilled and Mobile: Survey Evidence of AI Researchers' Immigration Preferences," 2021 AAAI/ACM Conference on AI, Ethics, and Society, https://arxiv.org/abs/2104.07237.[15]

Data on stay rates among Chinese STEM graduates from U.S. universities suggest that China's struggles also extend to Chinese citizens based abroad. As Figure 6 shows, almost 90 percent of Chinese STEM

PhD students have historically stayed in the United States for at least 10 years after graduating; and at the 10-year mark, nearly all Chinese STEM PhD graduates who remain in the United States are either permanent residents or citizens.[16] Moreover, there is little evidence of recent declines in retention. Surveys that ask STEM PhD graduates whether they intend to stay in the United States for their first post-graduation job find that intention-to-stay rates have consistently been around 85 to 90 percent in recent years (data available up to 2019).[17] The overall scope of China's brain drain problem is significant. One study of international machine learning conference attendees found that the United States may host more than twice as many top Chinese AI researchers than China itself.[18]

Figure 6: A large majority of Chinese STEM PhD graduates stay in the United States

Long-term stay rates among Chinese STEM Ph.D. graduates from U.S. universities (as of 2019)



Source: Jack Corrigan, James Dunham, and Remco Zwetsloot, *Long-Term Stay Rates of International STEM PhDs* (Washington, DC: Center for Security and Emerging Technology, forthcoming).

Why has China struggled to attract international talent? Studies suggest that societal and political factors play a major role. For example, in the *Nature* survey, international scientists said they actually considered China to be a more likely source of future breakthrough science than the United States, but political restrictions still made them unwilling to move there.[19] Anecdotal evidence also suggests that many international scientists recruited through Chinese talent programs decide to leave China within a few years—or even months—due to frustrations with political favoritism in resource allocation; repression and censorship of Google Scholar and other platforms; language barriers; and pollution, education, and housing issues.[20]

To be sure, China still manages to attract some high-profile scientists and engineers. However, because these barriers to recruitment are intimately linked with the CCP's tightening societal controls, it appears unlikely that China will be able to attract and retain international talent at a scale anywhere near the United States. This is why technology and national security leaders have begun calling STEM immigration a "key asymmetric advantage for the United States"—a U.S. strength that China, despite its ability and willingness to invest incredible amounts of money, will not be able to easily replicate.[21]

Immigration as an Asymmetric U.S. Advantage

A decade ago, Joseph Nye asked longtime Singapore leader Lee Kuan Yew whether he thought China would overtake the United States in the twenty-first century. His answer was no, because the United States has long attracted the world's best and brightest, fostering a "diverse culture of creativity," whereas China will struggle doing so: "China has 1.3 billion people to recruit from domestically, but . . . its Sino-centric culture makes it less creative than the United States, which can draw upon a talent pool of more than 7 billion people."[22]

Current Policies Risk Squandering America's Immigration Advantage

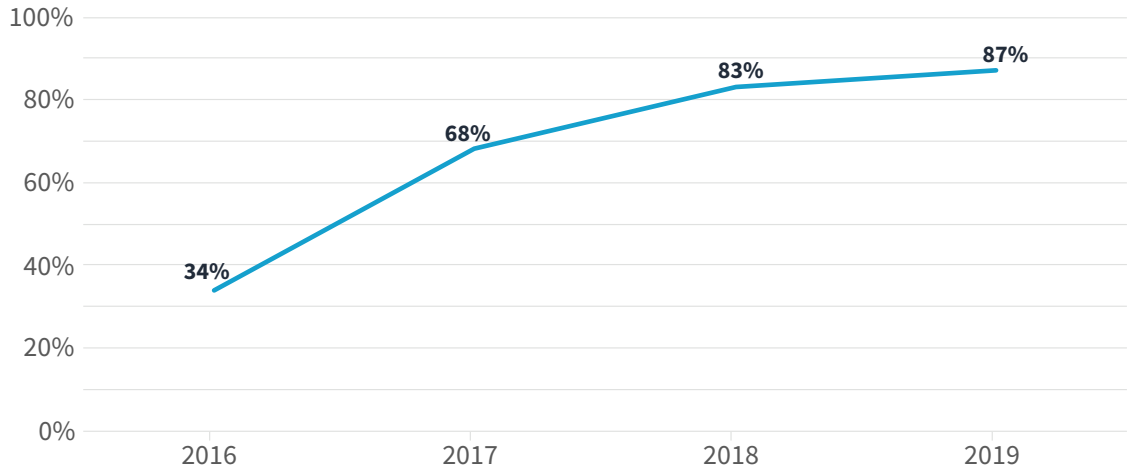
However, the broad appeal of U.S. society is only an asset if the world's best and brightest can actually come and stay in the United States. And on this front, U.S. policy has long been moving in the wrong direction.

