HOOVER INSTITUTION | Stanford University

HAI Stanford University Human-Centered Artificial Intelligence

SEPTEMBER 2026

The 2026 US Talent Report

Benchmarking America's STEM Pipeline Amid the Great Talent Competition

Emerson Victoria Johnston
Amy Zegart

The 2026 US Talent Report

Benchmarking America's STEM Pipeline Amid the Great Talent Competition

By Emerson Johnston and Amy Zegart

SEPTEMBER 28, 2026

A publication jointly produced by the Hoover Institution and the Institute for Human-Centered Artificial Intelligence at Stanford University.

Table of Contents

Authors

Emerson Victoria Johnston is a research assistant with the Hoover Institution's Technology Policy Accelerator. A Knight-Hennessy Scholar, she holds a master's in international policy from Stanford University, and is on leave from its master's program in the history of science, technology, environment, and medicine.

Dr. Amy Zegart is the Morris Arnold and Nona Jean Cox Senior Fellow at the Hoover Institution, director of Hoover's Technology Policy Accelerator, and a senior fellow and associate director at Stanford University's Institute for Human-Centered Artificial Intelligence.

The 2026 US Talent Report was written by human researchers. All data was processed in Python or Excel, and all figures and tables were hand-coded in R by Emerson Johnston. Claude was used to help refine editorial flow and ensure consistency.

Acknowledgments

We appreciate the following individuals who provided support for this project.

Fact-Checking and Editorial Support
Lila Batcheller, Phoebe Lemon, Taylor Johnson-McLamb, Jack Rhodes, Levi Schiffer, Abby Sim

Report Design
Michi Turner (report graphic design and cover art); Eden Beck (copy editing)

Report Publication
The Talent Report also thanks Caroline Meinhardt for her help in preparing the report; and Alex Armira, Chris Ellis, Shana Farley, Shana Lynch, and Daniel Zhang for their work in helping promote the report.

How to Cite this Report

Emerson V. Johnston and Amy Zegart, "The 2026 US Talent Report: Benchmarking America's STEM Pipeline Amid the Great Talent Competition," Technology Policy Accelerator, Hoover Institution, and the Institute for Human-Centered Artificial Intelligence, Stanford University, Stanford, CA, September 2026. https://doi.org/10.64576/8265368

Public Data and Tools

The public data and high-resolution images of all the charts in the report are available on Google Drive. We invite each reader to use the data and charts in a way most relevant to their work and interests.

Executive Summary

The United States-China technology competition is usually measured in chips, data centers, satellites, supply chains, and weapons. But every technological breakthrough depends on a key input that is harder to develop, stockpile, or replace: people. Scientists, engineers, researchers, and founders determine which ideas become discoveries, which discoveries become products, and which countries lead. Yet national talent in STEM fields (Science, Technology, Engineering, and Mathematics) remains one of the most important—and least systematically measured—dimensions of the competition.

America's STEM talent advantage has never rested on a single asset. It is a system: schools that develop talent at home, universities that attract it from abroad, laboratories and companies that put it to work, and immigration pathways that determine whether it stays and flourishes. Most assessments examine these pieces separately.

This index measures them together. It assembles decades of data from dozens of federal surveys, international databases, research rankings, publication and patent records, visa filings, and company histories. It analyzes evidence covering hundreds of thousands of students, graduates, researchers, workers, and founders across fields, countries, institutions, and stages of the talent pipeline.

No dataset captures the whole picture, and important measurement gaps remain. But taken together, this evidence provides the most comprehensive assessment to date of how America develops, attracts, deploys, and retains the STEM talent that powers its economic and national security. The data reveal a powerful system whose advantages remain substantial—but whose vulnerabilities are becoming harder to ignore.

Key Findings

1 **America's STEM education system has grown dramatically, but its advanced levels have become heavily dependent on international students.** International students earn more than half of STEM master's degrees and more than a third of STEM research doctorates, with still higher shares in computer science, engineering, and mathematics. Only at the bachelor's level is the share of international students in the single digits across most fields.[1]

2 **That international pipeline is increasingly concentrated by country and field.** India and China together now supply 61 percent of all international graduate students, while South Korea, the third-largest source, accounts for just 3 percent. The concentration produces intellectual and financial benefits, but it also creates exposure to changes in a small number of countries and US visa policies. India now sends more students to study in the United States than any other country (surpassing China in 2023).

3 **International talent powers American research and industry after graduation.** International graduates constitute majorities of postdoctoral researchers in several STEM fields, work in STEM at higher rates than US-born graduates with comparable degrees, and have founded or co-founded a large share of the country's leading AI firms.

4 **America's home-grown STEM talent system spends heavily but develops too little of its potential.** The United States ranks 34th in the world in mathematics, behind not only the East Asian systems that lead across all subjects, but also Slovenia, Poland, and Vietnam.[2] This is despite per-pupil spending 48 percent above the Organisation for Economic Co-operation and Development (OECD) average.[3] And, of the students who enter college intending to major in STEM, only about four in ten finish a STEM degree.[4]

Key Findings (cont.)

5

America's research magnet remains formidable, but its relative advantage is narrowing rapidly. In the past ten years, the US share of top-cited emerging technology publications has fallen from 14.2 percent to 8.4 percent, while China's share has risen from 11.5 percent to 20.8 percent.[5] China is quickly surpassing the United States in contributions to several leading artificial intelligence (AI) and machine learning (ML) conferences around the world.[6] China's patent office now grants roughly four times as many computer technology patents as the US Patent and Trademark Office, and twice as many in biotechnology and in semiconductors.[7]

6

International graduates increasingly want to stay, but retention falls short of intention—and the immigration system still operates under rules built for another era. 75.8 percent of new international PhDs report plans to remain in the United States, but only 67.8 percent of STEM PhDs are still in the country after ten years.[8] The United States should not retain every graduate, and national-security screening, labor protections, and program integrity remain essential. But the system rations permanent residence through per-country ceilings enacted in 1965, making birthplace—not talent or employer demand—a major determinant of wait time. Indian advanced-degree holders face waits exceeding twelve years, compared with roughly four to five years for many other nationalities. The country makes the talent it relies on most wait the longest.

7

These findings reveal a compounding risk. Weak domestic preparation increases reliance on international recruitment. Narrowing research advantages make international recruitment more competitive. Immigration bottlenecks and outdated policies make retention less certain. The United States still possesses enormous advantages, but none can safely be treated as permanent.

Executive Summary and Key Findings Endnotes

1 Authors' analysis of National Center for Education Statistics, "Integrated Postsecondary Education Data System (IPEDS)," data from completions component, 1995–2025 (US Department of Education), https://nces.ed.gov/ipeds/.

2 Organisation for Economic Co-Operation and Development (OECD), Programme for International Student Assessment (PISA) 2022 Results (vol. I): The State of Learning and Equity in Education (OECD Publishing, 2023), 52, https://doi.org/10.1787/53f23881-en.

3 OECD, Education at a Glance 2025: OECD Indicators (OECD Publishing, 2025), 286, https://doi.org/10.1787/1c0d9c79-en.

4 National Science Board, "STEM Talent: Education, Training, and Workforce," Science and Engineering Indicators 2026, NSB-2026-1 (National Science Foundation, 2026), 6, https://ncses.nsf.gov/pubs/nsb20261/.

5 Authors' analysis of citation statistics by field in *OpenAlex*, created by Jason Priem, Heather Piwowar, and Richard Orr (OurResearch, 2022–2025), OpenAlex API, https://openalex.org.

6 Authors' analysis of data from Paper Copilot, conference acceptance and submission statistics, https://papercopilot.com/.

7 Authors' analysis of data from World Intellectual Property Organization, WIPO Statistics Data Center, https://www.wipo.int/en/web/ip-statistics.

8 Authors' analysis of National Center for Science and Engineering Statistics, "Survey of Earned Doctorates Data Tables," data for 2010–2024 (National Science Foundation, 2024), https://ncses.nsf.gov/surveys/earned-doctorates; and Michael G. Finn, Stay Rates of Foreign Doctorate Recipients from US Universities, 2011 (Oak Ridge Institute for Science and Education, 2014), https://doi.org/10.2172/1303351.

INTRODUCTION

Introduction

A Tale of Two Futures

In fall 2025, a first-year student arrived at the University of California, San Diego (UC San Diego), planning to major in mechanical engineering. Call her Jane. She is a composite, but every part of her story comes from real students entering American universities today. She graduated with honors from a top California high school, where she took calculus and earned an A-minus average in math. UC San Diego's placement exam put her in MATH 2, a remedial course teaching elementary and middle-school mathematics. It was not a mistake.[1]

Over the previous five years, the share of incoming UC San Diego students placed into remedial mathematics had risen from 0.49 percent to 11.8 percent.[2] One-fifth of them had taken calculus in high school, yet they arrived unable to do the mathematics their transcripts said they had mastered. The problem has grown so severe that MATH 2 itself has changed: A course once designed to repair gaps in high-school algebra and geometry now teaches skills normally learned in elementary and middle school.

The students' grades offered little warning. In 2024, the students placed into MATH 2 had an average high-school GPA of 3.65. More than one-quarter had perfect 4.0 averages.[3] UC San Diego faculty warned that admitting large numbers of profoundly underprepared students risked "setting them up for failure."[4]

This isn't a UC San Diego problem, nor is it a California one. At UC Berkeley, between 20 and 30 percent of first-semester calculus students who participated in diagnostic testing displayed severe preparation deficits at the start of the semester, and 46 percent of the group withdrew or earned a D or F by the end.[5] At Temple University, in Pennsylvania, the pattern recurs: The number of students enrolled into Math 0702: Intermediate Algebra, which focuses on developing foundational skills for college math, rose to an all-time high of 1,174 in fall 2025.[6]

Nationally, students entering college with math achievement in the bottom tier complete science, technology, engineering, and mathematics (STEM) degrees at roughly half the rate of those in the top tier: 34 percent compared with 71 percent.[7] Those figures cannot predict Jane's future. But they show how steeply the odds fall when students begin college without the mathematical foundation their intended majors require. While we cannot observe who was turned away in admissions, the trade-off is clear. Every seat filled by an underprepared student is a seat not offered to a better-prepared one.

In Texas, a second student is doing a different kind of math. Call him Arjun. Like Jane, he is a composite assembled from the pathways and constraints documented in this report. Arjun just marked his ninth year in the United States. He came from India to study computer science, training first at the Indian Institute of Technology (IIT) Madras, one of that country's best engineering schools, and then completing his doctorate after six years at Carnegie Mellon. For the three years since, he has worked at a leading AI company in Austin under Optional Practical Training (OPT), a Department of Homeland Security program that authorizes international graduates to work in the United States for a limited time after they finish their degree. There, Arjun has quickly established himself in his field. He is published at top conferences, has filed patents for his employer, and is a highly cited researcher in his particular subfield. His company wants to hire him, permanently.

But Arjun's OPT authorization is expiring, and the next rung on the visa ladder, the H-1B visa, is awarded by lottery. This year, Arjun will enter the lottery for the third time. In his first two cycles, the draw was purely random. For the FY2025 lottery, 470,342 people registered for about 135,000 selections—making his odds less than one in three, about the same likelihood as Jane finishing her mechanical engineering degree with a middle-school math background.[8] Those draws did not weigh merit. Arjun's publications, his patents, his citations? None of them counted. The nine-year, multimillion-dollar investment American institutions made in Arjun came down to the same random draw as everyone else's, and he lost both times.

A rule that took effect in February 2026 changed the draw, giving applicants in higher-paid positions more entries.[9] Arjun's salary now improves his odds—but with the number of visas fixed and demand still far exceeding supply, better odds are not good odds. This third attempt is his last before his work authorization runs out.

Even if Arjun wins the H-1B lottery against the odds, it only buys him a place in a longer line. The backlog to obtain a green card for someone like Arjun is around thirteen years.[10] To get it, he cannot switch jobs, start his own company, or travel outside the country without delaying his clock. His employer controls his petition—and his future and livelihood in the United States. Merit got him into America, but it does not give him a way to stay.

Other countries have built more direct pathways for people like Arjun. Canada scores applicants on factors such as education, age, language skills, and work experience.[11] The United Kingdom's Global Talent visa can evaluate researchers on their records without requiring employer sponsorship.[12] Australia, Germany, and Singapore have also revised their systems to compete more deliberately for skilled workers. The details vary, but the strategic difference is clear: While competitors have made their pathways more predictable, the American route remains fragmented, scarce, and unusually dependent on employer sponsorship.

Jane and Arjun are the two streams that feed the American STEM workforce: the domestic talent the country develops and the international talent it draws. Both are in trouble. America's home-grown STEM talent increasingly looks prepared when it isn't, and the star STEM students and workers America attracts from abroad face a long, difficult, and precarious path to stay in the United States. The result: Jane may never be prepared enough to reach a laboratory or tech company. Arjun may not be able to stay in one.

Neither story is rare. Behind Jane stands a K–12 system with average fifteen-year-olds' achievement scores seven points below the Organisation for Economic Co-operation and Development (OECD) average in math,[13][a] and remedial classrooms on top college campuses across the country. Behind Arjun stands 1.18 million international students enrolled in American higher education—the most in American history—including over 600,000 enrolled in STEM disciplines alone.[14] Each of them will eventually run the numbers. Some will stay, but others won't, and those who leave take with them the tacit knowledge that America has spent years teaching them.

These two stories are also one story. A country that prepares fewer of its own students for technical work depends more heavily on talent from abroad. A country that has difficulty retaining international talent needs its domestic pipeline more than ever. The United States is developing too little of its domestic potential and retaining too little of the international talent it attracts. Fixing either problem requires seeing the other, which is why this report measures them together.

America's Hidden Talent Vulnerabilities

In a world of increasing technological competition, talent has become a strategic vulnerability that is easy to miss. Competition between the United States and China is often measured in hardware: chips, ships, satellites, and missiles. But artificial intelligence, biotechnology, and other strategic fields also rely critically on one input that cannot be stockpiled, export-controlled, or manufactured on demand. That input is people—the high-school graduates we educate over decades, and the graduates from abroad we recruit one at a time—and every major economy has started competing for them. The contest over weapons and supply chains has a quieter twin, one fought in classrooms, laboratories, and immigration queues, and it will have as much to do with who leads the technologies of the next half-century as any arsenal.

At the same time, much of the policy conversation about STEM talent still rests on the belief that America's talent advantage is enduring when evidence shows it is eroding. This perception gap is dangerous and is driven by three assumptions.

Assumption 1: The United States attracts the world's best and brightest, so the STEM talent pipeline takes care of itself.[15] For decades, the world's most ambitious scientists and engineers had powerful reasons to study and work in the United States: The best universities, colleagues, laboratories, companies, and opportunities were

a The Organisation for Economic Co-operation and Development (OECD) is an international group of thirty-eight mostly high-income democracies that focuses on economic and social policy and provides a knowledge hub for data and analysis.

concentrated here. That advantage remains substantial, but it is no longer unrivaled. Universities abroad have improved significantly, frontier research is being conducted in more countries, and governments are competing for skilled workers with faster and more predictable immigration pathways. More than half of the researchers behind DeepSeek AI's foundational papers had never studied or worked outside China.[16] The American challenge therefore begins before the visa line. The United States must work harder to persuade talented students to come, give them compelling opportunities after graduation, and provide a viable path to remain. Attraction is no longer automatic, and retention cannot be an afterthought.

Assumption 2: China imitates rather than innovates, so the rising number of Chinese-trained STEM graduates poses little risk to frontier tech development.[17] This was a reasonable read of the data a decade ago, when Chinese research output was long on quantity and short on impact.[18] It is no longer accurate. China now produces a larger share of the world's most-cited work in emerging technologies than the United States does, and its frontier AI labs ship models at the leading edge while drawing their researchers almost entirely from home.[19] A debate that treats Chinese science as derivative is arguing with a version of the country that stopped existing several years ago.

Assumption 3: The United States develops the best STEM talent at home, while talent from abroad provides an added boost.[20] That assumption is shaky on both counts. The American system still produces exceptional students, but other countries produce more top-scoring students as a percentage of the population. Even Massachusetts, the nation's highest-performing state, would rank only 20th in math globally if it were a country.[21] At the same time, America's dependence on international talent has grown significantly. International students now earn the majority of graduate degrees in several fields closest to technological competition. Talent from abroad is not a supplement to a self-sufficient domestic pipeline. It is a load-bearing part of the system—and the domestic foundation beneath it is weaker than many Americans assume.

These three assumptions point policy in the same wrong direction. They suggest the country can tighten the flow of international talent without cost, dismiss the pace of its chief rival, and lean on a domestic pipeline that the next chapters show is not keeping up.

What We Know and What We Don't

Important parts of this story are already well documented. Researchers at Georgetown's Center for Security and Emerging Technology have examined AI workforce dynamics, immigration pathways, and retention.[22] MacroPolo's Global AI Talent Tracker has mapped where leading AI researchers train and work.[23] This report builds on that research and asks a broader question:

What happens when America's domestic and international STEM pipelines are measured together, from initial education all the way through research and employment?

Existing work leaves three gaps.

- First, it concentrates heavily on elite AI researchers—the Arjuns who have already reached the frontier—rather than tracking the full population moving through American schools, universities, visa categories, and workplaces.
- Second, research on domestic education and international recruitment generally proceeds in separate silos, even though weakness in one increases dependence on the other.
- Third, the relevant evidence exists across dozens of datasets but has not been assembled into a single longitudinal assessment of American STEM talent.

Our aim is to fill all three gaps and update findings annually. This report brings together decades of evidence from federal surveys, international databases, publication and patent records, research rankings, visa filings, and company histories to examine America's STEM talent system from education through employment and retention. No single dataset captures the entire system, and important measurement gaps remain. But examining these sources together reveals relationships that disappear when domestic education, international recruitment, research performance, employment, and immigration are analyzed separately. Effective policy starts with seeing the system whole.

Taken together, the evidence reveals a system under pressure at several points at once. The United States is developing too little of its domestic STEM potential, relying heavily on international talent in the fields that matter most, facing stronger competition from research systems abroad, and making it unnecessarily difficult for some of the talent it trains to remain. None of these weaknesses alone erases America's substantial advantages. The danger lies in how they compound: Domestic weakness makes international talent more important just as attracting and retaining that talent is becoming more competitive.

How This Report is Organized

The report is organized around four questions.

1. How dependent is the United States on international STEM talent—and where is that dependence concentrated?

Chapter 1 traces the expansion of American STEM education and shows how international dependence rises sharply above the bachelor's level, especially in computer science, engineering, and mathematics.

Chapter 2 examines who supplies that international stream, what students study, how the source-country mix is changing, and why the pipeline's geographic, disciplinary, and financial concentration matters.

2. What does international talent contribute after graduation?

Chapter 3 follows graduates into post-graduate work placements, postdoctoral research, government-supported laboratories, companies, and entrepreneurship.

3. How strong are the domestic pipeline and the institutions that attract talent from abroad?

Chapter 4 traces American students from K–12 through undergraduate STEM completion, beginning with declining US test scores, then school spending, then attrition from STEM majors, and closing with study abroad and net student flows.

Chapter 5 measures American institutions against international competitors, starting with research outputs (publications, citations, conference presentations, and university rankings), moving to R&D spending, then patents, and finally the talent inside frontier firms.

4. How much of the international talent America trains does it retain?

Chapter 6 compares graduates' intentions with realized stay rates, then examines the sequence of OPT, H-1B status, labor certification, and employment-based permanent residence. It identifies the points where scarcity, delay, employer dependence, and policy volatility may contribute to the gap between wanting to stay and being able to build a durable American career.

Data and Methodology

This report draws on publicly available US government surveys and international databases, including the Institute of International Education's Open Doors, the National Center for Education Statistics' Integrated Postsecondary Education Data System (IPEDS), National Science Foundation graduate surveys, Department of State visa statistics, USCIS and DHS administrative records, OECD education indicators, and research output databases such as OpenAlex, WIPO, Clarivate's Highly Cited Researchers list, and Times Higher Education.

A note on measurement: The datasets used in this report classify international talent in different ways. "International student," "temporary visa holder," "noncitizen," and "foreign-born" describe overlapping but distinct populations. We preserve each source's relevant category rather than treating the terms as interchangeable. Methodological details regarding them appear in Appendix A.

Introduction Endnotes

1 Senate-Administration Workgroup on Admissions, *Final Report* (UC San Diego Academic Senate, updated January 8, 2026), 10–11, https://senate.ucsd.edu/media/740347/sawg-report-on-admissions-review-docs.pdf.

2 Senate-Administration Workgroup, *Final Report*, 12.

3 Senate-Administration Workgroup, *Final Report*, 17–18.

4 Senate-Administration Workgroup, *Final Report*, 7.

5 Zvezdelina Stankova et al., "Relationship Between Prerequisite Mastery and Failure/Attrition Rates in Calculus I at UC Berkeley: Fall 2021, 2022, 2023," 8, https://drive.google.com/file/d/1LnxJlOqUUUS7VVDs5Vzo1PKTuDPVOXia/view; Senate-Administration Workgroup, *Final Report*, 8.

6 Collin Binkley, "College Students Are Still Struggling with Basic Math. Professors Blame the Pandemic," Associated Press, August 31, 2023, https://apnews.com/article/college-math-test-help-6cca6a5e873d5aeb5e75b4f94125d48c; Nathan Horwitz, "More Students Are Struggling with Math, Professors Say," *Temple News*, April 7, 2026, https://temple-news.com/more-students-are-struggling-with-math-professors-say/.

7 National Science Board, "STEM Talent: Education, Training, and Workforce," *Science and Engineering Indicators 2026*, NSB-2026-1 (National Science Foundation, 2026), 6, https://ncses.nsf.gov/pubs/nsb20261/.

8 US Citizenship and Immigration Services (USCIS), "H-1B Electronic Registration Process," under "Historical Data," https://www.uscis.gov/working-in-the-united-states/temporary-workers/h-1b-specialty-occupations/h-1b-electronic-registration-process.

9 USCIS, "DHS Changes Process for Awarding H-1B Work Visas to Better Protect American Workers," news release, December 23, 2025, https://www.uscis.gov/newsroom/news-releases/dhs-changes-process-for-awarding-h-1b-work-visas-to-better-protect-american-workers; US Department of Homeland Security, "Weighted Selection Process for Registrants and Petitioners Seeking to File Cap-Subject H-1B Petitions," 90 Fed. Reg. 60864, final rule published December 29, 2025, https://www.federalregister.gov/documents/2025/12/29/2025-23853/weighted-selection-process-for-registrants-and-petitioners-seeking-to-file-cap-subject-h-1b.

10 The employment-based green card category for advanced degree holders, EB-2, where Arjun and most other STEM PhDs land, is currently processing applications filed by Indian nationals in September 2013, a backlog of nearly thirteen years. See US Department of State, Bureau of Consular Affairs, "Final Action Dates for Employment-Based Preference Cases," *Visa Bulletin* 15, no. 9 (June 2026), https://travel.state.gov/content/travel/en/legal/visa-law0/visa-bulletin/2026/visa-bulletin-for-june-2026.html.

11 Immigration, Refugees and Citizenship Canada, "How Express Entry Works," Government of Canada, https://www.canada.ca/en/immigration-refugees-citizenship/services/immigrate-canada/express-entry/works.html.

12 UK Home Office, "Global Talent Visa," GOV.UK, https://www.gov.uk/global-talent.

13 Organisation for Economic Co-operation and Development (OECD), *PISA 2022 Results (vol. I): The State of Learning and Equity in Education* (OECD Publishing, 2023), 28, https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/12/pisa-2022-results-volume-i_76772a36/53f23881-en.pdf.

14 Institute of International Education, "International Student: Enrollment Trends," *Open Doors Report on International Educational Exchange* (Institute of International Education, 2025), https://opendoorsdata.org/data/international-students/enrollment-trends/.

15 US Congress, House, Committee on Small Business, Subcommittee on Contracting and Workforce, *Help Wanted: The Small Business STEM Workforce Shortage and Immigration Reform*, 113th Cong., 1st sess., April 25, 2013, Small Business Committee Document No. 113-014 (US Government Printing Office, 2013), https://www.congress.gov/event/113th-congress/house-event/LC631/text.

16 Emerson Johnston and Amy Zegart, *Update: DeepSeek AI and the Great Talent Competition* (Technology Policy Accelerator, Hoover Institution and the Stanford Institute for Human-Centered Artificial Intelligence, June 2026), https://doi.org/10.64576/0626.

17 Office of the United States Trade Representative, *Findings of the Investigation into China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation Under Section 301 of the Trade Act of 1974* (Executive Office of the President, 2018), 9, https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF.

18 Caroline S. Wagner et al., "Recent Developments in China-US Cooperation in Science," *Minerva* 53, no. 3 (2015): 199–214, https://doi.org/10.1007/s11024-015-9273-6.

19 Authors' analysis of citation statistics by field in OpenAlex, created by Jason Priem, Heather Piwowar, and Richard Orr (OurResearch, 2022–2025), *OpenAlex* API, https://openalex.org. Amy Zegart and Emerson Johnston, *A Deep Peek into DeepSeek AI's Talent and Implications for US Innovation* (Technology Policy Accelerator, Hoover Institution, in collaboration with the Stanford Institute for Human-Centered AI, 2025), 2, https://www.hoover.org/research/deep-peek-deepseek-ais-talent-and-implications-us-innovation.

20 Ronil Hira, statement before the US Congress, Senate, Committee on the Judiciary, Subcommittee on Immigration and the National Interest of the Senate, *The Impact of High-Skilled Immigration on US Workers*, 114th Cong. (2016), https://www.judiciary.senate.gov/imo/media/doc/Hira%20Testimony.pdf.

21 National Center for Education Statistics, “Mathematics Literacy: Average Scores,” in *Program for International Student Assessment (PISA): 2015 Results* (US Department of Education, Institute of Education Sciences, 2015), https://nces.ed.gov/surveys/pisa/pisa2015/pisa2015highlights_5.asp.

22 Catherine Aiken et al., *Career Preferences of AI Talent* (Center for Security and Emerging Technology, 2020), 4–5, https://cset.georgetown.edu/publication/career-preferences-of-ai-talent/; Remco Zwetsloot et al., *Keeping Top AI Talent in the United States* (Center for Security and Emerging Technology, 2019), iii–iv, https://cset.georgetown.edu/wp-content/uploads/Keeping-Top-AI-Talent-in-the-United-States.pdf.

23 Matt Sheehan and Sophie Zhuang, “Have Top Chinese AI Researchers Stayed in the United States?,” Emissary (blog), Carnegie Endowment for International Peace, December 2025, https://carnegieendowment.org/emissary/2025/12/china-ai-researchers-us-talent-pool; MacroPolo, “The Global AI Talent Tracker 2.0,” Paulson Institute, https://archivemacropolo.org/.

The 2026 US Talent Report

CHAPTER 1

America’s STEM Talent System

Growth and International Dependence

Chapter 1

America's STEM Talent System:

Growth and International Dependence

FIGURES

TABLES

Chapter 1

Key Takeaways

1. **America's STEM training system has grown dramatically over time.** US universities awarded just under 800,000 STEM degrees in 2025, roughly two and a half times the 1995 total. The system has not only grown but tilted toward advanced training, with science and engineering now accounting for 79.0 percent of awarded research doctorates, up from 65.6 percent in 1958.[1]

2. **The master's degree drove the expansion.** STEM master's production grew from 63,800 degrees in 1995 to 230,000 in 2025, a 261 percent increase that far outpaced the 112 percent growth in doctorates over the same period. The master's is now America's dominant advanced STEM credential.

3. **The headline enrollment figure hides how much America depends on international talent.** While international students make up just 6.1 percent of total US higher-education enrollment, that share climbs once the population is broken out by degree level and field. International students turn out to supply most of America's advanced STEM graduates.

4. **International dependence is concentrated at the graduate level.** International students earn just 4.11 percent of awarded bachelor's degrees, but one-fifth of all master's degrees and one-third of all research doctorates. The gap is wider in STEM, where they still earn just a small fraction of awarded bachelor's degrees, but 51.3 percent of master's degrees, and 36.4 percent of research doctorates. America's domestic pipeline supplies most undergraduates, but a much smaller share of advanced degree holders.[2]

5. **International dependence is greatest in strategically important fields like computer science and engineering.[3]** In 2025, international students earned 64.9 percent of computer and information sciences master's degrees, 54.6 percent in mathematics and statistics, and 49.3 percent in engineering, with doctoral shares above 50 percent in all three as well.[4] Remove these students, and American graduate output in AI, semiconductors, and cryptography would fall by more than half.

6. **China and India are on track to far out-produce the United States in STEM PhDs.** China already trains more STEM doctorates per year than the US in absolute terms, and India is projected to pass the US around 2033. On current trajectories, the gap widens through 2050, when China is expected to reach roughly 118,000 STEM PhDs per year and India roughly 143,000, versus about 72,000 for the US. These projections do not show that American research leadership will disappear. They show that the countries supplying much of America's international talent will have increasingly large talent pools of their own.

Chapter 1 – By the Numbers:

MEASURE	1995	2025	CHANGE	
EXPANSION OF US HIGHER EDUCATION				
Research doctorates awarded	41,700*	**58,100**[2024]	1.39×	▲
Bachelor's degrees awarded, all fields	1,160,000*	**2,040,000**	1.76×	▲
Master's degrees awarded, all fields	404,000*	**983,000**	2.44×	▲
Doctorates awarded, all fields	114,000*	**218,000**	1.91×	▲
GROWTH AND COMPOSITION OF STEM TRAINING				
Total STEM degrees awarded	306,000	**792,000**	2.59×	▲
STEM bachelor's degrees awarded	223,000	**521,000**	+134%	▲
STEM master's degrees awarded	63,800	**230,000**	+261%	▲
STEM doctorates awarded	18,800	**39,900**	+112%	▲
Master's-to-doctorate ratio in STEM	3.39:1	**5.77:1**	1.7×	▲
STEM share of bachelor's degrees	19.2%	**25.5%**	+6.3 pp	▲
STEM share of master's degrees	15.8%	**23.4%**	+7.6 pp	▲
STEM share of doctorates	16.5%	**18.3%**	+1.9 pp	▲
INTERNATIONAL ENROLLMENT AND DEGREE DEPENDENCE				
Students in US higher education	453,000*	**1,180,000**	2.6×	▲
Share of total US enrollment	3.2%*	**6.1%**	+2.9 pp	▲
Share of all bachelor's degrees	3.17%	**4.11%**	+0.9 pp	▲
Share of all master's degrees	12.2%	**21.5%**	+9.3 pp	▲
Share of all doctorates	21.2%	**33.3%**[2024]	+12.2 pp	▲
Share of STEM bachelor's degrees	4.94%	**6.34%**	+1.4 pp	▲
Share of STEM master's degrees	30%	**51.3%**	+21.3 pp	▲
Share of STEM doctorates	26.1%	**36.4%**[2024]	+10.3 pp	▲
INTERNATIONAL SHARE IN SELECTED STEM FIELDS				
Computer science bachelor's degrees	9.28%	**8.51%**	-0.8 pp	▼
Computer science master's degrees	37.5%	**64.9%**	+27.4 pp	▲
Computer science research doctorates	42.1%	**54.9%**	+12.8 pp	▲
Engineering bachelor's degrees	7.58%	**7.09%**	-0.5 pp	▼
Engineering master's degrees	33.9%	**49.3%**	+15.4 pp	▲
Engineering research doctorates	49%	**54.7%**	+5.7 pp	▲
Mathematics and statistics bachelor's degrees	4.31%	**16.8%**	+12.5 pp	▲
Mathematics and statistics master's degrees	27.6%	**54.6%**	+27.0 pp	▲
Mathematics and statistics research doctorates	44.8%	**52.8%**	+8.0 pp	▲
Physical sciences bachelor's degrees	3.73%	**5.94%**	+2.2 pp	▲
Physical sciences master's degrees	30.6%	**32.7%**	+2.1 pp	▲
Physical sciences research doctorates	32.8%	**38.1%**	+5.2 pp	▲

* Data are available further back than 1995 for marked series.

Note: Historical comparisons use 1995 and 2025 observations. Superscript years mark rows with an earlier latest endpoint than 2025. Arrow colors indicate direction of change only.

Source: Derived from the current report Figures and Tables: Figures 1.01–1.08, Table 1.01.

In 2025, American colleges and universities awarded just under 800,000 STEM degrees, about two and a half times as many as they had thirty years earlier. The scale is a testament to one of the most successful investments made after World War II: building a research-and-education system capable of attracting and training scientific talent from around the world.

But that growth did not occur evenly. It was driven disproportionately by master's programs, increasingly populated by students from abroad, and concentrated in fields such as computer science, engineering, and mathematics. America has built the most powerful STEM training system in the world. It has also built one that depends heavily on international students in the places that matter most to technological competition.

This chapter traces how that happened. It begins with the postwar expansion of American science, follows the rise of STEM education and the master's degree, and then shows why the familiar figure—international students are just 6.1 percent of US higher-education enrollment—reveals so little about the system's actual reliance on talent from abroad.

Where the World Trained

For the first four decades of the twentieth century, the United States was not where the world came to train. Students who wanted to be on the frontier of physics or chemistry sailed to Germany, to Göttingen and Berlin, where the discipline was being made. The American research doctorate, itself modeled on the German system, was still young and untested.

World War II reversed the direction of this travel. Refugee scientists fleeing Europe carried the center of whole fields into American laboratories, and the wartime projects that produced radar and the atomic bomb showed the federal government what trained physicists were worth in a war. Vannevar Bush's 1945 report to the president, *Science, the Endless Frontier*, recommended that the federal government continue paying for that talent once the fighting stopped to fuel American innovation.[5] It did. Bush's model of innovation—where the federal government funded fundamental science and engineering research in universities that laid the foundation for private sector commercialization—has been the engine of American technological progress and economic growth for the past eighty years. Today, American universities award far more doctorates than Vannevar Bush could have imagined. And STEM graduates are claiming a steadily growing share.

How the System Grew

The modern American graduate-education system was built partly to solve a shortage of college teachers. The Association of American Colleges had warned of a looming faculty shortage as early as 1946, when the GI Bill was sending veterans to college faster than the war-drained graduate schools could train instructors to teach them.[6] In response, Congress chartered the National Science Foundation in 1950, which funded the nation's first graduate fellowships by 1952,[a] while states drew up plans for new campuses.[7]

The Cold War raised the stakes further. In 1957, Sputnik transformed an existing concern about scientific manpower into a national talent emergency.[8] If the Soviets could put a satellite in orbit first, the reasoning went, the gap was one of scientific and technical manpower, and the country that trained more scientists and engineers would win the contests that mattered. In response, Congress passed the National Defense Education Act (NDEA) in 1958, which expanded federal support for students and institutions in fields considered important for national security.[9b] Universities

a The National Science Foundation's Graduate Research Fellowship, first awarded in 1952, was a small and highly competitive program that gave stipends directly to individual graduate students in scientific and engineering fields, chosen on the strength of their research promise. The award follows the student rather than funding a department, and its purpose was, and still is, to find and support the country's most capable young researchers wherever they enroll. It should not be confused with the larger National Defense Education Act fellowships that followed in 1958, which were awarded to prospective college teachers and were built as much to expand graduate programs as to support the students in them. For more information, see Vincent Tedjasaputra, "NSF 101: The Graduate Research Fellowship Program" (National Science Foundation, 2021), https://www.nsf.gov/science-matters/nsf-101-graduate-research-fellowship-program; National Science Foundation, "NSF Graduate Research Fellowship Program solicitation," NSF 25-547, (2025), https://www.nsf.gov/funding/opportunities/grfp-nsf-graduate-research-fellowship-program/nsf25-547/solicitation.

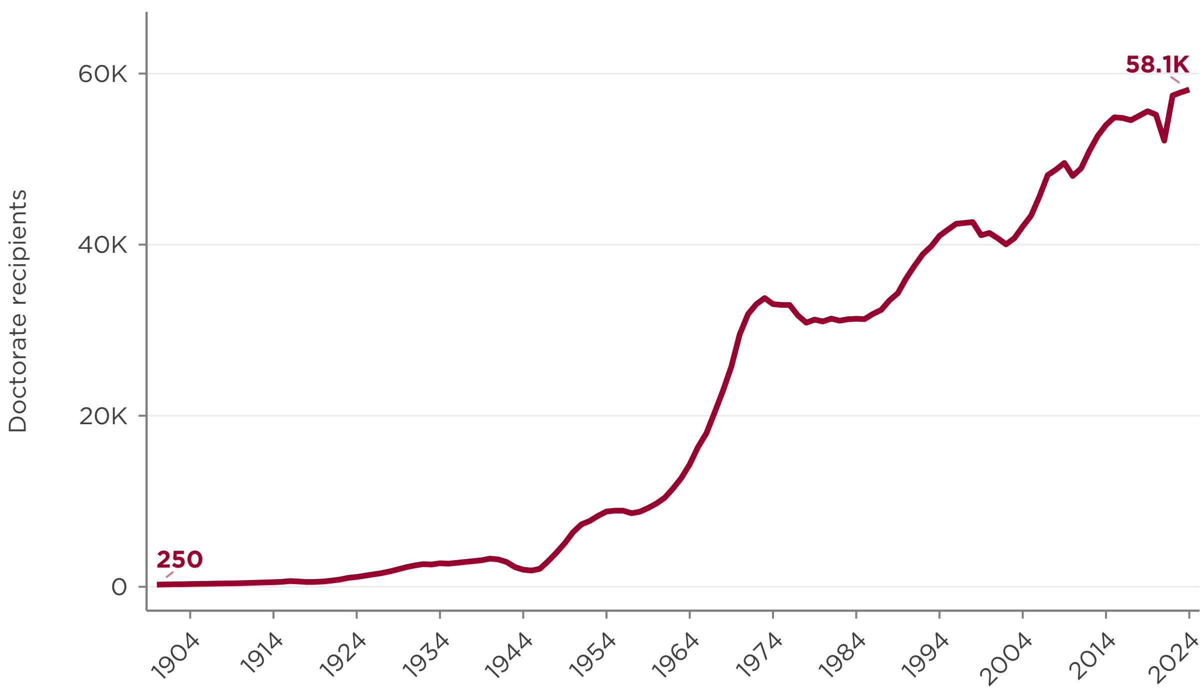
b Title IV of the National Defense Education Act of 1958 created a much larger fellowship program with a different aim. It was meant to relieve a shortage of college teachers. It worked in two ways. Three-year fellowships supported doctoral students who intended to enter college teaching, and separate allowances were paid to universities to strengthen their graduate programs and to establish new ones in parts of the country that had few. Priority went to applicants who stated an intention to become professors. Over its life from 1959 to 1973, the program supported more than 45,000 people. Where the National Science Foundation fellowships of 1952 rewarded individual research promise, Title IV was designed to produce college faculty and to build the programs that would train them. For more information, see Clarence Lindquist, "NDEA Fellowships for College Teaching, 1958–1968: Title IV, National Defense Education Act of 1958" (ERIC ED054739), (US Department of Health, Education, and Welfare, Office of Education, 1971), https://eric.ed.gov/?id=ED054739; National Academy of Sciences follow-up study: Lindsey Harmon, "Career Achievements of the National Defense Education Act (Title IV Fellows)," 1959–1973 (ERIC ED150929), National Academy of Sciences, 1977. https://files.eric.ed.gov/fulltext/ED150929.pdf.

awarded 8,773 research doctorates that year (See Figure 1.01).[10] Fifteen years later, output had already quadrupled, and the United States was awarding just over 33,000 research doctorates annually.[c] After a brief decline through the 1970s, as the post-Sputnik surge in federal research funding leveled off and a weak academic job market discouraged new entrants, degree production resumed its climb.[11] [d]

Research doctorates were not the only degree to grow over time. American higher education has expanded at every degree it confers (See Figure 1.02).[12] Over the past century, annual bachelor's degrees rose from about 27,000 to two million, master's degrees from under 2,000 to just under a million, and doctorates of every kind, research and professional alike, from a few hundred to more than 218,000.

This growth increasingly favored STEM. American universities awarded approximately 306,000 STEM degrees in 1995, but 792,000 by 2025 (See Figure 1.03).[13] STEM's share rose at every degree level, too. The STEM share of bachelor's degrees climbed from 19.2 percent in 1995 to 25.5 percent in 2025, the master's share from

Figure 1.01 How Many Research Doctorates Are Awarded by US Universities?

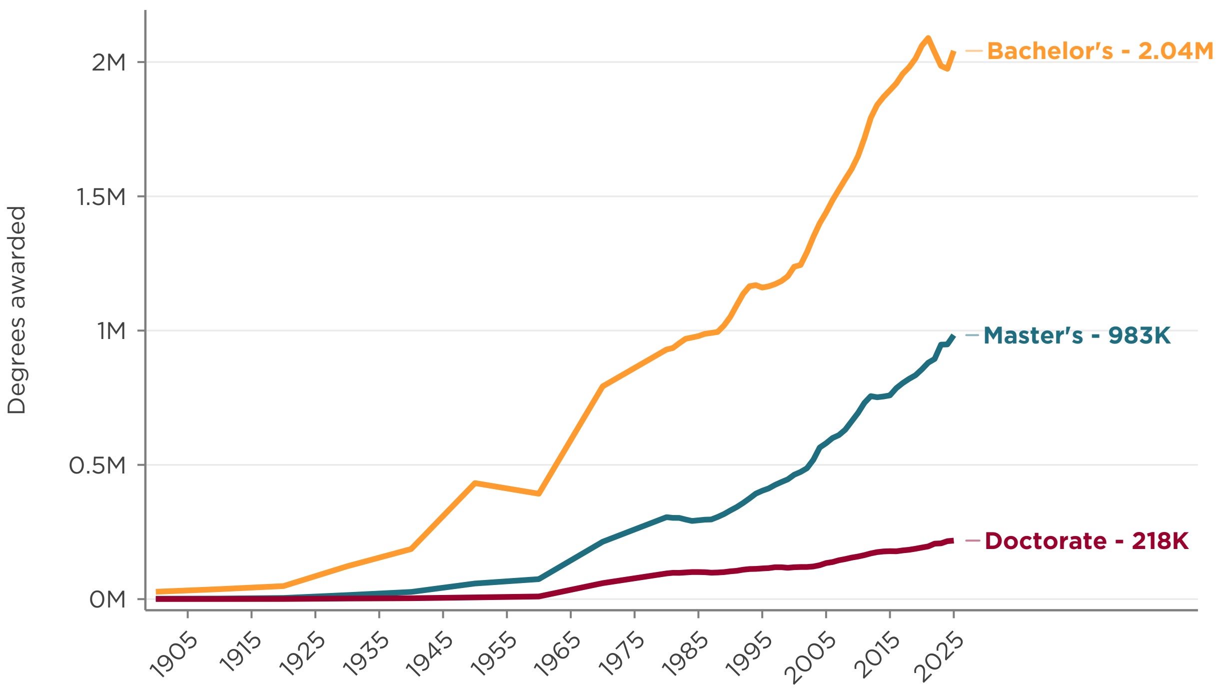


Data from NCSES, Survey of Earned Doctorates; Thurgood, Golladay, and Hill, US Doctorates in the 20th Century, 2006.
Chart by Emerson Johnston and Amy Zegart, Stanford University

c Only 4.8 percent of doctorates earned in the twentieth century in the US were earned in the first half of the century. For more information, see Lori Thurgood et al., US Doctorates in the 20th Century, NSF 06-319 (National Science Foundation, 2006), https://dpcpsi.nih.gov/sites/g/files/mnhszr346/files/opep/document/Final_Report_(03-517-OD-OER)%202006.pdf.

d Output recovered through the 1980s and 1990s, and then a second surge of federal money accelerated it. Between 1998 and 2003, in a rare bipartisan project, Congress doubled the budget of the National Institutes of Health, from roughly $14 billion to $27 billion.

Figure 1.02 **How Has American Degree Production Changed Over Time?**



Data from NCES Digest of Education Statistics Table 318.10 and IPEDS Completions
Chart by Emerson Johnston and Amy Zegart, Stanford University

15.8 percent to 23.4 percent, and the *research* doctoral share 65.6 percent to 79.0 percent.[14e]

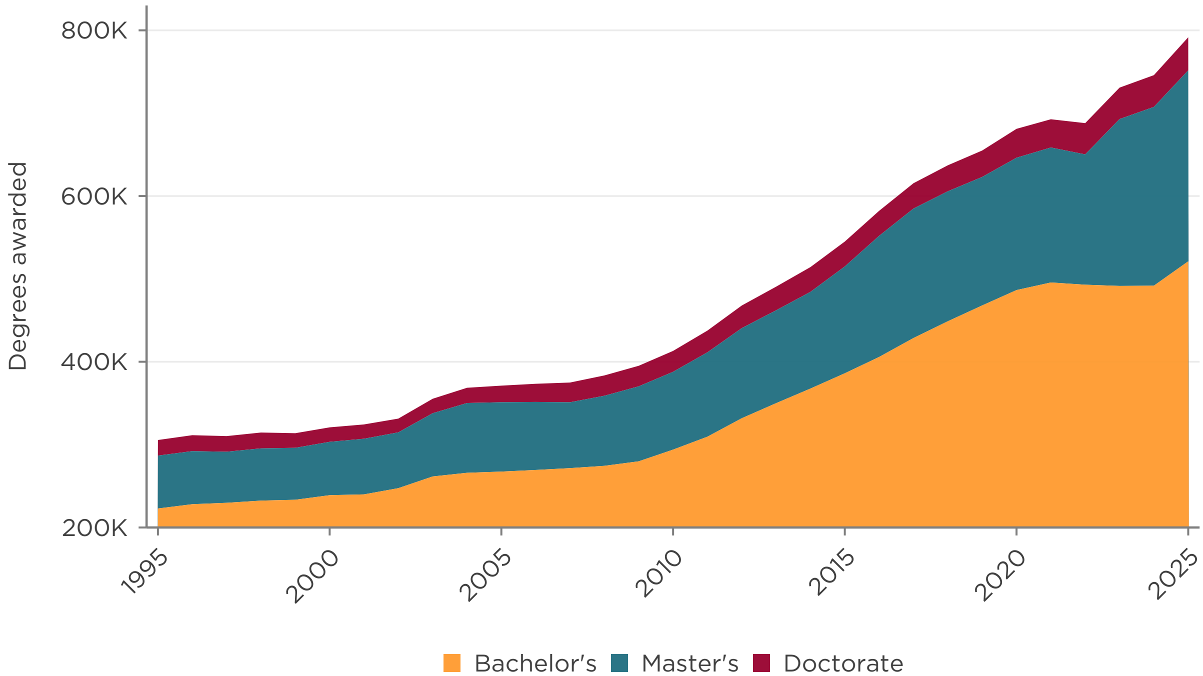
Notably, STEM count and share did not grow evenly across the three levels of degree credentials. In 1995, the United States was producing three times as many STEM master's degrees as STEM doctorates. Over the next thirty years, master's STEM degrees skyrocketed 261 percent, while doctoral STEM degrees grew 112 percent. By 2025, the master's degree was the largest form of advanced STEM education in the country: 230,000 degrees awarded in 2025 against 40,000 STEM research doctorates.[f]

The master's grew fastest in part because it is the easiest of the three to expand. A doctorate is rationed largely by funding. At major research universities, a department can only admit as many PhD students as it can support through grants, fellowships, and teaching lines, which ties much of doctoral growth to the federal research budget. At other programs, where federal funding is more limited, students fund their own study, making the constraint the student's own resources rather than a research budget. Either way, the doctorate answers to funding of one kind or another, which makes it slower to expand than a credential that does not. At the other extreme, a bachelor's is rationed by space and

e Doctorate figures in this chapter are specifically research doctorates as reported by the NSF's Survey of Earned Doctorates (SED), unless noted otherwise. We use the SED rather than the Integrated Postsecondary Education Data System (IPEDS) because IPEDS combines research PhDs with professional doctorates such as the MD, JD, and DDS, which are earned predominantly by Americans and mask the trend in research training. IPEDS series (bachelor's and master's) run through 2025, the most recent year available; SED series (research doctorates) run through 2024, since the 2025 SED is not yet published. Endpoint years therefore differ by degree level.

f Both figures here are from IPEDS for 2025: 230,479 STEM master's degrees and 39,993 STEM research doctorates. The National Science Foundation's Survey of Earned Doctorates reports a higher doctorate count, 45,402 for 2024, the most recent year available; the 2025 SED figure is not yet published. The two series differ in coverage and timing and are not directly comparable.