Numerical caps on immigration have not materially changed since the 1990s, despite the fact that the U.S. economy and population have grown significantly. These caps limit the annual number of STEM workers that U.S. employers can hire and have caused immense backlogs; in 2020, the employment-based green card backlog—which counts only people whose applications have already been approved by U.S. Citizenship and Immigration Services (USCIS)—exceeded 1.2 million individuals. Under the current system, an Indian STEM PhD holder who receives a job offer today faces a projected wait time of 84 years before their green card application is issued.[23]

The negative impact of current U.S. immigration policy is now clearly visible across several indicators. For example, recent declines in international enrollments at U.S. universities appear to be caused at least in part by visa issues (Figure 7). Research also suggests that visa issues and poor immigration prospects disproportionately deter higher-quality students.[24]

Figure 7: Immigration issues deter international talent from coming to the United States

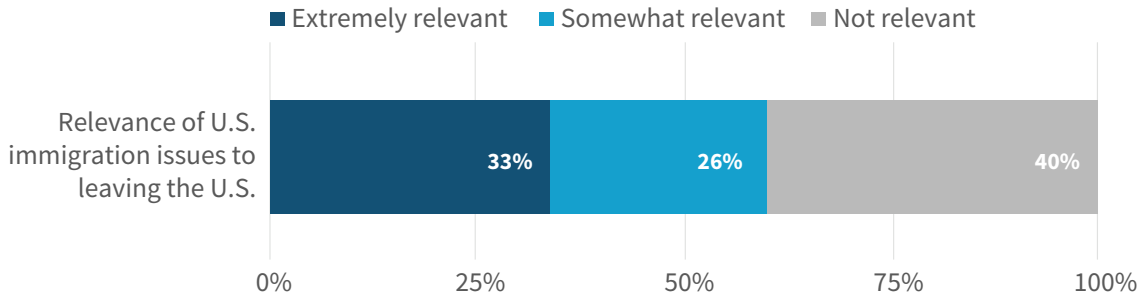
Percent of U.S. universities who say they saw international enrollments decline due to visa issues



Source: "Losing Talent 2020: An Economic and Foreign Policy Risk America Can't Ignore," NAFSA: Association of International Educators, March 2020, 6, https://www.nafsa.org/sites/default/files/media/document/nafsa-losing-talent.pdf.

Immigration barriers also affect top STEM students who have already come to the United States. In one survey of international AI PhD graduates who left the United States after completing their degrees, more than half report that immigration issues played a role in their decision (Figure 8). Studies like this suggest that STEM immigration reforms could significantly boost U.S. retention of top talent.[25]

Figure 8: Immigration reforms would help America retain more U.S.-trained STEM talent



Source: Catherine Aiken, James Dunham, and Remco Zwetsloot, "Immigration Pathways and Plans of AI Talent," Center for Security and Emerging Technology, *Data Brief*, September 2020, https://cset.georgetown.edu/publication/immigration-pathways-and-plans-of-ai-talent/.

Other countries are beginning to take advantage of America's atrophying immigration system, reforming their rules and launching dedicated programs to attract U.S.-based STEM talent.[26] Canada, for example, regularly runs billboard campaigns in American technology hubs advertising its opportunities, with slogans like "H-1B Problems? Pivot to Canada." And these efforts appear to be paying off. Between 2017 and 2019, the number of high-skilled U.S.-based workers who applied for permanent residency in Canada more than doubled; immigration data suggest American companies and universities lost more than 20,000 workers to Canada during these three years alone.[27]

The Emerging Bipartisan Consensus on STEM Immigration as a National Security Priority

These realities are creating a consensus among U.S. technology and national security leaders that STEM immigration reform is now, as the National Security Commission on Artificial Intelligence recently wrote, a "national security imperative."[28]

Chinese Leaders Fear U.S. STEM Immigration Reforms

Chinese leaders understand the extent to which the United States benefits from international talent inflows. They therefore celebrate America's flawed immigration system and fear reforms that would improve U.S. talent attraction and retention.

- Commenting on U.S. retention of Chinese STEM students, the head of the CCP's Central Talent Work Coordination Group has complained that "the number of top talents lost in China ranks first in the world."[29]
- A state-run consulting firm wrote in an AI policy white paper that U.S. immigration restrictions "have provided China opportunities to bolster its ranks of high-end talent."[30]
- The deputy editor of *China Daily USA*, a government newspaper, said that expansion of the U.S. employment-based immigration system "would pose a huge challenge for China, which has been making great efforts to attract and retain talent."[31]

Notably, this idea has sparked bipartisan congressional interest. In 2019, the Ronald Reagan Institute launched a task force on the twenty-first-century national security technology workforce, members of which included multiple former and current Republican and Democratic representatives. Its report concluded that "U.S. immigration policies . . . impede the war for talent, often requiring foreign students graduating with high-demand technical degrees to return to their home countries rather than providing pathways for them to stay and contribute to the U.S. [national security innovation base]." To address this problem, it argued "Congress should create a 'National Security Innovation Base Visa' that would encourage appropriately vetted, highly skilled workers to come to the United States or foreign national students graduating with relevant degrees to stay in the United States."[32]

The following year, these conclusions were echoed by the Future of Defense Task Force, a group launched by the House Armed Services Committee (HASC) to assess national security priorities for long-term U.S. leadership. Recognizing the importance of talent to great power competition, it looked beyond the traditional boundaries of committee jurisdiction to argue that "the quantifiable success of recent [STEM] immigrants is staggering" and that "immigration policy hinders the U.S.'s ability to attract and retain foreign STEM talent that instead flows to other countries, including competitors," calling on Congress to "aggressively [expand] visas for STEM talent."[33]

These arguments were translated into bipartisan legislation by Representatives Jim Langevin and Elise Stefanik, then chair and ranking member on HASC's Subcommittee on Emerging Threats, respectively. Their National Security Innovations Pathway Act creates hundreds of visas (100 in its first fiscal year, up to 500 after five years) for foreign-born talent working in defense-relevant technology areas.[34] The act was successfully added as an amendment to the House version of the FY 2021 National Defense Authorization Act, but its Senate counterpart did not include similar language. The provision was ultimately omitted from the bill's reconciled version.

2

Part 2. The Solutions

Converting Consensus into Action

The emerging bipartisan consensus on STEM immigration must be turned into concrete action before China further expands its domestic advantage and the United States loses out on more international talent. In doing so, policy changes should be made in pursuit of at least three goals: (1) reforming STEM immigration to boost national security, (2) ensuring immigration reforms complement domestic workforce investments, and (3) safeguarding research and technology while maintaining an open system.

Policy Priorities	**Reforming STEM Immigration to Boost National Security**	**Ensuring Immigration Reforms Complement Domestic Workforce Investments**	**Safeguarding Research and Technology While Maintaining an Open System**
Legislative Policy Options	• Exempt advanced STEM graduates from green card caps. • Create a new green card category for workers in critical and emerging technology fields related to national security. • Create a dedicated and secure student-to-worker pathway.	• Create a dedicated entrepreneur ("start-up") visa. • Raise visa application fees to fund additional STEM training for domestic students and workers. • Prioritize visa applications in high-demand critical and emerging technology fields.	• Create a new public-private research security partnership. • Prioritize and fund open-source science and technology intelligence.
Executive Policy Options	• Recapture a large number of unused green cards. • Clarify and broaden the scope of the O-1 "extraordinary talent" visa. • Grant "National Interest Waivers" to workers in critical and emerging technology fields.	• Utilize the International Entrepreneur Rule. • Utilize existing immigration authorities related to labor shortages.	• Implement Presidential Proclamation 10043 in a targeted way. • Streamline information sharing across science agencies. • Engage with allies and partners on research security and technology transfer.