Figure 1.03 How Many STEM Degrees Are Awarded in the United States?



Data from NCES, IPEDS Completions, 1995–2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

politics: four years of seats, capped class sizes, and public legislatures that expect those seats to go to residents.

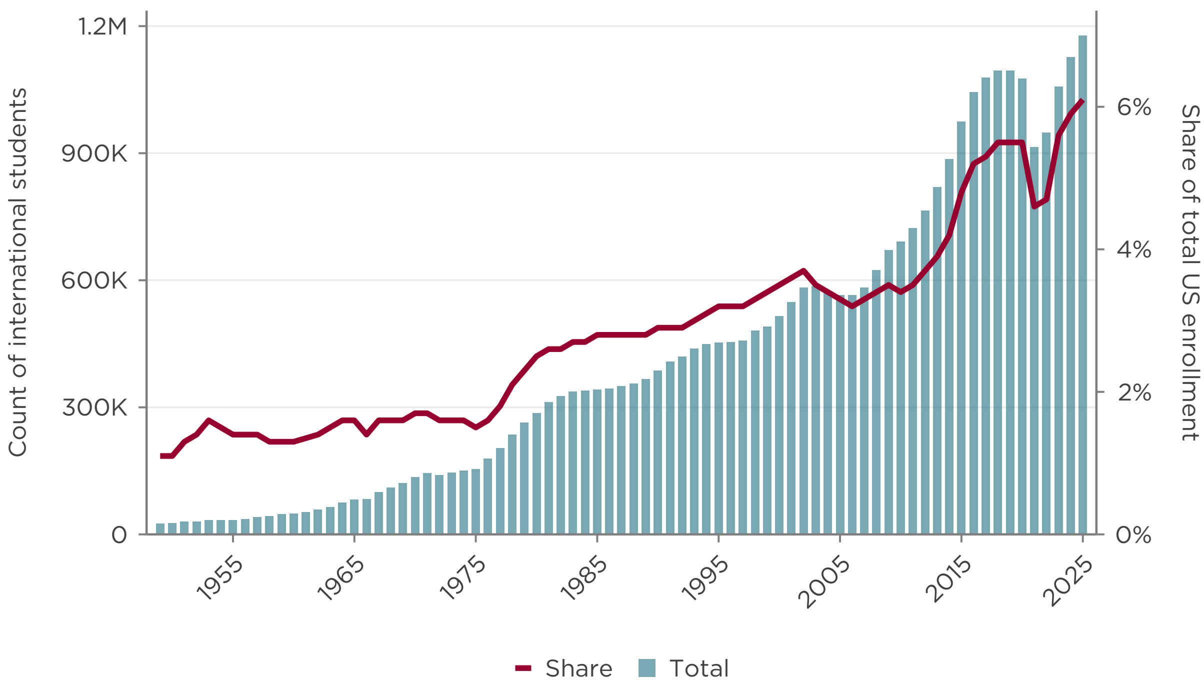
The master's has far fewer constraints on growth. Most master's students pay their own way, through savings, income, or loans, and programs that run on tuition have a direct reason to enroll more of them. In the 2019–20 National Postsecondary Student Aid Study, 28 percent of full-time master's students received a fellowship or assistantship, against the near-universal funding packages standard in STEM doctoral programs.[15] A university that wants to grow can mostly just admit more students at the master's level. That makes the master's the most elastic credential American higher education offers, and the only one that can grow with demand.

Where that demand came from is the next part of the story.

Two Streams of Talent

American higher education draws on two streams of talent: students developed at home and students drawn from abroad. The international stream has grown almost continuously since World War II, accounting today for 6.1 percent of overall US enrollment across bachelor's, master's, and doctoral degrees and about a million students annually since 2015 (See Figure 1.04).[16]

Figure 1.04 How Has International Enrollment in US Higher Education Grown?



Data from IIE, "International Student Enrollment Trends," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The climb is due largely to how US policymakers fought the Cold War. The federal grants that built the postwar laboratories supported graduate researchers, and those positions were open to foreign applicants as well as Americans. Programs such as Fulbright brought international scholars to the United States, and immigration reforms in 1952 and 1965 gave many a pathway to remain.[17] Talent that came tended to stay, and talent that stayed was talent a rival did not have.

One in three research PhDs awarded today in the United States goes to an international student.

For decades, international students remained between 2 percent and 4 percent of total enrollment, even though their absolute numbers rose into the hundreds of thousands. Two moments interrupted that pattern. The first came in the mid-1970s, when the oil shock gave the petrostates sudden money to spend on education, and they spent it on American degrees.[g] Iran alone became the largest source country by the end of the decade, until the 1979 revolution cut the flow off.

The second pattern break began in 2009, with China, and it has not subsided. As China's middle class grew large enough to pay full American tuition,[h] Chinese enrollment quadrupled over the following decade, helping to push the international share from about 3.4 percent to more than 6 percent as China became the single largest source of international students.[i] But the new students did not spread evenly across higher education. Master's programs absorbed much of the growth.

The 6 Percent Illusion

The 6 percent average conceals three very different systems. At the bachelor's level, American education remains overwhelmingly domestic: International students earned approximately 4 percent of all bachelor's degrees in 2025, and 6 percent of STEM bachelor's degrees. At the master's level, they earn one in five of all degrees awarded, but more than half of those in STEM. At the research-doctorate level, the balance tips again. We examine each degree and STEM subfield in greater detail below.

International students have earned about 4 percent of all American bachelor's degrees since 1995, with little change (See Figure 1.05).[18] Cost is one constraint. International undergraduates generally cannot receive federal aid and often pay nonresident tuition for four years. Public universities, which award approximately two-thirds of American bachelor's degrees, also face political pressure to reserve seats for state residents. California and North Carolina, for example, cap nonresident enrollment at public campuses.[19] The result is an undergraduate system that remains overwhelmingly domestic.[20]

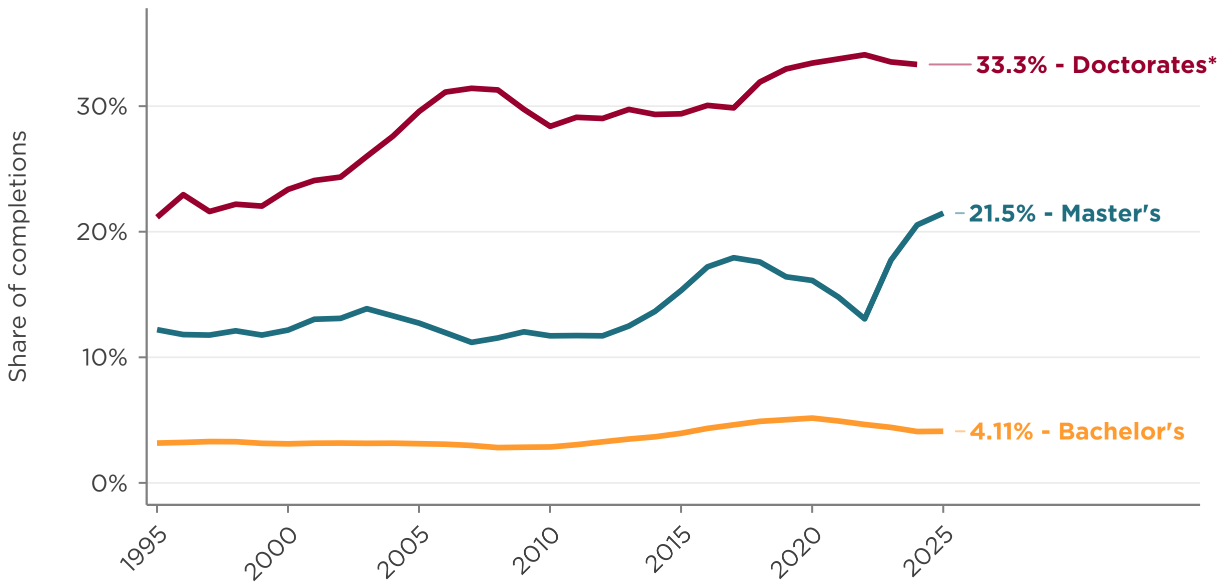
The master's degree followed a very different trajectory. Across all fields, its international share remained near 12 percent from 1995 to 2013, then rose sharply to 21 percent by 2023. As noted above, the reason lies partly in financing. Because master's programs tend to be funded by tuition, universities can expand them quickly when demand rises. One study found that universities

g On the petrodollar windfall of 1973–74 and its recycling into education, see David M. Wight, "The Petrodollar Era and Relations Between the US and the Middle East and North Africa, 1969–1980" (PhD diss., University of California, Irvine, 2014), https://escholarship.org/content/qt9m52q2hk/qt9m52q2hk.pdf. The dependence of these students on state oil funding became visible when it collapsed: see Marlene Sokol, "Foreign Students Face Money Woes as Their Nations' Currencies Suffer," Washington Post, May 11, 1983, https://www.washingtonpost.com/archive/local/1983/05/11/foreign-students-face-money-woes-as-their-nations-currencies-suffer/86572d1f-5096-45ba-bd4d-71e82b4e774a/.

h Rakesh Kochhar, A Global Middle Class Is More Promise than Reality (Pew Research Center, July 8, 2015), https://www.pewresearch.org/global/2015/07/08/a-global-middle-class-is-more-promise-than-reality/. Pew's analysis finds the share of Chinese who were middle income rose from 3 percent in 2001 to 18 percent in 2011, using a threshold of $10–20 per day in 2011 purchasing-power parities.

i For more on the demographic concentration of US international students, including by country of origin, see chapter 2.

Figure 1.05 **What Share of All Degrees Awarded in the US Are Earned by International Students?**



*Doctorate completions for 2025 are not yet available, so the doctorate series ends at 2024; bachelor's and master's run through 2025.

Data from NCES, IPEDS Completions (bachelor's, master's) and NSF, Survey of Earned Doctorates (doctorates), 1995-2025. Chart by Emerson Johnston and Amy Zegart, Stanford University

opened new STEM master's programs in near-lockstep with the arrival of full-fee students, roughly one new program for every hundred additional Chinese students on a campus.[21]

The international share of US doctorates has also grown substantially, rising from 21 percent in 1995 to 33 percent in 2024. In other words, one in three research PhDs awarded today in the United States goes to an international student.

The Dependence on International Talent: A Closer Look by Degree and Field

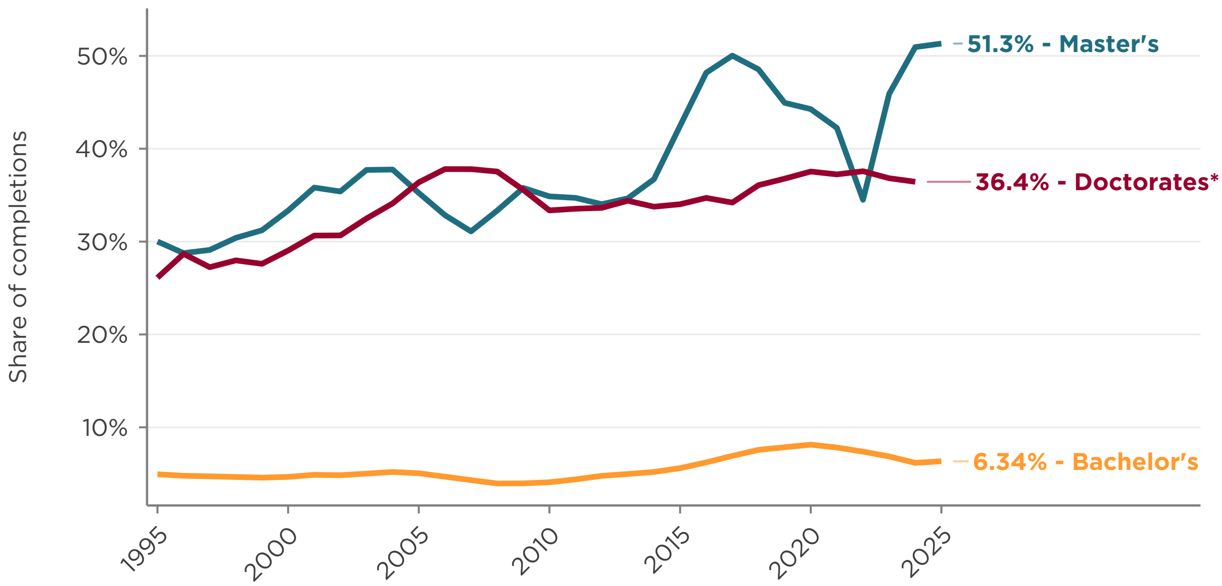
If we focus the analysis on STEM degrees, the trends grow more pronounced (See Figure 1.06).

International students earned only 6.34 percent of STEM bachelor's degrees in 2025, up only slightly from 4.94 percent in 1995. At the master's level, however, their share rose from just under a third in 1995 to 51.3 percent, so that more than half of all STEM master's degrees awarded now go to a student from abroad. Among research doctorates, the share grew from 26.1 to 36.4 percent over the same period.

A closer examination of STEM fields finds that bachelor's degrees in STEM go overwhelmingly to American students and have for some time (See Table 1.01).

Over the past 30 years, the international share of STEM bachelor's degrees has remained consistently low across every field but one: mathematics and statistics—which has quadrupled. Everywhere else the shares remain small. In 2025 international students received 8.5 percent of

Figure 1.06 What Share of STEM Degrees Awarded in the US Are Earned by International Students?



*Doctorate completions for 2025 are not yet available, so the doctorate series ends at 2024; bachelor's and master's run through 2025.

Data from NCES, IPEDS Completions (bachelor's, master's) and NSF, Survey of Earned Doctorates (doctorates), 1995-2025. Chart by Emerson Johnston and Amy Zegart, Stanford University

Table 1.01 What is the Field Breakdown of International STEM Degree Production Since 1995?

	BACHELOR'S[1]			MASTER'S[1]			DOCTORATE[1]		
	1995	2025	CHANGE	1995	2025	CHANGE	1995	2025	CHANGE
Computer and Information Sciences	9.28%	8.51%	−0.8 pp	37.5%	64.9%	+27.4 pp	42.1%	54.9%	+12.8 pp
Mathematics and Statistics	4.31%	16.8%	+12.5 pp	27.6%	54.6%	+27.0 pp	44.8%	52.8%	+8.0 pp
Engineering	7.58%	7.09%	−0.5 pp	33.9%	49.3%	+15.4 pp	49%	54.7%	+5.7 pp
Architecture and Related Services	5.06%	7.24%	+2.2 pp	18.1%	28.4%	+10.3 pp	39.7%	51.9%	+12.2 pp
Physical Sciences	3.73%	5.94%	+2.2 pp	30.6%	32.7%	+2.1 pp	32.8%	38.1%	+5.2 pp
Biological and Biomedical Sciences	2.25%	3.31%	+1.1 pp	16.2%	22.6%	+6.4 pp	25%	23.2%	−1.8 pp
Natural Resources and Conservation	1.18%	1.98%	+0.8 pp	11.6%	16.9%	+5.3 pp	29.6%	27.2%	−2.5 pp

[1] Values are the percent of degree completions awarded to international (nonresident) students. Change is the percentage-point change in that share from 1995 to 2025, with fields ordered by their average 2025 share across the three degree levels.

Data from NCES, IPEDS Completions, 1995–2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

computer science bachelor's, 7.09 percent of engineering degrees, 5.94 percent of physical sciences degrees, and even smaller shares of biological sciences and natural resources and conservation degrees. The share of international students receiving bachelor's degrees in both engineering and computer science actually went down from 1995 to 2025.

But, while a smaller percentage of computer science bachelor's degrees were awarded to international students in 2025, the international share of master's degrees in computer science nearly doubled, from 37.5 percent in 1995 to 64.9 percent in 2025. This is one of the clearest signs that the American domestic undergraduate supply in computer science is not feeding the graduate programs above it.

At the master's level, international students now receive more than half of the degrees awarded in computer science and mathematics, and just under half in engineering.

The doctorate level shows similar trends. International students in 2025 received 54.9 percent of computer science PhDs, 52.8 percent of mathematics PhDs, and 54.7 percent of engineering doctorates. Each is a strategic discipline that underpins advances in artificial intelligence, quantum computing, cryptography, and the design of physical systems. The international share has increased meaningfully in all three since the 1990s.

Putting the pieces together, we find that over thirty years, American higher education has built the largest STEM training apparatus in its history, one that awarded 792,000 STEM degrees across all levels in 2025 alone. International students have become an increasingly large part of that system, but not evenly. They are concentrated at the master's level and in a handful of fields, above all computer science, engineering, and mathematics. The result is a system that is overwhelmingly American at the undergraduate level and progressively less so at every level above, until, in the graduate programs that train computer scientists, engineers, and mathematicians, more than half the degrees go to students who call another country home.

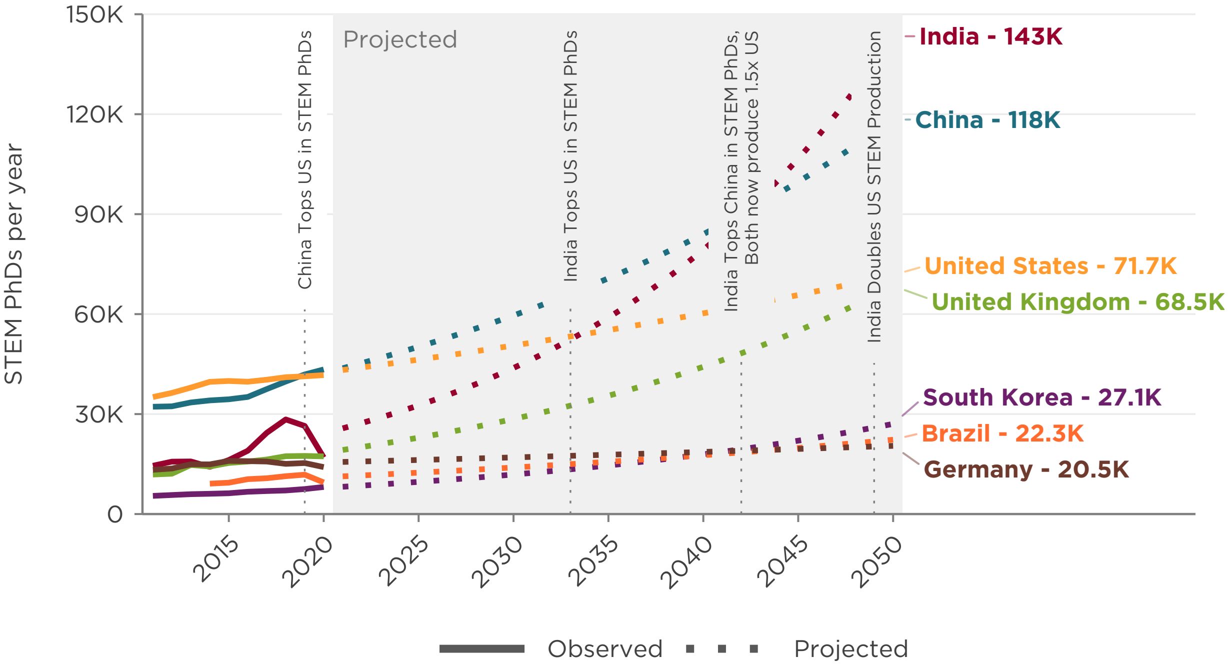
The result is a system that is overwhelmingly American at the undergraduate level and progressively less so at every level above, until, in the graduate programs that train computer scientists, engineers, and mathematicians, more than half the degrees go to students who call another country home.

The Numbers Ahead

Everything up to this point has reviewed historical data, measuring changes in international enrollment in American STEM degrees until 2025. Here, we look ahead, examining projections for STEM degree production in the United States and around the world. If current trends continue, the United States is likely to be overtaken in STEM PhD production, both absolutely and as a percentage of the population (See Figure 1.07).[22j]

j These projections extrapolate recent compound growth rates to 2050 and should be interpreted as trajectories rather than point forecasts. Extrapolation over a twenty-five-year horizon is sensitive to the assumed growth rate, and the terminal-year estimates for China and India are correspondingly uncertain; modest revisions to either rate shift the absolute figures substantially. The qualitative result, however, is robust to such adjustments. Across the plausible range of growth assumptions, both China and India expand doctoral output considerably faster than the United States, and the US share of global STEM doctoral production declines in every case. The uncertainty attaches to the magnitude of the divergence, not its direction.

Figure 1.07 **Which Country Will Produce More STEM PhDs by 2050?**



Data from NSB, "International Comparisons of S&E Higher Education," Science and Engineering Indicators 2023; authors' projections beyond reported figures.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Today, the United States produces roughly 40,000 STEM PhDs a year. That puts the United States among the most in the world, but the trend lines are shifting. China, which trailed the United States in absolute degree production as recently as the late 2010s, passed the United States in STEM doctorate production in 2019. On its current trajectory, China is expected to award close to 118,000 STEM doctorates a year by 2050, more than 1.5 times what the United States is projected to produce.[k]

[America's] lead will erode not because it retreats, but because it advances more slowly while others sprint.

Today, India sits further back but is on a path to overtake the United States too, around 2033. It's expected to pass China about a decade after that, and by 2050 to produce roughly double the American number of doctorates. Through it all, American production is projected to rise, from roughly 40,000 toward a projected 70,000, but it will rise roughly 2 to 3 percent

k Authors' projections. We fit an exponential growth curve to each country's historical STEM doctorate counts and extrapolated to 2050 using the GROWTH function in Google Sheets (=GROWTH(known_y, known_x, new_x)), which returns predicted values along a best-fit exponential trend. Figures are rounded.

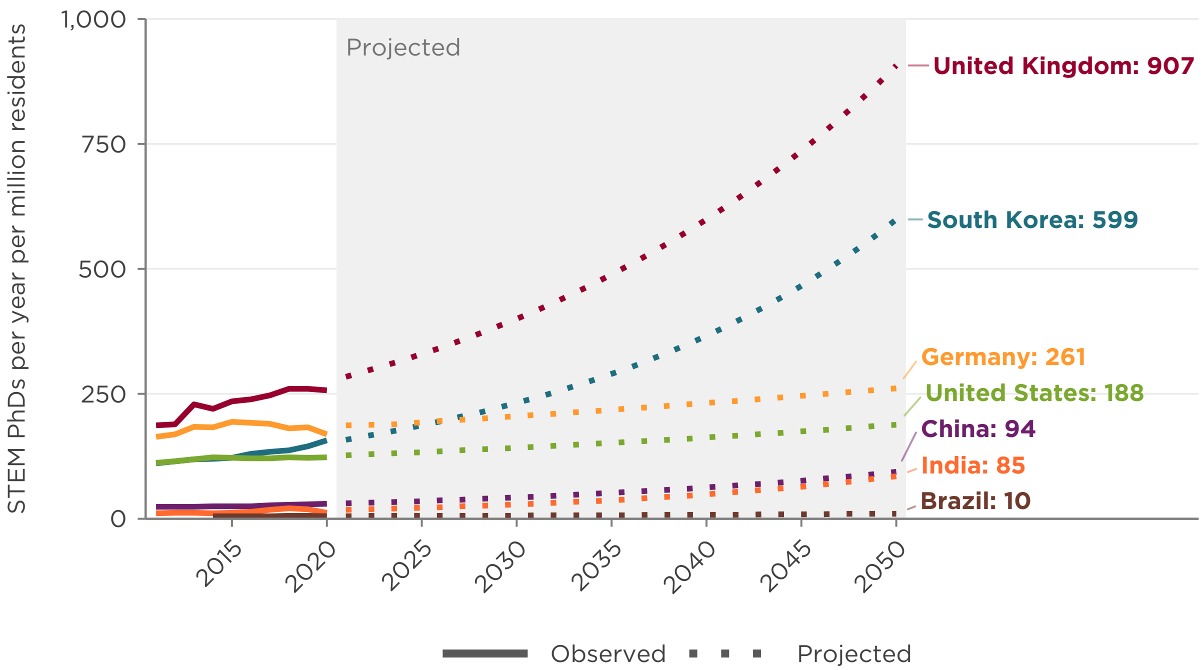
a year, while the two ascendant systems compound at three to four times that pace. Its lead will erode not because the United States retreats, but because it advances more slowly while others sprint.

Of course, counting the number of degrees produced by various countries is only one way to measure talent competition. China and India are the world's two most populous countries. Factoring in population differences yields a different picture. Adjust for population, and the ranking inverts (See Figure 1.08).[1]

By 2050, the United States is projected to produce about 188 STEM PhDs per million residents, against China's 94 and India's 85. A nation of 1.68 billion producing 118,000 doctorates is training a far thinner slice of its population than a nation of 381 million producing 70,000. Per person, the United States is still on pace to out-train both of its rivals.

Looking ahead, there's an important question about which is likely to matter more, the quantity or quality of advanced STEM education. Increasingly, however, China and India are developing both. The more both countries mature their educational pipelines and networks, the more risk there is to the traditional international talent supply chain advantages the United States has enjoyed.

Figure 1.08 Which Country Will Produce More STEM PhDs per Person by 2050?



Data from NSB, "International Comparisons of S&E Higher Education," Science and Engineering Indicators 2023; authors' projections beyond reported figures.
Chart by Emerson Johnston and Amy Zegart, Stanford University

1 On a per-capita basis, the United States does not lead the field. The United Kingdom is projected to reach roughly 900 STEM PhDs per million residents by 2050, South Korea about 600, and Germany about 260, all well above the US figure of 188. The British rate is inflated in part by doctoral program length: UK PhDs typically run three to four years against five to seven in the United States, so an equivalent stock of funded positions yields more completions per year, raising the annual per-capita rate without a corresponding difference in training capacity. South Korea produced 157 STEM PhDs per million residents in 2020, behind both the United Kingdom and Germany, but its rate is projected to nearly quadruple by 2050 and to pass Germany's around 2027. Part of that rise is demographic. South Korea's population is projected to fall from 51.9 million in 2020 to 45.1 million in 2050, so the same number of graduates yields a higher per-capita rate. At its 2020 population, South Korea's 2050 figure would be about 520 rather than 600.

Chapter 1 Endnotes

1 National Center for Science and Engineering Statistics (NCSES), "Survey of Earned Doctorates, Doctorate Recipients from US Universities: 2024," Table 1-3 (National Science Foundation, 2024), https://ncses.nsf.gov/surveys/earned-doctorates/; Lori Thurgood et al., *US Doctorates in the 20th Century*, NSF 06-319 (National Science Foundation, 2006), https://wayback.archive-it.org/5902/20160210153510/http://www.nsf.gov/statistics/nsf06319/.

2 Authors' analysis of National Center for Education Statistics, "Integrated Postsecondary Education Data System (IPEDS)," data from completions component, 2025 (US Department of Education, Institute of Education Sciences, 2024), https://nces.ed.gov/ipeds/.

3 Authors' analysis of National Center for Education Statistics, "IPEDS," completions component, 2025.

4 Authors' analysis of National Center for Education Statistics, "IPEDS," completions component, 2025.

5 Vannevar Bush, Science, the Endless Frontier: A Report to the President (US Government Printing Office, 1945), https://nsf-gov-resources.nsf.gov/2023-04/EndlessFrontier75th_w.pdf.

6 William P. Tolley, "Report of the Commission on Academic Freedom and Academic Tenure," *Association of American Colleges Bulletin* 32, no. 1 (March 1946): 95, https://archive.org/details/sim_liberal-education_1946-03_32_1/page/95.

7 Laurie A. Harris, *The National Science Foundation: An Overview*, CRS Report R46753 (Congressional Research Service, April 9, 2021), https://www.congress.gov/crs-product/R46753.

8 US Senate, "Sputnik Spurs Passage of National Defense Education Act," Senate Historical Office, https://www.senate.gov/artandhistory/history/minute/Sputnik_Spurs_Passage_of_National_Defense_Education_Act.htm.

9 Pamela Ebert Flattau et al., *The National Defense Education Act of 1958: Selected Outcomes*, IDA Document D-3306 (Institute for Defense Analyses, Science and Technology Policy Institute, 2005), https://www.ida.org/research-and-publications/publications/all/t/th/the-national-defense-education-act-of-1958-selected-outcomes.

10 All data in Figure 1.01 are drawn from NCSES, "Survey of Earned Doctorates Data Tables," data for 2010–2024, US National Science Foundation, 2024, data tables compiled by the authors across available survey years, https://ncses.nsf.gov/surveys/earned-doctorates; and Thurgood et al., *US Doctorates in the 20th Century*.

11 Congressional Research Service, *National Institutes of Health (NIH) Funding: FY1996–FY2026*, CRS Report R43341 (Congressional Research Service, 2026), https://www.congress.gov/crs-product/R43341.

12 Data in Figure 1.02 are drawn from National Center for Education Statistics, *Digest of Education Statistics* (US Department of Education, Institute of Education Sciences), https://nces.ed.gov/programs/digest/; and National Center for Education Statistics, "Integrated Postsecondary Education Data System (IPEDS)," completions component, data for 1995–2024 (US Department of Education, Institute of Education Sciences, 2024), compiled by the authors using Python from annual IPEDS Completions survey files, https://nces.ed.gov/ipeds/datacenter/DataFiles.aspx?year=-1&surveyNumber=3&sid=bd7f629c-c359-478c-a31c-7a82876497ed&rtid=7.

13 Data in Figure 1.03 and Table 1.01 are drawn from National Center for Education Statistics, IPEDS completions component, compiled by the authors using Python from annual IPEDS Completions survey files, https://nces.ed.gov/ipeds/datacenter/DataFiles.aspx?year=-1&surveyNumber=3&sid=bd7f629c-c359-478c-a31c-7a82876497ed&rtid=7.

14 Authors' analysis of IPEDS data.

15 Authors' analysis of National Center for Education Statistics,"National Postsecondary Student Aid Study" (NPSAS:20), data for 2019–20 (US Department of Education, Institute of Education Sciences, 2023), https://nces.ed.gov/datalab.

16 All data in Figure 1.04 are drawn from Institute of International Education, "International Student: Enrollment Trends," data for 1948/49–2024/25, *Open Doors Report on International Educational Exchange* (Institute of International Education, 2025), https://opendoorsdata.org/data/international-students/enrollment-trends/.

17 Immigration and Nationality Act, Pub. L. No. 82-414, 66 Stat. 163 (1952); Immigration and Nationality Act Amendments of 1965, Pub. L. No. 89-236, 79 Stat. 911; Fulbright Act, ch. 723, Pub. L. No. 79-584, 60 Stat. 754 (1946) (amending the Surplus Property Act of 1944).

18 All data in Figures 1.05 and 1.06 are drawn from National Center for Education Statistics, IPEDS completions component, for bachelor's and master's, and NCSES, "Survey of Earned Doctorates," data for 1995–2024 (National Science Foundation, 2024), for doctorates.

19 Authors' analysis of National Center for Education Statistics, IPEDS completions, degrees conferred by control of institution; University of North Carolina System, Board of Governors, "Policy on Nonresident Undergraduate Enrollment," effective fall 2025 (University of North Carolina, updated 2026), https://www.northcarolina.edu/apps/policy/doc.php?id=789.

20 University of California, Board of Regents, "Regents Policy 2109: Policy on Nonresident Student Enrollment," adopted May 18, 2017 (University of California, 2017), https://regents.universityofcalifornia.edu/governance/policies/2109.html.

21 Ruixue Jia et al., *The Ripple Effects of China's College Expansion on American Universities*, NBER Working Paper No. 34391 (National Bureau of Economic Research, October 2025), 22, https://doi.org/10.3386/w34391.

22 Data in Figures 1.07 and 1.08 are drawn from National Science Board, "International Comparisons of S&E Higher Education," in "Higher Education in Science and Engineering," NSB-2023-32, *Science and Engineering Indicators 2023* (National Science Foundation, 2023), 53–62, https://ncses.nsf.gov/pubs/nsb202332/international-comparisons-of-s-e-higher-education#educational-attainment; original data appear on p. 56, and projections beyond the reported figures were generated by the authors.

CHAPTER 2

Who Comes

The Changing Sources of America's International STEM Talent

HOOVER INSTITUTION | Stanford University

HAI Stanford University Human-Centered Artificial Intelligence

Chapter 2

Who Comes —

The Changing Sources of America's International STEM Talent

FIGURES

TABLES

Chapter 2

Key Takeaways

1. **America's international student pipeline is becoming more regionally concentrated.** Asia's share of international students rose from 54.4 percent in 2000 to 71.6 percent in 2025, and it did so while every other region receded or stayed put, Europe from 17.6 to 7.93 percent, Latin America from 12.2 to 7.47 percent, and North America from 4.57 to 2.54 percent. The other regions did not so much collapse as fail to grow while Asia surged.

2. **Within Asia, India has overtaken China to become the single largest source of international graduate students.** Indian nationals were 36.4 percent of international graduate students in 2025 versus China's 24.6 percent, a share that has roughly doubled over the decade while the next-largest source, South Korea, trails at just 3.0 percent. The gap looks set to widen, since India's median age is about 30 with its college-age cohort near its peak, while China's has been contracting since the mid-2010s.

3. **China's decline is partly a policy choice.** The measures that tightened access to American graduate programs, shorter visas in sensitive STEM fields and a bar on applicants tied to China's military-civil fusion programs, singled out China more than any other country. The screening addresses a documented espionage and transnational-repression threat, but the same machinery falls on students who clear it and pose no risk.

4. **International enrollment is concentrated in computing.** Math and computer science enrolled 305,000 international students in 2025, and the pull toward those fields is not country-specific. More than two in five Indian students and nearly one in four Chinese students now study a STEM degree, and all 29 of the largest source countries raised the share of their students entering in STEM.

5. **Recruitment is following enrollment away from China.** Named the top recruiting target by 65.8 percent of reporting institutions in 2015, China has fallen to sixth for undergraduates, behind Vietnam, India, Brazil, South Korea, and Canada. When asked what was driving overall international enrollment down, institutions pointed most often to the visa application process, cited by 96 percent of respondents.

6. **America's dependence is financial as well as intellectual.** International students contributed $55.98 billion to the US economy in 2025, and much of that flows through tuition-funded master's programs that have become important sources of university revenue. A disruption in international enrollment would therefore affect both the supply of advanced STEM talent and the institutions that train it.

Chapter 2 – By the Numbers:

MEASURE	2001	2025	CHANGE	
SCALE AND ACADEMIC LEVEL				
International students in US higher education	548,000	**1,180,000**	2.15×	▲
International undergraduate students	254,000	**357,000**	+40.4%	▲
International graduate students	238,000	**488,000**	+105%	▲
Master's share of international enrollment	22.6%	**26%**	+3.4 pp	▲
Doctorate share of international enrollment	14.1%	**13%**	-1.1 pp	▼
OPT share of international enrollment	3.84%	**25%**	+21.1 pp	▲
GEOGRAPHIC CONCENTRATION				
International students from Asia	302,000	**843,000**	+179%	▲
Asia's share of international students	55.1%	**71.6%**	+16.4 pp	▲
China's share of international undergraduates	3.16%	**22%**	+18.8 pp	▲
China's share of international graduate students	19.7%	**24.6%**	+5.0 pp	▲
India's share of international undergraduates	4.7%	**11.2%**	+6.5 pp	▲
India's share of international graduate students	16.3%	**36.4%**	+20.1 pp	▲
South Korea's share of international graduate students	8.82%	**3.04%**	-5.8 pp	▼
Europe's share of international students	17.1%	**7.93%**	-9.2 pp	▼
Sub-Saharan Africa's share of international students	5.37%	**5.55%**	+0.2 pp	▲
CONCENTRATION BY STEM FIELD				
International students in math and computer science	67,800	**305,000**	+350%	▲
International students in engineering	83,400	**217,000**	+160%	▲
STEM students from India	72,200[2010]	**260,000**	+261%	▲
STEM students from China	55,500[2010]	**138,000**	+149%	▲
PROJECTED CHANGES TO INTERNATIONAL ENROLLMENT BETWEEN 2025 AND 2026				
Undergraduate enrollment	357,000[2025]	**364,000[P]**	+2%	▲
Graduate enrollment	488,000[2025]	**430,000[P]**	-12%	▼
OPT participation	294,000[2025]	**335,000[P]**	+14%	▲
RECRUITMENT AND BARRIERS (2015–2025)				
Top recruitment target	China: 65.8%[2015]	**India: 53%**	China → India	
Institutions citing China as a recruitment priority	65.8%[2015]	**31%**	-34.8 pp	▼
Institutions citing India as a recruitment priority	40.5%[2015]	**53%**	+12.5 pp	▲
Institutions citing South Korea as a recruitment priority	28.9%[2015]	**33%**	+4.1 pp	▲
Institutions citing visa application process	12%[2015]	**96%**	+84.0 pp	▲
Institutions citing feeling unwelcome in the US	49%[2019]	**67%**	+18.0 pp	▲
Institutions citing US social/political environment	58%[2019]	**64%**	+6.0 pp	▲
ECONOMIC CONTRIBUTION				
International-student contribution to the US economy	$10.7B	**$56B**	5.22×	▲

[P] Projected values are drawn directly from the Open Doors Fall 2025 snapshot's 2026 enrollment projection.

Note: Historical comparisons use 2001 and 2025 observations. Superscript years mark rows with a later earliest start point than 2001 or earlier latest endpoint than 2025. Arrow colors indicate direction of change only.

Source: Derived from the current report Figures and Tables: Figures 2.01–2.08, Tables 2.01-2.02.

Chapter 1 showed that international students account for just 6.1 percent of total US higher-education enrollment—but far larger shares of advanced STEM degrees. That disparity revealed where America depends on international talent. This chapter asks the next question: Who supplies it?

The answer has changed dramatically over the last 50 years. America once drew students from a relatively broad range of regions and countries. Today, nearly three-quarters of the US's international students come from Asia, and two countries—India and China—dominate the graduate pipeline. The United States is not simply relying more heavily on international talent. It is relying more heavily on a supply that is becoming more concentrated both by country and by field.

These concentrations matter. America's reliance on international talent is also a reliance on particular countries, demographic trends, educational systems, and fields of study. A pipeline that appears broad when measured in the aggregate becomes much narrower when sorted by origin and discipline.

The Changing Geography of International Talent

Sort the United States' growing international student population by country of origin, and the geographic concentration becomes immediately clear. The United States is not drawing from the world evenly—it is increasingly drawing international students from just one corner. Regionally, Asia sent 280,000 students to the United States across all degree levels in 2000 and 843,000 in 2025, a 201 percent increase that lifted the region's share of all international students from 54.4 percent to 71.6 percent (See Table 2.01).[1]

Table 2.01 Which Regions Do International Students Come From?

	ENROLLMENT[1]			SHARE OF TOTAL[1]		
	2000	2025	CHANGE	2000	2025	CHANGE
Asia	280,000	843,000	**+201%**	54.4%	71.6%	**+17.1 pp**
Africa, Sub-Saharan	26,100	65,400	**+150%**	5.08%	5.55%	**+0.5 pp**
Oceania	4,680	7,270	**+55.4%**	0.909%	0.617%	**−0.3 pp**
Middle East and North Africa	26,900	51,000	**+89.7%**	5.23%	4.33%	**−0.9 pp**
North America	23,500	29,900	**+27%**	4.57%	2.54%	**−2.0 pp**
Latin America and Caribbean	62,700	87,900	**+40.3%**	12.2%	7.47%	**−4.7 pp**
Europe	90,700	93,400	**+2.98%**	17.6%	7.93%	**−9.7 pp**

[1] Counts represent total international students across all degree levels by region of origin. Shares are calculated as a percentage of all international students. Change is the relative change for enrollment and the percentage-point change for share, between 2000 and 2025.

Data from IIE, "International Student Totals by Place of Origin," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

Over the same period, almost every other region lost ground in relative terms, and the steepest losses came exactly where the United States once drew its most traditional students. Europe's share fell from 17.6 percent to 7.93 percent from 2000 to 2025, the largest decline overall, even as its absolute enrollment barely moved (90,661 to 93,361). Latin America's share fell from 12.2 percent to 7.47 percent, North America's from 4.57 percent to 2.54 percent. [a] Only Sub-Saharan Africa gained share among the non-Asian regions, edging from 5.08 percent to 5.55 percent on fast growth from Nigeria, Ghana, and a few others, though from a far smaller base.

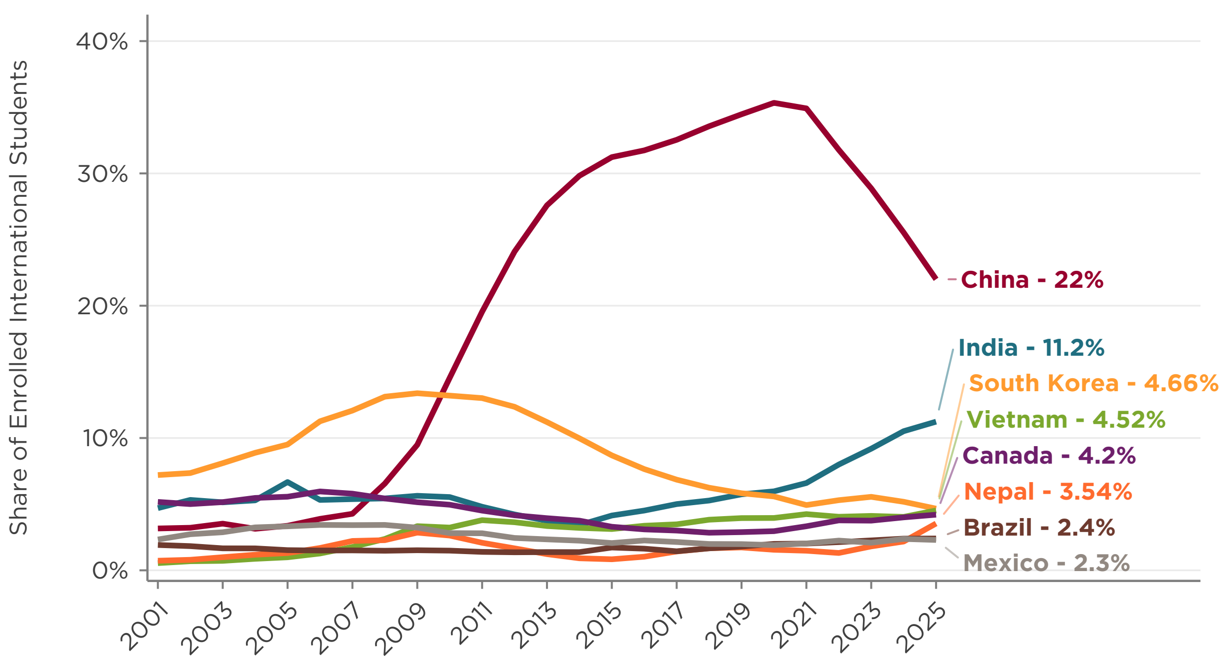
The pattern is not that other regions shrank, but that Asia grew so much faster that everywhere else receded by comparison. Nearly three of every four international students in the country now come from a single continent, up from barely half a generation ago.

a In Open Doors data reporting, the "North America" regional classification excludes Mexico to align with the US Department of State's regional bureaus; consequently, the North American category primarily reflects student mobility data from Canada. Mexico is instead aggregated under Latin America and the Caribbean.

Within that Asian majority, two countries account for most of the weight, though which one leads depends on the education level. At the undergraduate level, China is still ahead, with 79,000 students, or 22.0 percent of all international undergraduates, but its line is falling fast, down from a peak of 35.3 percent in 2020 (See Figure 2.01).[2] India is the mirror image, climbing to 11.2 percent as China's share declines.

Nearly three of every four international students in the country now come from a single continent, up from barely half a generation ago.

Figure 2.01 Which Countries Account for the Largest Share of International Students at the Bachelor's Level?



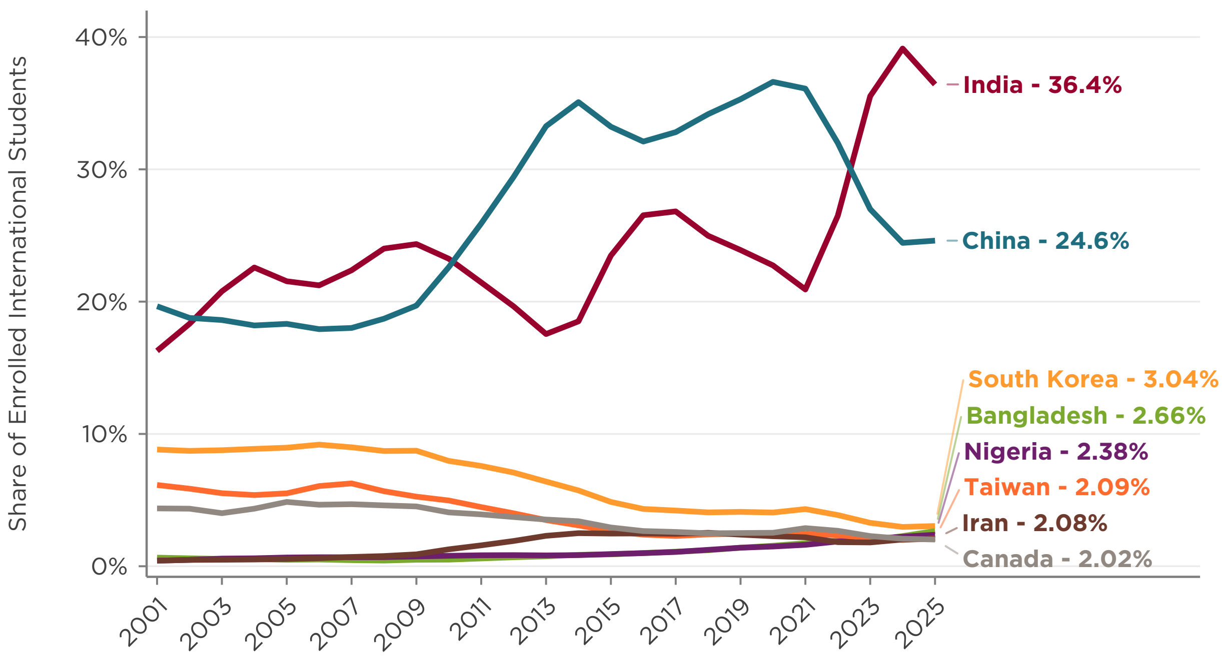
Data from IIE, "International Students by Academic Level and Place of Origin," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

At the master's and doctoral levels, the order flips.[b] India dominates and is pulling further ahead. Indian nationals accounted for 36.4 percent of all international graduate students in 2025, some 178,000 people, while Chinese nationals accounted for 24.6 percent, or 120,000 people (See Figure 2.02). Here, India's share roughly doubled over the decade while China's, after leading through the 2010s, slipped back beneath it. Together, though, the two account for more than 60 percent of all international graduate students in the country, and have for some time. The next largest source, South Korea, sits at just 3.0 percent. Put another way: The US graduate pipeline does not draw on the world so much as on two countries.

The US graduate pipeline does not draw on the world so much as on two countries.