Part 2 of this paper briefly outlines these goals and lays out several steps that Congress and the executive branch can take to pursue these goals. The lists of policy options are far from exhaustive, but the proposed priorities and policies at least illustrate some of the key components of any twenty-first-century technology talent strategy.

Reforming STEM Immigration to Boost National Security

America's national security depends on the health of the U.S. technology ecosystem, which is often tied to the concept of "STEM"—all of science, technology, engineering, and mathematics. The U.S. government has also recently worked to identify a narrower set of "critical and emerging technology areas" that are especially central to economic and military competitiveness.[35] The immigration reforms reviewed below could target STEM fields broadly or focus more specifically on these "critical and emerging" areas (see next section for more discussion).

Immigration policy can also bolster national security by increasing the U.S. government's access to technical talent. From this perspective, it is especially important that policymakers ensure international talent is able to obtain permanent residency and, eventually, citizenship. Focusing on permanent residency also makes sense from a broader competitiveness perspective, as green card caps are the principal bottleneck in the U.S. immigration system. The recommendations below therefore focus primarily on green card reforms.[36]

LEGISLATIVE POLICY OPTIONS

- **Exempt advanced STEM graduates from green card caps.**[37] Currently, the U.S. government can issue 140,000 employment-based green cards per year. Legislation should exempt advanced STEM graduates from those caps.[38] The number of exempted individuals will depend on whether it applies to PhDs only or to master's graduates as well; U.S. universities currently graduate around 20,000 international STEM PhD students per year, compared to around 100,000 master's graduates (see Figures 3 and 4 above). If degree holders from non-U.S. universities are included (e.g., anyone in the world with a STEM PhD), the number of individuals eligible for the cap exemption would be significantly higher; exact numbers would depend on the criteria used.
- **Create a new green card category for workers in critical and emerging technology fields related to national security**. If STEM exemptions are infeasible, a more targeted approach could increase the number of available green cards—and speed the path to citizenship—for individuals working in a select set of fields. One model for this approach is the bipartisan National Security Innovations Pathway Act discussed above, which would make available up to 500 new green cards for individuals working in "critical" technology areas.[39]
- **Create a dedicated and secure student-to-worker pathway.** International graduates from U.S. universities currently account for the majority of new STEM immigrants.[40] The Optional Practical Training (OPT) program allows F-1 student visa holders to work for a U.S. employer for up to three years after graduation (one year for non-STEM graduates). While it is little-known, OPT is essential for U.S. retention of international STEM graduates and for American firms; more than 1 million STEM graduates have used OPT since 2004, and the chip giant Intel has said that "without OPT, we would be able to hire just 30% of the highly skilled graduates we currently hire."[41] But the program was created through regulation rather than legislation, rendering it insecure; it has been challenged in court and the Trump administration reportedly came close to eliminating the

program. Congress should enshrine OPT (or an equivalent student-to-work pathway) into statute to protect it from such threats.

EXECUTIVE POLICY OPTIONS

- **Recapture a large number of unused green cards.** There are currently hundreds of thousands of "unused" green cards: permanent residency slots that agencies could have issued in prior years but, for a variety of reasons, did not.[42] Such unused green cards can be "recaptured" and allocated to current applicants. Recapture would significantly reduce green card backlogs and likely help tens of thousands of STEM workers. It is unclear whether recapture can happen without legislation; the American Immigration Lawyers Association argues agencies can "implement [recapture] through administrative means not requiring legislation," though other legal experts have doubts.[43] If further legal assessments show that executive green card recapture is not possible, or only a partial solution, congressional action should be a high priority.[44]
- **Clarify and broaden the scope of the O-1 "extraordinary talent" visa.** The O-1 temporary worker visa is for individuals with "extraordinary ability or achievement" in the sciences (among other fields). The visa is statutorily uncapped and can be renewed indefinitely, which makes it attractive to advanced STEM talent, but immigration lawyers often advise clients against applying due to the uncertainty and administrative burden of the O-1 application and adjudication process. Executive actions could make the O-1 visa more accessible by clarifying which metrics are used to assess eligibility (e.g., what it means to publish in a "major" outlet or do "original work" of "major significance").[45] About 10,000 to 15,000 new O-1 visas are currently issued annually; relaxing the criteria, within statutory bounds, could feasibly increase eligibility by thousands of STEM workers per year.
- **Grant "National Interest Waivers" to workers in critical and emerging technology fields.** As part of the "exceptional ability" employment-based green card category (EB-2), for which there are roughly 40,000 slots per year, USCIS is allowed to grant applicants a National Interest Waiver (NIW). The waiver allows companies to sidestep time-consuming recruitment and labor certification (PERM) requirements and workers to sponsor their own application. To qualify for a NIW, applicants must demonstrate that their "proposed endeavor has both substantial merit and national importance" and that they are "well positioned to advance the proposed endeavor." To encourage the appropriate granting of NIWs to workers in fields that the U.S. government has designated as "critical and emerging technologies," USCIS could issue public guidance confirming that certain fields, such as AI, are of "national importance."[46] This could save thousands of STEM workers per year several months in the application process, reducing administrative burdens and backlogs.

Ensuring Immigration Reforms Complement Domestic Workforce Investments

The U.S. government's foremost talent policy priority should be domestic workers and students. The National Security Commission on AI called for a "National Defense Education Act II," with ambitions equal in scope and scale to the U.S. government's investments made in the wake of Sputnik through the first National Defense Education Act.[47] Such measures are necessary, but, as the commission recognized, they are not sufficient. Today, the labor needs of the U.S. science and technology system—and the scope of the talent challenge—are simply too great to be met by domestic talent alone.[48]

Fortunately, immigration reforms and domestic workforce investments can complement each other. Fears that international STEM talent mainly "crowds out" domestic students and workers appear exaggerated. A large body of economic evidence suggests that high-skilled immigrants generally have neutral or positive impacts on domestic employment and wage levels and that international students tend to boost domestic enrollments by funding university program expansions.[49] Recent data on U.S. physics PhD programs suggest that decreases in international applicants did not lead to more domestic enrollment—instead, universities were forced to shrink their programs.[50] Nonetheless, even small amounts of displacement are cause for concern and could erode support for immigration reforms. The recommendations outlined below would help ensure that STEM immigration measures benefit domestic talent and can be supported by a broad political coalition.

LEGISLATIVE POLICY OPTIONS

- **Create a dedicated entrepreneur ("start-up") visa.** The U.S. immigration system is designed for employees; most employment-based visa categories require employer sponsorship. This strongly disadvantages entrepreneurs who want to start their own companies, forcing them to abandon their plans, to find awkward workarounds under existing visa categories, or, frequently, to take their companies elsewhere. Those who have found workarounds demonstrate the potential value of immigrant entrepreneurs: more than half of America's 91 recent "unicorns" (new companies worth $1 billion or more) had immigrant founders, and, according to one analysis, "immigrant founders have created an average of more than 1,200 jobs per company."[51] By allowing more foreign talent to start high-technology companies, a "start-up" visa would boost U.S. innovation and create jobs for American workers.[52] Several legislative templates for such a visa category already exist.[53]
- **Raise visa application fees to fund additional STEM training for domestic students and workers.** Hundreds of millions in H-1B visa application fees ($350 million in FY 2019) are already spent on STEM training for domestic students and workers. The funds, which fall outside of the annual appropriations process, are allocated by the National Sciences Foundation and Department of Labor (DOL). Current fee levels were set in 2004 and have not been updated since; simply adjusting the fees for post-2004 inflation would raise them by 30 percent (more than $100 million). Large companies have also expressed a willingness to pay higher fees. One existing proposal would raise annual income from H-1B fees to $1 billion, nearly tripling funds for domestic STEM training activities.[54] The recent National Security Innovations Pathway Act adopted a similar approach by allocating green card application fees to domestic STEM scholarships.
- **Prioritize visas for high-demand critical and emerging technology fields.** Currently, the availability of U.S. visas is tied only indirectly to labor market conditions. Other countries, including Canada and the United Kingdom, more directly integrate economic data into their immigration systems. This is important because not all STEM fields follow the same labor market cycles; talent shortages may exist in some STEM fields or occupations but not in others.[55] Explicitly prioritizing technology fields and occupations where data suggests that domestic labor supply cannot meet demand would alleviate concerns about immigrants "crowding out" domestic workers. In practice, this could be accomplished by reserving a number of new or existing visa slots for workers in professions deemed by the DOL or other agencies to be facing shortages (see below on related existing authorities). The UK and Canadian systems can serve as inspiration.[56]