Several forces help explain the dependence crossover. The first is demographic. India is young and still growing. Its median age is about 30, roughly a decade below China's, and the 15-to-24 cohort that feeds study abroad represents 17.2 percent of its population and is growing faster than Indian universities can absorb.[3] China is the opposite case. Its working-age population

Figure 2.02 Which Countries Account for the Largest Share of International Students at the Master's and Doctorate Levels?



Data from IIE, "International Students by Academic Level and Place of Origin," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

b Open Doors reports enrollment by place of origin at two academic levels, undergraduate and graduate, and does not separate master's from doctoral students in its country-of-origin data. "Graduate" here therefore covers both. Open Doors does resolve master's, professional, and doctoral degrees in some national-total tables, but not at the country level this figure uses. This differs from Chapter 1, where IPEDS and SED completions data allow the three degree levels to be reported separately.

has been falling since the mid-2010s, its birth cohorts are contracting, and the college-age pool that fed two decades of American enrollment growth is now narrowing each year.[4] Today, their 15-to-24 cohort represents just 11.2 percent of their population, down from its historical peak of 23.5 percent in 1987.[5]

The same divergence explains the regions at the bottom of the table. Europe's college-age population has been flat or shrinking for a generation, which is why its enrollment in the United States barely moved over twenty-five years and its share fell.[6] It did not decline so much as it failed to grow while Asia surged. Reservoirs moving in opposite directions will, in time, trade places in the pipeline they both feed.

Second, the educational alternatives across the world improved unevenly. India has generally placed fewer restrictions on outward student mobility, while its domestic universities have struggled to absorb demand for elite STEM education. China, by contrast, has expanded domestic university capacity and promoted its leading institutions as alternatives to study abroad.[7] Europe offered a third version of the same pull: A student weighing a four-year American bachelor's against a cheaper, often English-language, three-year degree in the Netherlands, Germany, or Ireland increasingly chose the latter, a shift visible in Europe's flat enrollment in Table 2.01. India had no comparable off-ramp. Its own system, for all its growth, could not meet domestic demand for elite STEM training, so the outflow continued where others slowed.

Third, the crossover was shaped by a policy dilemma that still confronts policymakers today: the tension between keeping the research system open, which is much of what draws talent to it, and protecting it from a documented threat. Testifying before the Senate Select Committee on Intelligence in February 2018, FBI Director Christopher Wray warned that China was using nontraditional intelligence collectors, including professors, scientists, and students, across nearly every discipline. By 2019, the Bureau had roughly 1,000 open investigations into Chinese theft of US intellectual property, many running through universities.[8]

Compounding the concern is a basic asymmetry. China exploits the openness of American universities while restricting American scholars' access to its own.

Compounding the concern is a basic asymmetry. China exploits the openness of American universities while restricting American scholars' access to its own.[9]

The same openness runs the other way. The Chinese state that Director Wray described as exploiting American universities also reaches into them to monitor its own nationals, a practice the FBI calls transnational repression. Freedom House names China as the leading source of such pressure on international students in the United States, through surveillance, harassment, and coercion by proxy.[10] Nearly a third of Chinese students interviewed across eight countries reported officials had contacted their families to deter them from criticizing Beijing.[11] Many students who clear the screening still self-censor rather than risk consequences for relatives at home, and since 2018 the FBI has added to the strain by urging universities to monitor students tied to certain Chinese institutions. The result is that talented, innocent students who clear the screening are still not free once they arrive.

The United States has addressed this tension by screening. Two measures singled out China specifically. First, in 2018 the State Department cut the duration of visas for Chinese graduate students in certain sensitive STEM fields from five years to one.[12] Then, in June 2020, Presidential Proclamation 10043 barred entry to Chinese graduate students and researchers with ties to universities linked to the country's military-civil fusion programs.[13] And, in 2024, the State Department issued roughly 24,000 fewer F visas to Chinese nationals than it had in 2019.[14] None of this was aimed at India. This is not to say India's students sailed through; Indian F visa refusal rates have historically run higher than China's, and Indian issuances have themselves swung sharply year to year. But the specific machinery of dual-use screening and research-security review was built for and aimed at China, and the Indian pipeline met little of it.

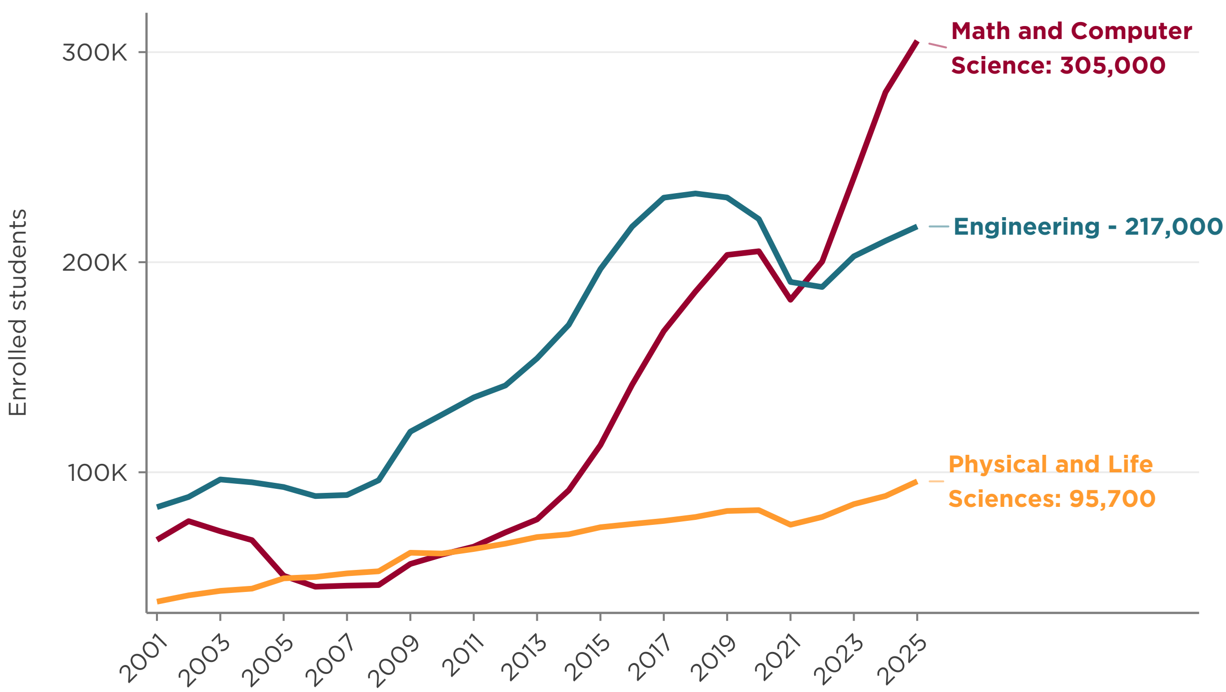
A shrinking Chinese cohort, improving universities at home, and more restrictive American screening all pushed Chinese enrollment downward. India faced a different combination: a growing college-age population, intense demand for advanced STEM education, and fewer US restrictions targeted specifically at its students. Together, these forces produced a relatively rapid crossover.

Sorting by Field

Chapter 1 measured international concentration from the American side: what share of US degrees in each field goes to students from abroad. The same pipeline looks different when viewed from the supply side: what the students arriving from each country choose to study.

Sorted by field, the inflow funnels into computing. Math and computer science enrolled 305,000 international students in 2025, more than any other STEM field and far above engineering's 217,000 after trailing engineering for two decades (See Figure 2.03).[15]

Figure 2.03 Which STEM Fields Draw the Most International Students?



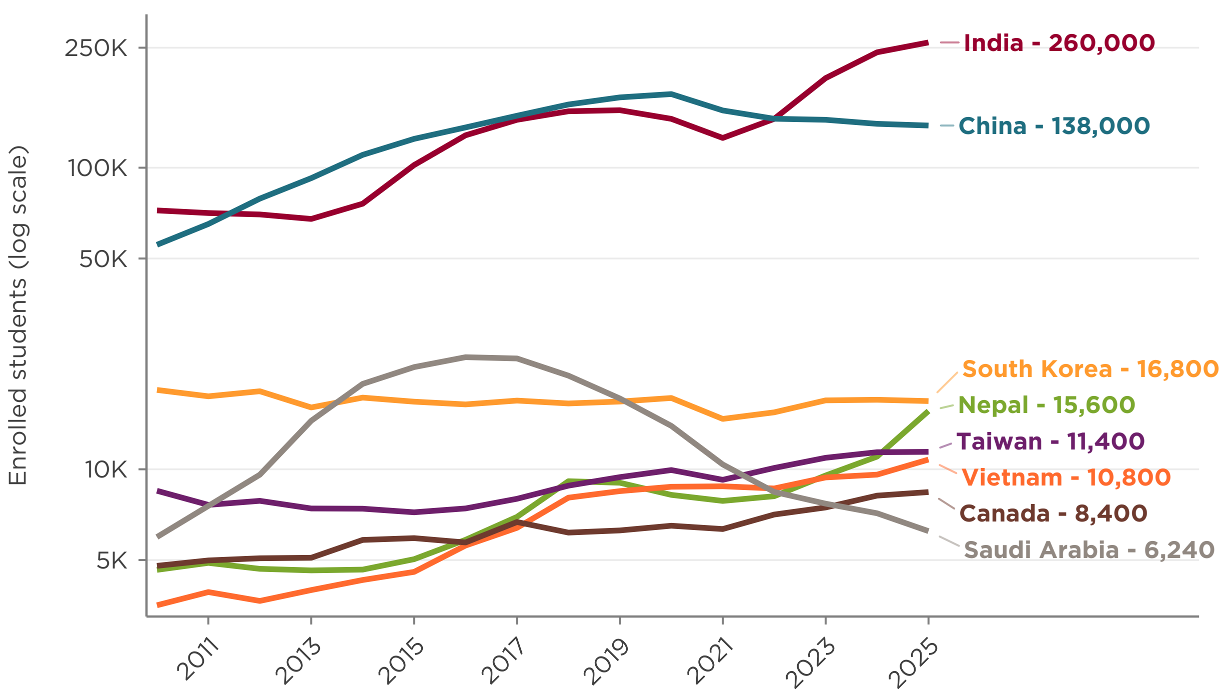
Data from IIE, "Number of International Students by Field of Study," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The shift reflects the changing value of technical fields in the American labor market. The smartphone economy, the expansion of software, and the machine-learning boom increased demand for programmers and data scientists. American universities responded by rapidly expanding computer science master's programs, while international students increasingly treated those programs as routes into one of the country's, and the world's, most dynamic labor markets. Chapter 3 examines the work-authorization policies that strengthened that connection between degree choice and employment.[16]

In the last chapter, we examined the international share of students in STEM fields. Here, we examine absolute numbers by country and how they have changed over time.

As Figure 2.04 shows, India leads overall, with 260,000 STEM students in 2025. China places second, with 138,000.[17] India retook its lead in 2022, after a decade of China sending more, and the gap has widened fast. The two countries were separated by just 129 students in 2022, and more than 120,000 by 2025.

Figure 2.04 Which Countries Send the Most International STEM Students?



Data from IIE, "Fields of Study of Students from Selected Places of Origin," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Below India and China, the third-largest source of STEM students in 2025 was South Korea, at just under 17,000, followed by Nepal (15,600), Taiwan (11,400), and Vietnam (10,800), a ranking that tracks neither population nor school quality. South Korea, a country of 52 million whose fifteen-year-olds scored 527 in mathematics on the 2022 Program for International Student Assessment (PISA), among the highest in the world, sends nearly as many STEM students as Nepal, a country of 30 million with no national PISA data but a well-documented record of weak secondary-exam outcomes.[18] Vietnam sends roughly the same number of students as Taiwan, though Taiwan's students outscored Vietnam's by nearly eighty points on the same assessment.

Trajectory tells the same story. South Korea's enrollment barely moved in fifteen years, decreasing from about 18,000 in 2010 to under 17,000 in 2025, while Nepal's more than tripled from 4,600 to over 15,000. Saudi Arabia ran the opposite course, peaking around 2016 and falling by more than half since, the steepest drop on the chart. What separates the rising lines from the flat and falling ones appears to be whether a country's own system can meet demand. Where strong domestic or regional options exist, as in South Korea and Taiwan, the flow to the United States has stalled, a theme we return to below.

Delving more deeply into country-level data, we find consistent field choices. Table 2.02 shows that nearly every country, whatever their size or origin, has moved students into math and computer science over the past fifteen years. In 2010, for example, about one in every ten Chinese students in the United States was studying computer science. By 2025, the number was one in four. The field migration from Indian students was even more significant. While fewer than 20 percent of Indian students in the United States were studying computer science in 2010, by 2025, more than 40 percent were. The gains run down the entire list and across countries with little else in common: Nepal's math-and-CS share climbed 18.6 percentage points, Taiwan's 13.1, Vietnam's 12.4, Pakistan's 10.4, and Nigeria's and Hong Kong's 9.9 apiece. All twenty-nine countries in the table increased their share, six of them by more than 10 percentage points, and in most the field at least doubled.

Table 2.02 Which Fields Are Gaining and Which Are Losing as a Share of Each Country's US-Bound Students?

	CHANGE IN SHARE OF THE COUNTRY'S U.S.-BOUND STUDENTS (PCT. POINTS)[1]							
	COMPUTING	SCIENCES	SOCIAL SCI.	ARTS	ENGG	HEALTH	EDU	BUSINESS
India	+23.6	−4.70	−0.900	−0.300	−16.0	−2.30	−0.400	−4.00
China	+12.9	−2.10	+3.60	+2.90	−2.40	−0.600	+0.100	−13.1
South Korea	+9.40	+1.00	+1.00	−1.40	+4.00	−0.400	−1.80	−5.10
Canada	+6.30	+3.00	−0.700	+0.800	+1.80	−5.90	−9.70	+3.30
Vietnam	+12.4	+1.90	+1.80	+0.800	+0.800	−0.100	−0.600	−16.3
Nepal	+18.6	+0.600	−1.70	−0.300	+2.20	+0.600	−0.200	−14.3
Taiwan	+13.1	−0.100	−1.60	+0.500	+4.30	−1.00	−4.40	−8.60
Nigeria	+9.90	+6.50	+0.300	+0.200	−5.70	−4.00	+0.900	−7.10
Bangladesh	+5.30	+1.60	+0.100	−0.900	−7.20	−0.400	0	−1.50
Brazil	+4.70	+4.80	+2.70	−1.00	+4.50	−1.40	−1.40	−7.50
Mexico	+3.00	+4.80	−0.100	+0.800	−0.400	+0.300	−1.20	−0.500
Japan	+4.60	+0.600	−1.20	−3.00	+3.00	−1.40	−1.80	−2.30
Pakistan	+10.4	+4.90	−0.100	−0.700	−3.50	−1.80	−0.700	−9.60
Ghana	+0.500	−0.500	−1.00	−0.100	+0.600	+0.400	+0.400	+0.400
Saudi Arabia	+1.40	+3.60	+2.90	+1.40	+6.40	+4.50	+0.800	−7.60
Iran	+2.50	+5.30	+0.600	+1.90	−14.0	+1.00	+0.900	+1.00
United Kingdom	+4.80	+0.400	+0.500	−0.900	+1.30	−0.900	−3.10	−0.400
Colombia	+3.60	+2.00	+0.400	+1.10	−1.50	−0.700	−1.50	−2.30
Turkey/Türkiye	+5.60	+1.00	+1.20	+2.00	+1.20	+0.200	−0.900	−6.80
Spain	+5.30	+3.40	−0.400	−5.50	+5.00	0	−0.800	+2.40
Germany	+3.20	+0.600	+2.70	−0.700	+0.200	−1.40	0	−0.900
France	+4.00	−1.00	+2.60	+0.300	+1.90	−1.00	−0.400	−6.40
Indonesia	+7.90	+3.10	+4.30	−1.20	−4.20	−1.30	+0.400	−15.3
Italy	+1.20	+0.100	0	+0.200	0	+0.100	+0.500	+0.100
Hong Kong	+9.90	+2.80	−0.800	+4.50	−0.300	+0.600	+0.600	−18.2
Kuwait	+1.90	+4.50	+3.00	+0.500	+5.10	+0.900	−0.200	+2.20
Russia	+0.700	−0.500	+0.800	+4.00	+0.600	−1.20	−0.700	+0.700
Thailand	+0.400	+2.10	+0.800	+5.20	−4.70	−0.100	−1.60	−3.10
Venezuela	+5.00	+0.200	+1.20	+2.80	+1.50	+0.100	−1.70	−5.60

[1] Cells show the change, in percentage points, in the share of each country's US-bound international students enrolled in the field, from the earliest to the latest year available: 2010 to 2025 for most countries, 2012 to 2025 for Iran, and 2018 to 2025 for Bangladesh. Red means the field gained share, blue that it lost. Column headings are abbreviated: Computing is mathematics and computer science; Sciences is physical and life sciences; Social Sci. is social sciences; Arts is fine and applied arts; Engg is engineering; Health is health professions; Edu is education. Columns run from the field gaining the most share across countries to the field losing the most; countries are ordered by total international enrollment, largest first.

Data from IIE, "Fields of Study of Students from Selected Places of Origin," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

The corresponding losses fell almost entirely on one field: business. Business and management fell in twenty-two of the twenty-nine countries. Where it fell, it fell significantly—Hong Kong down 18.2 percentage points, Vietnam 16.3, Indonesia 15.3, Nepal 14.3, China 13.1.

Engineering is the one field that doesn't move uniformly one way or another. India's engineering share fell from 38.8 percent to 22.8 percent, a drop of 16.0 percentage points. Similarly, Iran shed 14.0 points and Bangladesh 7.2. But in Saudi Arabia engineering rose 6.4 points, in Kuwait 5.1, in Spain 5.0, in Brazil 4.5—modest gains, nothing like the computing surge beside them, but gains all the same. No other field spans so wide a range. Whatever is pushing students away from engineering in South and East Asia is not operating on the Gulf.

This restructuring and its resulting concentrations are recent, and closely move with the labor market the degrees feed. For most of these countries computing barely registered as a destination in the early 2000s. Chinese and Indian students still went abroad chiefly for engineering, the field that had defined technical study since the postwar decades. The turn toward software began in earnest after 2010, as the smartphone economy and then the machine-learning boom pulled hiring toward programmers and data scientists, and American computer science departments built out the master's programs described earlier to meet the demand. A computer science master's degree increasingly offered international students both a valuable credential and a potential route into the American technology workforce.

The two cuts converge. By origin, the international student population is increasingly concentrated in India and China. By field, international students are increasingly concentrated in mathematics and computer science. The 6.1 percent international student headline conceals both developments. Spread across all of American higher education, international enrollment looks like a modest supplement. But, overall enrollment data counts a first-year art history survey course the same as a graduate machine-learning seminar, and the international presence in those two rooms has nothing in common. Examining which nations supply the most students and what most of those students study reveals growing geographic and field concentrations that are directly tied to technological innovation.

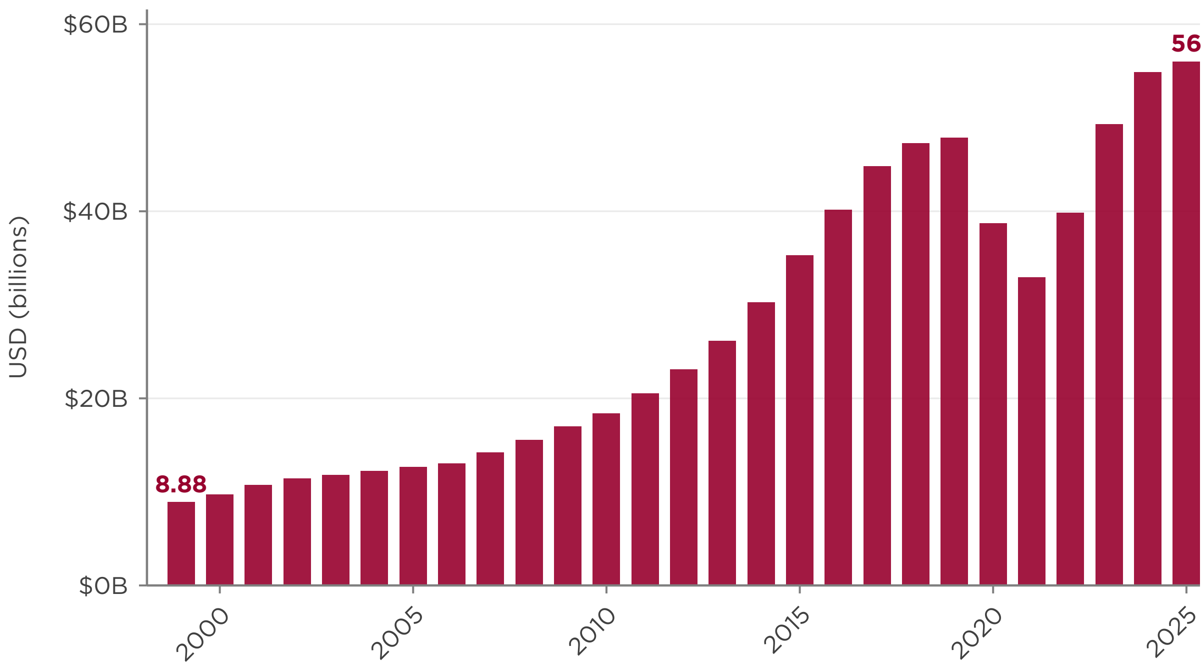
For universities, international enrollment is therefore not only a source of talent but also an important source of revenue—particularly in tuition-funded master's programs where international students more often pay in full.

It is worth noting that international students do more than supply talent to American universities. They also contribute to the US economy, through tuition, housing, and living expenses. The Department of Commerce classifies that spending as a services export, and on those books it outsells whole categories of American goods sent abroad, including soybeans, oil, and steel.

In 2025, international students contributed $56.0 billion to the US economy, up from $8.88 billion in 1999 (See Figure 2.05).[19] For universities, international enrollment is therefore not only a source of talent but also an important source of revenue—particularly in tuition-funded master's programs where international students more often pay in full.

The dependence documented in this chapter is therefore both intellectual and financial. International students supply large shares of the talent entering in strategically important fields, and their tuition and spending help sustain the universities and programs where that training occurs.

Figure 2.05 How Much Do International Students Contribute to the US Economy?

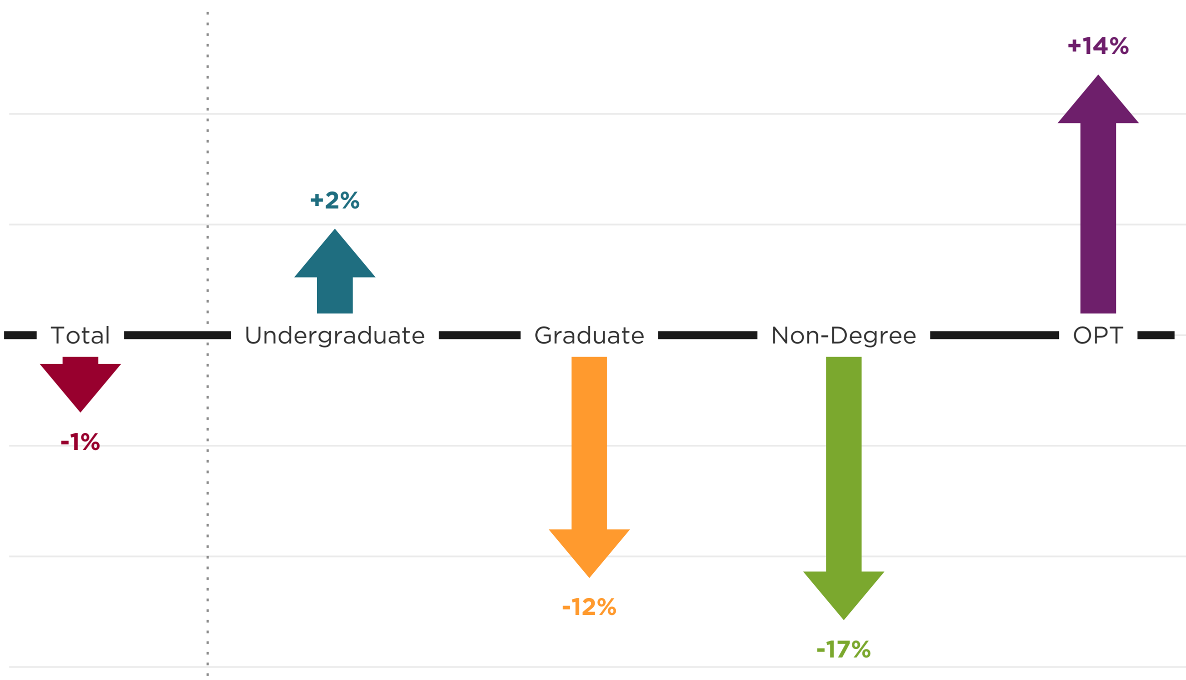


Data from US Bureau of Economic Analysis, "US Trade in Services," Table 2.1, line 21; first reported in Baer and Ekin, Fall 2025 Snapshot (IIE, 2025).
Chart by Emerson Johnston and Amy Zegart, Stanford University

A Look Ahead: International Enrollment in 2025

The Institute of International Education's *Fall 2025 Snapshot* offers a glimpse of how trends may unfold in the future. Each November it surveys 828 institutions—a subset of the roughly 3,000 covered by IIE's full Open Doors report, to be released in late 2026—together accounting for about 63 percent of all international students. The survey provides the first national read after a year of visa and travel-policy turbulence, and it suggests the redistribution this chapter has described is now running into a policy shock that most affects the stages this chapter identified as most consequential (See Figure 2.06).[20]

Figure 2.06 How Much Did International Enrollment Change in 2025?



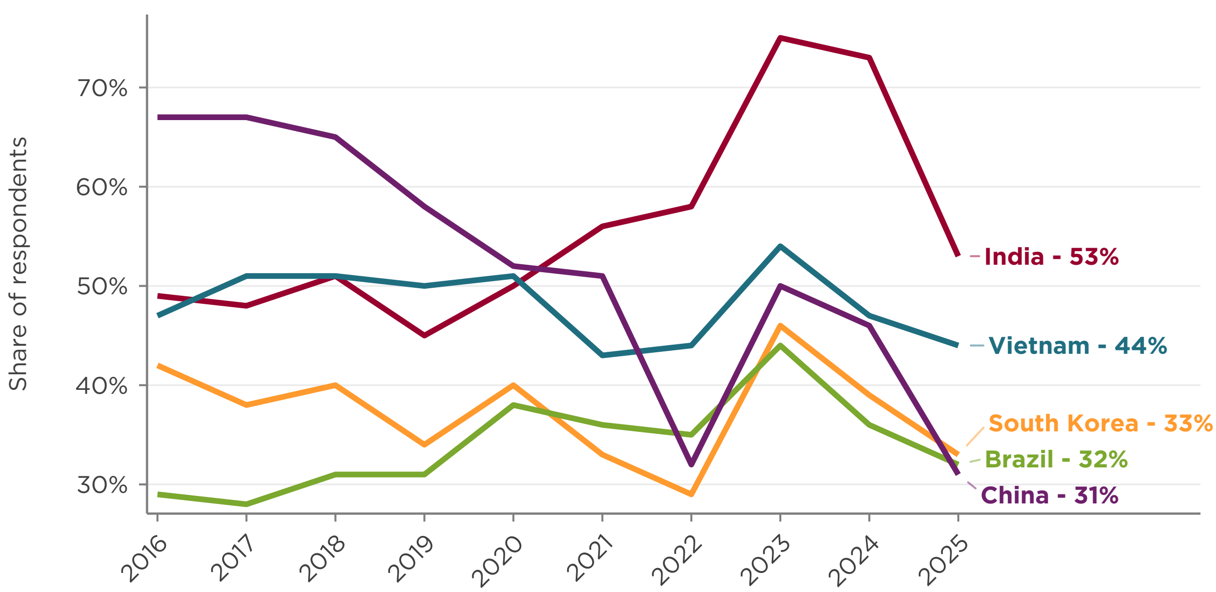
Data from IIE, Open Doors Fall 2025 Snapshot on International Student Enrollment, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The survey finds that international enrollment from 2024 to 2025 has remained stable, down about 1 percent overall. However, as Figure 2.06 shows, aggregate enrollment numbers again obscure important trends. Graduate enrollment at the surveyed institutions fell 12 percent, nearly the largest single-year drop on record, matched only by the 2020 pandemic year. New enrollment, the first-time students who are the leading edge of any trend, fell 17 percent, and 57 percent of institutions reported their international enrollment declining overall.[c]

Enrollment decline is concentrated at graduate entry, while Optional Practical Training enrollment (OPT), the post-graduate work stage, grew considerably. In other words, the graduate-trained population is not leaving the system so much as the pipeline that refills it is being constricted at the front end. The system remains tilted toward the graduate-and-after stages. What is new is friction at the point where students enter.

Where colleges and universities are recruiting talent from abroad is also changing. According to the survey, institutions named Vietnam and India as their top undergraduate and graduate recruitment targets in Fall 2025, with China sixth among undergraduate targets and outside the graduate top three (See Figure 2.07).

Figure 2.07 Where Are American Institutions Focusing Their Recruitment Efforts Abroad?



Data from IIE, Open Doors Fall International Student Enrollment Snapshots, 2016–2025
Chart by Emerson Johnston and Amy Zegart, Stanford University

Figures for 2023–2025 average the share of respondents citing each country as a recruitment priority across the undergraduate and graduate samples, which Open Doors began reporting separately after 2023.

c Figure 2.06 reproduces the academic-level breakdown reported in the IIE Fall 2025 Snapshot. The 17 percent decline in new enrollment cited above is reported separately in the Snapshot and does not correspond to any of the levels shown in the figure.

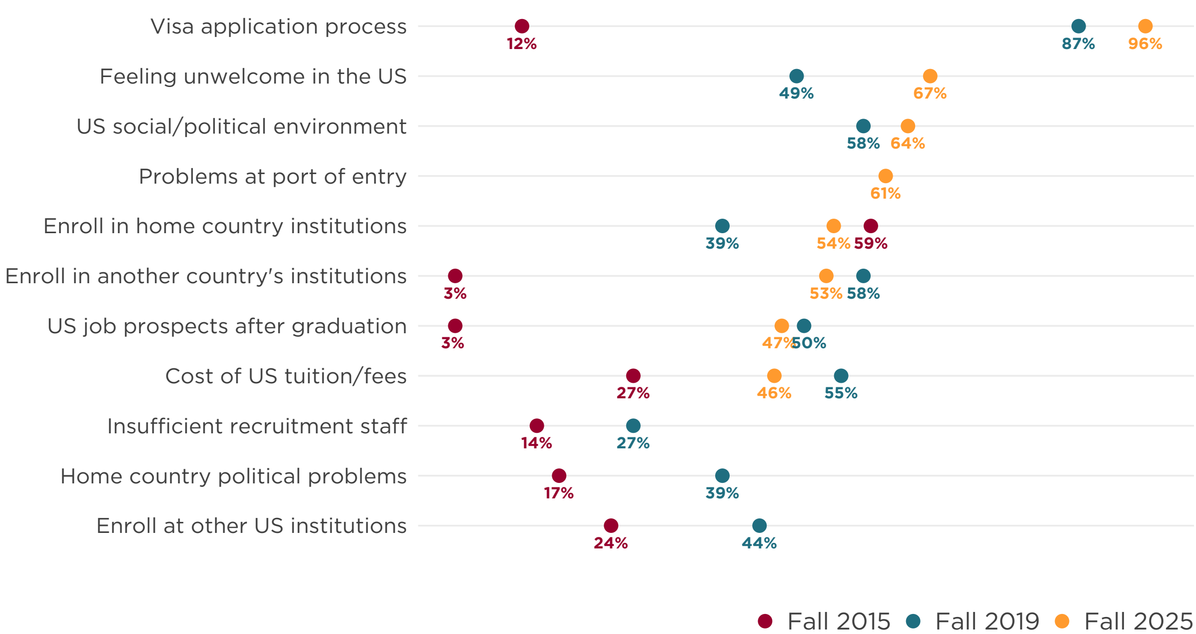
This reordering, much like the demographic shift described earlier, has been underway for a decade. In 2015, China towered over every other market, named by 65.8 percent of reporting institutions as a place they actively recruited, against 40.5 percent for India, and 28.9 for South Korea.[21] By 2020, China had slipped to 52.0 percent and India had climbed to 50.0, with Vietnam now wedged between them at 51.0.[22] It has since dropped to 31.0 percent for undergraduates, behind Vietnam, India, Brazil, South Korea, and Canada.

The market that led recruitment just ten years ago—by twenty-five points—now sits sixth. Recruitment is chasing the India-and-away-from-China trend the enrollment numbers documented, now reinforced by the schools' own outreach priorities.

The market that led recruitment just ten years ago—by twenty-five points—now sits sixth.

When asked what was driving international enrollments down, institutions in the survey point overwhelmingly to friction the United States controls directly (See Figure 2.08): the visa application process, cited by 96.0 percent, up from just 12.0 percent in 2015; US travel restrictions and problems at port of entry at 61.0 percent; and students feeling unwelcome at 67.0 percent, up from 49.0 percent in 2019.[d]

Figure 2.08 What Do Institutions Cite as the Reason for Decreasing International Enrollments?



Data from IIE, Open Doors Fall 2025 Snapshot on International Student Enrollment, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

d Institutions reporting enrollment gains most often credited their own recruitment effort (71 percent) and outreach to admitted students (54 percent), the mirror image of the recruitment-targeting pattern in Figure 2.07.

The Fall 2025 Snapshot is a preview, not a verdict. Again, it surveys a subset of institutions and measures a single fall against the prior one. Much of the policy that will come to shape enrollment numbers in 2025–26 was announced after admissions decisions were already made, so the Snapshot likely understates rather than overstates their effects. The direction, however, is clear.

The parts of the US talent machine that hold the most strategic value—graduate training in computing and the work that follows it—are also most exposed to changes in a visa regime. What the country built to draw the world's technical talent can be closed, quickly, from the inside, and the early data suggests that is beginning to happen.

What the Concentration Means

America's international talent pipeline is global in name but much narrower in practice. Nearly three-quarters of its students come from Asia, and India and China alone dominate graduate enrollment. And, students from every major source country are moving into the same cluster of fields: math and computing.

Concentration is not inherently weakness. It can reflect success: American universities have attracted large numbers of technically ambitious students from the world's two most populous countries and directed them toward fields where demand is high. These students enlarge American programs, strengthen university finances, and expand the pool of talent available to US research and industry.

But concentration also creates exposure. The United States does not control India's demographics, China's university policies, or the alternatives students encounter elsewhere. It does control whether its own universities remain attractive and whether applicants can enter. A major change affecting one or two countries—or a visa disruption that disproportionately, intentionally or otherwise, hits US STEM graduate programs—could therefore have consequences far larger than the 6.1 percent headline suggests.

This chapter has followed international talent to the university door: who comes, where they come from, and what they study. The next chapter begins where enrollment ends. It follows graduates into OPT, postdoctoral research, American companies, and entrepreneurship to ask how much of the talent trained in the United States enters the American workforce—and what happens to those who do not.

Chapter 2 Endnotes

1 Data in Table 2.01 are drawn from Institute of International Education, "International Students: All Places of Origin," data for 2000/01 to 2024/25, *Open Doors Report on International Educational Exchange*, 2025, https://opendoorsdata.org/data/international-students/all-places-of-origin/.

2 Data in Figures 2.01 and 2.02 are drawn from Institute of International Education, "International Students: Academic Level and Place of Origin," data for 2001/02–2024/25, *Open Doors Report on International Educational Exchange*, 2025, https://opendoorsdata.org/data/international-students/academic-level-and-places-of-origin/.

3 United Nations, Department of Economic and Social Affairs, "Population Division, World Population Prospects 2024," Online Edition (United Nations, 2024), https://population.un.org/wpp/.

4 United Nations, "World Population Prospects 2024."

5 United Nations, "World Population Prospects 2024."

6 Institute of International Education, "International Students: All Places of Origin," data for 1999/00–2024/25.

7 Ministry of Education of the People's Republic of China, "China to Further Promote the Double First-Class Initiative," press release, February 16, 2022, http://en.moe.gov.cn/news/press_releases/202203/t20220301_603547.html.

8 Christopher A. Wray, testimony before the US Congress, Senate, Select Committee on Intelligence, *Open Hearing on Worldwide Threats*, 115th Cong., 2nd sess., February 13, 2018, https://www.intelligence.senate.gov/hearings/open-hearing-worldwide-threats-0; Christopher A. Wray, testimony before the US Congress, Senate, Committee on the Judiciary, *Oversight of the Federal Bureau of Investigation*, 116th Cong., 1st sess., July 23, 2019, https://www.judiciary.senate.gov/imo/media/doc/Wray%20Testimony1.pdf; Christopher A. Wray, opening remarks at the Department of Justice China Initiative Conference, February 6, 2020, https://www.csis.org/analysis/fbi-director-christopher-wrays-opening-remarks-china-initiative-conference.

9 Larry Diamond and Orville Schell, eds. *China's Influence & American Interests: Promoting Constructive Vigilance* (Hoover Institution Press, 2019).

10 Yana Gorokhovskaia and Grady Vaughan, "Addressing Transnational Repression on Campuses in the United States" (Freedom House, 2024), https://freedomhouse.org/report/transnational-repression/2024/addressing-transnational-repression-campuses-united-states.

11 Amnesty International, "China: Overseas Students Face Harassment and Surveillance in Campaign of Transnational Repression" (Amnesty International, May 13, 2024), https://www.amnesty.org/en/latest/news/2024/05/china-overseas-students-face-harassment-and-surveillance-in-campaign-of-transnational-repression/.

12 Josh Lederman, "US to Shorten Length of Some Visas for Chinese Citizens," Associated Press, May 29, 2018, https://apnews.com/united-states-government-82a98fecee074bfb83731760bfbce515; see also Elizabeth Redden, "Chinese Officials Warn Students of Visa Problems If They Come to US," *Inside Higher Ed*, June 3, 2019, https://www.insidehighered.com/news/2019/06/04/chinese-officials-warn-students-visa-problems-if-they-come-us.

13 Proclamation No. 10043, "Suspension of Entry as Nonimmigrants of Certain Students and Researchers from the People's Republic of China," 85 Fed. Reg. 34353 (June 4, 2020), https://www.federalregister.gov/documents/2020/06/04/2020-12217/suspension-of-entry-as-nonimmigrants-of-certain-students-and-researchers-from-the-peoples-republic.

14 US Department of State, Bureau of Consular Affairs, "Table XVI: Nonimmigrant Visas Issued by Classification and Nationality (Including Border Crossing Cards), Fiscal Year 2024," Report of the Visa Office, 2024, https://travel.state.gov/content/dam/visas/Statistics/AnnualReports/FY2024AnnualReport/Table%20XVI.pdf; and "Table XVII: Nonimmigrant Visas Issued by Classification and Nationality, Fiscal Year 2019," *Report of the Visa Office*, 2019, https://travel.state.gov/content/dam/visas/Statistics/AnnualReports/FY2019AnnualReport/FY19AnnualReport-TableXVII.pdf. F-visa issuances to China (mainland) nationals fell from 107,974 in FY2019 to 84,437 in FY2024.

15 Data in Figure 2.03 are drawn from Institute of International Education, "International Students: Field of Study," data for 1998/99–2024/25, *Open Doors Report on International Educational Exchange*, 2025, https://opendoorsdata.org/data/international-students/fields-of-study/.

16 Improving and Expanding Training Opportunities for F-1 Nonimmigrant Students with STEM Degrees and Cap-Gap Relief for All Eligible F-1 Students, 81 Fed. Reg. 13040 (March 11, 2016) (codified at 8 C.F.R. pts. 214, 274a), https://www.federalregister.gov/documents/2016/03/11/2016-04828/improving-and-expanding-training-opportunities-for-f-1-nonimmigrant-students-with-stem-degrees-and.

17 Data in Figures 2.04 and Table 2.02 are drawn from Institute of International Education, "International Students: Fields of Study of Students by Place of Origin," data for 2009/10–2024/25, *Open Doors Report on International Educational Exchange*, 2025, https://opendoorsdata.org/data/international-students/fields-of-study-by-place-of-origin/.

18 National Examination Board (Nepal), "Secondary Education Examination (SEE) Results 2080 BS (2024)," Sanothimi, Bhaktapur, June 2024, https://edusanjal.com/news/see-result-2080-published/.

19 Data in Figure 2.05 are drawn from US Bureau of Economic Analysis, "Table 2.1. US Trade in Services, by Type of Service," line 21, International Transactions, International Services, and International Investment Position Tables, https://apps.bea.gov/iTable/; first reported in Julie Baer and Sumeyra Ekin, *Fall 2025 Snapshot on International Student Enrollment* (Institute of International Education, 2025), https://iie.widen.net/s/xd9xrsft6q/iie_fall-2025-snapshot_full-report.

20 Data in Figures 2.06, 2.07, and 2.08 are drawn from Baer and Ekin, *Fall 2025 Snapshot on International Student Enrollment*.

21 Institute of International Education, *Fall 2015 Snapshot on International Student Enrollment* (Institute of International Education, 2015), https://www.iie.org/wp-content/uploads/2023/02/Fall-Enrollment-2015-Report_Final.pdf.

22 Julie Baer and Mirka Martel, *Fall 2020 Snapshot on International Student Enrollment* (Institute of International Education, 2020), https://www.iie.org/wp-content/uploads/2022/12/Fall-2020-Snapshot-Report-Full-Report.pdf.

CHAPTER 3

From Campus to Work

How International Talent Powers American Research and Industry

HOOVER INSTITUTION | Stanford University

HAI Stanford University Human-Centered Artificial Intelligence

Chapter 3

From Campus to Work

How International Talent Powers American Research and Industry

FIGURES

TABLES

Chapter 3

Key Takeaways

1. **OPT has become a major bridge from American campuses into the workforce.** In 2025, 294,000 international graduates, or 25 percent of the international student population, were working through OPT, up from 9.10 percent in 2008. But the bridge is a short one. It opens the first door into American employment but doesn't provide a permanent route to remain.

2. **International STEM graduates conduct much of the research inside American laboratories, including federally funded ones.** Temporary visa holders account for 68.0 percent of engineering postdocs, 57.3 percent of science postdocs overall, and 55.4 percent of postdocs at federally funded research and development centers. This is not a recent shift the way graduate enrollment is—postdoctoral research has been majority-international for decades.

3. **As with graduate enrollment, international talent is concentrated in strategically important technical fields.** Temporary visa holders hold 13.7 percent of computer and mathematical science jobs but only 3.27 percent of non-scientific ones.

4. **Producing more domestic STEM graduates will not automatically produce proportionately more STEM workers.** Of all STEM bachelor's graduates from US universities, domestic and international combined, only 44.0 percent worked in STEM occupations in 2023. The conversion recurs at higher degree levels but splits widely by origin: at the doctorate, 75.9 percent of foreign-born degree holders worked in STEM, against 56.7 percent of US-born ones.

5. **The H-1B system is broadening and shifting toward American product companies.** In professional and technical services, the ten largest employers' share of approvals fell from 72.3 percent in 2012 to 51.5 percent in 2025. Behind that broadening is a change in who the top employers are, as outsourcing firms such as Cognizant lost an average of 6.70 percentage points of approval share between 2017 and 2025 while end employers such as Google gained an average of 4.60.

6. **International talent creates American companies as well as staffs them.** In 2025, 65.1 percent of Forbes AI 50 companies had at least one immigrant founder, and that pattern strengthens at the top of the market. Every firm worth $100 billion or more had at least one immigrant founder.

7. **Concerns about research security have grown.** A 2026 White House report explicitly casts the United States' reliance on foreign students as a national-security vulnerability. But the policies meant to reduce that risk carry risks of their own, because a researcher deterred from coming, or pushed out once trained, is a loss the domestic pipeline cannot quickly replace.

Chapter 3 – By the Numbers:

MEASURE	2000	2025	CHANGE	
WHERE INTERNATIONAL STUDENTS SIT IN THE TALENT PIPELINE				
Enrolled in bachelor's programs	177,000	**301,000**	+69.7%	▲
Enrolled in master's programs	111,000	**306,000**	+176%	▲
Enrolled in doctoral programs	72,900	**153,000**	+110%	▲
Enrolled in professional programs	9,480	**16,300**	+72.4%	▲
Enrolled in non-degree programs	34,400	**37,800**	+9.77%	▲
Participating in Optional Practical Training (OPT)	24,900	**294,000**	+1,080%	▲
INTERNATIONAL TALENT IN RESEARCH				
Temporary visa holder share of science postdocs	57.1%	**57.3%[2024]**	+0.2 pp	▲
Temporary visa holder share of engineering postdocs	67.7%	**68%[2024]**	+0.3 pp	▲
Temporary visa holder share of health postdocs	47.1%	**55.7%[2024]**	+8.6 pp	▲
Temporary visa holder share of postdocs at FFRDCs*	58.6%[2012]	**55.4%[2023]**	-3.2 pp	▼
STEM DEGREE TO STEM JOB CONVERSION RATES				
Overall, average	61.2%[2003]	**52.5%[2023]**	-8.7 pp	▼
Bachelor's STEM degree holders in STEM jobs	53.8%[2003]	**44%[2023]**	-9.8 pp	▼
Master's STEM degree holders in STEM jobs	66.4%[2003]	**59.3%[2023]**	-7.1 pp	▼
Doctorate STEM degree holders in STEM jobs	78.8%[2003]	**68.4%[2023]**	-10.4 pp	▼
US-born, average	26.7%[2003]	**31.9%[2023]**	+5.2 pp	▲
US-born bachelor's degree holders in STEM jobs	25%[2003]	**30.4%[2023]**	+5.4 pp	▲
US-born master's degree holders in STEM jobs	27.7%[2003]	**32%[2023]**	+4.4 pp	▲
US-born doctorate degree holders in STEM jobs	52.3%[2003]	**56.7%[2023]**	+4.4 pp	▲
Foreign-born, average	40.8%[2003]	**46.6%[2023]**	+5.8 pp	▲
Foreign-born bachelor's degree holders in STEM jobs	34.3%[2003]	**39.3%[2023]**	+5.0 pp	▲
Foreign-born master's degree holders in STEM jobs	45%[2003]	**50.9%[2023]**	+6.0 pp	▲
Foreign-born doctorate degree holders in STEM jobs	70.4%[2003]	**75.9%[2023]**	+5.5 pp	▲
TEMPORARY-VISA CONCENTRATION BY OCCUPATION				
Computer and mathematical scientists	16.6%[2017]	**13.7%[2023]**	-2.9 pp	▼
Engineers	11.2%[2017]	**8.93%[2023]**	-2.2 pp	▼
Biological and life scientists	17.2%[2017]	**13.7%[2023]**	-3.5 pp	▼
Physical scientists	11.3%[2017]	**9.39%[2023]**	-1.9 pp	▼
H-1B EMPLOYER CONCENTRATION				
Top 10 employers' share of H-1B approvals	55.2%[2009]	**51.5%**	-3.8 pp	▼
Largest riser — Google	2.18%[2017]	**8.34%**	+6.2 pp	▲
Second-largest riser — LTIMindtree	0%[2017]	**3.29%**	+3.3 pp	▲
Largest faller — Cognizant	22.1%[2017]	**5.97%**	-16.1 pp	▼
Second-largest faller — Infosys	10.7%[2017]	**4.37%**	-6.4 pp	▼

* FFRDCs = federally funded research and development centers.

Note: Historical comparisons use 2000 and 2025 observations. Superscript years mark rows with a later start points or earlier endpoints. Average rows are population-weighted across degree levels. Arrow colors indicate direction of change only.