EXECUTIVE POLICY OPTIONS

- **Utilize the International Entrepreneur Rule.** Until a legislative "start-up" visa is created, the executive branch could utilize the International Entrepreneur Rule (IER), which grants a period of authorized stay to international entrepreneurs who demonstrate that "their stay in the United States would provide a significant public benefit through their business venture."[57] If the IER were fully utilized, around 3,000 additional entrepreneurs could come to the United States per year according to Department of Homeland Security estimates. A recent study projects that, in this scenario, the IER program would create between 100,000 and 300,000 jobs over 10 years. The study also discusses several specific executive actions that would promote IER utilization.[58] The Biden administration already appears to be taking steps in this direction.
- **Utilize existing immigration authorities related to labor shortages.** Under current law, the DOL can designate occupations as suffering from a labor shortage, meaning DOL has "determined there are not sufficient U.S. professionals who are able, willing, qualified and available" for work and that hiring foreign professionals therefore "will not adversely affect the wages and working conditions of U.S. professionals similarly employed."[59] If an occupation is added to the shortage list (called "Schedule A"), companies that want to sponsor workers for employment-based green cards (specifically EB-2 and EB-3) are exempt from time-consuming recruitment and labor certification (PERM) requirements. Schedule A authorities were used extensively during the Cold War to recruit talent in high-priority areas such as aeronautical and electrical engineering.[60] However, there are currently only two occupations on the list (physical therapists and nurses), and the list has not been kept up to date, despite indications of shortages in critical fields such as AI.[61] Prioritizing STEM immigrants in occupations with shortages can both boost national security and help alleviate concerns about immigrants "crowding out" domestic workers.

Safeguarding Research and Technology while Maintaining an Open System

America's open science and technology ecosystem confers many advantages, including the foreign talent that is attracted to its shores, the networks that keep U.S. scientists and engineers at the cutting edge, and the science and technology intelligence that can be gained through international collaborations. In the context of talent competition with China, one particularly salient advantage is the "brain drain dilemma" that U.S. openness creates for the CCP: Chinese students remain in the United States at much higher rates than Chinese leaders would like.[62]

But openness also poses inevitable risks. For example, government officials are concerned some Chinese students and scientists wittingly or unwittingly work as "nontraditional collectors" in pursuit of the CCP's technology priorities.[63] Such risks can and must be dealt with while simultaneously maintaining the fundamental openness of the system. Striking this balance requires targeted reforms on both the domestic and international levels.

LEGISLATIVE POLICY OPTIONS

- **Create a new public-private research security partnership.** Recent research security measures have been focused on federally funded research, for example, investigating the accuracy of information provided in grant applications. However, only around 20 percent of U.S. R&D is federally funded,

and current efforts suffer from limited information, authorities, and trust.[64] To address these issues, experts have proposed a public-private partnership—an "independent research security clearinghouse" that would be "empowered . . . but not run by the government"—based on successful models from the cybersecurity world, such as the National Cyber Forensics and Training Alliance.[65] This institution could collect and synthesize non-public and public data, disseminate threat findings and best practices, and serve as a non-punitive forum where stakeholders—whether federally funded or not—could share concerns and receive tailored advice. Congress should provide the resources and authorities necessary for relevant federal agencies to enter into research security partnerships with academia, industry, and other R&D funders and performers.