Source: Derived from the current report Figures and Tables: Figures 3.01–3.06 and Tables 3.01–3.03.

Chapter 2 followed international talent into American universities and asked where those students come from and what they study. But attracting and educating talent is only the beginning. America benefits also when those graduates put their training to work—in university laboratories, established companies, and firms of their own.

This chapter begins at that transition. It follows international graduates from the classroom into Optional Practical Training (OPT) and postdoctoral research, then into the companies they staff and found. The question is no longer who comes to study. It is what international talent contributes after graduation.[a]

a This chapter draws on datasets that classify international talent differently. "OPT participants" are international graduates who are working while remaining on F-1 student visas. "Temporary visa holders" include workers and researchers without permanent US status. "Foreign-born" is the broadest category, including temporary visa holders, permanent residents, and naturalized US citizens, whether or not they studied in the United States. These categories should not be treated as interchangeable. For more information on these differences, see Appendix A.

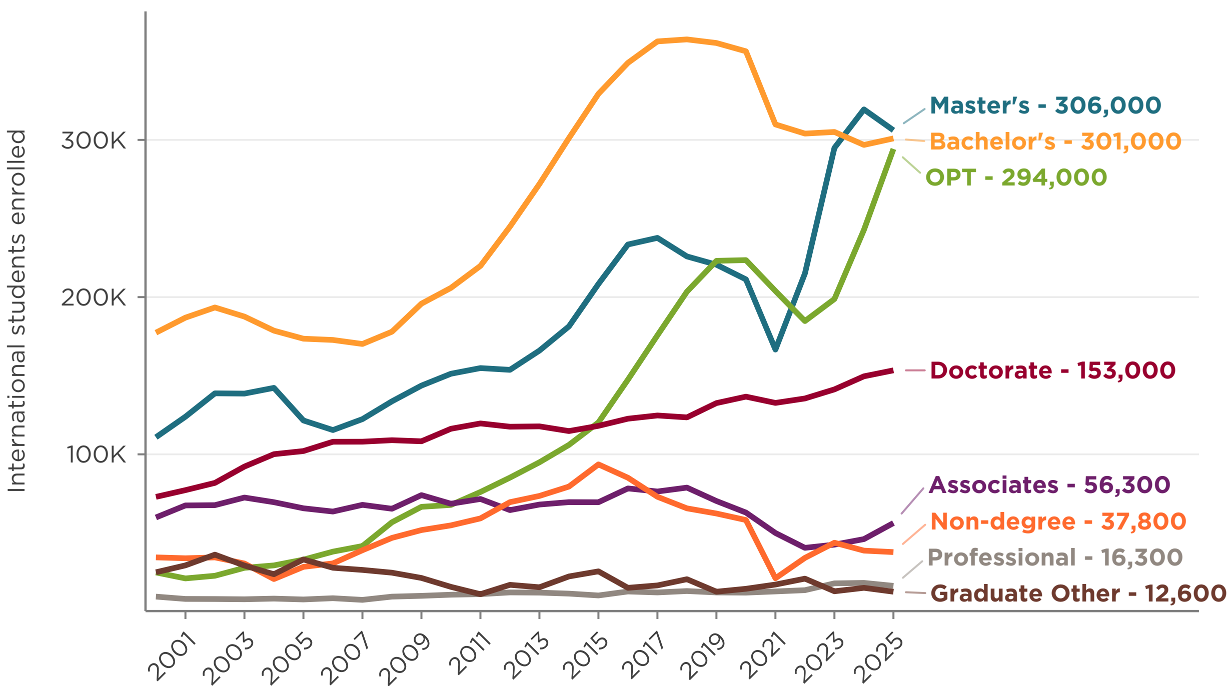
OPT: The Bridge from Campus to Work

For most international graduates, the first bridge from an American degree to an American job is OPT, which allows graduates to work in a field related to their degree for twelve months while remaining in F-1 student status. Today, graduates in qualifying STEM fields can receive an additional twenty-four months, giving them up to three years of work authorization.[b]

OPT has grown from a small appendage of the international student system into one of its largest components (See Figure 3.01).[1] In 2008, OPT participants accounted for approximately 9.1 percent of the international student population. By 2025, their share had reached roughly 25 percent, or 294,000 graduates—nearly as many international students as were enrolled in American bachelor's or master's programs.[c]

That growth changes how the international talent pipeline should be understood. The population is no longer concentrated only inside universities. Hundreds of thousands of graduates are also working in American companies and laboratories.

Figure 3.01 Where Is International Talent in the Education-to-Work Pipeline?



Data from IIE, "International Students by Academic Level," Open Doors, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

b The OPT system was changed in 2016 to lengthen the STEM extension from seventeen months to twenty-four, which gives a computer-science graduate thirty-six months of work authorization in total where most other graduates have twelve.

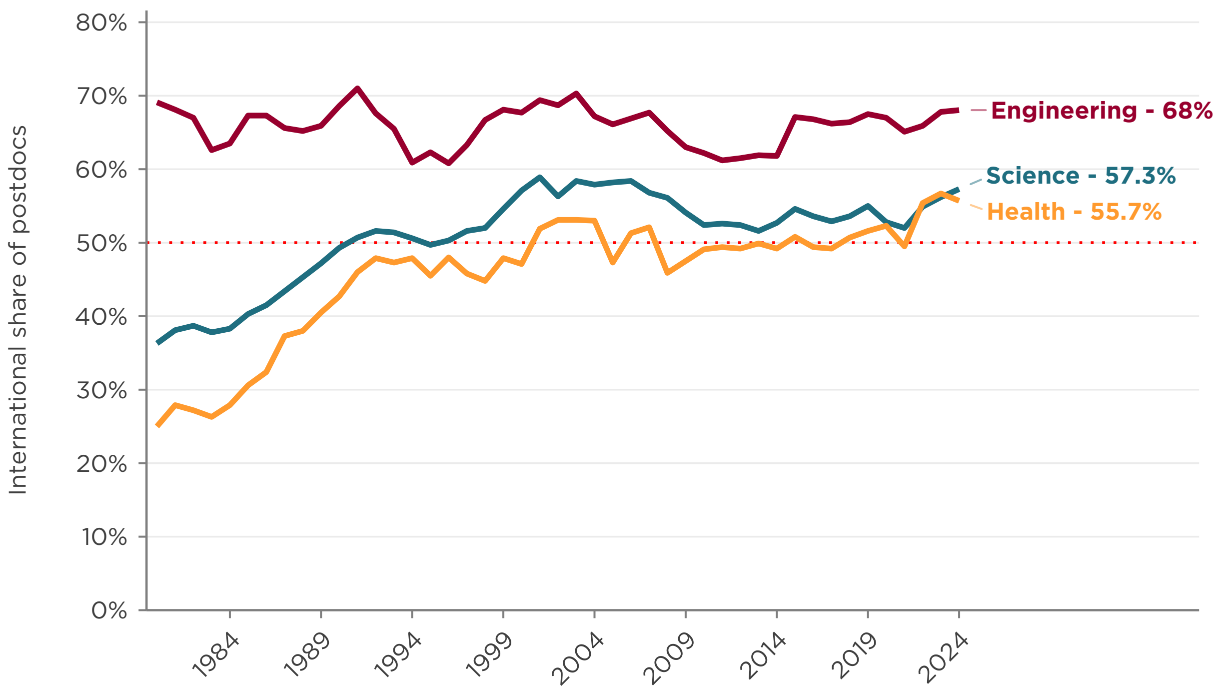
c OPT opens the first door into the American workforce. It does not provide a permanent way to remain. Chapter 6 examines what happens when that temporary bridge ends. In this chapter, the question is where graduates go while the door remains open.

The Other First Job: Postdoctoral Research

For many STEM PhDs, the first job after graduation is a postdoctoral appointment—the apprenticeship stage between doctoral education and an independent research career. Postdocs staff the benches of university labs, running experiments, publishing papers, and training the graduate students beneath them. So, while doctoral degrees show who the United States is training, postdoctoral appointments show who is conducting much of the research inside American laboratories.

International researchers dominate this stage. In 2024, temporary visa holders accounted for 68.0 percent of all postdocs in engineering, 57.3 percent in the sciences, and 55.7 percent in health and medicine—the fields where they have historically held the smallest share (See Figure 3.02).[2] Unlike graduate enrollment or doctoral degrees, where the international share crossed the halfway mark only recently in some fields, postdoctoral research has been majority international for decades.

Figure 3.02 How International Are US Postdoctoral Researchers, by Field?



Data from NCSES, Survey of Graduate Students and Postdoctorates in Science and Engineering, 1994–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University

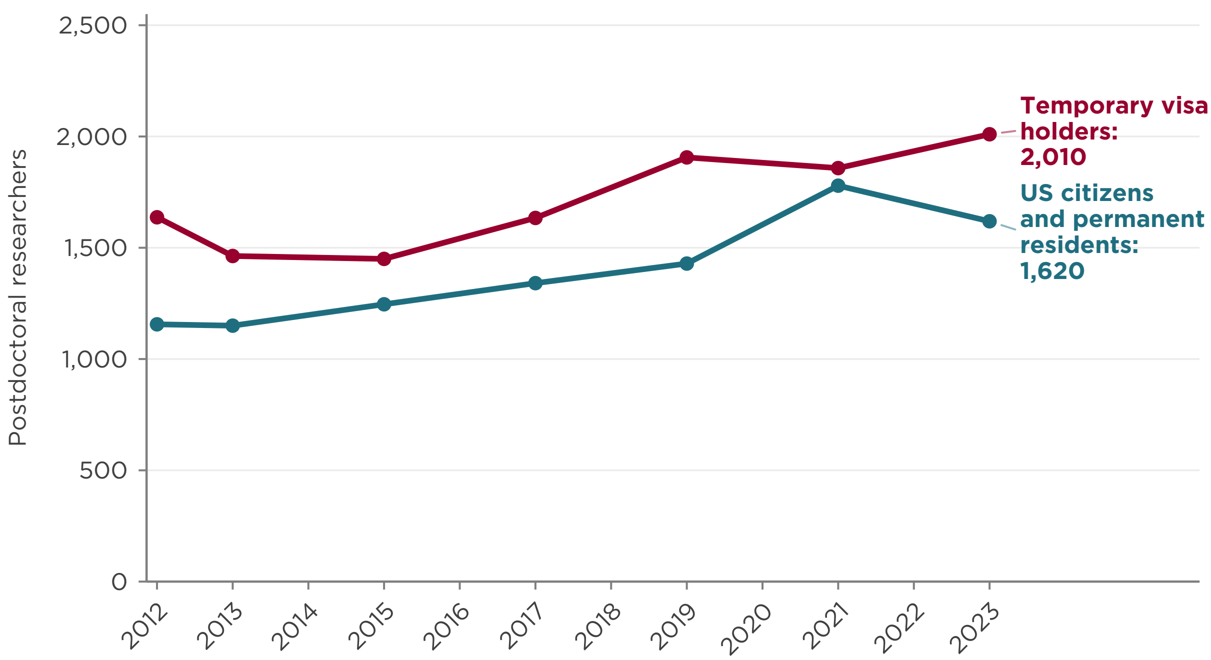
The concentration reflects both the economics and immigration value of postdoctoral work. Postdocs offer several years of full-time research at salaries generally well below industry alternatives, with no guarantee of a faculty position afterward. For international graduates, an appointment also provides continued access to American laboratories, additional experience, and time to pursue a longer-term immigration pathway. Universities and qualifying nonprofit or government research organizations can sponsor cap-exempt H-1B petitions, making academic research one of the few employment routes not constrained by the annual lottery.[d]

Postdoctoral research has consequently become one of the most international parts of the American scientific workforce. There, international talent does not merely train in American laboratories; they conduct the experiments, they publish papers, and they sustain research programs.

International talent inside government-supported laboratories

The pattern extends beyond universities. In 2023, temporary visa holders accounted for 55.4 percent of postdoctoral researchers at federally funded research and development centers—government-sponsored laboratories that conduct research for agencies such as the Department of Energy, the Department of Defense, and National Aeronautics and Space Administration. Their share declined from 58.6 percent in 2012, but their absolute number rose from 1,640 to 2,010. US citizens and permanent residents also increased, from 1,160 to 1,620. In other words, the postdoctoral workforce expanded for both US citizens and temporary visa holders, resulting in rising counts across both populations even as shares shifted slightly (See Figure 3.03).[3e]

Figure 3.03 Who Holds Postdoctoral Positions at Federally Funded Research Centers?



Data from NCSES, Postdocs at Federally Funded R&D Centers, 2012–2023.
Chart by Emerson Johnston and Amy Zegart, Stanford University

d See Chapter 6 for more information on the H-1B lottery.

e Note that these figures apply to postdocs, not the entire federal-laboratory workforce. Citizenship requirements limit who may perform classified or export-controlled work. But international researchers remain heavily represented in the unclassified fundamental science that supports many government research missions. The reliance documented inside universities therefore extends into institutions created to serve public and national-security purposes.

From Research to Industry

OPT and postdoctoral appointments reveal the two principal routes out of American universities: One leads directly into industry, the other into additional research by way of academia. Both ultimately feed the same larger system. International graduates staff American technology companies, conduct corporate research, and supply expertise in fields where the domestic workforce remains comparatively thin.

A STEM degree is not the same thing as a STEM career, and the gap between the two is wider than many assume. Over time, the United States has become less efficient at turning its STEM graduates into STEM workers. In 1993, 72.1 percent of students who graduated from US universities with a STEM doctorate, regardless of country of origin or citizenship status, worked in a STEM occupation, but by 2023 that share had fallen to 68.4 percent (See Table 3.01).[4] The master's slipped from 60.6 percent to 59.3 percent, and the bachelor's from 46.6 percent to 44.0 percent. The declines are not large, but they run in the same direction: Across thirty years, a STEM degree of any kind for a student trained in the United States became a somewhat weaker predictor that its holder would end up doing STEM work.

Across thirty years, a STEM degree of any kind for a student trained in the United States became a somewhat weaker predictor that its holder would end up doing STEM work.

Table 3.01 **What Share of US-Trained STEM Graduates Work in STEM Occupations?**

	SHARE EMPLOYED IN STEM[1]				
	1993	2003	2013	2023	CHANGE
Bachelor's	46.6%	53.8%	44.2%	44%	−2.5 pp
Master's	60.6%	66.4%	62%	59.3%	−1.3 pp
Doctorate	72.1%	78.8%	74.1%	68.4%	−3.7 pp

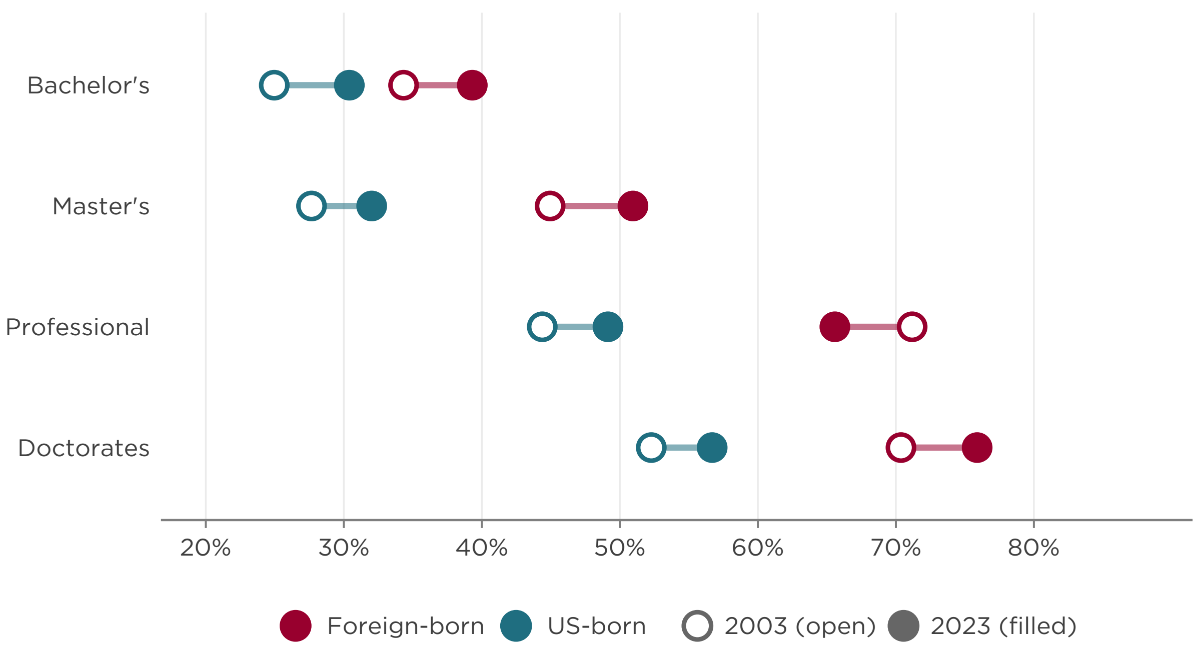
[1] Each year column is the share of graduates at each degree level employed in a STEM occupation. Change is the percentage-point change from 1993 to 2023.

Data from NCSES, National Survey of College Graduates.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

Even at its 2003 peak, a bachelor's degree in a STEM field sent just over half its holders into STEM jobs.[f] The graduate degrees do better—most master's and doctorate holders do work in the field—but the bachelor's, the credential the country produces in by far the largest volume, has almost always leaked more graduates than it keeps.

The picture obscures important differences between US-born and foreign-born students. Grouped by their highest degree earned, foreign-born graduates work in STEM at higher rates than the US-born graduates, and the gap widens as the credential rises. Among doctorates the gap is close to twenty points: 75.9 percent of foreign-born PhDs work in a STEM occupation, compared to 56.7 percent of American-born ones (See Figure 3.04).[g] This means that among the roughly 900,000 PhD holders who are foreign-born in the STEM workforce, approximately 683,000 work in core STEM occupations. If those workers departed and were replaced by domestic PhDs following domestic employment patterns, only about 510,000 of the replacements would work in STEM roles. That's a net loss of 173,000 positions at the highest skill level.[h]

Figure 3.04 How Does STEM Employment Differ Between US-Born and Foreign-Born Graduates?



Data from NCSES, National Survey of College Graduates.
Chart by Emerson Johnston and Amy Zegart, Stanford University

f That gap between degrees and jobs is not an artifact of recent data. Salzman and Lowell counted it in 2007, when American colleges were producing far more science and engineering graduates each year than the economy hired, and Teitelbaum's history of American shortage scares found the same surplus in every postwar cycle he examined. The country has trained more STEM graduates than it employs in STEM for as long as anyone has measured the two against each other. For more information see Michael Teitelbaum, *Falling Behind? Boom, Bust, and the Global Race for Scientific Talent* (Princeton University Press, 2014); the short version is his 2014 Atlantic piece, https://www.theatlantic.com/education/archive/2014/03/the-myth-of-the-science-and-engineering-shortage/284359/; Daniel Kuehn and Hal Salzman, "The Engineering Labor Market: An Overview of Recent Trends," in *US Engineering in a Global Economy* (University of Chicago Press, 2018): 11–46, https://www.nber.org/system/files/chapters/c12684/c12684.pdf.

g The 68.4 percent blended figure from Table 3.01 is an average of those two very different rates, pulled upward by the foreign-born graduates who convert at three-quarters and dragged down by the domestic ones who convert at barely more than half.

h (683,100 = 900,000 × 0.759; 510,300 = 900,000 × 0.567; difference 172,800. Rounded to 683,000 / 510,000 / 173,000.)

This data suggest that America could not easily reduce its reliance on foreign talent by training more of its own students, because STEM degrees do not reliably turn into STEM careers at the same rates. Adding degrees at the front of the pipeline does not produce commensurate increases in the number of workers at the end.

There are several potential reasons for these trends. Among them, a foreign-born graduate who remains in the country typically does so on a status that is conditioned on employment in the field the degree certifies. For them, leaving STEM can mean leaving the country. The same is not true for the US-born graduates who have far more freedom to enter and exit a wider range of fields.

Selection compounds the effect. The foreign-born STEM workforce is drawn disproportionately from the graduate levels, where conversion is highest for everyone, and from the strategic fields—computer science, engineering—where degrees lead most directly into technical work. A US-born STEM population that includes far more bachelor's holders, spread across far more fields, will convert at a lower average rate almost by design.

The choices differ too. An American graduate with a quantitative degree faces a labor market that pays well for those skills outside of STEM, in careers such as finance and management consulting. The foreign-born graduate more often does not have that option to exercise.

You cannot replace an international PhD with a domestic PhD one-for-one, because domestic PhDs are substantially less likely to work in STEM.

...foreign talent is thinnest in non-technical work done by bachelor's holders and thickest in technical work done by PhDs.

None of these reasons is the whole story. But the unmistakable pattern is that America's STEM workforce leans on its foreign-born graduates not because they are more numerous—they are not—but because a larger share of the ones trained actually end up doing the work. You cannot replace an international PhD with a domestic PhD one-for-one, because domestic PhDs are substantially less likely to work in STEM. The 19-percentage-point gap in STEM education-to-employment conversion rates means every international PhD who leaves takes a fraction of a position with them that no domestic replacement fills.

In short, the domestic pipeline is wider but leakier. It supplies most of the workforce only because it starts so much larger. But the further up the credential ladder one looks, the more the balance shifts, resulting in a system where foreign talent is thinnest in non-technical work done by bachelor's holders and thickest in technical work done by PhDs—the computer science and engineering fields Chapters 1 and 2 found majority-international at the doctorate level.

Where temporary visa holders concentrate

The country's dependence on visa workers is not spread thinly across the labor market. Instead, it is concentrated in a handful of occupations, and they are the ones closest to the research bench. Of every hundred people employed as computer or mathematical scientists in the United States, roughly fourteen are in the country on a temporary visa. For biologists the figure is nearly the same. Move to the other edge of the technical economy—the sales, management, and other non-scientific occupations that employ most of the workforce—and it falls to three (See Table 3.02).

Table 3.02 How Concentrated Are Temporary Visa Holders in STEM Occupations?

	TEMPORARY VISA HOLDER SHARE[1]				
	2017	2019	2021	2023	CHANGE
Computer/math scientists	16.6%	15.5%	11.6%	13.7%	−2.9 pp
Engineers	11.2%	9.51%	9.17%	8.93%	−2.2 pp
Biological scientists	17.2%	15.6%	16%	13.7%	−3.5 pp
Physical scientists	11.3%	12.7%	18.8%	9.39%	−1.9 pp
Social scientists	4.8%	6.08%	6.93%	6.82%	+2.0 pp
S&E-related occupations	5.67%	5.67%	5.72%	5.41%	−0.3 pp
Non-S&E occupations	3.22%	3.3%	3.55%	3.27%	+0.1 pp

[1] Each year column is the temporary visa holder share of employment within each STEM occupation category. Change is the percentage-point change from 2017 to 2023. Rows are ordered from occupations most directly tied to science and engineering to those least tied.

Data from NCSES, National Survey of College Graduates.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

In 2017, in each of the four hard science occupations—computer and mathematical scientists, engineers, biologists, physical scientists—more than a tenth of the people employed were temporary visa holders, from 11.2 percent up to 17.2 percent. In the same year, the share sat below 6 percent for all three of the non-science categories: social scientists at 4.8 percent, science-and-engineering-related occupations at 5.7 percent, non-S&E occupations at 3.2 percent.

Over the last six years, that share fell in every technical field. Each of the four hard-science occupations dropped between 1.9 and 3.5 percentage points, roughly a fifth of its 2017 level, and the only gains came in the social sciences and non-S&E occupations.[i]

The declines across STEM fields are easy to misread as the country needing fewer foreign scientists. The enrollment data suggests the opposite. International enrollment did not fall over these years; it rose, and the strategic fields drew the largest inflows of all. More students arrived to study computer science and engineering even as the visa-holder share of those same occupations shrank in the workforce. Studying in America and working in America are becoming more like two separate paths rather than one pipeline.

i It's also worth noting how much the year-to-year path can mislead. Physical sciences are the clearest case. The share rose from 11.3 percent in 2017 to 12.7 percent in 2019, then peaked at 18.8 percent in 2021—nearly one physical scientist in five on a temporary visa—before falling to 9.4 percent by 2023. If you were to read only the middle years, physical sciences would look like the fastest-internationalizing field in the table. Read only the endpoints, you'd simply see a net decline of 1.9 percentage points. A few years seen in isolation can tell the opposite story from the full span.

Studying in America and working in America are becoming more like two separate paths rather than one pipeline.

The gap between the two is largely the result of H-1B tightening. The country has kept admitting students to its classrooms, but has made it harder for them to stay once they leave, even as it has extended OPT authorization for STEM degree holders. Concern about technology transfer has also driven a decade of research-security policy, from mandatory disclosure of foreign funding to certifications against foreign talent-recruitment programs.[5] Most recently, the United States' dependence on foreign students was explicitly cast as a national security vulnerability.[6]

The concern is legitimate—foreign governments do recruit researchers trained in the United States—but the tools meant to reduce that risk carry a risk of their own.[7] A researcher deterred from coming, or pushed out once trained, is a loss the domestic pipeline cannot quickly replace.

The H-1B employer story

The Immigration and Nationality Act of 1952 created a visa system where high-skilled temporary workers could enter the United States under a single H-1 category, designated for people of "distinguished merit and ability". It was a catch-all that held nurses, professors, entertainers, and athletes alongside engineers.[8] The Immigration Act of 1990, which passed with bipartisan support, refined the categories. Nurses went to a new H-1A, entertainers and athletes to the O and P visas, and what remained was renamed the H-1B and redefined around "specialty occupations," meaning jobs requiring a bachelor's degree in a specific field.[9] These typically included software engineers, financial analysts, researchers, and the like. The same statute imposed a numerical cap on new admissions for the first time, set at 65,000, and created the labor condition application that obliges an employer to pay the prevailing wage. Congress expected the ceiling to be enough.

It was, for about seven years. The cap was first exhausted in 1997, as the internet boom created more demand for programmers than American universities were producing, and the technology industry began lobbying to raise it.[10] Congress lifted the ceiling to 115,000 and then to 195,000 through the early 2000s, before reducing it to 65,000 in 2004, where it has remained.[11] A separate exemption added 20,000 slots for graduates of American master's and doctoral programs.[12] Since then, the cap has not moved even as demand has grown substantially. By fiscal year 2025, employers filed more than 470,000 registrations for those 85,000 slots.[13j]

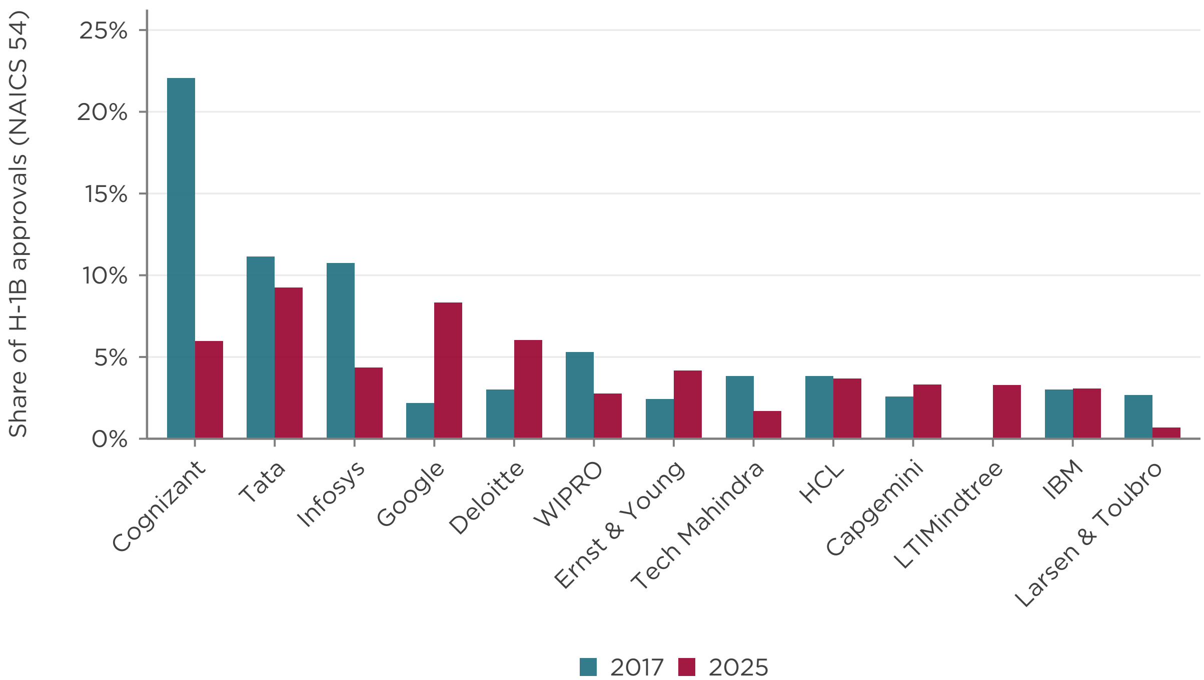
When petitions exceed the cap, the government fills them by lottery, and the design of that lottery shapes everything. Prior to February 2026, selection was random, meaning that a petition for a distinguished researcher had the same odds as one for an entry-level programmer. Such a design also rewarded volume. A firm that submitted ten thousand petitions won, on average, ten thousand times as many as a firm that submitted one.

For two decades, a handful of Indian software-services companies, including Tata Consultancy Services, Infosys, and Wipro, dominated the lottery process. They made their living by sending engineers to work onsite at Western client offices.[14] These firms filed H-1B petitions

j The registration and petition figures in this report describe different stages of the H-1B process and different cycles. The 85,000 slots are the statutory cap—65,000 general visas plus a 20,000 exemption for holders of US advanced degrees. The US Citizenship and Immigration Services (USCIS) selects well more than 85,000 registrations each year, roughly 135,000 in the most recent cycle, because many selected registrations never convert into a filed or approved petition. The 470,000 count also reflects the implementation of the beneficiary-centric selection rule that ended multiple registration—which is why the number fell by just under 300,000 from 2024 without demand falling. For more information see 89 Fed. Reg. 7456 (Feb. 2, 2024).

in bulk, won a proportional share of the cap, and contracted the resulting workers out to American clients who wanted technical labor without sponsoring visas themselves. In 2017, the ten largest H-1B recipients in professional and technical services took 68.2 percent of all approvals in the sector, and Cognizant, a New Jersey-headquartered IT-services firm that runs much of its delivery from India, alone accounted for 22.1 percent (See Figure 3.05).[15]

Figure 3.05 Which Employers Receive the Most H-1B Approvals?



Data from USCIS, H-1B Employer Data Hub, 2009–2026.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Starting around 2017, increasing denial rates, greater scrutiny of bulk lottery filing, and changing lottery design widened the concentration of winning firms and changed who won.[16] By 2025, Indian information services firms saw dramatic declines, while product firms like Google and Deloitte gained. The distribution of companies receiving H-1B visas for international workers also widened significantly. In 2012, the ten largest employers received 72.3 percent of visas, but by 2025, they accounted for just over half (51.5 percent) (See Figure 3.06 and Table 3.03).

Figure 3.06 Are H-1B Approvals Still Concentrated Among a Few Employers?

Data from USCIS, H-1B Employer Data Hub, 2009–2026.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Table 3.03 How Has the Mix of Top H-1B Employers Changed?

	2017	2025	CHANGE[1]
Google Inc	2.18%	8.34%	**+6.2 pp**
Ltimindtree Limited	0%	3.29%	**+3.3 pp**
Deloitte and Subsidiaries	3.02%	6.04%	**+3.0 pp**
Ernst & Young LLP	2.42%	4.16%	**+1.7 pp**
Capgemini America Inc	2.59%	3.3%	**+0.7 pp**
IBM and Subsidiaries	3.01%	3.06%	**+0.0 pp**
HCL Technologies Limited and Subsidiaries	3.82%	3.68%	**−0.1 pp**
Tata Consultancy Services Limited	11.2%	9.26%	**−1.9 pp**
Larsen & Toubro Infotech Limited	2.66%	0.681%	**−2.0 pp**
Tech Mahindra Americas Inc	3.84%	1.69%	**−2.2 pp**
Wipro Limited	5.31%	2.76%	**−2.5 pp**
Infosys Limited	10.7%	4.37%	**−6.4 pp**
Cognizant Technology Solutions US Corp	22.1%	5.97%	**−16.1 pp**

[1] Share of all H-1B approvals in NAICS 54 (professional, scientific, and technical services). Firms shown ranked among the ten largest employers in 2017 or 2025. Change is the percentage-point change in share from 2017 to 2025.

Data from USCIS, H-1B Employer Data Hub, 2009–2026
Chart by Emerson Johnston and Amy Zegart, Stanford University.

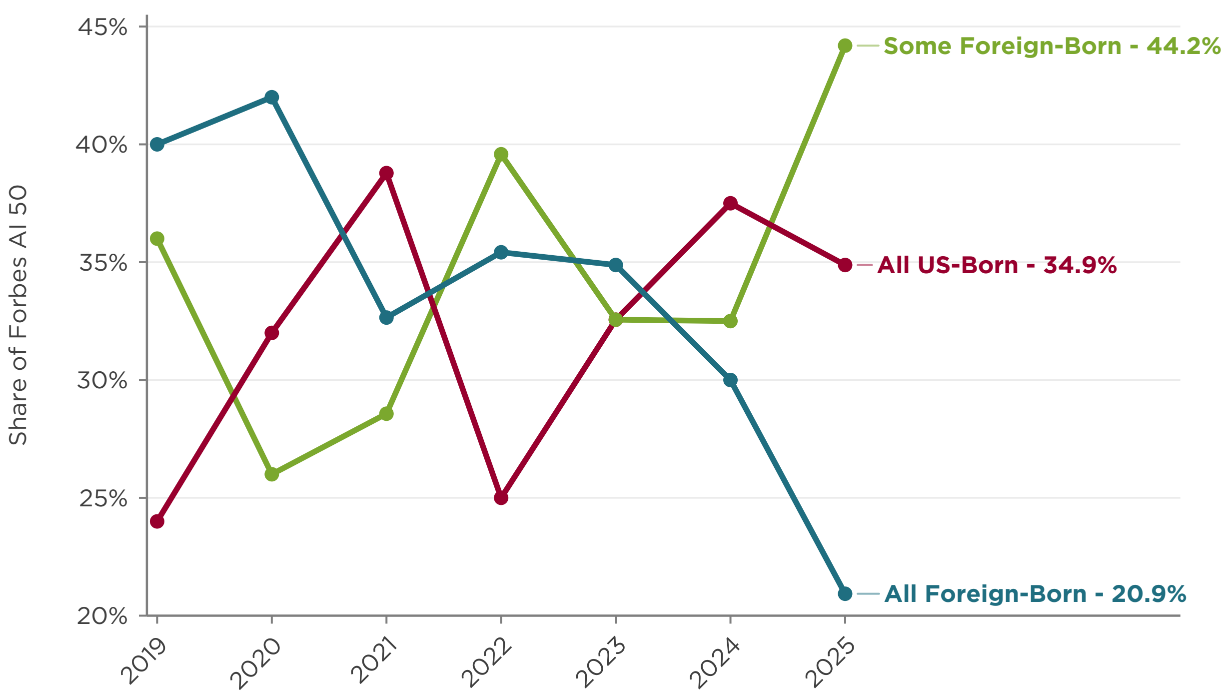
From Employees to Founders

International talent does more than fill positions in companies founded by Americans. It also creates new American companies.

Of the companies on the Forbes AI 50—the list of the most promising private artificial-intelligence firms in the United States published annually by Forbes—65.1 percent had at least one immigrant among their founders in 2025 (See Figure 3.07).[17] [k] In other words, close to two-thirds of the country's leading AI startups were built, in part or in full, by someone born elsewhere.

Where those founders come from tracks the enrollment data (See Figure 3.08). India is first by a wide margin, the origin of 76 immigrant founders across the period, followed by Israel at 38, China at 36, and Canada at

Figure 3.07 Who Founded Leading US AI Companies?



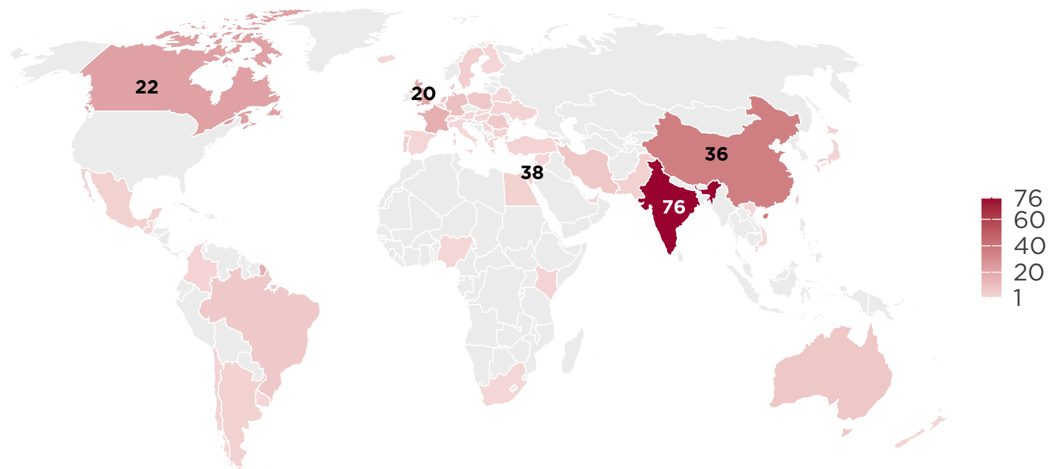
Data from Forbes AI 50, 2019–2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

k Before 2023, the Forbes AI 50 was limited to companies based in North America; beginning with the 2023 list, Forbes opened eligibility to privately held companies worldwide. See Kenrick Cai, "AI 50 2023 Methodology: Our New, Improved Process for Selecting Honorees," Forbes, April 11, 2023, https://www.forbes.com/sites/kenrickcai/2023/04/11/ai-50-2023-methodology-judges/. For consistency across years, the data in this report include only companies headquartered in the United States. In 2025, that was 43 of the 50 companies on the list.

22. The same two countries that dominate graduate enrollment and the H-1B dominate the founder map, and in the same order. The pipeline that begins with an Indian student in a computer-science master's program also produces Indian-born founders in the AI 50.

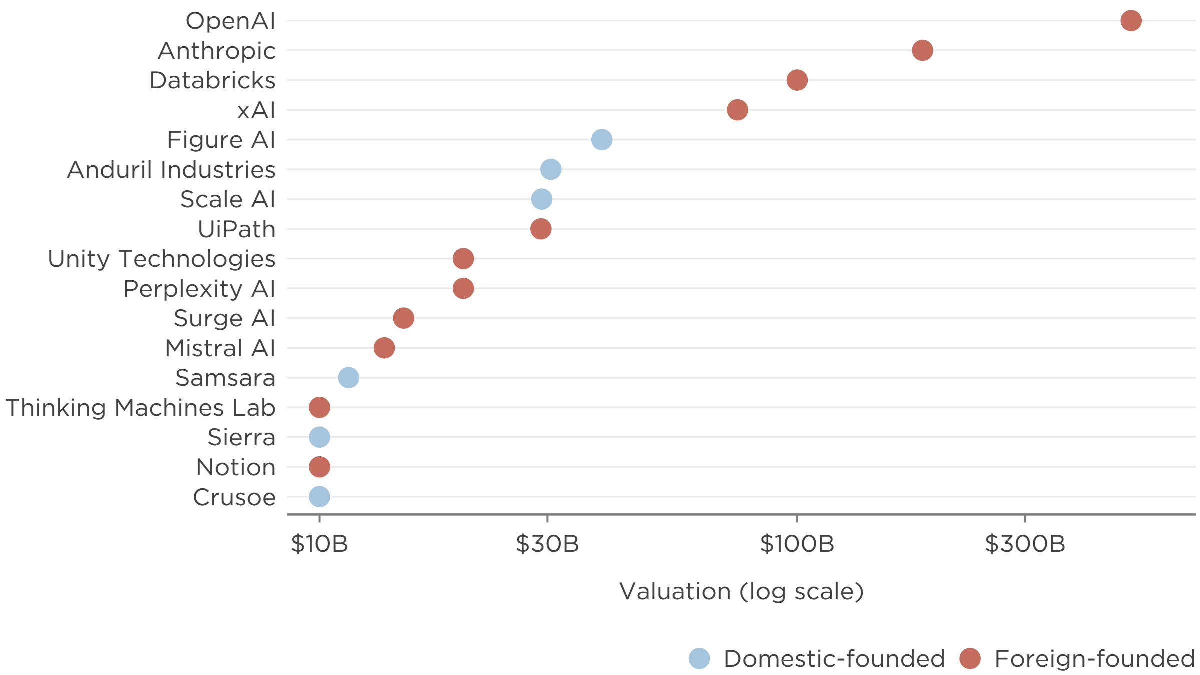
Immigrants sit on the founding teams of nearly every top AI company. The four most valuable—OpenAI, Anthropic, Databricks, and xAI—each have at least one immigrant founder, and the highest-ranked company founded entirely by US natives, Figure AI, comes in fifth (See Figure 3.09).[18]

Figure 3.08 Where Do Immigrant AI Founders Come From?



Data from Forbes AI 50, 2019–2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Figure 3.09 Which Leading AI Companies Were Founded by Immigrants?

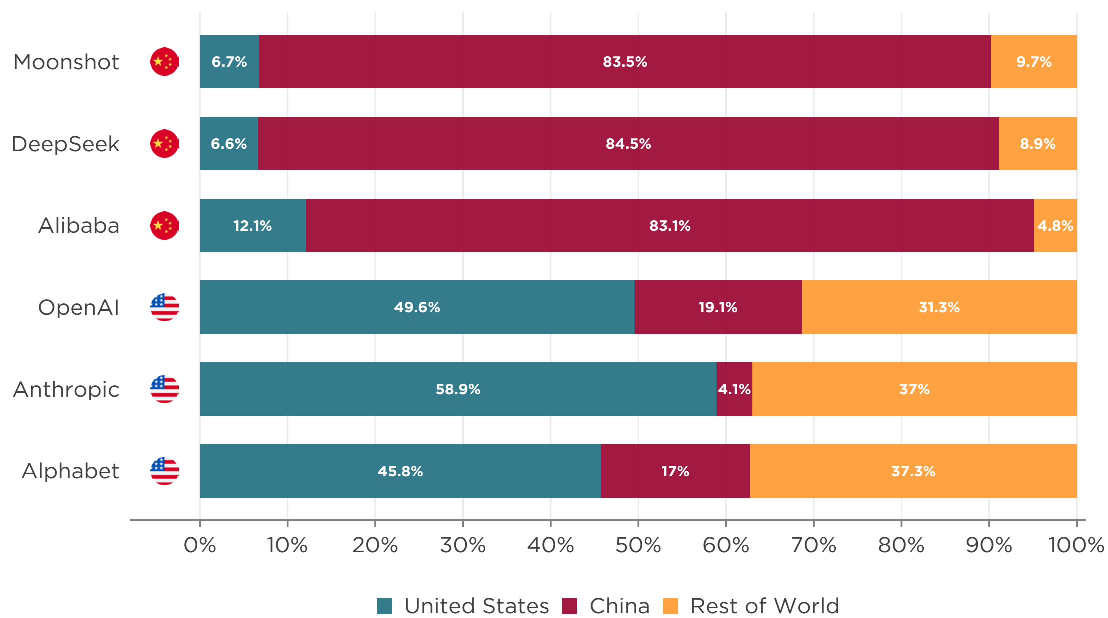


Data from Forbes AI 50, 2019–2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Box 3.01 – Where the Research Gets Done

The reliance on foreign talent that runs through the American AI workforce runs through its research as well, and comparing American and Chinese frontier labs shows two different models of how to staff a research program (See Figure 3.10).[19] [l]

Figure 3.10 **Do Leading AI Companies Employ Domestic or Foreign AI Talent?**



Data from OpenAlex (Priem, Piwowar, and Orr).
Chart by Emerson Johnston and Amy Zegart, Stanford University

American labs draw researchers from around the world. Among the people contributing to Anthropic's published research, 58.9 percent are based in the United States, 4.10 percent in China, and 37.0 percent elsewhere.[20] OpenAI's contributors are 49.6 percent US-based, 19.1 percent China-based, and 31.3 percent based elsewhere in the world. Alphabet, the parent company of Google, has a similar split. No American lab draws even 60 percent of its researchers from inside the country.

Chinese labs do not work this way. DeepSeek draws 84.5 percent of its research contributors from within China, and just 15.5 percent from the rest of the world, of which 6.60 percent are US-based.21 Moonshot and Alibaba are nearly identical, at 83.5 percent and 83.1 percent China-based respectively. The American labs are staffed from everywhere; the Chinese labs are staffed from home.[m]

l Fixing a single country to a researcher is not straightforward. People train in one place and work in another, hold joint appointments, and move between institutions over a career, so nationality and location often diverge. The measure used here is institutional affiliation: the country of the institution listed on a researcher's published work. It captures where a company's research is physically done rather than where its researchers were born or educated, which is the question the comparison turns on.

m This extends an analysis we published in April 2025, when we examined the 223 researchers behind DeepSeek's first five foundational papers. We found then that more than half had never held an affiliation outside China, and that among the quarter who trained in the United States, most returned home. An update in June 2026, covering all seven of DeepSeek's foundational papers and 356 researchers, held to the same result: DeepSeek built its frontier models on a talent base that is overwhelmingly domestic and increasingly self-sufficient.

Three Ways International Talent Powers the United States

The figures in this chapter describe three distinct ways American industry relies on foreign talent. Each sits at a different point in the economy, each would fail differently under stress, and a policy aimed at one may leave the other two untouched, or disrupt them without meaning to.

First, international talent powers research. Temporary visa holders constitute the majority of postdocs in engineering, science, and health, and at federally funded research centers.

Second, international talent supplies the technical workforce. Temporary visa holders cluster in the occupations closest to research, even if they don't hold the majority share in any field. Foreign-born STEM graduates are also likelier than their US-born peers to end up in STEM work, a gap that widens at higher degrees. This dependence is the residue of decades of graduate-program composition, and it cannot be unwound faster than the domestic pipeline can replace it.

Third, international talent builds companies. Immigrant founders have helped create a large share of America's leading AI firms, including every company in the highest valuation tier examined here.

These contributions are distinct but connected. American universities train international students, OPT and postdoctoral appointments move them into employment, and companies and laboratories convert their skills into research and products. The result is not one point of dependence, but several, all working in tandem, so that a failure at any one stage cascades into the next.

This is the return on America's investment in international education. The system works because American education and American employment have historically operated as parts of the same talent engine.

But the connection is neither automatic nor permanent. OPT expires. Postdoctoral appointments end. Temporary workers eventually need another legal status if they are to remain. And policies meant to address genuine security risks can, depending on how they are drawn, discourage the researchers the pipeline depends on faster than the domestic supply can replace them. Chapter 6 examines how much of the talent America trains it ultimately keeps. First, Chapters 4 and 5 turn to the other side of the system: the domestic talent America develops and the research institutions competing to attract the world's best.

Chapter 3 Endnotes

1 Data in Figure 3.01 are drawn from Institute of International Education, "International Students: Academic Level," data for 1948/49–2024/25. *Open Doors Report on International Educational Exchange*, 2025, https://opendoorsdata.org/data/international-students/academic-level/. Chart by authors.

2 Data in Figure 3.02 are drawn from National Center for Science and Engineering Statistics (NCSES), "Survey of Graduate Students and Postdoctorates in Science and Engineering," data for 1994–2024 (National Science Foundation, 2024), https://ncses.nsf.gov/surveys/graduate-students-postdoctorates-s-e/2024. Chart by authors.

3 Data in Figure 3.03 are drawn from NCSES, "Survey of Postdocs at Federally Funded Research and Development Centers," data for 2012–2023 (National Science Foundation, 2023), https://ncses.nsf.gov/surveys/ffrdc-postdocs/2023.

4 Data in Tables 3.01 and 3.02 and in Figure 3.04 are drawn from NCSES, "National Survey of College Graduates Data Tables," (National Science Foundation, 2023), data tables compiled by the authors across all available survey years, https://ncses.nsf.gov/surveys/national-survey-college-graduates.

5 CHIPS and Science Act, Pub. L. No. 117-167, §§ 10631–10632, 136 Stat. 1366 (2022).

6 Michael Kratsios, *Science: A New Golden Age* (White House Office of Science and Technology Policy, 2026), 10, https://www.whitehouse.gov/science/.

7 Communist Party of China Central Organization Department, "Detailed Rules for the 'Thousand Talents Program' High-Level Foreign Expert Project," 2011, trans. Etcetera Language Group and Ben Murphy (Center for Security and Emerging Technology, 2020), https://cset.georgetown.edu/publication/detailed-rules-for-the-thousand-talents-program-high-level-foreign-expert-project/.

8 Immigration and Nationality Act, Pub. L. No. 82-414, 66 Stat. 163 (1952), https://www.congress.gov/bill/82nd-congress/house-bill/5678/text.

9 Immigration Act of 1990, Pub. L. No. 101-649, 104 Stat. 4978 (November 29, 1990), https://www.justice.gov/sites/default/files/eoir/legacy/2009/03/04/IMMACT1990.pdf

10 Norman Matloff, "On the Need for Reform of the H-1B Non-Immigrant Work Visa in Computer-Related Occupations," *University of Michigan Journal of Law Reform* 36, no. 4 (2003): 2, https://heather.cs.ucdavis.edu/Mich.pdf.

11 Matloff, "Need for Reform of the H-1B Visa," 815; John Bound et al., "Understanding the Economic Impact of the H-1B Program on the US," NBER Working Paper 23153 (National Bureau of Economic Research, February 2017), 1–67, https://www.nber.org/papers/w23153.

12 US Citizenship and Immigration Services (USCIS), "H-1B Cap Season," accessed via https://www.uscis.gov/working-in-the-united-states/temporary-workers/h-1b-specialty-occupations/h-1b-cap-season.

13 USCIS, *Characteristics of H-1B Specialty Occupation Workers: Fiscal Year 2024 Annual Report to Congress* (USCIS, 2024), https://www.uscis.gov/sites/default/files/document/reports/ola_signed_h1b_characteristics_congressional_report_FY24.pdf.

14 Ashish Arora et al., "The Indian Software Services Industry," *Research Policy 30*, no. 8 (October 2001): 1267–87, https://doi.org/10.1016/S0048-7333(00)00148-7.

15 Data in Figures 3.05 and 3.06 and in Table 3.03 are drawn from USCIS, H-1B Employer Data Hub, data for 2009–2025 (USCIS, 2026), data downloaded by the authors across all available fiscal years, https://www.uscis.gov/tools/reports-and-studies/h-1b-employer-data-hub.

16 The "Buy American, Hire American" executive order of April 2017 directed USCIS to scrutinize third-party placement arrangements, and the numbers show the effect was immediate. Exec. Order No. 13788, 3 C.F.R. 370 (2018), reprinted in 82 Fed. Reg. 18837 (April 21, 2017), https://www.federalregister.gov/documents/2017/04/21/2017-08311/buy-american-and-hire-american; US Citizenship and Immigration Services, "USCIS Strengthens Protections to Combat H-1B Abuses," news release, April 3, 2017, archived July 2024, https://www.uscis.gov/archive/uscis-strengthens-protections-to-combat-h-1b-abuses.

17 Data in Figures 3.07, 3.08, and 3.09 are drawn from "Forbes AI 50" lists, 2019–2025, compiled by the authors; individual lists by Jillian D'Onfro (2019), Alan Ohnsman (2020, 2021), Helen A. S. Popkin (2022), Konstantine Buhler (2023), Kenrick Cai (2024), and Rashi Shrivastava (2025), *Forbes*, https://www.forbes.com/lists/ai50/.

18 Authors' analysis of PitchBook data for companies named to the Forbes AI 50 list, 2019–2025.

19 Data in Figure 3.10 are drawn from Emerson Johnston and Amy Zegart, *Update: DeepSeek AI and the Great Talent Competition* (Technology Policy Accelerator, Hoover Institution and Stanford Institute for Human-Centered Artificial Intelligence, June 2026), 20–26, https://doi.org/10.64576/0626; underlying affiliation data gathered by the authors via the OpenAlex API (Jason Priem, Heather Piwowar, and Richard Orr, OpenAlex [OurResearch, 2022–2025], https://openalex.org).

20 Authors' analysis of authors affiliated with each company using the OpenAlex API. For a fuller extension of this analysis, see Johnston and Zegart, *Update: DeepSeek AI and the Great Talent Competition*.

21 Johnston and Zegart, *Update: DeepSeek AI and the Great Talent Competition*.

The 2026 US Talent Report

CHAPTER 4

The Home-Grown Pipeline

Where America Loses STEM Talent

HOOVER INSTITUTION | Stanford University   HAI Stanford University Human-Centered Artificial Intelligence

Chapter 4

The Home-Grown Pipeline

Where America Loses STEM Talent

FIGURES

TABLES

Chapter 4

Key Takeaways

1. **US math performance has declined on every major assessment.** Across NAEP, TIMSS, and PISA, scores peaked in the early-2010s and have since receded toward their late-1990s levels, a decline that began before the pandemic. The size of the decline is easiest to see on PISA, where US fifteen-year-olds' scores on the math exam fell 28 points between 2000 and 2022, equivalent to roughly a year of schooling.[a]

2. **American 15-year-olds rank near the bottom of the developed world in math.**[b] US performance in math now ranks 34th in the world and in the bottom third of the OECD, with only 7 percent of American students reaching PISA's highest proficiency levels. The weakness is not confined to struggling states: Even America's strongest performing state, Massachusetts, sits above the OECD average but far behind the leading East Asian systems.

3. **Spending has not translated into stronger math performance.** Real per-pupil K–12 spending has roughly tripled since 1970, and the United States spends more than most OECD countries, yet math achievement among seventeen-year-olds has remained largely flat.

4. **Only about four in ten college students who begin in STEM complete a STEM degree.** Most of those who leave STEM do not leave college, but graduate in another field, making the primary loss not college graduates but technical graduates.

5. **The domestic pipeline is weakest in fields where international talent matters most.** Field degree completion in the broad sciences fell from 55.3 percent to 47.5 percent, even as computing retention improved. This would be reassuring, except that computing is also America's most internationally dependent graduate field. Domestic weakness and international dependence are reinforcing the same parts of the talent system.

6. **America's talent advantage depends on two increasingly precarious streams.** The domestic pipeline begins with weak math preparation and loses students through college, while the international pipeline supplies much of the advanced talent beyond the bachelor's degree.

a The OECD uses 20 PISA score points as a rough benchmark for the average annual learning gain of fifteen-year-olds, meaning a 28-point decline is somewhat larger than one year's typical progress. The benchmark is a rough guide rather than a precise conversion, since the pace of learning varies across countries and over time. For more information, see OECD, *PISA 2022 Results (vol. I): The State of Learning and Equity in Education* (OECD Publishing, 2023), Box I.5.1, https://doi.org/10.1787/53f23881-en.

b PISA figures throughout this report draw on the 2022 cycle. The 2025 results, released September 8, 2026, arrived after production close and carry substantially greater uncertainty for the United States. US samples have missed OECD reporting standards in both cycles, but the 2022 shortfall was narrower: school participation was 63 percent after replacement, against 54 percent in 2025, and the OECD has yet to publish a quantified bias range. In 2025, it estimated that non-participation could shift US scores by roughly sixteen points in either direction without being able to determine which, filed the US under limited reporting, and noted that more than 40 percent of US test-takers never received the student questionnaire. Because that uncertainty is not shared by the countries the US is measured against, rankings and gap estimates built on the 2025 figures are less reliable than those built on 2022.

Chapter 4 – By the Numbers:

MEASURE	EARLIER	LATEST	CHANGE	
US EDUCATIONAL PERFORMANCE VERSUS ROW	**2000**	**2022**		
US Math PISA Rank	#19	**#34**	-15	▼
US Math PISA Score	493	**465**	-28	▼
US Science PISA Rank	#14	**#16**	-2	▼
US Science PISA Score	489[2006]	**499**	+10	▲
OECD Average Math PISA Rank	#17	**#29**	-12	▼
OECD Average Math PISA Score	493	**472**	-21	▼
OECD Average Science PISA Rank	#13	**#28**	-15	▼
OECD Average Science PISA Score	495[2006]	**485**	-10	▼
US Math PISA Score vs OECD Average	+1	**-7**	-8	▼
US Science PISA Score vs OECD Average	-6[2006]	**+14**	+20	▲
STEM PERSISTENCE AND COMPLETION	**'03 ENTRANTS**	**'11 ENTRANTS**		
Computer science entrants staying in field	49.3%	**66.7%**	+17.4 pp	▲
Computer science entrants finishing outside STEM	42.4%	**27.9%**	-14.5 pp	▼
Engineering entrants staying in field	62.5%	**66.5%**	+4.0 pp	▲
Engineering entrants finishing outside STEM	26.2%	**23.3%**	-2.9 pp	▼
Sciences and math entrants staying in field	55.3%	**47.5%**	-7.8 pp	▼
Sciences and math entrants finishing outside STEM	42.3%	**48.3%**	+6.0 pp	▲
Never switched majors	62.3%	**41.8%**	-20.5 pp	▼
Switched majors 2+ times	5.7%	**25.9%**	+20.2 pp	▲
Left college in year 1	3.8%	**3.1%**	-0.7 pp	▼
Left college in year 6	3%	**2%**	-1.0 pp	▼
US STUDY ABROAD	**2005**	**2024**		
US students studying abroad	7.7%	**6.1%**	-1.6 pp	▼
Where US students study abroad				
Europe	60.3%	**64.1%**	+3.8 pp	▲
Latin America and Caribbean	14.4%	**10.6%**	-3.8 pp	▼
Asia	8%	**10.2%**	+2.2 pp	▲
Oceania	6.7%	**3.3%**	-3.4 pp	▼
Sub-Saharan Africa	3.5%	**3%**	-0.5 pp	▼
Middle East and North Africa	1%	**1.6%**	+0.6 pp	▲
What US students study abroad				
STEM	16.3%	**27.2%**	+10.9 pp	▲
Social sciences†	22.6%	**17.8%**	-4.8 pp	▼
Humanities†	13.3%	**3%**	-10.3 pp	▼
Business and management	17.5%	**21.7%**	+4.2 pp	▲

† Open Doors revised its field classifications in 2014, so values before and after that year are not strictly comparable.

Note: Historical comparisons use the endpoints shown in each subheader; PISA = Programme for International Student Assessment; ROW = rest of world.

Source: Derived from the current report Figures and Tables: Figures 4.02, 4.07–4.09 and Tables 4.01–4.04.

In 1983, a federal commission published a report on the condition of American schooling and gave it a title borrowed from the vocabulary of national security: *A Nation at Risk*. Its most famous line made the analogy explicit. Had a hostile foreign power imposed the country's existing educational performance on the United States, the commission wrote, Americans might have regarded it as an act of war.[1]

The commission issued its warning amid fears that Japan was overtaking American industry, but its logic dates back to the Sputnik panic of the late 1950s, which had produced the National Defense Education Act and the expansion of doctoral programs described in Chapter 1. The same 1958 law that expanded the doctoral system also poured federal money into school mathematics and science education for the first time, on the theory that the country's technical strength began in the tenth-grade classroom.[2]

Four decades after *A Nation at Risk*, American mathematics performance remains weak. US fifteen-year-olds now rank in the bottom third of OECD countries even though the United States has for years outspent nearly every peer on a per-student basis. The alarm is old. What is new is our ability to trace the performance weakness through the entire talent pipeline—from the math that students learn in school to the STEM majors and careers they ultimately complete, or don't.

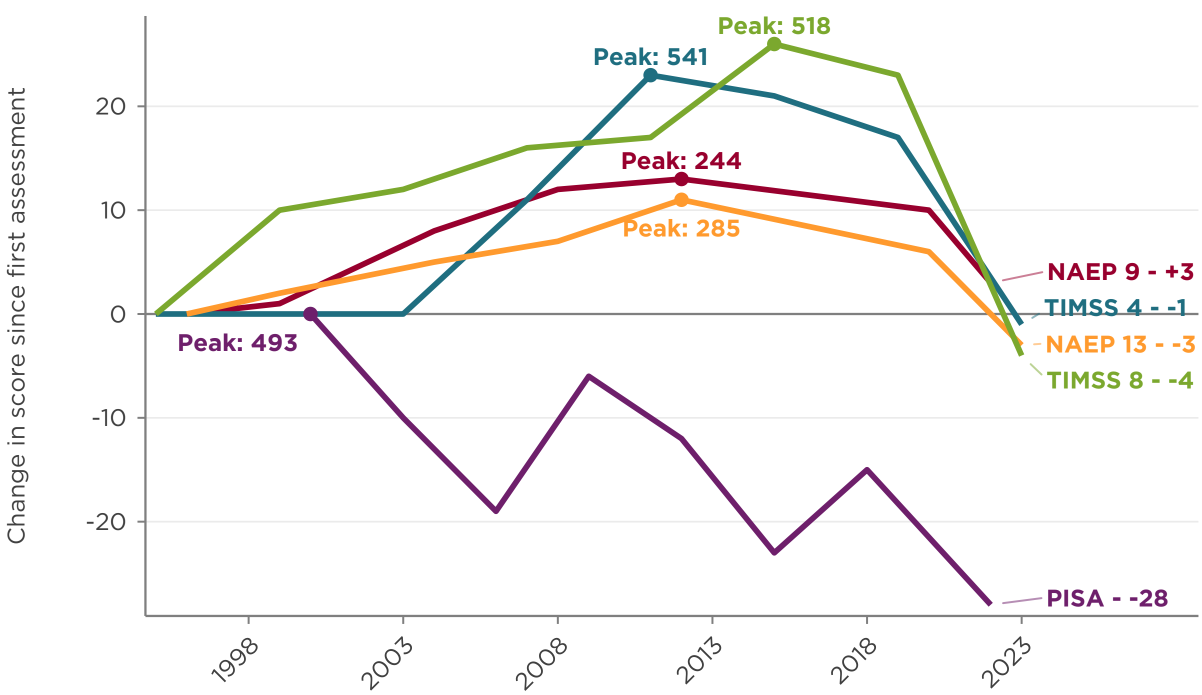
The first three chapters followed international talent into American classrooms, laboratories, and companies. They also revealed a second problem: Domestic STEM graduates are less likely than their foreign-born counterparts to work in STEM careers. This chapter moves backward through that domestic pipeline to ask where the losses begin. It follows American students—the Janes that the United States develops at home—from mathematics preparation in secondary school through college STEM completion, then places that domestic stream beside the ever increasing flow of students the United States draws from abroad.

Falling Against Its Own Past

A country's talent base can be compared against its own history and against other countries. The data clearly show that American K–12 performance is concerning on both measures.

Across three major assessments, American math scores have fallen back to—and in some places below—their late-1990s baselines, after climbing steadily and peaking through the early-2010s (See Figure 4.01).[3] The National Assessment of Educational Progress (NAEP), the closest thing to a national report card, has tested American students since 1969. Its long-term trend series, baselined in Figure 4.01 to 1996 for comparability, shows mathematics scores among nine- and thirteen-year-olds rising modestly into the late 2000s before receding back to baseline levels after 2012.[4] The Trends in International Mathematics and Science Study (TIMSS), which tests fourth- and eighth-graders and is baselined to 1995 in Figure 4.01, traces the same arc.

Figure 4.01 **How Has US Math Achievement Changed Over Time?**



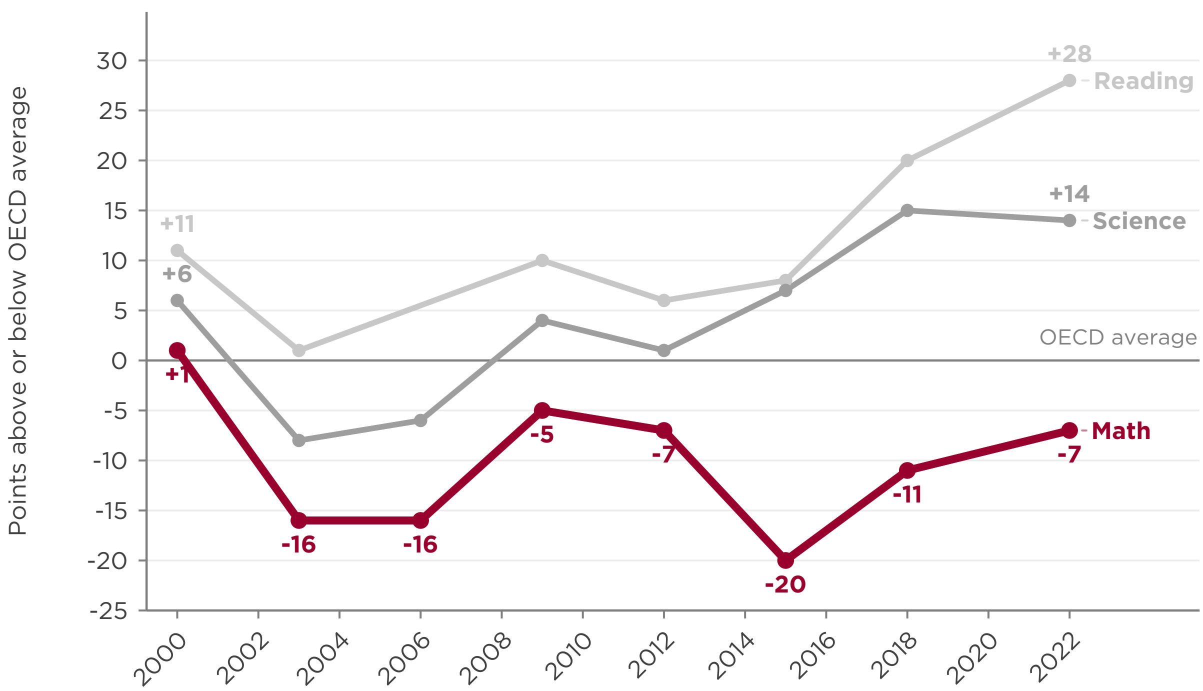
Data from OECD PISA, NAEP Long-Term Trend, and IEA TIMSS, 1995–2023.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The steepest decline in US average mathematics performance is measured from the Programme for International Student Assessment, or PISA, which the OECD first administered in 2000. Measured against that baseline, the US average has fallen 28 points.

What sets PISA apart is both what it measures and its international scale.[c] Unlike the curriculum-based exams NAEP and TIMSS, PISA tests whether fifteen-year-olds can apply mathematics to unfamiliar problems. It therefore captures a form of mathematical reasoning that conventional curriculum-based exams may not. PISA is scored on a common scale across countries and years, enabling countries to measure their performance over time as well as how nations compare to each other.[5]

By that international measure, American mathematics has been slipping for two decades. US fifteen-year-olds scored essentially at the OECD average in 2000, fell below it by 2003, and have stayed below it in every cycle since, scoring seven points under the average in 2022 (See Figure 4.02).[6] Science followed a different path. American students scored above the average in 2000, dropped below it in 2003 and 2006, the same years the mathematics decline was steepest, then recovered from 2009 onward. Reading scores follow a similar trajectory to science.

Figure 4.02 How Does US Achievement Compare to International Averages?



Data from OECD, PISA 2022 Results.
Chart by Emerson Johnston and Amy Zegart, Stanford University

c Because OECD's membership includes most of the countries the United States competes with for scientific and technical talent, PISA measures American students against that comparison group directly.

The fact that scores in mathematics never fully recovered while the others did is striking. The country that has spent seventy years since Sputnik trying to fix its mathematics teaching—through the "New Math" of the 1960s, the back-to-basics reaction that followed, and the "math wars" of the 1990s over whether to teach concepts or procedures—is not weak across the board.[7] It is uniquely weak in the one subject that is the most important foundation for all technical fields, and it has not improved despite many reform efforts.[8]

America's federal structure creates variation by state in educational outcomes, but even the best state in the country by math performance is not internationally competitive in math. Massachusetts has posted the highest NAEP mathematics scores of any state for over two decades, ranking first again in 2024. It was one of three US jurisdictions to field a separate sample on the 2015 PISA assessment, but even with its lead over every other state on other exams, it averaged just 500 in mathematics—above the OECD average of 490 and the US national average of 470, but far behind the leading East Asian systems, where Singapore reached 564.

The other two US jurisdictions that fielded separate samples, North Carolina (471) and Puerto Rico (378), landed at the national average and near the bottom of participating systems respectively.[9] State averages cannot tell us whether particular districts or schools match the world's best. They can, and do, show that even America's strongest state does not perform at the top on a global scale.

… even America's strongest state does not perform at the top on a global scale.

The timing rules out any simple explanation. Because the domestic decline is visible in both NAEP and PISA before 2020, the pandemic accelerated a decline already under way.[d] Why scores turned when they did is less clear. Researchers have proposed the rollback of test-based accountability after No Child Left Behind, the funding cuts that followed the 2008 recession, the arrival of the smartphone in adolescents' hands, and changes in who takes the test.[10] None of these arguments accounts for the decline alone and their relative weight is unknown. What is not in dispute is the timing.

Whatever has been pulling American math scores down has been operating since before today's college first-year students reached middle school—which is where Jane's story actually begins, years before her placement exam. A fifteen-year-old scoring below the OECD average in applied mathematics is, three years later, a college first-year student who takes the placement test and ends up in remedial arithmetic. A decline against one's own past, though, would matter less if the rest of the world were slipping in step too. It is not.

Falling Behind Peers

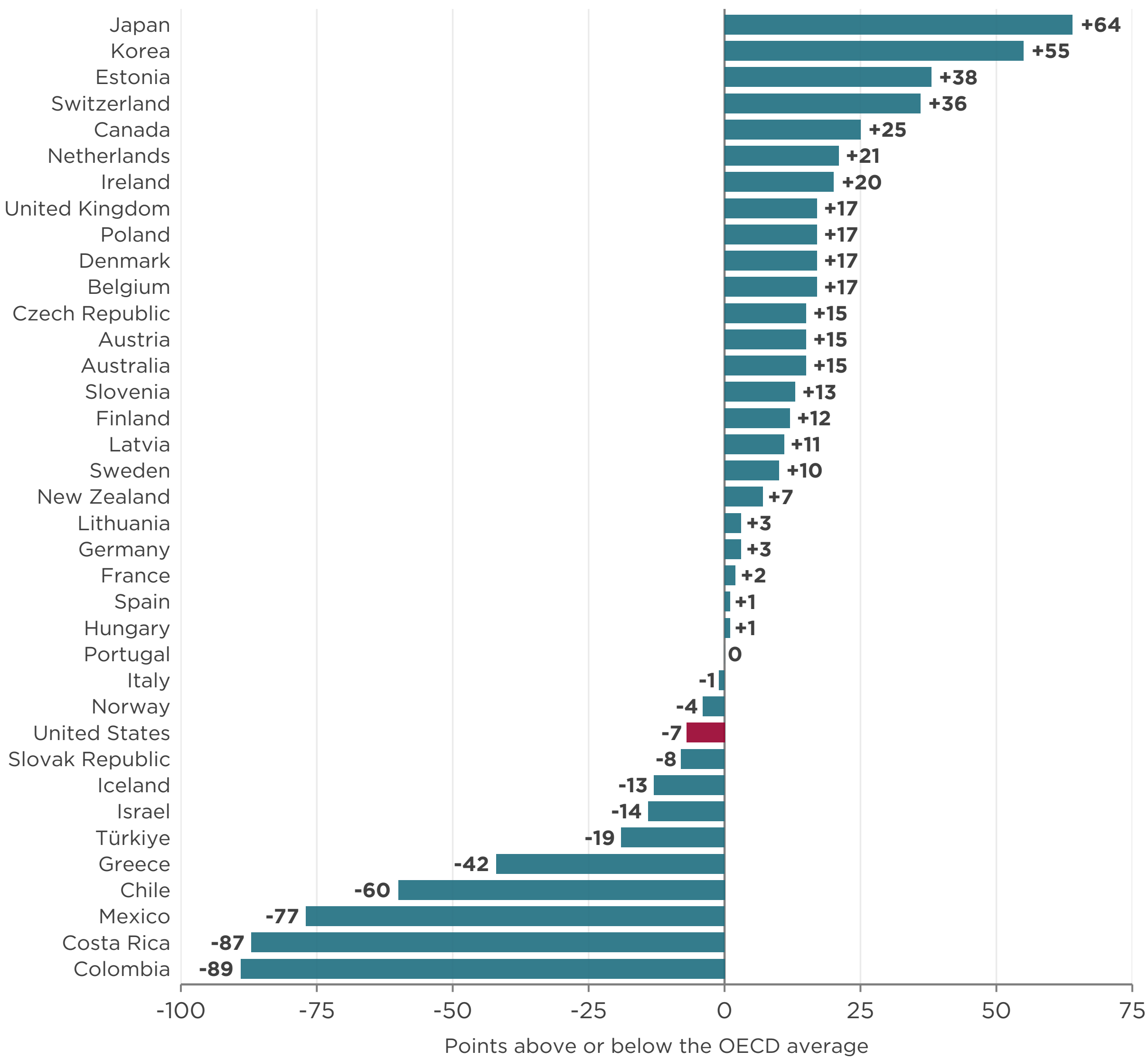
For most of the twentieth century the United States led the world in education by being first—first to near-universal high school, then first to offer higher education at scale.[11] That head start helped propel the country's growth and technological primacy.[12] As the rest of the world caught up, the question shifted from how many students a country kept in school to how much they learned in school.

d On the pre-pandemic decline and the absence of an established cause, see Jim Wyckoff, "Puzzling Over Declining Academic Achievement," EdWorkingPaper No. 25-1197 (Annenberg Institute, Brown University, 2025), https://edworkingpapers.com/policy-practice-series/ai25-1197; and Eric A. Hanushek, "Putting Pandemic Learning Loss in Perspective," Education Next 26, no. 2 (2026), https://www.educationnext.org/putting-pandemic-learning-loss-in-perspective-achievement-declines-21st-century-america-naep/.

Ranked against every country that took the 2022 exam, the United States places 34th in the world in mathematics, behind not only the East Asian systems that lead all three subject tables but also countries like Slovenia, Poland, and Vietnam. Restrict the comparison to the wealthy democracies of the OECD and the picture is worse: American fifteen-year-olds sit in the bottom third, below most of Western Europe and well beneath Canada, Japan, and Korea (see Figure 4.03).

American students perform relatively better in reading and science. But even those scores rank the United States only ninth and sixteenth respectively.

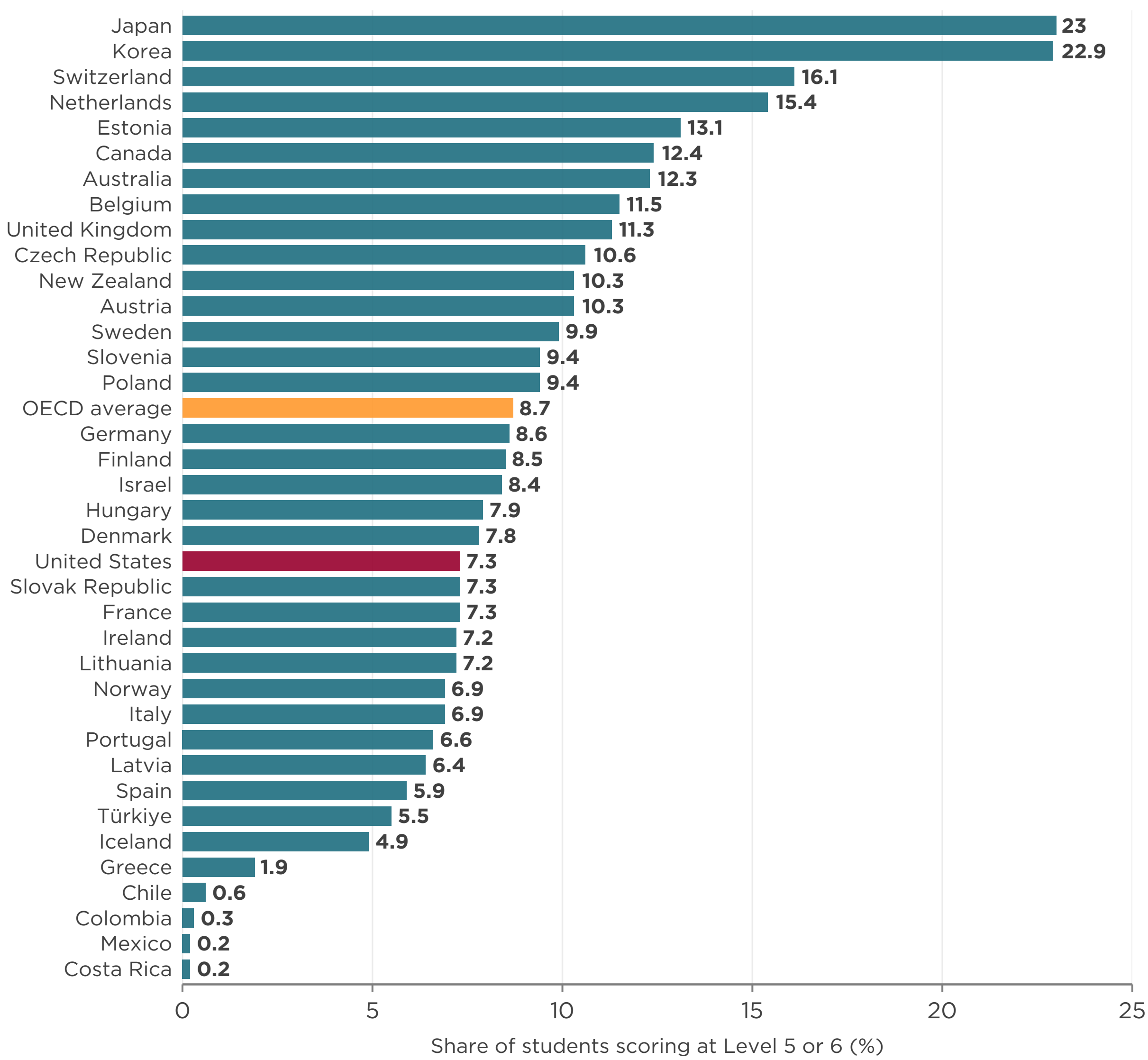
Figure 4.03 How Do OECD Countries Rank in Math?



Data from OECD, PISA 2022 Results.
Chart by Emerson Johnston and Amy Zegart, Stanford University

National averages conceal the part of the distribution that may matter most in a talent competition: the top end. Laboratories and advanced technical programs draw disproportionately from a country's strongest students, not its median ones. Yet only 7.3 percent of American fifteen-year-olds reached PISA's two highest levels of mathematics proficiency in 2022, compared with 8.7 percent across the OECD, 12.4 percent in Canada, and 23 percent in Japan (See Figure 4.04). Put another way, South Korea and Japan are producing top math performers at more than triple the American rate. At the other end, more than a third of American students failed to reach the baseline level of mathematical proficiency. The distribution is thin at the top and heavy at the bottom—the wrong shape for a country seeking to staff the technical frontier.

Figure 4.04 **How Do OECD Countries Rank in Math Proficiency?**



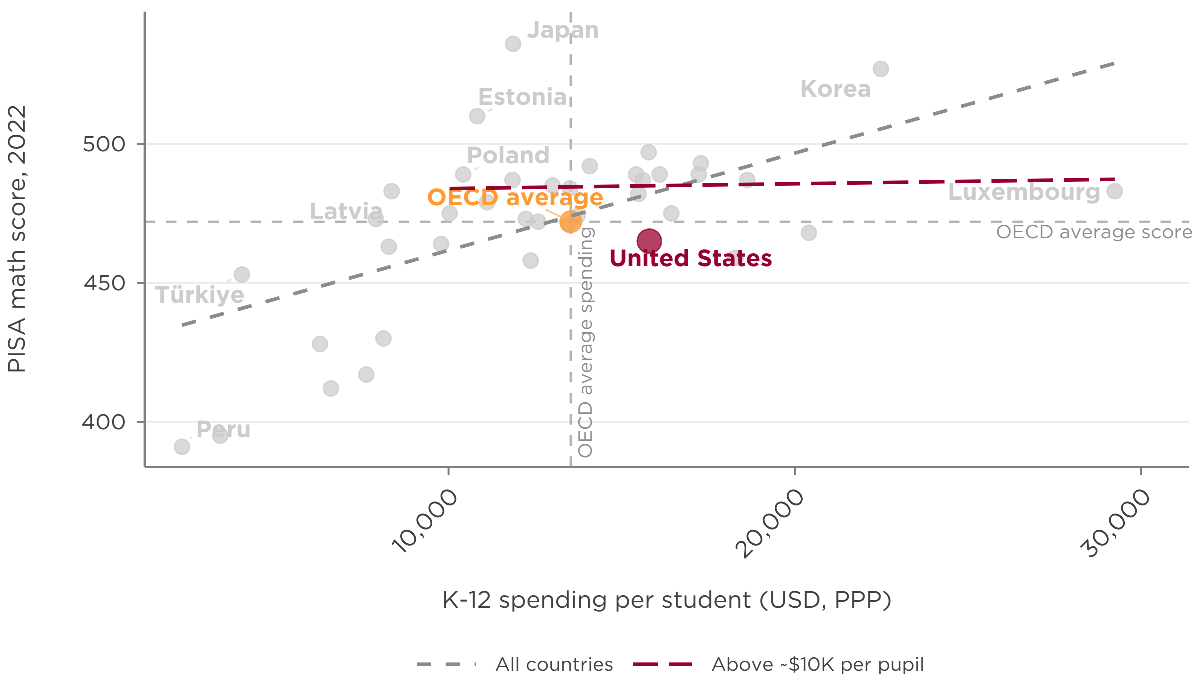
Data from OECD, PISA 2022 Results.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Spending Without Results

The relationship between education spending and educational achievement has been examined and debated for decades. In 1966, the sociologist James Coleman and his colleagues published *Equality of Educational Opportunity*, the largest study of American schools ever commissioned, expecting to document how much school resources drove student outcomes.[13] The report found instead that measured resources explained far less of the variation in achievement than family background did—a conclusion that has been refined and fought over for sixty years but never overturned in its essentials. Policy debates continue. But the data show that real per-pupil spending in American K–12 schools, adjusted for inflation, has roughly tripled between 1970 and the present, even as long-term-trend national achievement scores for seventeen-year-olds have remained flat.[14] Whatever the additional spending bought, it was not higher achievement at the end of secondary school.

The international data show similar results. Across the OECD members and accession candidates with comparable spending and PISA data, per-student spending tracks math performance strongly at first, but the relationship flattens once a country clears a threshold of roughly $10,000 per pupil. Above that level, higher spending has no statistically significant relationship with scores (See Figure 4.05).[15 e]

Figure 4.05 Does Spending More on Schools Produce Better Results?



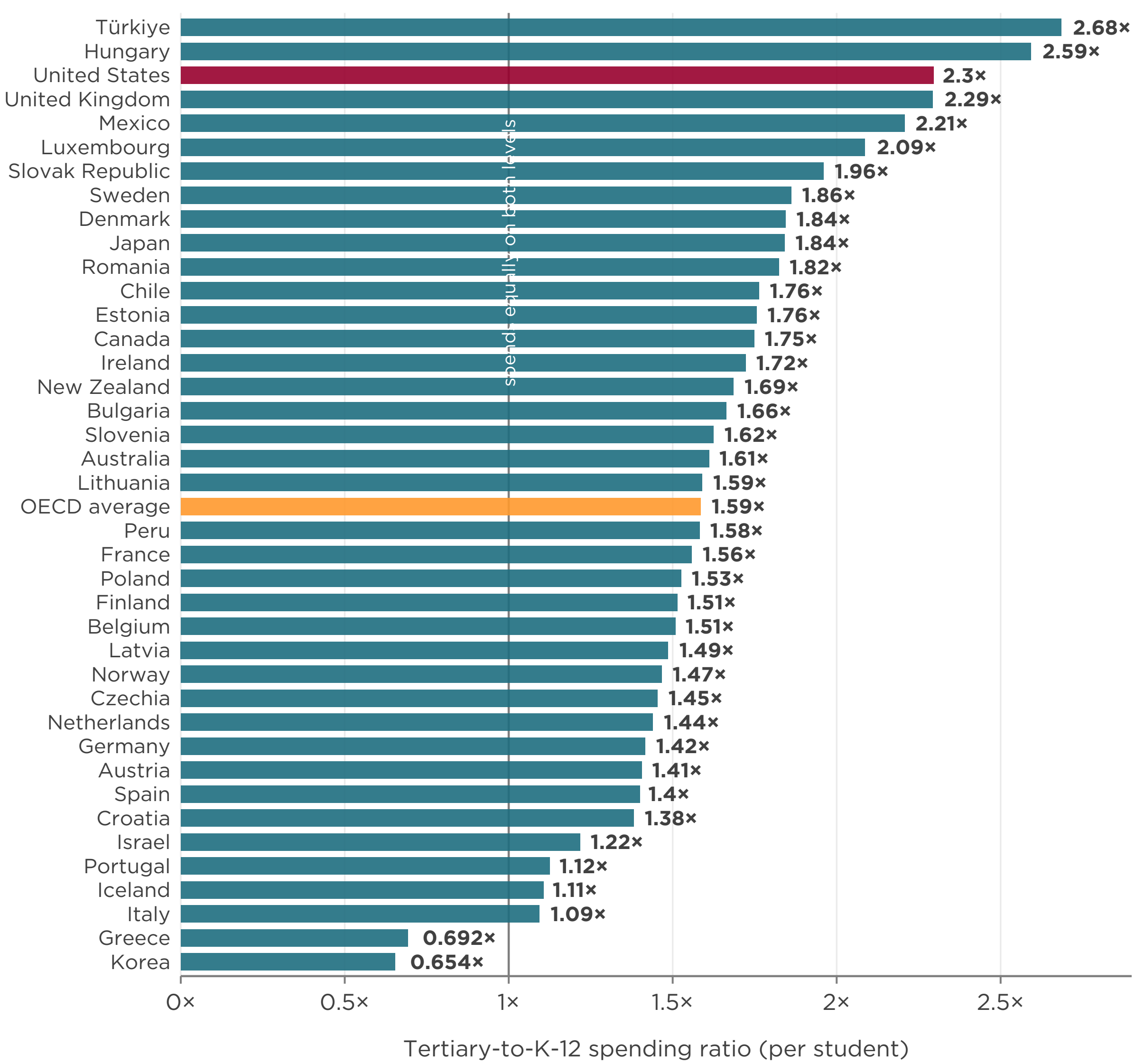
Data from OECD, Education at a Glance 2025; PISA 2022 Database; authors' analysis.
Chart by Emerson Johnston and Amy Zegart, Stanford University

e Figure 4.05 reflects the authors' analysis of 2022 PISA mathematics scores regressed on annual K–12 spending per student (PPP-adjusted), across 38 countries with comparable data. The sample covers OECD members and accession candidates for which both series are available; Bulgaria, Croatia, Peru and Romania are candidates rather than members. The OECD average plotted for reference is the membership average. Across the full sample, each additional $1,000 per pupil is associated with about 3.5 more PISA points ($p < 0.001$), and spending accounts for roughly 37 percent of the variation in mean scores between countries ($R^2 = 0.37$). The relationship holds only up to a threshold of roughly $10,000 per pupil. Among the 28 countries spending above that level—the group that includes the United States—the association disappears: An additional $1,000 is associated with just 0.2 points, statistically indistinguishable from zero ($p = 0.84$, $R^2 < 0.01$). The above-threshold result is robust to excluding the highest-spending and highest-leverage countries; dropping the United States, Luxembourg, or Korea leaves the slope near zero and non-significant in every case. This pattern is consistent with the OECD's own finding that cumulative spending predicts performance only up to about USD 75,000 per student between ages six and fifteen, above which additional investment is much less related to results. Spending data from OECD, OECD Data Explorer, custom table (authors' extraction); scores from OECD, PISA 2022 Database.

The United States is the clearest illustration. It spends more per K–12 student than the large majority of OECD countries—well above the average, and more than higher-scoring systems such as Japan, Estonia, and Poland—and still scores below the OECD math average. On the chart it sits far to the right and below the middle: high spending, mediocre results.

Where the money goes is as telling as how much of it there is. The United States spends disproportionately on the top of its educational pyramid rather than the base, devoting about 2.3 times as much per student to higher education as to primary and secondary schooling. The US trails only Türkiye and Hungary in the OECD, where the typical country spends roughly 1.59 times as much per student on tertiary—or university—education as on primary and secondary (See Figure 4.06).

Figure 4.06 How Lopsided Is US Education Spending?



Data from OECD, Education at a Glance 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

This spending pattern is largely structural. Education was a power the Constitution reserved to the states from the US's founding, and states in turn delegated most of the operational authority (and revenue-raising, via property taxes) down to local school districts. There was never a federal mandate to fund or run schools the way there was for interstate commerce or national defense. So the working assumption in American governance has always been that K–12 is a state and local responsibility, and federal involvement is an exception that requires special justification.

Higher education developed under no such constraint. When the federal government decided after World War II that the country's technical strength was a national asset, it could put its money directly into the research universities—and it did.

Federal dollars remain a small share of school budgets—roughly a tenth of K–12 revenue nationally. The funds are concentrated in targeted programs like Title I for low-income districts, special education, and child nutrition.[16f] States and localities carry the rest.

Where STEM Loses Its Students

Of the students who enter an American college intending to major in a STEM field, only about four in ten graduate with a STEM degree, and that figure has barely moved over time: 41.1 percent for the cohort that entered in 2003, 41.9 percent for the cohort that entered in 2011 (See Table 4.01).[17] In other words, across nearly a decade in which STEM enrollment grew, federal science funding rose, and public policy debates recognized the importance of technical education, the share of entrants converted into STEM graduates did not budge. Whatever filters students out has been operating at the same rate for years, unchanged by the growth in funding or enrollment.

Table 4.01 What Share of STEM Entrants Finish with a STEM Degree?

	SHARE OF STEM ENTRANTS[1]		
	2003/04	2011/12	CHANGE
Completed Bachelor's Degree in STEM Field	41.1%	41.9%	**+0.8 pp**
Completed Bachelor's Degree in Non-STEM Field	23.3%	25.8%	**+2.5 pp**
Still Enrolled	12.3%	11.2%	**−1.1 pp**
Left with No Degree	20.3%	16.9%	**−3.4 pp**
Completed a Sub-bac. Credential	3%	4.1%	**+1.1 pp**

[1] Values are the share of each entering STEM cohort ending in each outcome; each year column sums to 100%. Outcomes are mutually exclusive and reflect the highest credential attained at any institution, including after transfer, by the end of the six-year follow-up. The 'Sub-bac.' credential denotes an associate's degree or undergraduate certificate, in any field, earned without a bachelor's degree; Still Enrolled and Left with No Degree split the remaining students by enrollment status at follow-up. Change is the percentage-point change from the 2003/04 cohort to the 2011/12 cohort.

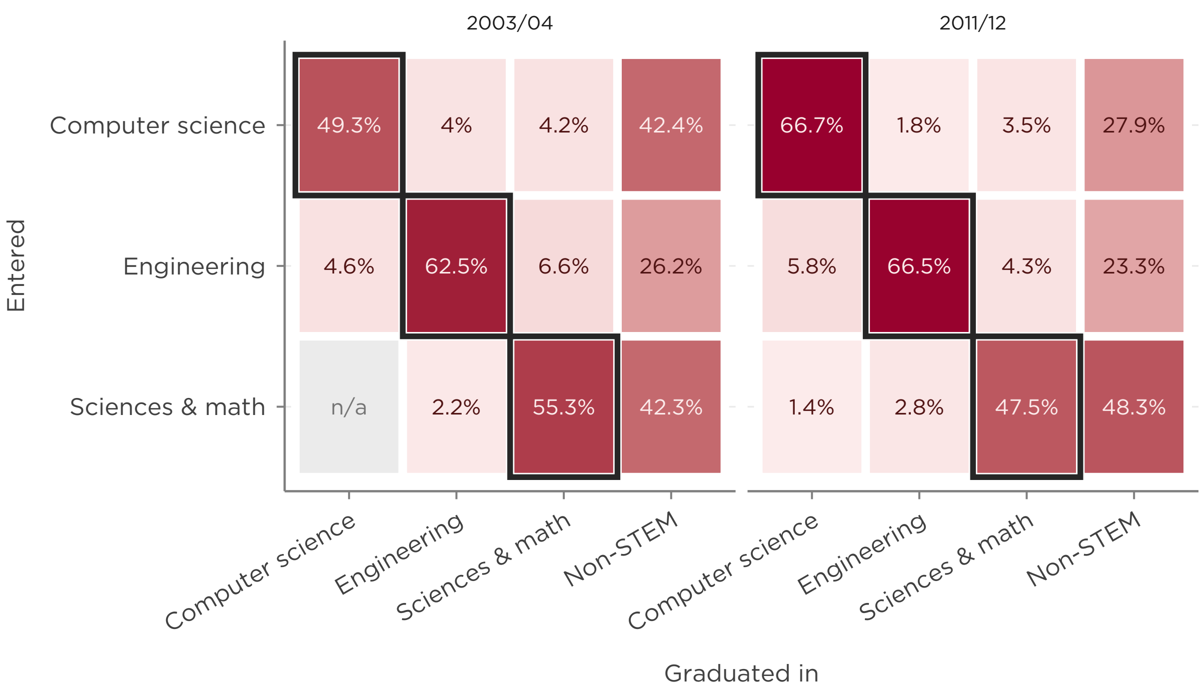
Data from NCES, BPS:04/09 and BPS:12/17 (PowerStats).
Chart by Emerson Johnston and Amy Zegart, Stanford University.

f Title I of the Elementary and Secondary Education Act of 1965 directs supplemental funds to school districts serving high concentrations of low-income students and the Individuals with Disabilities Education Act underwrites the added cost of educating students with disabilities. Neither is a general appropriation for strengthening instruction in mathematics or science. Federal sources supplied roughly 11 percent of the $954 billion in total public elementary and secondary school revenues in school year 2020–21, against 46 percent from states and 44 percent from local governments; the federal share rose temporarily above that level with pandemic relief. For more information, see National Center for Education Statistics, "Public School Revenue Sources," *Condition of Education* (US Department of Education, Institute of Education Sciences, 2024), drawing on the Common Core of Data, National Public Education Financial Survey, data for 2010–11 through 2020–21, (US Department of Education, Institute of Education Sciences), https://nces.ed.gov/programs/coe/pdf/2024/cma_508c.pdf.

The more revealing finding is what happens to the remaining six in every ten students—the ones who don't complete a STEM degree. Most do not leave college. In the 2011 cohort, 16.9 percent departed without a degree, while roughly one-quarter earned a bachelor's degree in a non-STEM field. The principal loss is therefore not from higher education altogether. It is from the technical pipeline.

Following students from the field they entered to the field they graduated in shows where the losses land (See Figure 4.07). In both cohorts, almost none of the students who left their entering field crossed into another STEM field. The cross-STEM cells never exceed seven percent and mostly sit below five. A student who did not finish in the STEM field she started in almost always finished outside STEM altogether.