- **Prioritize and fund open-source science and technology intelligence.** Much of the world's useful information on scientists, engineers, and their activities is available in the public domain ("open source"). Several recent Department of Justice indictments related to research security were based in large part on open-source intelligence (OSINT), for example, photos of Chinese scientists in military uniform publicly available on the Chinese internet.[66] Yet U.S. intelligence agencies have been criticized for prioritizing "marquee, classified collection activity" and "consistently marginaliz[ing] OSINT for decades."[67] By one expert estimate, China employs roughly 100,000 OSINT-focused science and technology analysts in its intelligence enterprise, compared to perhaps 100 in the U.S. government.[68] To address these concerns and imbalances, Congress should support a new, largely open-source-based National Science and Technology Analysis Center (NSTAC), of which one focus area would be international talent flows and risk assessments.[69]

EXECUTIVE POLICY OPTIONS

- **Implement Presidential Proclamation 10043 in a targeted way.** In May 2020, the Trump administration issued a proclamation barring Chinese graduate students and researchers from receiving visas if they were ever affiliated with Chinese institutions that "implement or support" China's "military-civil fusion strategy."[70] The proclamation tackles an important problem but also left many key terms undefined, causing significant uncertainty about its scope and eventual impact. Some worried it could "be interpreted as an effective ban on Chinese students."[71] The proclamation should be implemented in a targeted manner, with clear guidance for government officials on how to assess individual-level risk factors. Implementation will also benefit from greater science and technology intelligence resources (discussed above).
- **Streamline information sharing across science agencies.** To combat conflicts of commitment and deception, one of the main focus areas of recent research security efforts has been on scrutinizing undisclosed ties to foreign governments; the National Institutes of Health alone investigated hundreds of researchers since 2016, more than 50 of whom reportedly lost their jobs.[72] Greater integration of U.S. science agencies' data systems would allow information and potential red flags (e.g., on grantees, contractors, and funding applications) to be shared across the major science funders. This would help enforce research integrity rules while also benefiting researchers and universities by reducing administrative requirements.[73] The White House's Joint Committee on the Research Environment (JCORE) should continue prioritizing these reforms.[74]
- **Engage with allies and partners on research security and technology transfer.** Most of the world's cutting-edge R&D takes place outside of the United States. If the United States imposes restrictions unilaterally, Chinese technology acquisition would simply shift elsewhere, decreasing U.S. competitiveness without meaningfully slowing China's technological growth. These problems

are familiar from areas such as export and investment controls, where the United States was a key player in building multilateral structures for policy coordination and intelligence sharing. Several proposals now exist for similar initiatives in the domain of research security and technology transfer.[75] These conversations should include the top non-U.S. destinations for Chinese students today, all of which—Australia, the United Kingdom, Canada, Japan, and South Korea, as well as several European countries—are U.S. allies.[76]

3

Conclusion

The U.S. government should urgently take steps to reform its STEM immigration policies, ensure these immigration reforms complement ambitious domestic investments, and safeguard research and technology while maintaining the openness of America's science and technology ecosystem. China is reaping the rewards of longstanding domestic STEM investments, with rapid gains in both quantity and quality that show no signs of slowing down. Meanwhile, problems with the U.S. immigration system are worsening and increasingly deterring international talent. America can no longer assume it is the default destination for the world's best scientists and engineers.

Talent is arguably the single most important ingredient driving innovation. If the United States lost its international talent advantage, it would be a big nail in the coffin of American technological leadership. Fortunately, U.S. policymakers have several policy levers available to them to reverse current trends—but this is good news only to the extent that they use those levers. The time for action is now.

About the Author

Remco Zwetsloot is a trustee fellow in the International Security Program at the Center for Strategic and International Studies (CSIS) and a research fellow at the Center for Security and Emerging Technology (CSET). His areas of expertise include the U.S. technology workforce, STEM immigration, research security, and technology competition with China. His writing has been published in a variety of popular, policy, and academic outlets, including the *Wall Street Journal*, *Washington Post*, and *Foreign Affairs*, and his work has been cited in White House reports, congressional testimony, the National Security Commission on Artificial Intelligence, and publications including the *New York Times, Science,* and *The Atlantic*. He is also a research affiliate of the University of Oxford's Center for the Governance of AI, where he is completing his PhD in international relations. He holds a master's degree in political science from Yale University, a master's degree in international relations from Oxford, and a bachelor's degree in social science from University College Roosevelt.

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