Figure 4.07 **Do Students Who Leave STEM Leave College, or Just Leave STEM?**



Data from NCES, BPS:04/09 and BPS:12/17 (PowerStats).
Chart by Emerson Johnston and Amy Zegart, Stanford University

The students who do stay in STEM, regardless of subfield, are increasingly unsettled within STEM, switching majors within the broad STEM category at an increasing rate. In 2003–04, 62.3 percent of STEM entrants never switched their major. In 2011–12 the never-switching STEM majors had fallen to 41.8 percent. On the flip side, the share of STEM majors who changed their area of focus two or more times quadrupled, from 5.7 percent to 25.9 percent (See Table 4.02). The single-switch rate, students who switched majors only once, barely moved. A quarter of the students who set out to do STEM now change their intended field at least twice before they finish—a churn invisible in the flat completion rate but costly in lost credits, added semesters, and momentum. The conversion rate held steady, in other words, over a base that grew markedly more turbulent.

Table 4.02 How Often Do US STEM Entrants Change Majors?

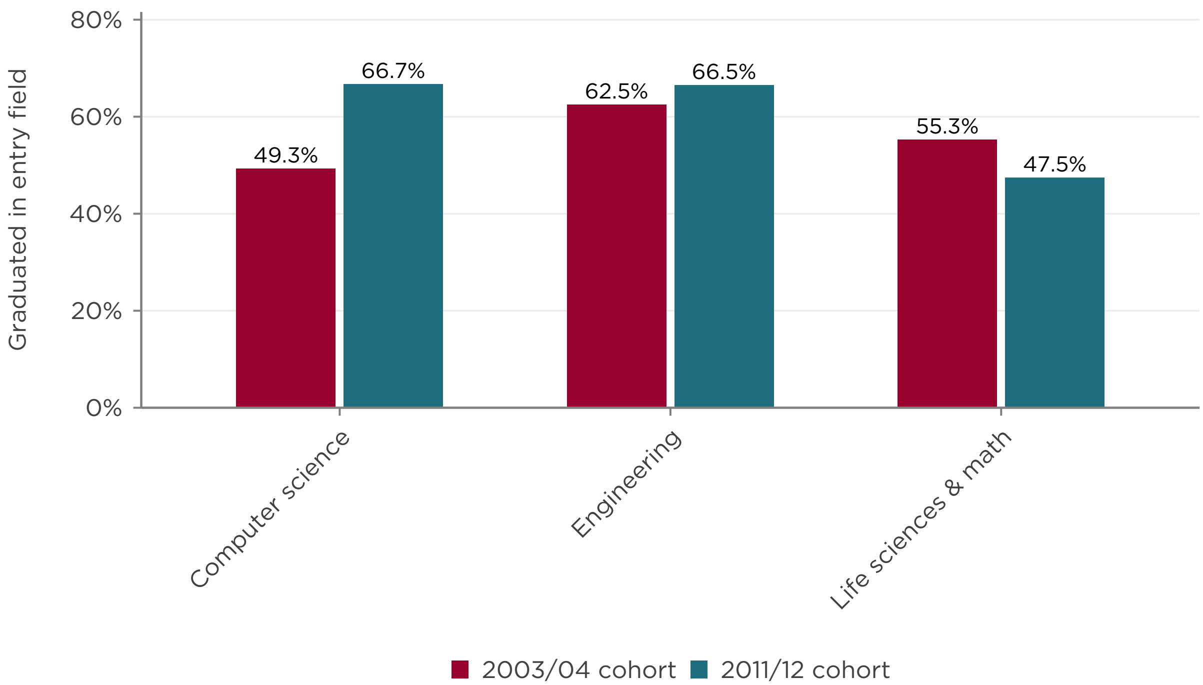
	SHARE OF STEM ENTRANTS[1]		
	2003/04	2011/12	CHANGE
Never switched	62.3%	41.8%	**−20.5 pp**
Switched once	32.1%	32.2%	**+0.1 pp**
Switched 2+ times	5.7%	25.9%	**+20.2 pp**

[1] Share of STEM entrants by number of major switches. Change is the percentage-point change from the 2004/2009 to the 2011/2012 cohort.

Data from NCES, BPS:04/09 and BPS:12/17 (PowerStats).
Chart by Emerson Johnston and Amy Zegart, Stanford University.

Across cohorts, within-field retention did improve. In the later cohort, two-thirds of students who entered computer and information sciences graduated in the field, up from about half. Engineering similarly held steady in the mid-sixties. But the broad sciences—biology, the physical sciences, mathematics, and agriculture grouped together—moved the other way; their own-field completion fell from 55.3 percent to 47.5 percent (See Figure 4.08).[g] By 2011, a broad-science entrant was likelier to graduate in a non-STEM field than in the one they began.

Figure 4.08 **Which STEM Fields Keep Their Students, and Which Lose Them?**



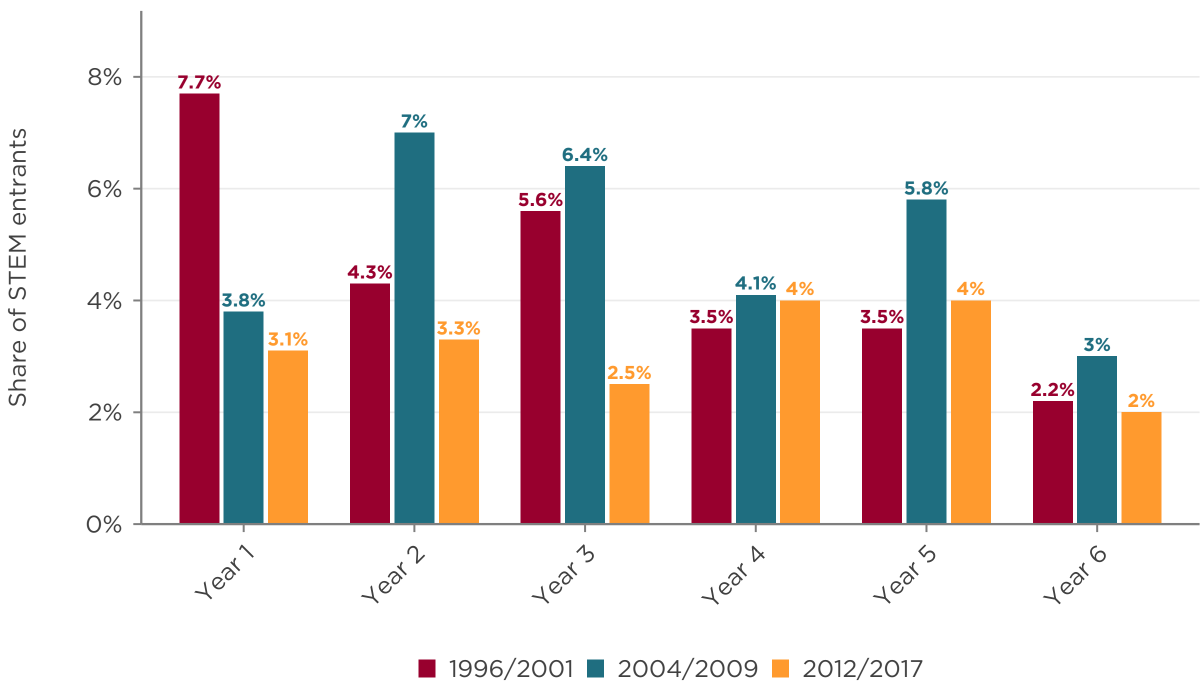
Data from NCES, BPS:04/09 and BPS:12/17 (PowerStats).
Chart by Emerson Johnston and Amy Zegart, Stanford University

g The grouping of biology, the physical sciences, mathematics, and agriculture into a single “broad sciences” category follows the field classifications in the source data rather than a choice by the authors.

Then there is the question of STEM majors who leave college before completing any degree. Our analysis finds that college departures for STEM majors are occurring later in a student's college career now than in the past (See Figure 4.09). In the oldest cohort, departures peaked hard in the first year and tapered after. In the most recent, they are lower overall and pushed later, with as many students leaving in the fourth and fifth years as in the first two. Students increasingly do not leave right away. They persist, switch, persist again, and the ones who ultimately leave do so after investing years.

Students increasingly do not leave right away. They persist, switch, persist again, and the ones who ultimately leave do so after investing years.

Figure 4.09 When Do Non-Completers Leave College?



Data from NCES, BPS:96/01, BPS:04/09, and BPS:12/17 (PowerStats).
Chart by Emerson Johnston and Amy Zegart, Stanford University

In sum, the country is accumulating a large stock of near-completers, people carrying two or three years of college-level calculus, chemistry, and coding who never cross the degree finish line. Some leave without any degree. Others finish a bachelor's in another field. Both are talent the country trained partway and did not keep in the technical workforce, and both are recoverable later—the former through re-entry programs, credit for prior coursework, or stackable credentials rather than the first-year fixes colleges favor, and the latter through post-baccalaureate certificates or conversion master's programs that build on the STEM coursework already done.[18]

Because STEM majors who leave their STEM fields increasingly do so after their first year, the first-year interventions colleges favor may not be optimally suited for improving the STEM pipeline. Jane illustrates this challenge. Placed into remedial math her first term, she is exactly the student the first-year cliff model predicts will wash out early. If she persists, but leaves later, with years of coursework behind her, she becomes not a dropout of the system caught early but a near-completer it failed to keep. Both dilemmas—how to drive Jane into STEM as a first-year student, and how to keep her in STEM to complete her degree—start with the poor math preparation she received before attending college.

Mathematical preparation is one of the strongest predictors of who persists in STEM degree completion. In 1997, researchers from the University of Colorado Boulder found that students left the sciences less because they lost interest than because the introductory sequence, calculus above all, functioned as a filter that drove out those who arrived underprepared or became demoralized and might otherwise have stayed.[19] The pattern held in the 2019 follow-up, which drew on national longitudinal data rather than interviews alone: 28 percent of students who started in a STEM major in 2004 switched to a non-STEM field before graduation, and another 20 percent left college altogether.[20] In other words, roughly half of all STEM entrants were lost from the field.

Federal longitudinal analysis, drawn from the same national cohorts this chapter uses, quantified the attrition rates by level of math preparation: Students entering with the strongest high-school mathematics preparation completed STEM degrees at roughly twice the rate of those who entered with the weakest preparation.[21] Studies of the calculus sequence specifically found that it pushed capable students out, women at appreciably higher rates than men, not for want of ability but for lack of preparation and confidence the course presumed.[22] Preparation, not interest or effort, is the strongest available predictor of who finishes, and preparation is exactly what the earlier sections showed the system failing to supply.

Students entering with the strongest high-school mathematics preparation completed STEM degrees at roughly twice the rate of those who entered with the weakest preparation.

This is where the thread that began with a fifteen-year-old's test score reaches the end of its logic. A student who arrives at college needing to relearn middle-school arithmetic is, before she declares a major, already on the wrong side of the preparation gradient those studies describe. And the number of students entering colleges and universities with poor math preparation is large and rising.

As we noted in the introduction, several top-ranked universities are being forced to expand remediation course offerings to absorb students who arrive underprepared despite strong transcripts: At the University of California, San Diego, the share of incoming students placed into remedial mathematics rose from 0.49 percent in 2020 to 11.8 percent in 2025, a fifth of whom had taken high-school calculus; UC Berkeley's diagnostics flagged severe gaps in 20 to 30 percent of first-semester calculus students; and Temple University's intermediate algebra enrollment hit a record 1,174 in fall 2025.[23]

Put the stages together and the pipeline's challenges become more visible. The United States begins with fifteen-year-olds scoring in the bottom third of the wealthy world in mathematics and producing top performers at a fraction of the rates achieved by leading nations. Many arrive at college without the preparation their intended majors require. Of those who enter STEM, roughly four in ten will complete a STEM degree, and fewer than half of the broad-science graduates will finish in their originally intended field. The domestic stream is large but loses potential technical talent at several successive stages. This is how the system that "grows domestic talent" currently works. These challenges help explain why the graduate programs, laboratories, and companies examined in Chapters 1 through 3 rely so heavily on talent from abroad.

A One-Way Exchange

The United States attracts more than a million students from abroad but sends relatively few of its own students to other countries' universities. The comparison does not suggest that a semester abroad can repair weak mathematics preparation or replace advanced STEM training. It reveals something different: how asymmetrically the American talent system depends on knowledge and people flowing inward.

Sending students for short terms of study abroad has been a national priority at various times. The first American junior-year-abroad program sailed for Europe from the University of Delaware in 1923 and after World War II, the Fulbright Program institutionalized a two-way flow of scholars.[24] In 2005 a federal commission set the country a goal of sending a million American undergraduates abroad each year by the end of the following decade, on the argument that a superpower could not afford a citizenry that did not know the world.[25] Despite these programs, less than 7 percent of US students study abroad annually.[26]

Americans are also far less likely than students elsewhere to enroll in a full degree program abroad.[h] At 0.65 percent, the US outbound mobility rate is the lowest in the OECD—below China at 1.81 percent and India at 1.95, both at just under three times the American share, and Korea at 3.25, close to five times (See Figure 4.10).[27] Among the countries the United States competes with for talent, it sends the fewest of its own students into the world.

The field mix has shifted, too. STEM's share of American study abroad has risen substantially over two decades, from roughly a sixth of participants to more than a quarter, while the humanities have declined significantly (See Table 4.03).[28] The students who do go abroad are increasingly technically focused ones, but the base is small against the 1.18 million foreign students inside the United States.

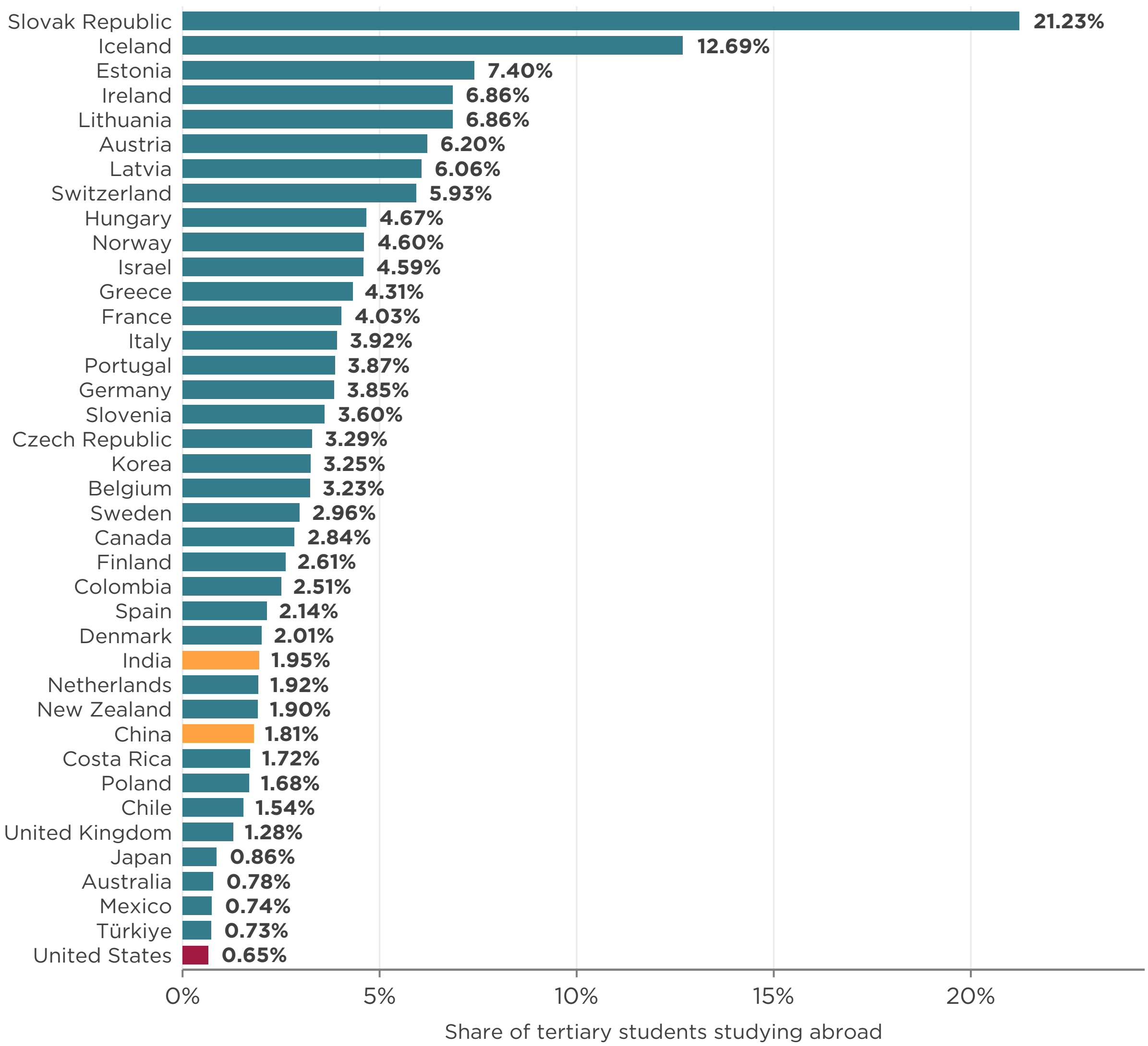
Where those students study is as telling as what they study. Nearly two-thirds of American study-abroad participants go to Europe, while approximately one in ten goes to Asia. That pattern reflects many drivers, including language acquisition, institutional partnerships, cost, student preferences, and the long history of American programs in Europe. It also means that the small American outbound flow is not concentrated in the countries supplying most international STEM students to the United States (See Table 4.04).[29]

Set the two flows side by side—a vast inbound tide, a small outbound trickle pointed away from the competition—and the United States is not conducting an exchange so much as a one-directional import.

---

h The outbound mobility ratio is the number of US students enrolled in a full degree program abroad as a share of total US tertiary enrollment. It is distinct from, and much smaller than, the study-abroad figures reported by IIE's *Open Doors*, which count US students earning academic credit abroad (predominantly through short-term, credit-bearing programs embedded in a US degree) and are therefore not directly comparable.

Figure 4.10 **How Many Students Study Abroad From Each Country?**



Data from UNESCO Institute for Statistics, "Total Outbound Internationally Mobile Tertiary Students," UIS.Stat; authors' compilation.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Table 4.03 What Do Americans Study Abroad?

	SHARE OF STUDENTS[1]		
	2005	2024	CHANGE
STEM	16.3%	27.2%	+10.9 pp
Business & management	17.5%	21.7%	+4.2 pp
Other[2]	22.7%	23%	+0.3 pp
Fine & applied arts	7.6%	7.3%	−0.3 pp
Social sciences[2]	22.6%	17.8%	−4.8 pp
Humanities[2]	13.3%	3%	−10.3 pp

[1] Share of US study-abroad students by field of study. Change is the percentage-point change from 2005 to 2024.

[2] Open Doors revised its field taxonomy between 2013 and 2014; shares for these categories are not directly comparable across that break, so the reported change reflects reclassification as well as any real shift.

Data from IIE, "Percent of US Study Abroad Students by Field of Study," Open Doors, 2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

Table 4.04 Where Do Americans Study Abroad?

	SHARE OF STUDENTS[1]		
	2005	2024	CHANGE
Europe	60.3%	64.1%	+3.8 pp
Asia	8%	10.2%	+2.2 pp
Multiple destinations	5.6%	6.5%	+0.9 pp
Middle East & North Africa	1%	1.6%	+0.6 pp
North America	0.5%	0.6%	+0.1 pp
Sub-Saharan Africa	3.5%	3%	−0.5 pp
Oceania	6.7%	3.3%	−3.4 pp
Latin America & Caribbean	14.4%	10.6%	−3.8 pp

[1] Share of US study-abroad students by host region. Change is the percentage-point change from 2005 to 2024.

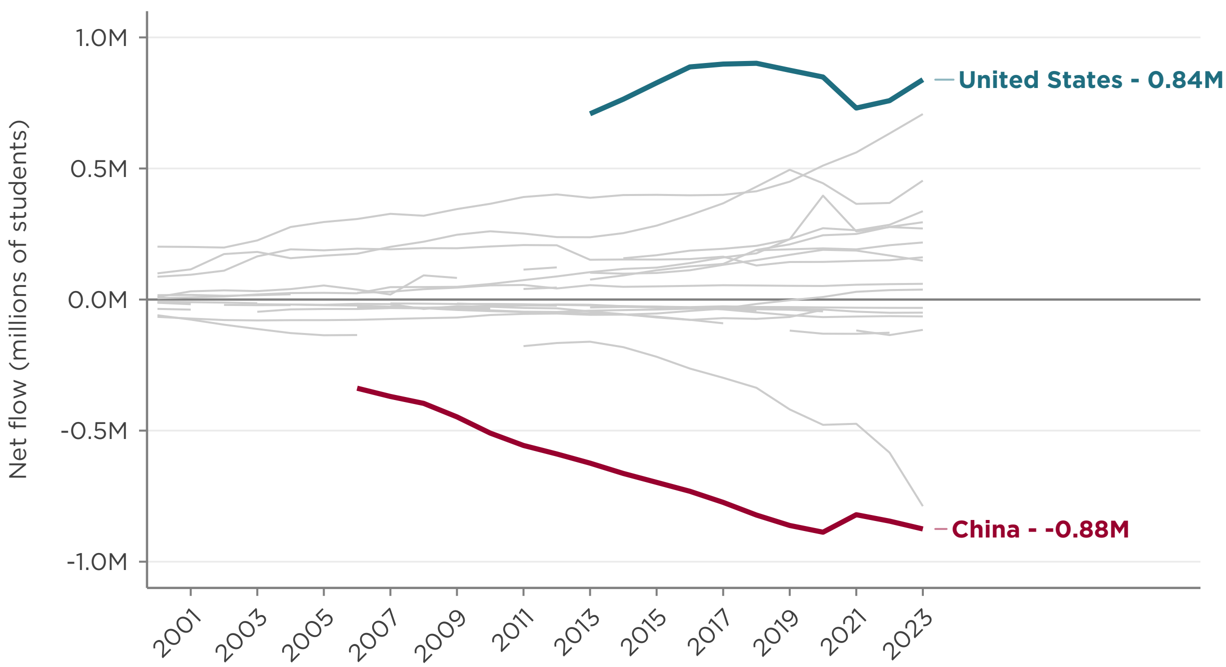
Data from IIE, "Host Regions of US Study Abroad Students," Open Doors, 2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

Who Imports, Who Exports

Net student flows do not measure the quality of students, the fields they enter, how long they remain, or where they ultimately work. But they reveal the basic architecture of the system. The United States takes in far more students than it sends abroad, and has a larger net inflow than any other country. By contrast, China sends abroad far more than it takes in, and has the largest net outflow in the world. America's advantage has long rested on its ability to draw talent inward. China's challenge has been to train more people at home and persuade more of those who study abroad to return.

The two countries now sit at the extremes of the same global ledger, and their numbers are near mirror images (See Figure 4.11).[30] The United States welcomes about 840,000 more students than it sends abroad, while China sends abroad about 880,000 more than it welcomes. For the United States, that inflow is the dependence the first three chapters traced—the graduate programs, laboratories, and companies that run increasingly on talent from abroad. For China, that outflow is a bet that some of those students return, carrying home the training its own universities could not

Figure 4.11 Which Countries Import Students, and Which Export Them?



Data from UNESCO Institute for Statistics, "Net Flow of Internationally Mobile Students (Inbound − Outbound)," UIS.Stat; authors' compilation.
Chart by Emerson Johnston and Amy Zegart, Stanford University

yet provide. Today, it sends more of its students into the world than any other country, many of them, as Chapter 2 showed, to the United States.

This imbalance reframes the dependence documented in Chapters 1–3. The United States has not historically faced a choice between developing talent at home and attracting it from abroad. Its scientific strength came from doing both. Domestic students supplied the base, and international students enlarged and strengthened the advanced pipeline.

The problem is that each stream, as well as the balance between them, has become more precarious. The domestic base loses a large share of its STEM entrants, concentrated in the fields where international dependence runs highest, and the advanced pipeline now rests on a few countries whose students may not keep coming. For decades the two covered for each other, and a strength in one masked any weakness in the other. That redundancy is thinning. What this combined system produces—the research and the companies it yields—is where the next chapter turns.

Chapter 4 Endnotes

1 National Commission on Excellence in Education, *A Nation at Risk: The Imperative for Educational Reform* (US Government Printing Office, 1983), 5, https://e4e.org/sites/default/files/a_nation_at_risk_1983.pdf.

2 National Defense Education Act of 1958, Pub. L. No. 85-864, title III, 72 Stat. 1580, 1588–90, https://www.govinfo.gov/content/pkg/STATUTE-72/pdf/STATUTE-72-Pg1580.pdf.

3 Data in Figure 4.01 are drawn from Organisation for Economic Co-operation and Development (OECD), PISA 2022 Results, 5 vols., (OECD Publishing, 2023), https://www.oecd.org/en/about/programmes/pisa.html, and Technical Report (OECD Publishing, 2024), https://www.oecd.org/en/publications/pisa-2022-technical-report_01820d6d-en.html; National Center for Education Statistics, "The National Assessment of Educational Progress (NAEP)" (US Department of Education, Institute of Education Sciences), https://nces.ed.gov/nationsreportcard/; and IEA, "Trends in International Mathematics and Science Study (TIMSS)," data for 1995–2023, https://www.iea.nl/studies/iea/timss.

4 National Center for Education Statistics, "The National Assessment of Educational Progress (NAEP)."

5 OECD, *PISA 2022 Results*; OECD, *PISA 2022 Technical Report*, https://www.oecd.org/en/about/programmes/pisa.html, and *Technical Report* (OECD Publishing, 2024), https://www.oecd.org/en/publications/pisa-2022-technical-report_01820d6d-en.html.

6 Data in Figures 4.02, 4.03, and 4.04 are drawn from OECD, *PISA 2022 Results* (OECD Publishing, 2023–2024), vol. I, "The State of Learning and Equity in Education" (December 5, 2023), https://doi.org/10.1787/53f23881-en; vol. II, "Learning During—and From—Disruption" (December 5, 2023), https://doi.org/10.1787/a97db61c-en; vol. III, "Creative Minds, Creative Schools" (June 18, 2024), https://doi.org/10.1787/765ee8c2-en; vol. IV, "How Financially Smart Are Students?" (June 27, 2024), https://doi.org/10.1787/5a849c2a-en; vol. V, "Learning Strategies and Attitudes for Life" (November 13, 2024), https://doi.org/10.1787/c2e44201-en; and *Technical Report* (February 29, 2024), https://doi.org/10.1787/01820d6d-en.

7 On the "New Math" movement and its collapse, see Christopher J. Phillips, *The New Math: A Political History* (University of Chicago Press, 2014), https://press.uchicago.edu/ucp/books/book/chicago/N/bo18991075.html; on the broader cycle of reform and reaction culminating in the "math wars," see Alan H. Schoenfeld, "The Math Wars," *Educational Policy* 18, no. 1 (2004): 253–86, https://eric.ed.gov/?id=EJ690082.

8 Xianglei Chen, *STEM Attrition: College Students' Paths into and out of STEM Fields,* NCES 2014-001 (National Center for Education Statistics, 2013), https://nces.ed.gov/pubs2014/2014001rev.pdf.

9 National Center for Education Statistics, "Mathematics Literacy: Average Scores," in *Program for International Student Assessment (PISA): 2015 Results* (Institute of Education Sciences, US Department of Education, 2015), https://nces.ed.gov/surveys/pisa/pisa2015/pisa2015highlights_5.asp.

10 Thomas J. Kane et al., "From Learning Recession to Learning Recovery: Understanding the Sources of US K–12 Improvement," (Center for Education Policy Research at Harvard University and Stanford Graduate School of Education, May 13, 2026), https://educationscorecard.org/wp-content/uploads/2026/05/Education_Scorecard_May_2026_Report.pdf

11 Amy Zegart, "The Crumbling Foundations of American Strength: Knowledge Is Power—and the United States Is Losing It," *Foreign Affairs*, August 20, 2024, https://www.foreignaffairs.com/united-states/crumbling-foundations-american-strength-amy-zegart; Nicholas Eberstadt and Evan Abramsky, "America's Education Crisis Is a National Security Threat: A Smarter World Is Changing the Balance of Power," *Foreign Affairs*, April 28, 2022, https://www.foreignaffairs.com/world/america-education-crisis-national-security-threat.

12 Claudia Goldin and Lawrence F. Katz, *The Race Between Education and Technology* (Belknap Press of Harvard University Press, 2008), https://www.nber.org/system/files/working_papers/w12984/w12984.pdf.

13 James S. Coleman et al., *Equality of Educational Opportunity* (US Government Printing Office, 1966), https://eric.ed.gov/?id=ED012275.

14 National Center for Education Statistics, "Table 236.55. Total and Current Expenditures per Pupil in Fall Enrollment in Public Elementary and Secondary Schools, by Function and State or Jurisdiction: Selected Years, 1969–70 through 2016–17," *Digest of Education Statistics 2019*, (US Department of Education, Institute of Education Sciences, 2021), https://nces.ed.gov/programs/digest/d19/tables/dt19_236.55.asp.

15 Data in Figures 4.05 and 4.06 are drawn from OECD, *Education at a Glance 2025: OECD Indicators* (OECD Publishing, 2025), https://doi.org/10.1787/1c0d9c79-en.

16 National Center for Education Statistics, "Public School Revenue Sources," in *Report on the Condition of Education* (US Department of Education, Institute of Education Sciences, 2024), https://nces.ed.gov/programs/coe/pdf/2024/cma_508c.pdf, drawing on the Common Core of Data, "National Public Education Financial Survey," data for 2010–11 through 2020–21 (US Department of Education, Institute of Education Sciences), https://nces.ed.gov/ccd/files.asp.

17 Data in Tables 4.01 and 4.02 and in Figures 4.07, 4.08, and 4.09 are drawn from National Center for Education Statistics, "Beginning Postsecondary Students Longitudinal Study," BPS:04/09 (2009, https://nces.ed.gov/pubs2009/200901.pdf) and BPS:12/17 (2019, https://nces.ed.gov/surveys/bps/), (US Department of Education, Institute of Education Sciences), data compiled by the authors from NCES PowerStats.

18 Jeremy Cohen et al., *Some College, No Credential Student Outcomes: Annual Progress Report — Academic Year 2023/24*, (National Student Clearinghouse Research Center, June 2025), 3, 9. Population figure and re-enrollment rate from page 3 (highlights) and page 9; combined two-year credential earning rate (14.1 percent for 2022–23 re-enrollees) from page 9, https://nscresearchcenter.org/some-college-no-credential/.

19 Elaine Seymour and Nancy M. Hewitt, *Talking about Leaving: Why Undergraduates Leave the Sciences* (Westview Press, 1997), https://sites.lsa.umich.edu/math-lcit/wp-content/uploads/sites/1398/2025/04/talkingAboutLeavingSeymourHewittOverview.pdf.

20 Elaine Seymour and Anne-Barrie Hunter, eds., *Talking about Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education* (Springer, 2019), https://casa.colorado.edu/~dduncan/wp-content/uploads/2019_Book_TalkingAboutLeavingRevisited.pdf.

21 Xianglei Chen, *STEM Attrition.*

22 Jessica Ellis et al., "Women 1.5 Times More Likely to Leave STEM Pipeline After Calculus Compared to Men: Lack of Mathematical Confidence a Potential Culprit," *PLOS ONE* 11, no. 7 (2016): e0157447, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157447.

23 Senate-Administration Workgroup on Admissions, *Final Report* (UC San Diego Academic Senate, updated January 8, 2026), https://senate.ucsd.edu/media/740347/sawg-report-on-admissions-review-docs.pdf; Zvezdelina Stankova et al., "Relationship Between Prerequisite Mastery and Failure/Attrition Rates in Calculus I at UC Berkeley: Fall 2021, 2022, 2023," appendix, 5, accessed July 29, 2026, https://drive.google.com/file/d/1LnxJlOqUUUS7VVDs5Vzo1PKTuDPVOXia/view; Nathan Horwitz, "More Students Are Struggling with Math, Professors Say," *Temple News*, April 7, 2026, https://temple-news.com/more-students-are-struggling-with-math-professors-say/.

24 The Delaware Foreign Study Plan, later the Junior Year Abroad, was conceived by Professor Raymond W. Kirkbride and launched with the support of University of Delaware president Walter S. Hullihen; the first group of eight students sailed for France aboard the Rochambeau on July 7, 1923. University of Delaware Institute for Global Studies, "Our Study Abroad History," University of Delaware, https://www.udel.edu/academics/global/study-abroad/history/; Fulbright Act of 1946, Pub. L. No. 79-584, 60 Stat. 754, sponsored by Senator J. William Fulbright of Arkansas and signed by President Harry S. Truman on August 1, 1946; the first grantees traveled in 1948. See US Department of State, Bureau of Educational and Cultural Affairs, "The Fulbright Program," https://www.state.gov/the-fulbright-program.

25 Commission on the Abraham Lincoln Study Abroad Fellowship Program, *Global Competence and National Needs: One Million Americans Studying Abroad* (2005), https://www.aplu.org/wp-content/uploads/global-competence-and-national-needs-one-million-americans-studying-abroad.pdf. The commission set a target of one million American students studying abroad annually by the 2016–17 academic year; the program it recommended was later enacted as the Senator Paul Simon Study Abroad Program.

26 Institute of International Education, "US Study Abroad for Academic Credit Trends," data for 1989/90–2023/24 (*Open Doors Report on International Educational Exchange,* 2024), https://opendoorsdata.org/data/us-study-abroad/u-s-study-abroad-for-academic-credit-trends/.

27 Data in Figure 4.10 are drawn from UNESCO Institute for Statistics, "Total Outbound Internationally Mobile Tertiary Students Studying Abroad, All Countries, Both Sexes (UIS Estimate) (Number)," UIS.Stat Database, data compiled by the authors by country over time, 2026, https://data.uis.unesco.org/.

28 Data in Table 4.03 are drawn from Institute of International Education, "US Study Abroad Students: Field of Study," data for 2000/01–2022/23 (*Open Doors Report on International Educational Exchange*, 2024), https://opendoorsdata.org/data/us-study-abroad/fields-of-study/.

29 Data in Table 4.04 are drawn from Institute of International Education, "US Study Abroad Students: Host Regions," data for 2004/05–2022/23 (*Open Doors Report on International Educational Exchange,* 2024), https://opendoorsdata.org/data/us-study-abroad/host-regions/.

30 Data in Figure 4.11 are drawn from UNESCO Institute for Statistics, "Net Flow of Internationally Mobile Students (Inbound − Outbound), Both Sexes (UIS Estimate) (Number)," UIS.Stat Database, data compiled by the authors by country over time, 2026, https://data.uis.unesco.org/.

The 2026 US Talent Report

CHAPTER 5

The Talent Magnet

America's Narrowing Research Advantage

HOOVER INSTITUTION | Stanford University
HAI Stanford University Human-Centered Artificial Intelligence

Chapter 5

The Talent Magnet

America's Narrowing Research Advantage

FIGURES

TABLES

Chapter 5

Key Takeaways

1. **America's research advantage remains formidable, but it is no longer unmatched.** At NeurIPS, one of the world's premier machine-learning conferences, the US-affiliated share of oral presentations fell from 69.1 percent in 2013 to 34.0 percent in 2025, while China's rose from 1.80 percent to 33.6 percent, bringing the two nearly level. America's relative decline and China's rise appear across twenty major AI conferences.

2. **China's rise is a story of quality, not only volume, and it was engineered.** Between 2015 and 2025, China's share of the most-cited emerging-technology publications nearly doubled, from 11.5 percent to 20.8 percent, while the US share fell from 14.2 percent to 8.42 percent. In other words, in the past decade America's share of top-cited technological publications fell by 40 percent while China's share nearly doubled.

3. **America's research capacity is still growing, but the rest of the world, especially China, is growing much faster.** The number of highly cited researchers working at US institutions rose from about 1,700 in 2014 to 2,670 in 2025, yet that gain was outpaced globally, and the US share of the global total fell from 52.9 percent to 37.4 percent as China's climbed from under 5 percent to 22 percent. The American decline is relative, not absolute—but still consequential.

4. **The depth of America's institutional advantage may be thinning.** The country's leading universities remain among the world's best, but the number of US universities in the global STEM top 100 has fallen over the last decade. The erosion is happening below the handful of institutions at the very top, in the broad bench that long distinguished the American research system.

5. **China has closed much of the resource gap while building a differently configured research system.** In purchasing-power-parity terms, Chinese R&D spending rose from one-nineteenth of the US level in 1991 to near parity in 2024, driven overwhelmingly by corporate investment. The two countries spend that money differently, with China concentrating on experimental development and commercialization while the United States keeps a substantial lead in basic research.

6. **The two countries now operate different talent models at the corporate frontier.** American AI laboratories depend on globally assembled teams, while Chinese laboratories rely more heavily on domestically trained researchers and returning talent. The contrast is stark at the frontier, where more than half of the AI researchers behind the breakthrough models released from two leading Chinese companies—DeepSeek AI and Moonshot—never left China.[1]

Chapter 5 – By the Numbers:

MEASURE	2014	2025	CHANGE	
RESEARCH LEADERSHIP				
United States' share of				
Global top-cited emerging-technology publications	14.2%[2015]	**8.42%**	-5.8 pp	▼
Global top papers with country-affiliated authors	22.3%[2015]	**16.2%**	-6.1 pp	▼
Global top 1% most-cited researchers	52.9%	**37.4%**	-15.5 pp	▼
NeurIPS oral presentations	47.1%*	**34%**	-13.0 pp	▼
China's share of				
Global top-cited emerging-technology publications	11.5%[2015]	**20.8%**	+9.4 pp	▲
Global top papers with country-affiliated authors	17.1%[2015]	**32.8%**	+15.7 pp	▲
Global top 1% most-cited researchers	4.85%	**22%**	+17.1 pp	▲
NeurIPS oral presentations	9.8%*	**33.6%**	+23.8 pp	▲
R&D SCALE AND INTENSITY				
United States: total R&D spending	$521B*	**$848B[2024]**	+62.7%	▲
United States: R&D intensity	2.71%*	**3.44%[2024]**	+0.7 pp	▲
China: total R&D spending	$362B*	**$859B[2024]**	+138%	▲
China: R&D intensity	1.98%*	**2.69%[2024]**	+0.7 pp	▲
R&D COMPOSITION				
United States: basic research	$90.5B*	**$122B[2024]**	+35%	▲
United States: experimental development	$329B*	**$570B[2024]**	+73%	▲
United States: business-performed R&D	$372B*	**$657B[2024]**	+76.3%	▲
China: basic research	$17.1B*	**$59.2B[2024]**	+247%	▲
China: experimental development	$306B*	**$698B[2024]**	+128%	▲
China: business-performed R&D	$280B*	**$667B[2024]**	+139%	▲
PATENTS IN CRITICAL TECHNOLOGIES				
United States: biotechnology patents	6,800*	**7,960[2024]**	+17%	▲
United States: semiconductor patents	9,640*	**7,040[2024]**	-27%	▼
United States: computer-technology patents	40,500*	**44,600[2024]**	+10.2%	▲
China: biotechnology patents	5,390*	**16,000[2024]**	+197%	▲
China: semiconductor patents	2,950*	**17,200[2024]**	+482%	▲
China: computer-technology patents	7,780*	**176,000[2024]**	+2,160%	▲
CORPORATE LEADERS IN US PATENTS				
Hewlett-Packard	1,450[2015*]	**322**	-1,130	▼
IBM	7,440[2015*]	**2,470**	-4,970	▼
Canon	4,240[2015*]	**2,990**	-1,250	▼
Samsung Electronics	5,060[2015*]	**7,530**	+2,470	▲
Taiwan Semiconductor	1,760[2015*]	**4,230**	+2,480	▲

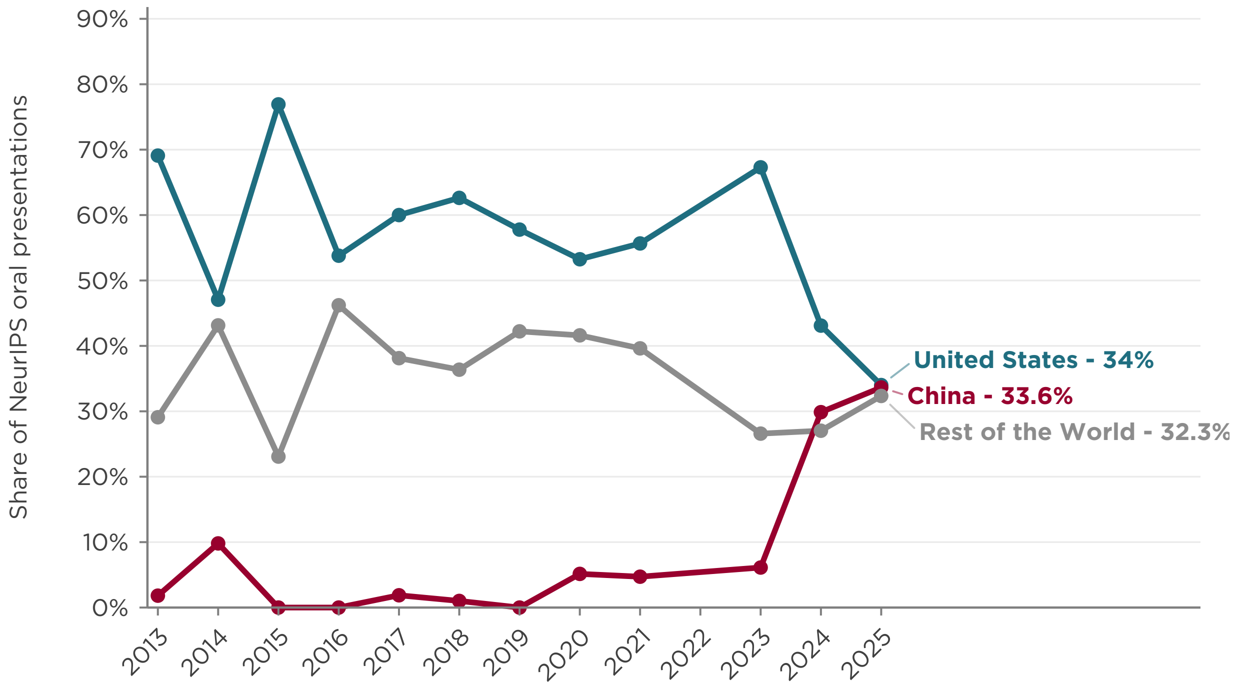
* Data are available further back than 2014 for marked series.

Note: Historical comparisons use 2014 and 2025 observations. Superscript years mark rows with alternative endpoints. NeurIPS = Conference on Neural Information Processing Systems. Arrow colors indicate direction of change only.

Source: Derived from the current report Figures and Tables: Figures 5.01–5.08, Tables 5.01-5.06.

In 2013, researchers affiliated with US institutions delivered 69.1 percent of the oral presentations at NeurIPS, the most selective presentation type at the world's premier conference in machine learning. In the same year, researchers affiliated with Chinese institutions delivered just 1.8 percent. The gap was 67.3 percentage points. By 2025, the US and China were neck and neck, separated only by four-tenths of one point (See Figure 5.01).[2]

Figure 5.01 **Who Presents at Machine Learning's Most Selective Venue?**



Data from Paper Copilot, conference acceptance and submission statistics; authors' compilation.
Chart by Emerson Johnston and Amy Zegart, Stanford University

China's rapid gains, at one of the world's most important AI conferences where an oral slot is hardest to win, are the story of this chapter—and it repeats across metrics and technological fields. We find that America's lead compared to China in most major technological areas has diminished almost entirely in a little over a decade.

Chapters 1 through 3 traced how extensively American universities, laboratories, and technology companies rely on STEM talent from abroad. Chapter 4 showed why that reliance has grown: The domestic pipeline loses potential scientists and engineers at every stage, from secondary-school mathematics through college STEM completion.

None of those challenges would matter as much if American research institutions were so far ahead of the rest of the world that the best students and scientists would keep coming to the United States. For the past eighty years, that was true. American research universities, national laboratories, and corporate research centers offered a concentration of funding, facilities, colleagues, and opportunity that few countries could approach. The pull was the institutions themselves, not just the door being open. That is the advantage we move to now.

This chapter examines whether those advantages remain strong enough to sustain America's talent model. It considers two parts of the innovation system: universities, which train scientists and produce much of the country's foundational research, and companies, which increasingly conduct frontier research and convert discoveries into commercial technologies and products. A country can slip in one and hold its lead through the other. The question we ask is whether the United States is holding its lead in either. The answer is yes, but America's formidable advantages are diminishing.

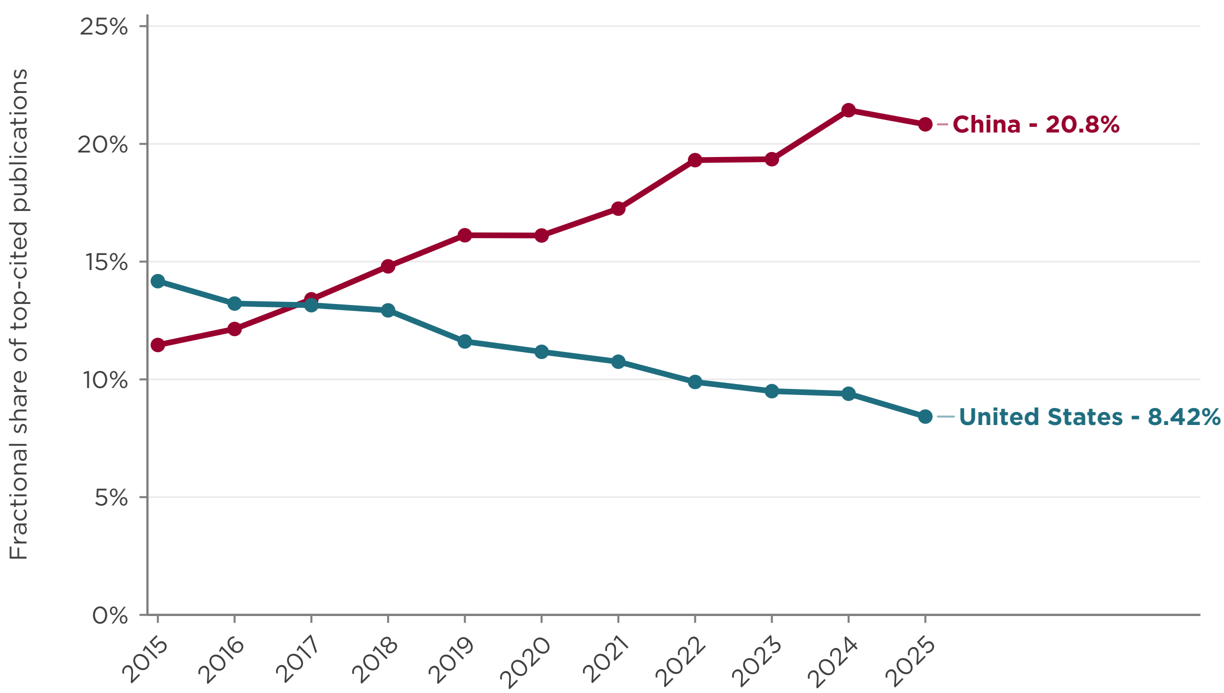
Part One: The Universities

Where the most-cited research is produced

If the purpose of a research system is to produce work that other scientists build on, the most meaningful test is not how many papers a country publishes but how many of the most-cited ones it produces. By that measure, China has already overtaken the United States in its share of the world's most-cited emerging-technology publications. That does not mean every Chinese paper is more influential than its American counterpart, or that China leads in every field. It simply means that China now accounts for a substantially larger portion of the highly cited research produced worldwide.

In 2015, the United States produced 14.2 percent of the top-cited publications in emerging technologies—the most in the world. China produced 11.5 percent. In 2017, China surpassed the United States for the first time, and the gap has only widened. By 2025, China contributed 20.8 percent of the top-cited publications globally, while the United States contributed just 8.4 percent. Put another way, in the past decade America's share of top-cited technological publications fell by 40 percent while China's share nearly doubled (See Figure 5.02).[3]

Figure 5.02 **Who Produces the Most-Cited Research in Emerging Technologies?**



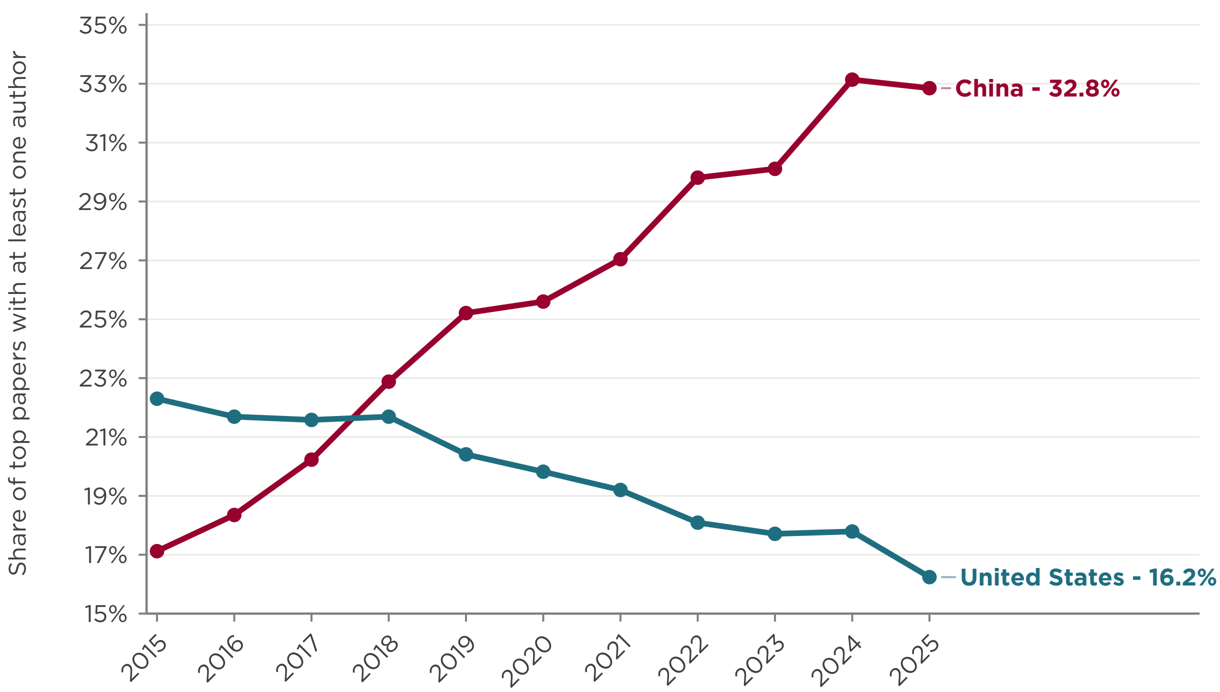
Data from OpenAlex (Priem, Piwowar, and Orr).
Chart by Emerson Johnston and Amy Zegart, Stanford University

China's rise is also visible in collaborative research: Chinese-affiliated authors now appear on a substantially larger share of the world's highly cited STEM papers than US-affiliated authors do. Because internationally coauthored papers may be credited to more than one country, these shares measure participation in influential research, not exclusive national ownership of it. Among the top 10 percent most-cited STEM publications, the share carrying at least one US-affiliated author fell from 22.3 percent in 2015 to 16.2 percent in 2025, while the share carrying at least one Chinese-affiliated author rose from 17.1 percent to 32.8 percent (See Figure 5.03).

In 2000, China produced roughly 5 percent of the world's scientific publications. Just over two decades later, it produces more than a quarter and has become the largest producer in absolute terms.[4] As late as its 2020 assessment, the National Science Board judged China's output comparable to the United States in volume but still lagging the United States and the European Union in impact, with Chinese work appearing among the world's top 1 percent most-cited papers at just above the rate its output would predict,

In 2000, China produced roughly 5 percent of the world's scientific publications. Just over two decades later, it produces more than a quarter and has become the largest producer in absolute terms.

Figure 5.03 Whose Authors Appear on the World's Top Papers?



Data from OpenAlex (Priem, Piwowar, and Orr).
Chart by Emerson Johnston and Amy Zegart, Stanford University

against a rate nearly twice as high for the United States.[5] That gap has narrowed considerably. By the board's more recent accounting, China's share of most-cited papers has passed the EU-27.[6]

The state programs behind China's technological research rise were deliberate and sequenced. Project 211, implemented in 1995, channeled priority funding to about a hundred universities to raise their research capacity for the coming century.[7] The first phase alone directed some $2.2 billion to the selected institutions. Project 985, announced by Jiang Zemin at Peking University's centenary in May 1998, went further, concentrating far larger sums on a narrow tier that began at nine universities and grew to thirty-nine, with the money aimed at recruiting senior faculty, funding laboratories, and buying a place in the international research conversation.[8]

Between 1995 and 2000, the selected universities absorbed roughly 70 percent of China's national research funding and trained four-fifths of the country's doctoral students. The Thousand Talents Program, launched in 2008, added the recruitment arm the university programs lacked, offering overseas researchers, most of them ethnic Chinese trained in the West, compensation packages and laboratory budgets to return.[9] It set out to bring back two thousand people, but had drawn more than seven thousand within a decade.

These programs were designed to develop research capacity and international influence, not merely to increase publication counts. The citation gains that followed are consistent with that objective—and concentrate in exactly the emerging technology fields of greatest national consequence and concern.[a]

The elite researcher base

Papers and citations are one measure. The people who write and earn them are another, and here the American position is stronger. It holds its lead as of 2025, though here too, the lead is narrowing. The number of the world's top 1 percent most-cited researchers working at US institutions did not fall over the past decade. It rose, from about 1,700 in 2014 to roughly 2,670 in 2025. What fell was the American *share* of that global elite, from 52.9 percent to 37.4 percent, while China's climbed from under 4.9 percent to 22.0 percent (See Figure 5.04).[10b]

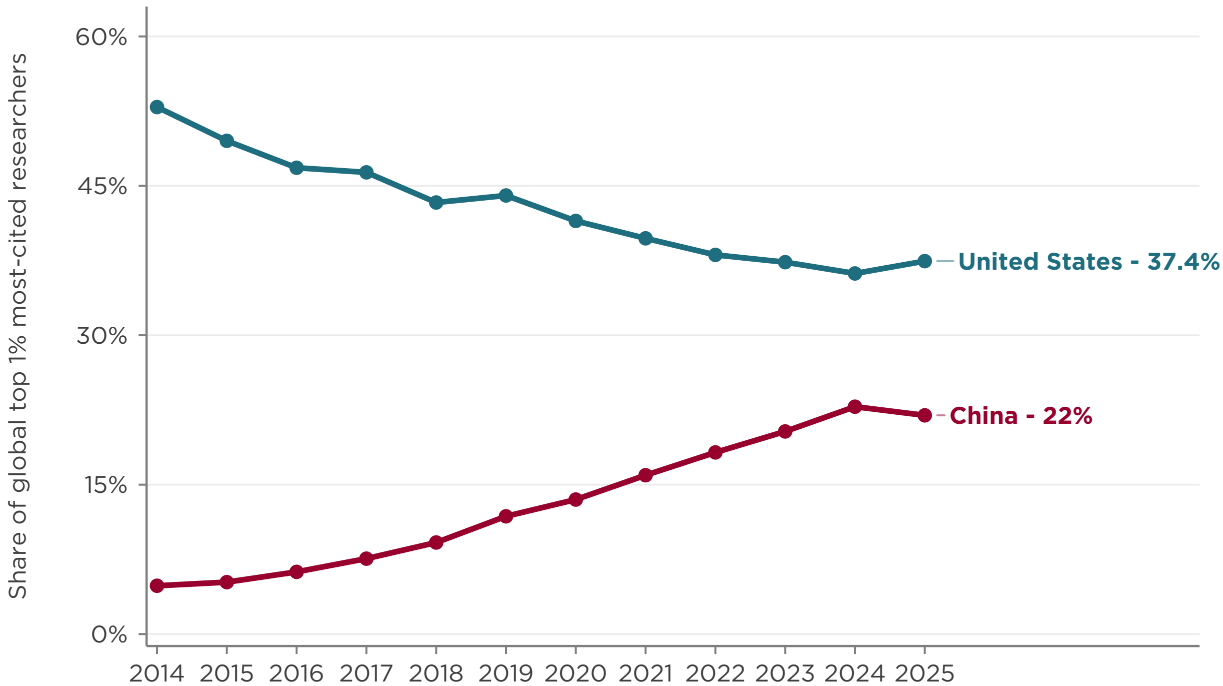
Notably, a substantial share of the researchers counted in China's rising number are people the American system trained.

The distinction between the count and the share is important. American institutions do not employ fewer researchers on the highly cited list than they did a decade ago. They employ more. But their share of the global total has fallen as institutions elsewhere—especially in China—have added highly cited researchers much faster. The climb tracks the same buildout the publication data reflect: The recruitment programs described above pulled established researchers to Chinese institutions across exactly the years the share moved. Notably, a substantial share of the researchers counted in China's rising number are people the American system trained.

a It is worth noting that the aggregate data cannot isolate the effects of these programs from China's broader economic growth, expanding university system, and increasing integration into global science.

b These figures come from Clarivate's Highly Cited Researchers list, which identifies the authors of papers ranking in the top 1 percent by citations in their field. Since 2021, Clarivate has sharply expanded its screening for excessive self-citation, hyper-prolific authorship, and anomalous citation patterns, excluding roughly 2,400 candidates in 2025 against about 500 in 2022; these exclusions have fallen disproportionately on China-affiliated researchers. Clarivate attributes part of the 2025 stabilization in the United States share to that tightened screening rather than to a change in underlying research output. China's rise in this metric is therefore real but likely overstated at its peak, and the recent flattening of the gap should be read with the methodology change in mind. For more information, see Clarivate, Analytics, "Highly Cited Researchers 2025 Analysis," 2025, https://clarivate.com/highly-cited-researchers/analysis/.

Figure 5.04 Where Do the World's Most-Cited Researchers Work?



Data from Clarivate, "Highly Cited Researchers," 2014–2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Conference Data

This chapter began by discussing how US dominance at NeurIPS fell while China achieved parity in just over a decade. NeurIPS was not an isolated development. We find the same patterns across twenty major AI and machine-learning conferences, though at different speeds and with different timing (See Table 5.01).[c]

The chart shows the same pattern at nearly every leading conference in natural language processing, machine learning, robotics, and AI: The US share falls, China's rises, and in 40 percent of venues, China has already passed the United States. At the robotics conference IROS, the crossover came as early as 2006, at the vision conferences ICCV and CVPR by 2019, and at NeurIPS

Table 5.01 When Did China Catch Up at Each AI Conference?

		UNITED STATES			CHINA			
	COVERAGE	FIRST	LATEST	CHANGE	FIRST	LATEST	CHANGE	OVERTOOK[1]
ACML (ML)	2010–2024	4.55%	6.19%	**+1.6 pp**	12.1%	59.1%	**+47.0 pp**	2010
NeurIPS (ML / AI)	1989–2025	39.4%	30%	**−9.4 pp**	0.433%	38.9%	**+38.4 pp**	2025
ICML (ML)	2013–2025	48.1%	33.8%	**−14.3 pp**	4.53%	32.2%	**+27.7 pp**	Not yet
CVPR (Vision)	2013–2025	34%	16.1%	**−17.8 pp**	14.4%	39.2%	**+24.9 pp**	2019
ICCV (Vision)	2013–2023	32%	20.3%	**−11.6 pp**	15.7%	40.3%	**+24.6 pp**	2019
ICLR (ML)	2021–2025	49%	37.2%	**−11.8 pp**	8.7%	32%	**+23.3 pp**	Not yet
EMNLP (NLP)	2021–2024	37.5%	36.6%	**−0.9 pp**	2.73%	21%	**+18.3 pp**	Not yet
IJCAI (AI)	2020–2024	16.4%	12.7%	**−3.6 pp**	42.5%	57.6%	**+15.1 pp**	2020
CoRL (Robotics)	2021–2025	63.1%	53.2%	**−9.9 pp**	4.35%	19.4%	**+15.0 pp**	Not yet
RSS (Robotics)	2011–2025	47.6%	40.3%	**−7.3 pp**	0.806%	14.9%	**+14.1 pp**	Not yet
IROS (Robotics)	2000–2024	6.54%	11.7%	**+5.1 pp**	1.64%	15%	**+13.4 pp**	2006
COLING (NLP)	2020–2025	43.3%	21.2%	**−22.0 pp**	4.49%	16.5%	**+12.0 pp**	Not yet
ICRA (Robotics)	2000–2024	12.8%	16%	**+3.2 pp**	3.14%	14.3%	**+11.1 pp**	Not yet
UAI (Prob. ML)	2019–2024	39.8%	18.8%	**−21.0 pp**	3.06%	11%	**+7.9 pp**	Not yet
NAACL (NLP)	2021–2025	52.5%	35.3%	**−17.3 pp**	14%	20.2%	**+6.1 pp**	Not yet
ACL (NLP)	2021–2024	32.8%	25.4%	**−7.4 pp**	41.8%	46.6%	**+4.8 pp**	2021
AISTATS (Stats)	1995–2025	48.1%	39.9%	**−8.2 pp**	1.53%	6.24%	**+4.7 pp**	Not yet
SIGGRAPH Asia (Graphics)	2008–2024	42.7%	17%	**−25.7 pp**	22.2%	25%	**+2.8 pp**	2022
COLT (Theory)	2011–2024	41.3%	61.2%	**+19.8 pp**	1.92%	3.29%	**+1.4 pp**	Not yet
WACV (Vision)	2020–2025	33.7%	26.1%	**−7.6 pp**	10.6%	10.2%	**−0.5 pp**	Not yet

[1] Each row gives the US and Chinese share of accepted author affiliations at the first and last year both countries are observed; that window is shown under Coverage and differs by venue. Change is the percentage-point change. "China overtook" is the first such year China's share exceeded the US share; "Not yet" means the US share still led in the latest observed year.

Data from Paper Copilot, conference acceptance and submission statistics; authors' compilation.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

c Table 5.01 records, for each venue, the US and Chinese shares of accepted-author affiliations at the first and last year both are observed, and the year—if there was one—that China's share first exceeded the American share.

itself in 2025. At the venues where the American share still leads, the trend nonetheless points toward decline.[d] That these conferences were built by the field's largely American and Western founders as the places its best work is presented and judged is part of what makes the shift telling. The composition of who now presents there is a real-time census of where the frontier work is done, and it looks very different today than it did a decade ago.

University Rankings

University rankings are a blunter and less stable measure than publications, citations, or conference participation—for many reasons. Methodologies change and can be highly subjective. Reputational measures often lag reality. Small differences in scores can produce large changes in ordinal rank. For all these reasons, institutional rankings should be treated as rough measures of trends and directionality, not definitive judgments about what nation or institution outranks another at a particular point in time.

Even bearing those limitations in mind, the rankings suggest two concerning broad trends: declining US rankings across the board, and what appears to be a narrowing of the depth of the research base relative to the rest of the world.

The average number of US universities in the global top 100 across STEM fields fell from 40.0 in 2014 to 34.2 in 2026 (See Table 5.02).[11] Physical sciences and life sciences each lost six schools, and engineering lost four. Computer science was the exception, although comparisons in that field begin later because it was not ranked separately until 2017.

The remaining US institutions did not collectively move upward enough to offset the schools falling from the list. Methodological changes and challenges make more careful comparisons impossible. These rankings do suggest, however, that the broad trends do not appear to be moving in the right direction.

Table 5.02 How Many US Universities Rank in the Global Top 100?

	U.S. UNIVERSITIES IN THE GLOBAL TOP 100[1]				
	2014	2018	2022	2026	CHANGE
Average	40.0	33.5	35.2	34.2	−5.8
Physical Sciences	44	35	35	38	−6.0
Life Sciences	40	35	36	34	−6.0
Engineering	36	32	35	32	−4.0
Computer Science	25	32	35	33	+8.0

[1] Counts are US universities in the global top 100 in each field, shown for 2014, 2018, 2022, and 2026. Change is the absolute change from 2014 to 2026. Computer science was first ranked in 2017; its 2017 count is shown in the 2014 column so its change can be computed.

Data from Times Higher Education, World University Rankings by Subject, 2011–2026.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

d COLT, the Conference on Learning Theory, is the lone exception: US-affiliated authors still account for 61.2 percent of the total and Chinese-affiliated authors for 3.3 percent, a distribution closer to the field in 2013 than to its peers today. The most plausible explanation is the nature of the subfield. COLT is a small, highly selective venue devoted to the mathematical theory of machine learning, where results are proofs rather than empirical benchmarks. The expansion that lifted China's share at the applied conferences, driven by large labs, data, and computing scale, bears less directly on a theoretical field whose leading groups are long established and concentrated in a handful of American and European departments. This reading is inferential as the data establish that COLT is an outlier, not why.

The second trend is the diminishing depth of US research universities. The schools that fell off the subject lists were overwhelmingly large public flagships and technical universities—Ohio State, Texas A&M, Rutgers, and Stony Brook in physical sciences; Penn State, Oregon State, and two University of California campuses in life sciences; Minnesota, Maryland, and Colorado Boulder in engineering—with a few mid-ranked private universities such as Notre Dame, Tufts, and Brown among them. This middle part of the system is important, and it's the story of America's post-World War II technological rise.

At the end of World War II perhaps half a dozen American universities were research universities in the sense that research was the faculty's principal work. By the early 1960s there were about twenty, and by 2000 at least a hundred, a tier built by the same postwar funding compact that Chapter 1 traced through the doctorate. What distinguished the United States was never only its handful of famous universities, which every competitor could match one or two of, but the depth of the bench beneath them: dozens of institutions capable of first-rate work, not three or four. That depth is what the rankings are now registering as thinner. The few American universities at the very top still place where they always have. It is the tier below, the one the buildout created, that is losing ground to the institutions China and others have spent two decades funding and building.

When the weakest institutions drop off a fixed-length list, the average standing of those that remain should rise on its own, since the departures come from the bottom of the group. Over the above period, though, the average rank of the included US universities did not rise.[12] For it to hold flat while the lowest-ranked US schools were falling out, the schools that remained had to be sliding down the table by just enough to cancel the lift their departure should have produced. Both things were happening at once: Schools were dropping off the bottom, and the ones still on the list were losing ground within it. The erosion is not concentrated at the cutoff. It runs through the whole cohort.

Part Two: The Companies

A country can lose ground in academic publications and still hold its lead commercially. The second half of this chapter asks whether it has.

Corporate R&D spending and patents do not measure talent directly. They measure the environment in which talent works: the resources available to researchers and the capacity to convert discoveries into technologies. They matter here because the American talent magnet has never consisted of universities alone. Scientists also choose where to work based on the laboratories, firms, funding, equipment, and commercial opportunities surrounding them.

The input: research spending

The United States still leads the world in R&D spending. In fact, spending has grown over time and is currently at record highs. While federal funding has declined significantly over time, industry spending has more than taken up the slack.

But set against China, the picture is more concerning. Here, too, the gap has narrowed considerably, and quickly.

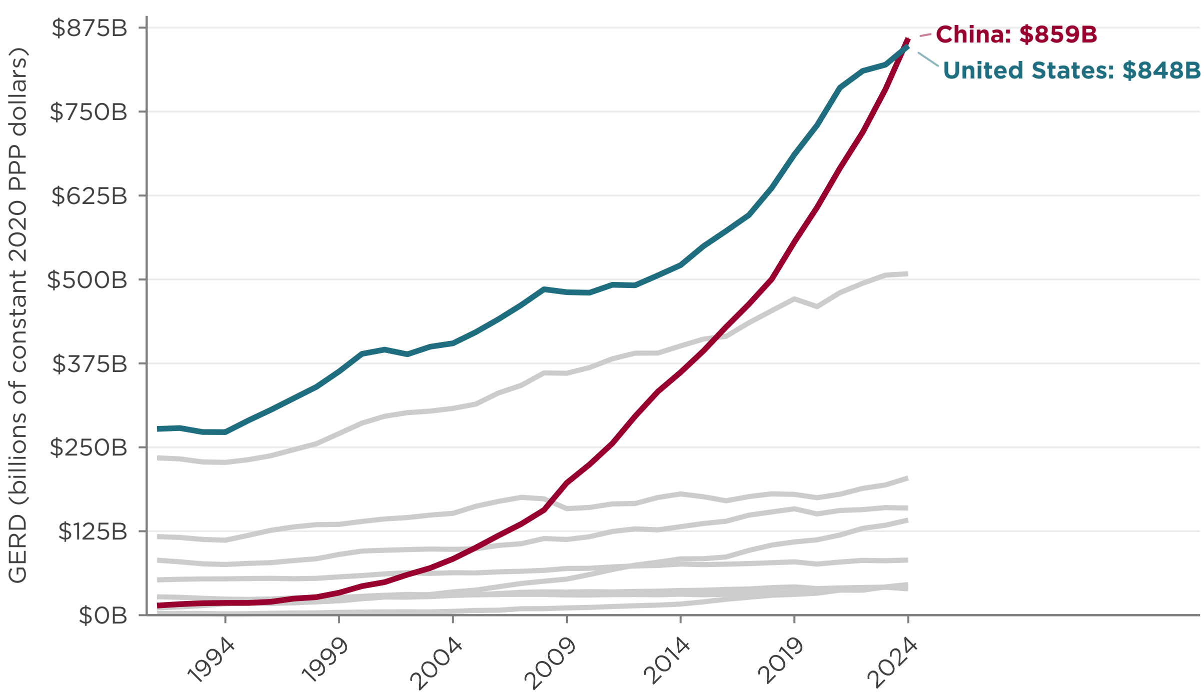
In 1991, the United States spent $277 billion of its gross domestic expenditure on research and development, and China spent about $14 billion—a ratio of roughly nineteen to one.[13e] China's research effort then amounted to less than three-quarters of one percent of its economy,

e R&D figures for China are drawn from Organisation for Economic Co-operation and Development (OECD) Main Science and Technology Indicators, which compile self-reported national statistics. While Chinese metrics should be treated with some caution, the best available data indicate a steep and sustained rise over three decades—a trajectory independently corroborated by patent, publication, and researcher counts, even where specific levels are uncertain.

a very small fraction of the American or Japanese rates. What followed was successive Five-Year Plans and the 2006 Medium- and Long-Term Plan for science and technology that together set rising national targets for research intensity (gross domestic expenditure on research and development as a percent of GDP)—and China met most of them.[14]

Across the same years, the US's R&D-to-GDP ratio stayed relatively flat, so the absolute spending gap closed accordingly. By 2024, China's gross R&D expenditure reached about $859 billion, edging past the United States at $848 billion, with the European Union at a distant third at $508 billion and every other economy far below (See Figure 5.05).[15] Thirty years ago, American R&D spending far outpaced Chinese R&D investment. Today, the two countries spend about the same, with China now slightly ahead.

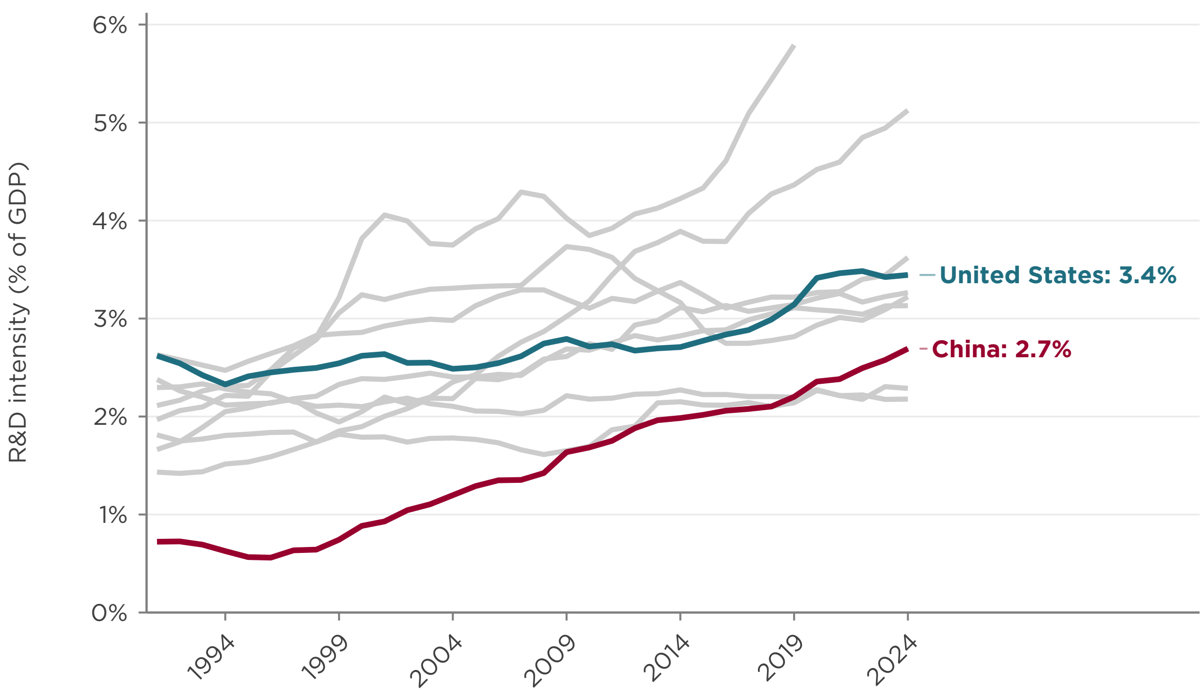
Figure 5.05 Who Spends the Most on R&D?



Data from OECD, Main Science and Technology Indicators (GERD, constant 2020 PPP USD), OECD.Stat, 1991–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University

As a share of the economy, the American position looks stronger. R&D intensity in the United States reached 3.4 percent of GDP in 2024, above China's 2.7 percent (See Figure 5.06).[16] But China started far behind. Its R&D intensity rose from 0.7 percent in 1991, roughly a fifth of the American rate, and it nearly doubled between 2000 and 2010, from 0.9 to 1.7 percent. China's rapid increase suggests that the current gap may continue to narrow, although the data cannot establish how far or how quickly.

Figure 5.06 How Intensely Does Each Country Invest in R&D?



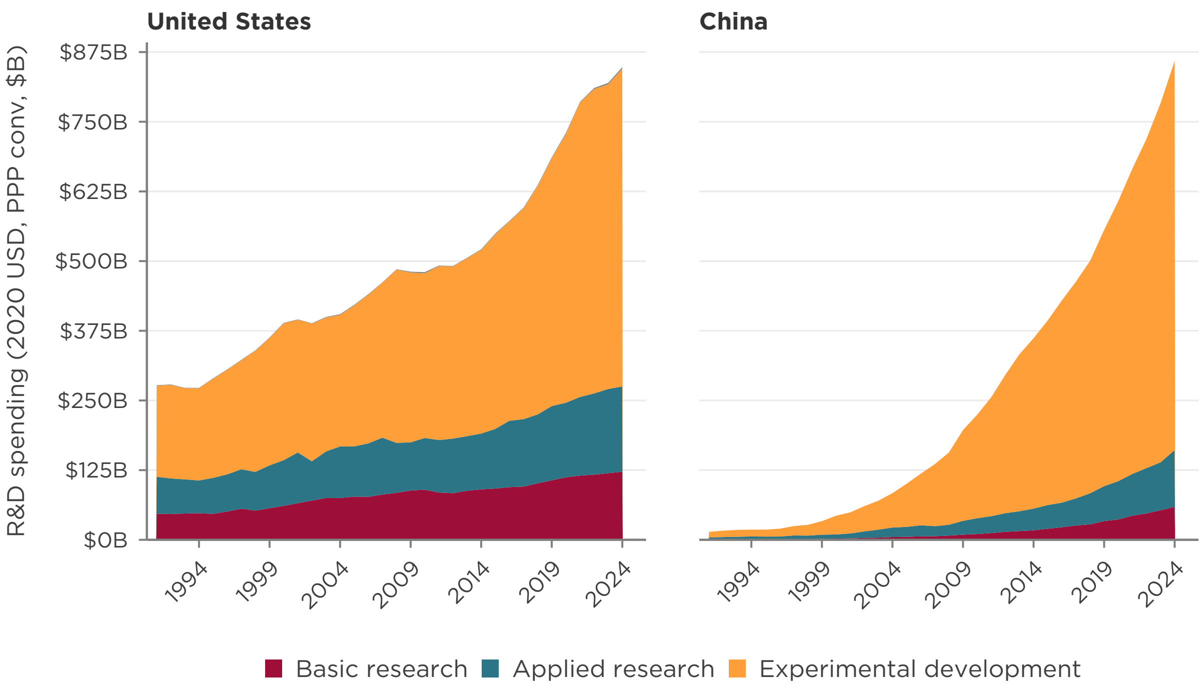
Data from OECD, Main Science and Technology Indicators (GERD as a percentage of GDP), OECD.Stat, 1991–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University

But all R&D is not the same—and a closer examination finds substantial differences between US and Chinese spending.

Generally speaking, research can be divided into three categories. Basic research seeks foundational understanding in a field and may take years, even generations, with no foreseeable commercialization. It investigates frontier questions such as whether dark matter is made of axions, or whether a genome can be written from scratch to run on a minimal set of essential genes. Applied research directs that understanding toward a specific practical aim. Experimental development draws on both to produce new products, processes, and materials. And, while fundamental research typically has a long time horizon, applied and experimental research seeks to apply new knowledge in the near term.

The United States and China may spend about the same overall, but the composition differs (See Figure 5.07).[17] In 2024 the United States spent more on basic research ($122 billion to China's $59.2 billion) and applied research ($153 billion to $102 billion), while China spent far more on experimental development ($698 billion to the US's $570 billion).

Figure 5.07 **Is R&D Spending Aimed at Today or Tomorrow?**



Data from OECD, Main Science and Technology Indicators (GERD, constant 2020 PPP USD), OECD.Stat, 1991–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University

That gap defines each country's mix. Experimental development is more than four of every five dollars China spends on R&D, and basic research barely one in fourteen. The American split is far more even: development takes about two-thirds, applied research a fifth, and basic research a seventh (See Table 5.03).

Chinese spending has grown faster than America's across every category since 1994. Basic research rose 5,780 percent over those three decades and experimental development 5,600 percent, against 156 and 245 percent for the United States. The gaps are closing from a base so small that even large percentage gains still leave China behind on basic research, where the United States still spends twice as much. Whether China keeps building that base is the question the composition raises: a system weighted toward development turns existing knowledge into products, while one that invests in basic research is funding the discoveries the next generation of products will draw on.

Table 5.03 Is R&D Spending Aimed at Today or Tomorrow?

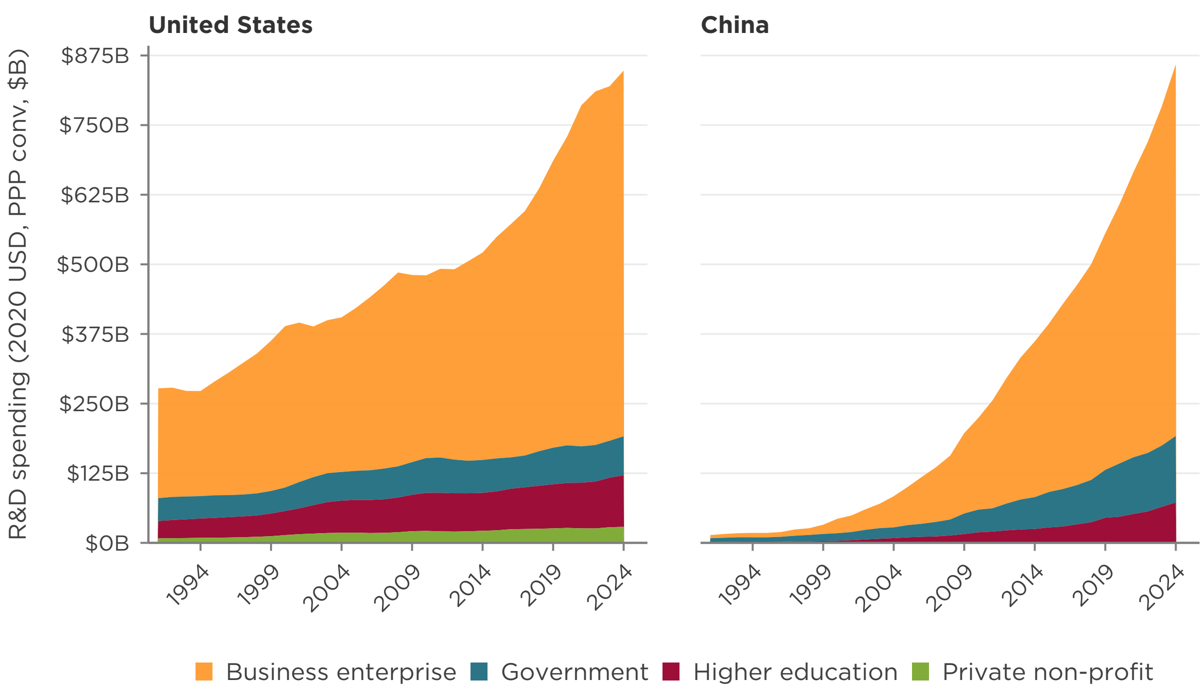
	GERD (USD BILLIONS, CONSTANT 2020 PPP)[1]				
	1994	2004	2014	2024	CHANGE
United States					
Basic research (for tomorrow)	$47.7B	$75.1B	$90.5B	$122B	**+156%**
Applied research (for today)	$58.9B	$92.4B	$100B	$153B	**+160%**
Experimental development (for today)	$165B	$236B	$329B	$570B	**+245%**
Capital expenditure (unallocated)	$0.665B	$1.46B	$1.13B	$2.72B	**+309%**
Total	**$273B**	**$405B**	**$521B**	**$848B**	**+211%**
China					
Basic research (for tomorrow)	$1.01B	$4.99B	$17.1B	$59.2B	**+5,780%**
Applied research (for today)	$4.98B	$17.1B	$38.9B	$102B	**+1,940%**
Experimental development (for today)	$12.3B	$61.7B	$306B	$698B	**+5,600%**
Total	**$18.2B**	**$83.8B**	**$362B**	**$859B**	**+4,610%**

[1] Spending levels in billions of constant 2020 US dollars, PPP converted (adjusted for inflation). Change is the relative change from the first to the last shown year. Basic research is investment in future capability; applied research and experimental development are nearer-term. Totals may not sum exactly because of rounding.

Data from OECD, Main Science and Technology Indicators (GERD, PPP), OECD.Stat, 1991–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

The same categories can be cut a different way, by who performs the research rather than what kind it is. Generally, R&D is performed in four sectors. Business enterprises do the applied and development work closest to market; government institutes run national laboratories and mission agencies; universities perform much of a country's basic research; and private nonprofits, foundations, and independent institutes make up the remainder. Here the two countries look more alike than the spending mix suggests. Businesses do most of the R&D in both, and the differences lie in the smaller performers (See Figure 5.08).

Figure 5.08 Who Performs R&D in the United States and China?



Data from OECD, Main Science and Technology Indicators (GERD, constant 2020 PPP USD), OECD.Stat, 1991–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University

Of China's R&D expenditure in 2024, business enterprises account for $667 billion, more than three in every four dollars. Government institutes take about $119 billion, and universities about $73 billion. China reports no private nonprofit R&D. The American distribution is similar at the top but wider at the base. Business performs about 77 percent, universities about a ninth, government about a twelfth, and the nonprofit sector about 3 percent, or roughly $29 billion (See Table 5.04).

Table 5.04 How Do the US and China Divide R&D Across Sectors?

	GERD (USD BILLIONS, CONSTANT 2020 PPP)[7]				
	1994	2004	2014	2024	CHANGE
United States					
Business enterprise sector	$189B	$278B	$372B	$657B	**+248%**
Government sector	$40.2B	$51.5B	$59.1B	$69.9B	**+73.7%**
Higher education sector	$34.7B	$57.7B	$68.1B	$92.7B	**+167%**
Private non-profit sector	$9B	$18.1B	$21.7B	$28.7B	**+219%**
Total	**$273B**	**$405B**	**$521B**	**$848B**	**+211%**
China					
Business enterprise sector	$7.87B	$56B	$280B	$667B	**+8,380%**
Government sector	$7.68B	$19.2B	$57.2B	$119B	**+1,460%**
Higher education sector	$2.3B	$8.56B	$25B	$72.5B	**+3,050%**
Private non-profit sector	$0B	$0B	$0B	$0B	**0%**
Total	**$17.8B**	**$83.8B**	**$362B**	**$859B**	**+4,710%**

[7] Spending levels in billions of constant 2020 US dollars, PPP converted (adjusted for inflation). Change is the relative change from the first to the last shown year. Sectors denote where R&D is performed. China reports no private non-profit R&D; it is shown as $0, and its change cell is undefined from a zero base and appears as 0%. China's 1994 total is given as $17.8 billion, the sum of the sector values shown; OECD reports $18.2 billion for that year, as in Table 5.03. Totals may not sum exactly because of rounding.

Data from OECD, Main Science and Technology Indicators (GERD, PPP), OECD.Stat, 1991–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

Again, across every sector, Chinese performance has grown faster over the past three decades, closing the gap, and in some places, passing the United States. Business enterprise is where China has drawn level, turning a roughly twenty-four-to-one deficit in 1994 into rough parity today. Its government sector went further, from a five-to-one gap to performing nearly twice the American level. Only in university research does the American lead still hold, and even there China closed on it from a fifteen-to-one deficit to roughly three-to-four. Whether the spending data are cut by type of research or by who performs it, the story is the same: China began far behind and has erased most of the distance in thirty years.

Whether the spending data are cut by type of research or by who performs it, the story is the same: China began far behind and has erased most of the distance in thirty years.

The output: patents

Spending is an input. Patents are one measure of what it produces. Where a published paper establishes priority for a scientific finding, a patent stakes a claim on a commercial application—which is why patents are more forward-looking where citations are more backward-looking. A paper published in 2025 describes research done in 2022 or 2023; a patent granted in 2025 protects a technology its owner expects to sell in 2027 or 2028.

Patent counts do not establish the value, originality, or market success of those inventions, and national patent systems create different incentives to file. But sustained changes across strategically important fields can reveal where inventive activity is expanding.

Across the three critical fields the shift is large (See Table 5.05).[18f] Between 2014 and 2024, the number of Chinese patent grants rose 197 percent in biotechnology,

Table 5.05 Who Patents in Critical Technologies?

	BIOTECHNOLOGY[1]			SEMICONDUCTORS[1]			COMPUTER TECHNOLOGY[1]		
	2014	2024	CHANGE	2014	2024	CHANGE	2014	2024	CHANGE
China	5,390	16,000	**+197%**	2,950	17,200	**+482%**	7,780	176,000	**+2,160%**
United States	6,800	7,960	**+17%**	9,640	7,040	**-27%**	40,500	44,600	**+10.2%**
Japan	2,560	2,270	**-11.5%**	21,200	14,500	**-31.9%**	22,700	17,900	**-21.1%**
South Korea	1,980	2,200	**+11.1%**	8,120	9,610	**+18.3%**	9,230	16,300	**+76.9%**
Germany	1,040	889	**-14.8%**	1,710	1,250	**-27.1%**	2,470	3,280	**+33%**
United Kingdom	436	703	**+61.2%**	205	210	**+2.44%**	911	2,180	**+139%**
Australia	206	154	**-25.2%**	28	12	**-57.1%**	215	258	**+20%**

[1] Patents granted by each country's patent office. Values are grants in 2014 and 2024 with the relative change between them. Countries are ordered by total 2024.

Data from World Intellectual Property Organization, "Patents Granted by Technology," WIPO IP Statistics Data Center, 2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

f The gap in patent counts may overstate the gap in innovation. Chinese filings are sometimes said to favor quantity over quality, and part of China's lead reflects where firms choose to file: Companies patent where they intend to sell, so China's large domestic market inflates its patent-office totals independent of any quality difference. Even granting a quality gap, volume compensates for a great deal—if the average Chinese patent were half as valuable as the average US one, an extreme assumption, China's roughly two-to-one edge in filings would still yield parity in effective output. And the quality gap appears to be narrowing as Chinese firms move from imitation to invention: Huawei's telecommunications patents, BYD's battery technology, and Chinese contributions to 5G standards reflect real technical capability, not paperwork.

482 percent in semiconductors, and 2,160 percent in computer technology, while US grants across the same fields were relatively flat or falling—up modestly in biotechnology and computer technology, down 27 percent in semiconductors.

In biotechnology, the two countries changed places outright. China was granted fewer biotech patents than the United States in 2014, 5,390 to 6,800, but more than twice as many by 2024, 16,000 to 7,960. Computer technology is the most extreme case. China went from 7,780 grants to 176,000, roughly twenty-three times its starting figure and nearly four times the current US total of 44,600.

Semiconductors are the exception to the head-to-head framing, because for most of the period the field's leader was neither country. Japan granted 21,200 semiconductor patents in 2014, more than twice the US total and seven times China's. By 2024 Japan's count had fallen by a third to 14,500, and China had passed it to lead the field at 17,200. US grants dropped from 9,640 to 7,040. The American position in chips was second a decade ago and is fourth today. The bigger change, though, is that China, not Japan, now sits on top.

That ascent is the one the United States tried hardest to halt. US export controls tightened between 2018 and 2022, culminating in the October 2022 restrictions and the CHIPS and Science Act, which attempted to slow Chinese progress in advanced chips.[19] The patent data show Chinese semiconductor grants climbing straight through those developments. While it's possible export controls may have slowed China's semiconductor development, they did not reverse it. And, China has succeeded in producing both more sophisticated chips and frontier AI models, defying most estimates.

The American position in chips was second a decade ago and is fourth today. The bigger change, though, is that China, not Japan, now sits on top.

The company-level view shows the same rebalancing as a change in the cast of leaders (See Table 5.06).[20 g]

The leaderboard has changed almost completely over twenty years. In 2005, IBM ranked first in US patent grants, followed by Hitachi, Canon, Hewlett-Packard, and Samsung. By 2025, Samsung was the only one still near the top, having climbed from fifth to first. Canon slipped from third to fifth, while IBM, Hitachi, and Hewlett-Packard fell further, IBM from first to ninth, Hitachi from second to sixteenth, and Hewlett-Packard to the bottom of the top twenty. While changes in corporate strategy as well as inventive output may have contributed to the decline, the broader shift is unmistakable: The companies dominating US patent grants today are not the American and Japanese incumbents that led a generation ago.

g The counts in Table 5.06 come from the Intellectual Property Owners Association's annual ranking of top US patent recipients (2005 and 2015) and Harrity & Harrity's "Top 300 Patent Owners" (2025); both rank organizations by US utility patents granted in the calendar year, aggregated to the parent company. Four firms fell below the Top 300 threshold in an earlier benchmark year; their counts for those years are taken directly from the US Patent and Trademark Office's PatentsView: Google, BOE, Huawei, and Samsung Display in 2005. Because these firms started out small, their early figures are drawn from supplemental sources rather than from the ranking, and the precise year-over-year percentages measured from those low starting counts are highly sensitive to small changes. The firms' subsequent presence in the 2015 and 2025 rankings, however, is drawn from the same source as every other firm, so the direction and scale of their rise does not depend on the patched starting values. More generally, because the underlying sources differ in how they consolidate corporate affiliates, individual firms' changes should be read as indicative of direction and magnitude rather than as exact counts.

Table 5.06 Which Companies Lead in US Patents, and How Has That Shifted?

	PATENTS GRANTED[1]			
	2005	2015	2025	CHANGE
Samsung Electronics ▲ **#5**	1,640	5,060	7,530	**+5,885**
Taiwan Semiconductor (TSMC)	441	1,760	4,230	**+3,792**
Qualcomm	200	3,210	3,920	**+3,725**
Huawei	34	799	3,480	**+3,448**
Canon ▾ **#3**	1,880	4,240	2,990	**+1,113**
Samsung Display	2	1,820	2,920	**+2,923**
Toyota	271	1,640	2,910	**+2,637**
Apple	85	1,940	2,850	**+2,769**
IBM ▾ **#1**	2,940	7,440	2,470	**−474**
Dell Technologies	131	356	2,440	**+2,314**
BOE Technology Group	21	276	2,370	**+2,353**
Google / Alphabet	13	3,200	2,250	**+2,236**
Intel	1,550	2,620	2,140	**+588**
Sony	1,230	2,450	2,060	**+828**
Microsoft	750	2,470	1,820	**+1,066**
Hitachi ▾ **#2**	1,920	1,700	1,480	**−442**
Siemens	1,340	1,490	1,060	**−281**
General Electric	1,210	2,630	956	**−250**
Toshiba	1,340	2,790	890	**−448**
Hewlett-Packard ▾ **#4**	1,810	1,450	322	**−1,486**

[1] The first three columns are patent grants in 2005, 2015, and 2025. Change is the absolute change from 2005 to 2025. Arrows mark the five firms that ranked in the top five by 2005 grants, with their 2005 rank; a down arrow marks a fall in rank by 2025 and an up arrow marks a rise. Rows are ordered by 2025 grants.

Data from IPO Association (2005, 2015), Harrity & Harrity "Patent 300" (2025), and USPTO PatentsView.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

The talent: who staffs the frontier

Chapter 3 showed that American and Chinese frontier laboratories draw on strikingly different talent models. American labs assemble international research teams; Chinese labs rely more heavily on researchers trained and employed within its domestic system, supplemented by researchers who studied or worked abroad and later returned. That contrast matters here because the international composition that strengthens American laboratories also exposes them to immigration friction and intensifying competition for mobile researchers.

Domestic staffing is not the same as technological self-sufficiency. Chinese laboratories still draw on knowledge, tools, and researchers that circulate internationally. The contrast is narrower but important: Their personnel model depends less on continuously attracting foreign nationals through an immigration system.

Perhaps the most compelling evidence for what that self-sufficiency now produces arrived in January 2025, when a Chinese firm few Western observers had heard of released a frontier-class AI model that rattled American markets and drew immediate comparisons to Sputnik. That firm was DeepSeek AI, founded in 2023. That a two-year-old lab (at the time), staffed overwhelmingly by domestically trained researchers, could ship work at the frontier is precisely what the composition data predict, and it undercuts the premise on which the American model rests: that the world's best AI researchers must come to the United States because that is where the frontier is.[21]

That was not a one-time shock. Eighteen months later, in July 2026, a second Chinese lab made the same point from a standing start. Moonshot AI released Kimi K3, a large open-weight model in the three-trillion-parameter class that trailed only closed American frontier models on broad benchmarks and led at least one live coding leaderboard.[22]

Like DeepSeek AI, Moonshot was a newcomer, founded in 2023, and also like DeepSeek, just over half of the traceable pool of Moonshot's research contributors never studied or worked outside China. Those who did pass through American institutions were among the most-cited contributors in the group and most, 22 of 24, returned to China.[23]

Two independent labs, a year and a half apart, now describe the same two pipelines—a domestic base that never leaves, and a return channel that recovers researchers America trained.

For decades, researchers seeking the best colleagues, facilities, funding, and opportunities had unusually strong reasons to come to the United States. That was the magnet. DeepSeek and the laboratories beside it weaken the assumption that frontier work requires an American affiliation. If researchers can pursue consequential work in Beijing, Hangzhou, London, Paris, Toronto, or elsewhere, the reason to come is less self-evident—and the reason to stay is more contested.

The double risk

Set the two halves of the chapter beside each other and the pattern is not American collapse. It is American convergence with a rapidly improving competitor. The United States still possesses many of the world's strongest universities, spends more on basic research, employs the largest share of highly cited researchers, and houses many of the companies operating at the technological frontier. Those are substantial advantages. But they no longer stand as far above the alternatives as they once did.

That narrowing matters because America's talent system depends on two streams. The domestic stream produces too few technically prepared students and loses many prospective STEM graduates along the way, as Chapter 4 showed. The international stream supplies much of the advanced talent in American graduate programs, laboratories, and technology companies, as Chapters 1 through 3 showed. The United States has compensated for weakness in the first stream by excelling at the second.

The distinctive risk is that the two weaknesses could compound. If the United States develops too little talent at home while the research and commercial advantages attracting talent from abroad continue to narrow, importing talent becomes both more important and more difficult. China need not surpass the United States on every measure for that danger to materialize. It needs only to offer enough talented researchers a credible alternative to leaving—or a compelling reason to return.

That is why retention is the next question. Attracting a student is not the same as keeping a scientist. Chapter 6 examines how much internationally trained talent the United States retains, where it loses people along the way, and how much of that attrition results from immigration rules of its own making.

America's dependence on international talent has been sustainable because its research system offered unmatched advantages. Those advantages remain, but they are no longer unmatched.

Chapter 5 Endnotes

1 Authors' analysis of OpenAlex institutional-affiliation data for the researchers named on Moonshot AI's most recent papers (n = 437; 271 with histories complete enough to trace cross-border movement), following the method of the authors' earlier DeepSeek analysis. See Zegart and Johnston, *A Deep Peek into DeepSeek AI's Talent*.

2 Data in Figure 5.01 and Table 5.01 are drawn from Paper Copilot, conference acceptance and submission statistics, data compiled by the authors across all conferences and years, 2026, https://papercopilot.com/.

3 Data in Figures 5.02 and 5.03 are drawn from Jason Priem, Heather Piwowar, and Richard Orr, OpenAlex (OurResearch, 2022–2025), citation statistics by field accessed via the OpenAlex API, with specific fields and year ranges noted accordingly, data compiled by the authors, https://openalex.org.

4 National Science Board, "Publications Output: US Trends and International Comparisons," *Science and Engineering Indicators 2024*, NSB-2023-33 (National Science Foundation, December 2023), Table PBS-1, https://ncses.nsf.gov/pubs/nsb202333/.

5 Jeffrey Brainard and Dennis Normile, "China Rises to First Place in Most Cited Papers," *Science*, August 17, 2022, https://www.science.org/content/article/china-rises-first-place-most-cited-papers; National Science Board, "Publications Output: US Trends and International Comparisons," *Science and Engineering Indicators 2020*, NSB-2020-6 (National Science Foundation, 2019), 19–20, 26, https://ncses.nsf.gov/pubs/nsb20206/.

6 National Science Board, "Publications Output: US Trends and International Comparisons," *Science and Engineering Indicators 2024*, Table PBS-1 (National Science Foundation).

7 Ministry of Education of the People's Republic of China, "'211 Project' and '985 Project'" (中华人民共和国教育部), 2015, http://www.moe.gov.cn/jyb_xwfb/xw_zt/moe_357/jyzt_2015nztzl/2015_zt15/15zt15_mtbd/201511/t20151106_217950.html; Futao Huang, "From Expansion to Governance: China's Higher Education at a Strategic Turning Point," International Higher Education, no. 126 (2026), https://doi.org/10.6017/895b9e0d.25b5a5f5.

8 Fei Shu, "The Institutionalized Stratification of the Chinese Higher Education System," *Quantitative Science Studies* 2, no. 1 (2021): 327–44, https://doi.org/10.1162/qss_a_00104.

9 Dongbo Shi et al., "Has China's Young Thousand Talents Program Been Successful in Recruiting and Nurturing Top-Caliber Scientists?," *Science* 379, no. 6627 (2023): 62–65, https://doi.org/10.1126/science.abq1218; on the program's 2008 launch and scale, see US Senate Permanent Subcommittee on Investigations, *Threats to the US Research Enterprise: China's Talent Recruitment Plans*, Majority and Minority Staff Report (Government Printing Office, 2019), https://www.hsgac.senate.gov/subcommittees/investigations/library/files/majority-and-minority-staff-report_-threats-to-the-us-research-enterprise-chinas-talent-recruitment-plans/.

10 Data in Figure 5.04 are drawn from Clarivate Analytics, "Highly Cited Researchers: Past Lists," data for 2014–2025, https://clarivate.com/highly-cited-researchers/past-lists/.

11 Data in Table 5.02 are drawn from Times Higher Education, "World University Rankings by Subject" (Times Higher Education [THE],) data for 2011–2026 and compiled by the authors across subject rankings (Life Sciences, Clinical & Pre-Clinical Health, Engineering, Physical Sciences, and Social Sciences, 2011–2026; Computer Science, 2017–2026), https://www.timeshighereducation.com/world-university-rankings/by-subject.

12 Data drawn from Times Higher Education, "World University Rankings by Subject."

13 Organisation for Economic Co-operation and Development (OECD), Main Science and Technology Indicators (MSTI) Database, OECD Data Explorer, http://data-explorer.oecd.org/; National Science Board, "Cross-National Comparisons of R&D Performance: US Trends and International Comparisons," *Science and Engineering Indicators 2024* (National Science Foundation, 2024), https://ncses.nsf.gov/pubs/nsb20246/cross-national-comparisons-of-r-d-performance.

14 ChinaPower Project, "Is China a Global Leader in Research and Development?" (Center for Strategic and International Studies, 2018, updated January 2021), https://chinapower.csis.org/china-research-and-development-rnd/.

15 Data in Figures 5.05 and 5.06 are drawn from OECD, Main Science and Technology Indicators (MSTI) Database.

16 National Bureau of Statistics of China, "China's Expenditure on Research and Experimental Development (R&D) Exceeded 3.6 Trillion Yuan in 2024," February 7, 2025, https://www.stats.gov.cn/english/PressRelease/202502/t20250207_1958579.html; 2000 and 2010 shares from OECD, Main Science and Technology Indicators.

17 Data in Figures 5.07 and 5.08 and Tables 5.03 and 5.04 are drawn from OECD, Main Science and Technology Indicators, "Gross Domestic Expenditure on R&D (GERD) by Sector of Performance," converted to US dollars at purchasing power parity, OECD. Stat, data for 1991–2024; Patent and Trademark Law Amendment (Bayh-Dole Act), Pub. L. No. 96–517, 94 Stat. 3015 (1980), https://www.govinfo.gov/content/pkg/STATUTE-94/pdf/STATUTE-94-Pg3015.pdf.

18 Data in Table 5.05 are drawn from World Intellectual Property Organization, "Patents Granted by Technology" (indicator 5), WIPO IP Statistics Data Center, data compiled by the authors, 2024, https://www3.wipo.int/ipstats.

19 CHIPS and Science Act of 2022, Pub. L. No. 117-167, 136 Stat. 1366 (2022), https://www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf; and Bureau of Industry and Security, "Implementation of Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items," 87 Fed. Reg. 62186 (October 13, 2022), https://www.federalregister.gov/documents/2022/10/13/2022-21658/implementation-of-additional-export-controls-certain-advanced-computing-and-semiconductor.

20 Data in Table 5.06 are drawn from US utility patents granted to each organization; the panel is the union of the top ten recipients in 2005, 2015, and 2025. Figures for 2005 and 2015 are from Intellectual Property Owners Association, "2005 Top 300 Patents Owners" and "2015 Top 300 Patents Owners," https://ipo.org/index.php/2005-top-300-patent-owners/; 2025 figures are from Harrity & Harrity, "The 2025 Patent 300® List," 2026, https://harrityllp.com/patent300/. Company-years missing from a published list were filled from USPTO PatentsView. Compiled by the authors.

21 Amy Zegart and Emerson Johnston, *A Deep Peek into DeepSeek AI's Talent and Implications for US Innovation* (Technology Policy Accelerator, Hoover Institution, in collaboration with the Stanford Institute for Human-Centered AI, 2025); Hannah Miao and Jon Emont, "China's Best and Brightest Tech Talent Is Going Back to China," *Wall Street Journal*, May 2026, https://www.wsj.com/business/china-silicon-valley-sea-turtles-tech-ai-talent-46385d38.

22 Moonshot AI, "Kimi K3," model release and technical report, July 16, 2026, https://platform.kimi.ai/. For coverage, see Michael Nuñez, "China's Moonshot AI Releases Kimi K3, the Largest Open-Source Model Ever, Rivaling Top US Systems," VentureBeat, July 16, 2026, https://venturebeat.com/technology/chinas-moonshot-ai-releases-kimi-k3-the-largest-open-source-model-ever-rivaling-top-u-s-systems.

23 Authors' analysis of OpenAlex institutional-affiliation data; Zegart and Johnston, *A Deep Peek into DeepSeek AI's Talent*.

CHAPTER 6

The Retention Gap

Why America is Losing Talent That Wants to Stay

HOOVER INSTITUTION | Stanford University

HAI Stanford University Human-Centered Artificial Intelligence

Chapter 6

The Retention Gap

Why America is Losing Talent That Wants to Stay

FIGURES

TABLES

Chapter 6

Key Takeaways

1. **International students increasingly intend to remain in the United States.** The share rose from 67.1 percent in 2002 to 75.8 percent in 2024, and the rise was broad, climbing in every region except Europe and across every STEM field.[1]

2. **Realized stay rates have risen but lag those intentions.** Among international STEM PhDs, 73.4 percent remain after five years and 67.8 percent after ten, so outcomes fall short of the roughly three-quarters who say they want to stay. The ten-year rate also proved fragile, falling 7.3 percentage points between the 2017 and 2021 observations before partially recovering.

3. **The H-1B lottery is the first gate, and most graduates do not clear it.** Before any question of staying long term, a graduate has to win a visa, and in the fiscal year 2025 cycle, 470,000 applicants competed for about 135,000 selections drawn at random, leaving any given applicant a chance below one in three. The 2026 change tilting selection toward higher-paid positions does little to ease that, since it did not raise the number of visas.

4. **The green-card wait is longest for graduates from the countries that send the most students.** Indian nationals face waits over twelve years for EB-2 and EB-3 green cards, compared with four to five years for most countries. The cause is largely structural; the same annual limit applies to every country regardless of how many of its nationals apply, so the largest source of graduate students draws the longest queue almost by design.[2]

5. **The core components of the immigration system were built decades ago for a geopolitical world and talent map that no longer exist.** That per-country cap dates back to 1965, when no one imagined a single country would come to dominate the graduate pipeline, and the J-1 exchange rules date to 1961, written on the Cold War theory that scholars trained in America should return home to seed allied countries.

6. **Each international STEM PhD cohort loses about a third within a decade.** That works out to roughly 11,000 people and $3.8 billion in training investment across the 2012–14 cohorts, both gone from the workforce and science and technology ecosystem that funded it.

7. **Other countries decide faster, and recent reforms are widening the gap.** While the US wait can run a decade or more, Canada launched Express Entry in 2015 to return a verdict in six months, and the UK's Global Talent visa now decides in weeks, neither of them requiring an employer to sponsor the wait.[3]

Chapter 6 – By the Numbers:

MEASURE	2021	2025	CHANGE	
STAY INTENTIONS				
Overall	73%*	**75.8%**[2024]	+2.8 pp	▲
By region				
International students from Africa	72.5%*	**86.5%**[2024]	+14.0 pp	▲
International students from the Americas	60.1%*	**69.3%**[2024]	+9.2 pp	▲
International students from Asia	79%*	**80%**[2024]	+1.0 pp	▲
International students from Europe	67.4%*	**66.4%**[2024]	-1.0 pp	▼
International students from the Middle East	58%*	**55.3%**[2024]	-2.7 pp	▼
By field				
International students studying computing	87.4%	**89.8%**[2024]	+2.4 pp	▲
International students studying engineering	85.2%	**89.5%**[2024]	+4.3 pp	▲
International students studying mathematics	74.8%	**81.7%**[2024]	+6.9 pp	▲
International students studying the physical sciences	81.9%	**87.2%**[2024]	+5.4 pp	▲
REALIZED RETENTION				
Five-year stay rate	70.8%*	**73.4%**[2023]	+2.6 pp	▲
Ten-year stay rate	64.7%*	**67.8%**[2023]	+3.1 pp	▲
CAREER PATHS AFTER THE PHD				
US citizens: academe	39.9%*	**42.5%**[2024]	+2.6 pp	▲
US citizens: industry or business	33.8%*	**32.2%**[2024]	-1.6 pp	▼
Temporary visa holders: academe	24.8%*	**32.2%**[2024]	+7.4 pp	▲
Temporary visa holders: industry or business	69.4%*	**60.9%**[2024]	-8.5 pp	▼
WORK-VISA BRIDGE				
STEM OPT applications received	5,940*	**22,300**	3.75×	▲
STEM OPT applications approved	5,990*	**18,700**	3.13×	▲
H-1B approvals: tech occupations	106,000*	**85,100**	-19.8%	▼
IMMIGRATION PATHWAYS AND BOTTLENECKS				
EB-2 green-card wait for **Indian** nationals	10y 6m*	**12y 5m**	+2y	▲
EB-2 green-card wait for **Chinese** nationals	3y 10m*	**4y 8m**	+9 mo	▲
EB-2 green-card wait for all other nationalities	2y 10m*	**4y 6m**	+1y 8m	▲

ESTIMATED LOSS FROM DEPARTING STEM TALENT

FIELD	NO. DEPARTING	SHARE DEPARTING	MONEY LOST
Engineering	4,350	29%	**$1.52B**
Life, health, and agricultural sciences	3,140	30%	**$1.15B**
Physical sciences	2,240	35%	**$0.712B**
Computer and math sciences	1,280	24%	**$0.449B**

* Data are available further back than 2021 for marked series.

Note: Historical comparisons use 2021 and 2025 observations. Superscript years mark rows with an earlier latest endpoint than 2025. Estimated money lost = departures × field-specific time to degree × $53,000 annual NSF GRFP support.

Source: Derived from Figures 6.01-6.07; Tables 6.01–6.04.

In March 2026, Arjun checked a government website at 6 a.m. Pacific time, before the office filled, to see whether a computer had selected his name.

We met him in the introduction. Arjun was born and raised in India, trained at IIT for his bachelor's, and then received a doctorate in computer science at Carnegie Mellon. Following graduation, he has spent the last three years working for a Texas AI lab, where his publication, citation, and patent record has been outstanding. His employer would like to hire him permanently. What stands between him and that job is the lottery for an H-1B visa.

He has entered it twice already and lost both times. In his first cycle, 470,000 people competed for about 135,000 selections and applicants were selected entirely at random, so his chance of getting a visa was less than one in three. The second cycle ran roughly the same odds. In his third cycle, even with policy changes in 2026 that improved the odds for higher-paid positions rather than drawing winners entirely at random, the number of visas stayed fixed, and applicants still far outnumber them.a The numbers are still against him. Arjun does not receive an H-1B visa and so must leave the United States.[4]

Had Arjun received a visa, his path to remain in the US would still have been challenging and long. He would have been able to stay in this job while he joined a second line, the employment-based green card queue. But the green card system is so backlogged, visa lottery winners from India can expect to wait close to thirteen years.

Arjun's story is not real, but it is highly realistic. It illustrates the challenges facing high-skilled STEM talent who wish to remain in the United States and contribute to the nation's technological development. Many of the immigration rules that determine whether Arjun and others like him can stay in the United States were established decades ago, for a geopolitical era and talent map that has changed considerably. The system was never designed to win the race for STEM talent today.

---

a The 2026 rule enters each registrant into the lottery between one and four times according to how the offered wage ranks against the Department of Labor's four prevailing-wage levels—four entries at the highest level, one at the lowest. A higher wage improves the odds of selection but does not guarantee it, since registrations at every wage level remain eligible and the draw still weights the odds rather than ranking applicants outright. With the number of visas fixed and demand far exceeding supply, even applicants weighted toward the top of the pool can go unselected. For more information, see "The Lottery: The H-1B Visa" later in this chapter.

The thirteen-year green card line for Indian nationals is the result of a per-country ceiling written back in 1965, in a reform meant to end discrimination by national origin. In 1965, no one imagined that America's international talent pipeline would be so heavily concentrated.5 Similarly, the exchange-visitor rules that govern the scholars in American laboratories were drawn up in 1961 to send foreign researchers home again—on the Cold War theory that knowledge gained in America should seed allied countries abroad.6 Every instrument that will decide whether Arjun stays was built decades ago, for a country and a contest that no longer exist.

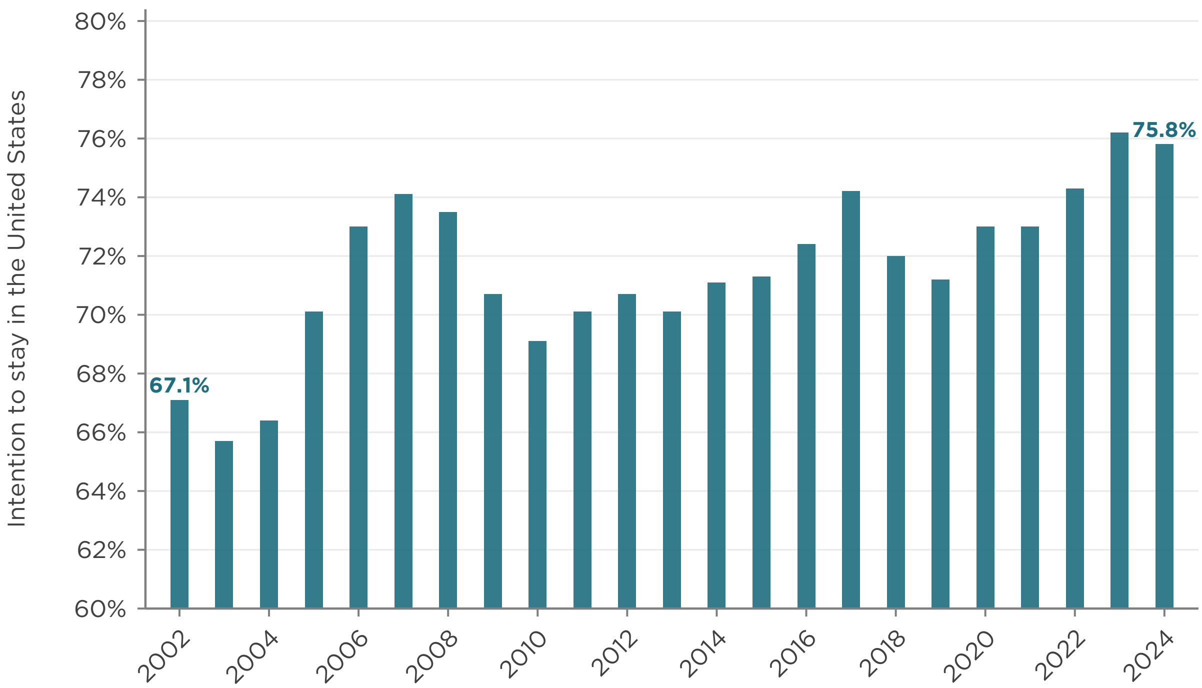
The introduction of this report described two streams feeding the American technical workforce, students developed at home and students drawn from abroad. The past five chapters have traced both streams to this point. Chapters 1 through 3 focused on the international talent stream, and how it is concentrated by country, by field, and by degree level in ways that make consequential STEM fields at the most advanced levels the most dependent on talent coming to the US from abroad. Chapter 4 showed why the domestic STEM talent stream would be unlikely to fill the gaps if these international talent flows were to decline or end. Chapter 5 examined metrics showing America's lead in many frontier research areas has narrowed significantly in the past decade and in many areas has already been eclipsed by Chinese researchers and institutions. These changes suggest that the United States may become a less attractive destination for top researchers in technical fields—if it hasn't already.

This chapter takes up the question those findings raise. Talent comes to America—but does it stay? Retention depends on two different things: whether graduates want to remain and whether the system permits them to do so. The data reveal that the desire to stay is high and rising, but the pathway for international talent to stay in the US workforce is difficult, slow, and unpredictable. Arjun's 6 a.m. refresh is where the two meet.

What International Graduates Want

Since 2002, the National Science Foundation's Survey of Earned Doctorates has asked international students completing research doctorates whether they intend to remain in the United States. The answer has consistently been yes—and the share saying so has grown. It rose from 67.1 percent in 2002 to 75.8 percent in 2024, just below its 2023 peak, after dipping during the immigration turbulence and pandemic disruptions between 2017 and 2021. Whatever else has changed, the people America trains increasingly say they want to stay (See Figure 6.01).[7]

Figure 6.01 Do International PhD Recipients Plan to Stay in the United States?



Data from NCSES, Survey of Earned Doctorates, 2010–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The increase extends across nearly every region of origin, although its magnitude varies (See Table 6.01). Intentions among African recipients climbed 27.5 percentage points between 2002 and 2024, from 59.0 percent to 86.5 percent, and among recipients from the Americas 20.2 points, from 49.1 percent to 69.3 percent. Asia, already the largest source and Chapter 2's dominant supplier, rose more modestly, from 74.2 percent to 80.0 percent, off the highest baseline level. The single exception is Europe, where stay intentions fell 3.1 percentage points, from 69.5 percent to 66.4 percent, the only region to decline.

Overwhelming preference to remain in the United States can also be seen across fields (See Table 6.02). Between 2021 and 2024, every STEM discipline recorded a higher share of graduates planning to remain. Intentions were highest in the biological and biomedical sciences, at 90.6 percent, followed closely by computer sciences, which rose from 87.4 percent to 89.8 percent, and engineering, which rose from 85.2 percent to 89.5 percent. The largest gains came from the fields that started lowest, the social sciences rising from 53.5 percent to 65.7 percent, with psychology the lone near-flat exception at a fractional 0.3 percentage point gain. In the disciplines closest to the technological competition, computing and engineering, nearly nine in ten international graduates now intend to build their careers in the United States.

These figures capture intention at graduation, not outcome. A graduate who plans to stay does not yet know whether an employer will sponsor a visa, whether a petition will succeed, or how long permanent residence will take. The talent balance is settled during the decade that follows.

Table 6.01 Do Stay Intentions Differ by Region of Origin?

	INTEND TO STAY		
	2002	2024	CHANGE
Africa	59%	86.5%	**+27.5 pp**
Asia	74.2%	80%	**+5.8 pp**
Americas	49.1%	69.3%	**+20.2 pp**
Europe	69.5%	66.4%	**−3.1 pp**
Australia-Oceania	54.9%	62.5%	**+7.6 pp**
Middle East	54.5%	55.3%	**+0.8 pp**

Data from NCSES, Survey of Earned Doctorates, 2010–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

Table 6.02 What Do New STEM PhDs Plan to Do After Graduation, by Field?

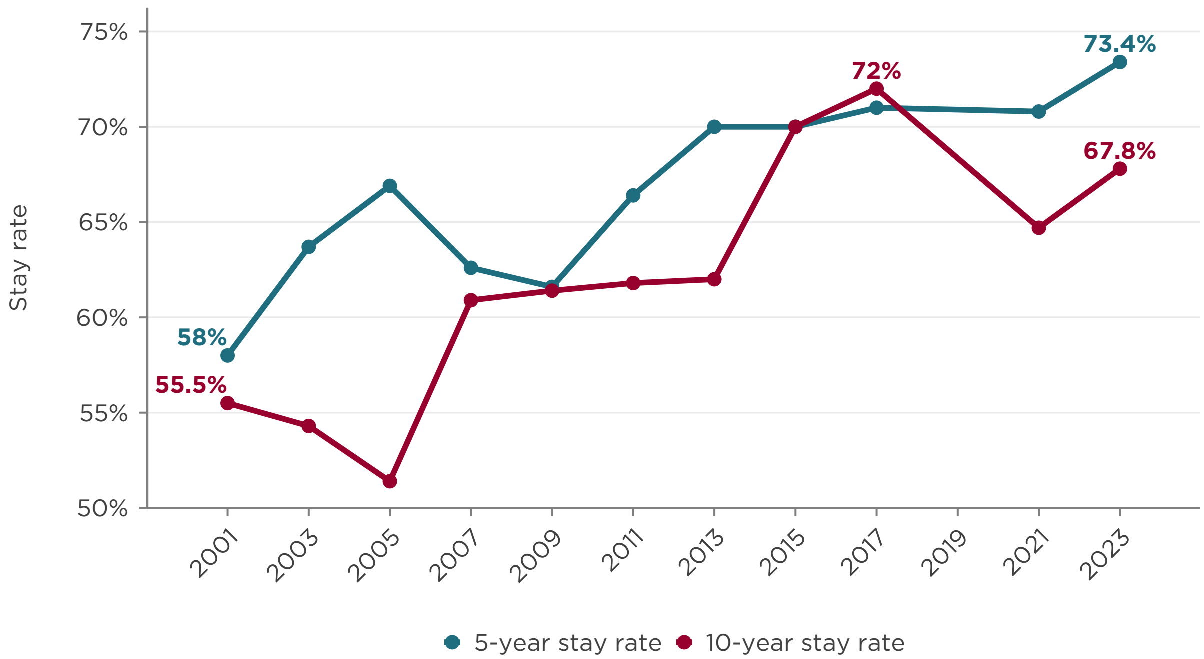
	SHARE WITH US PLANS		
	2021	2024	CHANGE
Social sciences	53.5%	65.7%	**+12.2 pp**
Non-science and engineering	58.2%	69.3%	**+11.1 pp**
Geosciences, atmospheric, and ocean sciences	74.4%	81.7%	**+7.3 pp**
Mathematics and statistics	74.8%	81.7%	**+6.9 pp**
Agricultural sciences and natural resources	74.6%	80.9%	**+6.2 pp**
Biological and biomedical sciences	84.4%	90.6%	**+6.2 pp**
Physical sciences	81.9%	87.2%	**+5.4 pp**
Engineering	85.2%	89.5%	**+4.3 pp**
Computer and information sciences	87.4%	89.8%	**+2.4 pp**
Health sciences	72.2%	74.5%	**+2.3 pp**
Multidisciplinary/Interdisciplinary sciences	84.1%	85.4%	**+1.3 pp**
Psychology	76.1%	76.4%	**+0.3 pp**

Data from NCSES, Survey of Earned Doctorates, 2010–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

The Intention-Reality Gap

Realized stay rates both confirm and complicate the intentions data. Building on a longitudinal series developed by Michael Finn at Oak Ridge Institute for Science and Education, the National Science Board estimates the share of international STEM doctorate recipients remaining in the United States five and ten years after graduation. The five-year stay rate rose from 58.0 percent in 2001 to 73.4 percent in 2023, the latest observation year.[b] The ten-year rate rose as well, from 55.5 percent to 67.8 percent, after peaking near 72.0 percent in 2017 (See Figure 6.02).[8 c]

Figure 6.02 Do International STEM PhDs Stay in the United States?



Data from NCSES, "Foreign-Born STEM Workers," Science and Engineering Indicators 2024; Finn, Stay Rates of Foreign Doctorate Recipients, 2011.
Chart by Emerson Johnston and Amy Zegart, Stanford University

b The stay-rate figures are anchored to the graduating cohort, not the observation year. The 73.4 percent five-year rate reported for 2023 describes doctorate recipients who graduated around 2018 and were still in the United States five years later; the ten-year rate for 2023 reflects the cohort that graduated roughly a decade earlier. Because the measure requires following graduates forward, the most recent observation years necessarily describe earlier graduating classes rather than current ones.

c The tracked population is not identical across the series. The Oak Ridge estimates historically relied on Social Security earnings records to determine whether a graduate remained in the country, while later editions incorporated the National Science Foundation's Survey of Doctorate Recipients, a sampled survey with its own coverage and nonresponse characteristics. Successive cohorts are therefore measured against moderately different reference populations rather than one fixed panel, and the year-to-year movements in Figure 6.02 should be read as a consistent trend rather than as precise cohort-to-cohort comparisons.

The two rates differ for systematic reasons. The first is mechanical. The ten-year rate is almost always lower than the five-year rate because it measures a longer exposure to departure. Every graduate counted as "stayed" at five years is still at risk of leaving in the second five, and some do—for a host of reasons: a green card that never came, a parent aging in Bangalore, a Chinese or European employer that did not exist a decade ago. The gap between the two lines is the attrition of the second five years, and it has varied significantly over time, from near zero for the cohorts measured in 2009 and 2015, to a sixteen-point difference at its worst in 2005.

The second reason is timing. The two rates describe different graduating cohorts observed at the same moment. The ten-year rate reported for 2021 is not a statement about people who finished in 2021; it is the decade outcome of people who finished around 2011. That lag is why the ten-year line carries the steeper decline, falling 7.3 points between 2017 and 2021. The drop does not describe the graduates of those years. Instead, it describes the cohorts who entered the workforce during the recovery from the 2008 crisis and whose second five years coincided with the tightened H-1B adjudications and heightened visa scrutiny of 2017–2021 that the second half of this chapter documents. The timing is consistent with that squeeze, but a ten-year stay rate also moves with economic conditions, green-card queue lengths, return opportunities abroad, and cohort composition, and the aggregate series cannot isolate which graduates left or why. The recovery in the most recent readings, roughly 67.8 percent, reflects cohorts who came through after that squeeze eased.

The broader pattern is clear even if the causes of individual departures are not: three out of every four international graduates intend to stay at graduation, roughly seven in ten remain after five years, and about two-thirds remain after ten. The distance between intention and outcome is the retention gap. The rest of the chapter examines the institutional barriers that may help create it.

Where the Stayers Work

Before turning to the machinery, it is worth discussing where the graduates who do stay end up. Over the past three decades, new PhDs have increasingly moved toward industry rather than academia—and that shift has been especially pronounced among international graduates.

Among US-citizen PhD recipients with definite plans, the share reporting they'd be going into academia fell from 51.5 percent in 1994 to 42.5 percent in 2024, while the share reporting going into industry rose from 19.3 to 32.2 percent—a near one-for-one substitution. The shift reflects several forces, including limited growth in tenure-track positions, rising private-sector demand for advanced technical skills, and substantial differences in compensation.

International graduates moved in the same direction, but further and faster. The share of temporary-visa-holding PhD recipients going into academia fell from 48.0 percent in the mid-1990s to 32.2 percent by 2024, and their industry share rose from 41.8 to 60.9 percent (See Table 6.03).

The gap is not simply a difference in preference. International graduates who need H-1B status generally require an employer willing to sponsor them, to absorb the cost, and to accept the risk of an unsuccessful petition. Large companies are often better positioned to do so than small firms and startups. Research universities are a partial exception: they still sponsor and pay for petitions, but as cap-exempt employers they can file year-round without competing in the lottery.

Because international PhDs enter industry at nearly twice the rate of domestic PhDs, retaining them depends heavily on the work-visa and employment-based green-card systems. The rest of the chapter follows that pathway—and its alternatives—stage by stage.

Table 6.03 How Do the Career Paths of International and US PhDs Differ?

	US CITIZENS			TEMPORARY VISA HOLDERS		
	1994	2024	CHANGE[1]	1994	2024	CHANGE[1]
Academe	51.5%	42.5%	−9.0 pp	48%	32.2%	−15.8 pp
Industry or business	19.3%	32.2%	+12.9 pp	41.8%	60.9%	+19.1 pp
Government	9.2%	9.8%	+0.6 pp	2%	2%	0.0 pp
Nonprofit organization	6.8%	7.9%	+1.1 pp	3.3%	3.1%	−0.2 pp
Other or unknown	13.2%	7.6%	−5.6 pp	4.9%	1.8%	−3.1 pp

[1] 1994 and 2024 are shares of PhDs with definite commitments (%). Change is the percentage-point change between the two years.

Data from NCSES, Survey of Earned Doctorates, 2010–2024.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

The Entry Ramp: Optional Practical Training

For many international graduates, the first step after graduation is Optional Practical Training, or OPT—the status under which Arjun could work for up to three years.

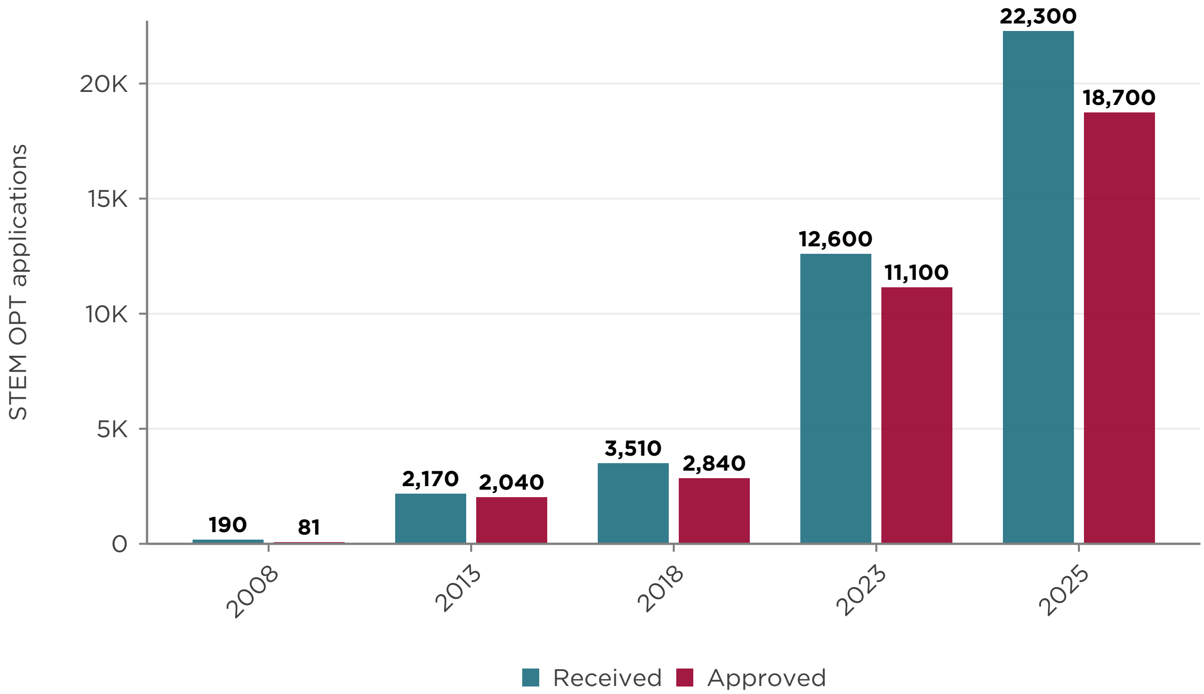
OPT originally allowed international graduates to work in their fields for up to twelve months while remaining in F-1 student status. In 2008, the Department of Homeland Security (DHS) added a seventeen-month extension for graduates in designated STEM fields. A federal court later vacated that rule because DHS had not followed required notice-and-comment procedures, while allowing the program to continue temporarily. DHS replaced it in 2016 with the current twenty-four-month STEM extension, providing eligible graduates with up to three years of postgraduation work authorization.[9] The replacement rule survived a second legal challenge—a divided federal appeals court upheld DHS's authority, and the Supreme Court declined review—but it rests now on executive regulation rather than a dedicated statutory visa category.[10]

So, while the program stands, the path is still filled with uncertainty. The entry ramp—at its most generous, granting a graduate three years of work authorization against the six that H-1B allows—rests on regulation that has already been struck down once, rewritten under court order, and upheld only by a two-to-one vote, and it remains open to revision by a future administration.[11]

New STEM OPT applications rose from 190 in 2008 to 22,300 in 2025, an increase of roughly 12,000 percent (See Figure 6.03).[12] The growth outran international enrollment because OPT was absorbing dysfunction downstream: As the H-1B lottery tightened, the three-year STEM OPT option became more attractive as a stop-gap measure.

The headline approval rate is high—above 95 percent.[13] But it is important to bear in mind that the approval rate measures approvals against completed adjudications, not against applications filed. In 2025, of the 22,300 new applications received, 18,700 were approved and only 797 were denied. However, 7,270 applications from prior years were still pending by the end of the year—they had been filed but not adjudicated.

Figure 6.03 How Fast Has STEM OPT Grown?



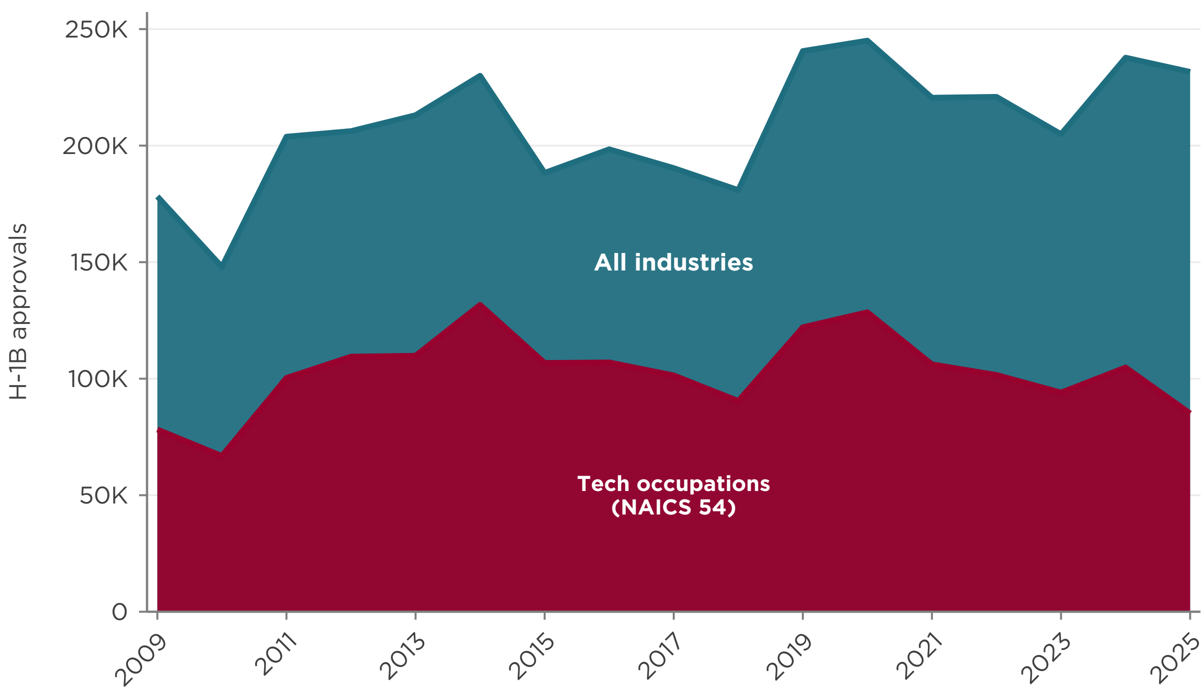
Data from USCIS, Form I-765 Application for Employment Authorization, FY2003–2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The Lottery: The H-1B Visa

For graduates moving from OPT into longer-term private-sector employment, H-1B status has been the principal channel. Congress created the modern specialty-occupation category in 1990. The annual cap now provides 65,000 regular slots for first-time applicants plus 20,000 additional slots for holders of advanced degrees from US institutions, subject to several exemptions. Demand has exceeded supply for years. The February 2026 rule may have changed who has a chance to win, but it didn't change how many. The number of cap-subject visas stayed fixed, and registrations still far outnumber them.

Counting renewals and extensions alongside new admissions, H-1B approvals across all industries have run between roughly 150,000 and 245,000 a year since 2009.[d] Professional, scientific, and technical services—the sector classified as NAICS 54—account for between a third and half of them in any given year (See Figure 6.04).[14]

Figure 6.04 How Many H-1B Visas Are Approved Each Year?



Data from USCIS, H-1B Employer Data Hub, 2009–2026.
Chart by Emerson Johnston and Amy Zegart, Stanford University

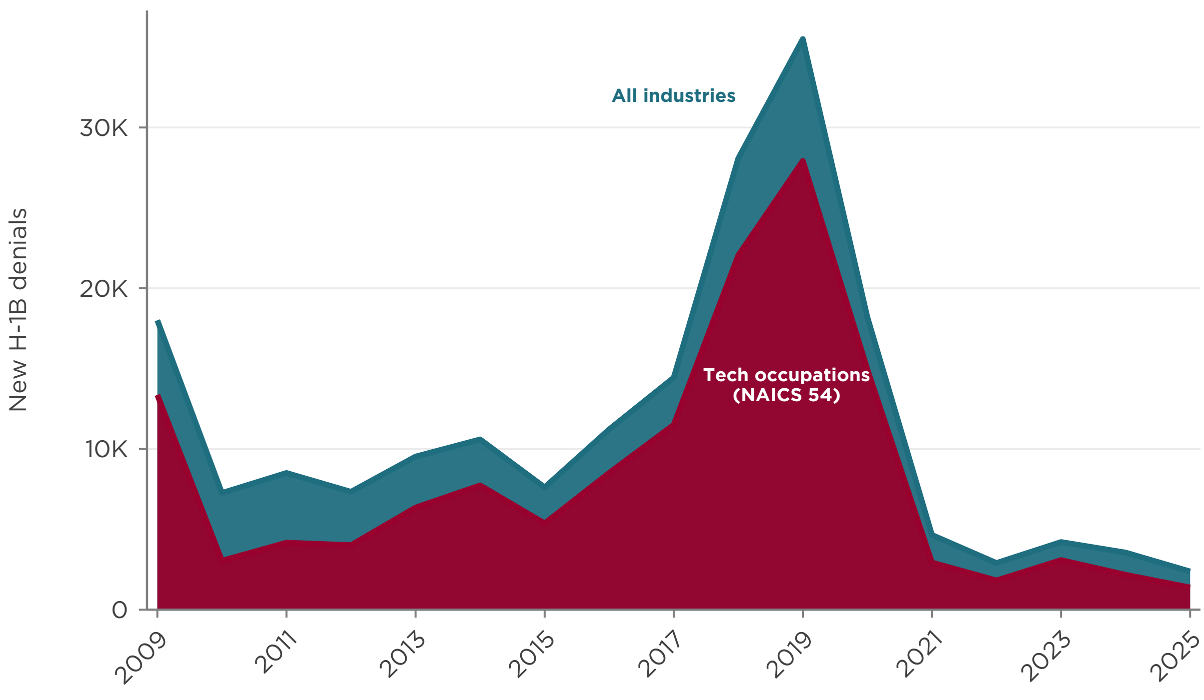
d The 85,000 annual cap applies only to new cap-subject petitions. The 150,000–245,000 figure counts all H-1B approvals in a year, which includes renewals and extensions for workers already in H-1B status, changes of employer, and amended petitions, none of which count against the cap. It also includes petitions from cap-exempt employers—universities, nonprofit research organizations, and government research institutions—which face no numerical limit. New cap-subject approvals remain bounded by the 85,000 ceiling; the larger number reflects the full stock of H-1B activity, not annual entries.

The approval numbers are relatively stable. The volatility can be found in the denials. Denials rose sharply after the Trump administration's 2017 "Buy American and Hire American" executive order and related changes in adjudication. In FY 2019, initial H-1B petitions faced denial rates at their peak of 24 percent.[15] Courts and subsequent policy changes later reversed important parts of that approach, and denial rates fell (See Figure 6.05).[16]

Policy volatility continued. In September 2025, a presidential proclamation required an additional $100,000 payment for certain new H-1B petitions. The government described the measure as a way to curb program abuse and protect American workers; employers, universities, and other challengers argued that it exceeded presidential authority and would make it prohibitively expensive to hire international talent. Whatever its legal fate, the measure demonstrated how abruptly the price and terms of the channel could change.[17] Policy uncertainty makes it difficult for both employers and workers to make multiyear investments in human capital.

The problem is not simply that the channel is restrictive. It is that employers and workers making multiyear investments cannot know what its rules will be when they reach the next gate.

Figure 6.05 When Did H-1B Denials Spike?



Data from USCIS, H-1B Employer Data Hub, 2009–2026
Chart by Emerson Johnston and Amy Zegart, Stanford University

Green Card Country Caps and Their Effects

An H-1B applicant, even one who clears the lottery and survives the adjudication, buys time, not permanence, with their acceptance. The authorization runs only three years, can be renewed once, and ends at six years unless something more durable is underway. That something is a green card, and a graduate who wants one cannot simply apply.

The Immigration and Nationality Act of 1965 imposed the same green-card ceiling for every country regardless of size—a fairness measure meant to keep any one nation from dominating the flow as favored European countries had before. The Immigration Act of 1990 then capped employment-based green cards at 140,000 a year, divided across five preference categories. Three carry most skilled workers: EB-1 for those with extraordinary ability or outstanding research records, EB-2 for advanced-degree holders, and EB-3 for other skilled workers. That legislation also fixed the per-country share at 7 percent of the visas issued in a category.[18]

For most of the world the queue is navigable (See Table 6.04).[19] As of 2025, the advanced-degree EB-2 category was processing recent applicants from all countries, aside from India and China, within about four and a half years, and EB-3 within roughly five. A Nigerian or Brazilian engineer with the same degree files into that same four-to-five-year queue. For Chinese nationals the waits run somewhat longer—about four and a half to five years across the categories—long but survivable within an H-1B's renewable term.

Table 6.04 How Long Are Employment-Based Green Card Waits, by Nationality?

	REST OF WORLD[1]			CHINA[1]			INDIA[1]		
	EB1	EB2	EB3	EB1	EB2	EB3	EB1	EB2	EB3
2005	0	0	19	16	16	45	0	0	35
2010	0	15	89	0	55	85	0	57	104
2015	0	28	62	0	48	60	0	100	135
2020	17	37	46	30	55	45	42	131	131
2025	14	54	57	31	56	55	40	149	146

[1] Cell values are in months.

Data from US Department of State, Visa Bulletin, 2002–2026.
Chart by Emerson Johnston and Amy Zegart, Stanford University.

For Indian nationals the queue is a different story entirely: it takes 12 years and 5 months on average for an EB-2 and 12 years and 2 months for an EB-3. Even the priority EB-1 tier, once reserved for those with extraordinary ability, runs over three years for Indian applicants—short beside the others, but still the longest EB-1 wait of any group, ahead of China and the rest of the world.

An Indian advanced-degree holder who files today can expect a green card around 2038. This is Arjun's thirteen-year line, and it is the consequence of a 7 percent ceiling applied back in 1990, even though India now sends 36.4 percent of America's international graduate students. The system attracts talent from India for school, then makes that talent wait the longest.

The wait has second and third-order effects. H-1B status binds a worker to the sponsoring employer, so a decade in the queue is a decade in which changing jobs may mean restarting the process. Meanwhile, a spouse's or child's dependent status hangs on the primary holder's, and children who turn twenty-one during the wait age out and must leave or find their own visa.

The system attracts talent from India for school, then makes that talent wait the longest.

Perhaps most consequential for a report about technological leadership, an H-1B holder cannot readily start a company, because the visa requires an employer-employee relationship that a startup of one's own does not satisfy. Chapter 3 found that 65.1 percent of the leading American AI companies had an immigrant founder, and that no company worth more than $100 billion had been founded without immigrants. The companies that do not get founded during those years do not appear in any table. They are the counterfactual the data cannot show.

The term "golden handcuffs" captures this dynamic. The phrase comes from compensation and labor economics, where it is used to explain how stock that vests only over years, or a bonus that must be repaid on early departure, keeps a valued employee in place by making the act of leaving expensive. Here it describes something the worker never negotiated and the employer did not design. The thing that makes leaving expensive is not equity or a bonus but a place in a line, and the cost of walking away is not forfeited pay but forfeited years, the decade already spent waiting and the decade that starts over with a new sponsor.

The J-1 Exchange-Visitor Program

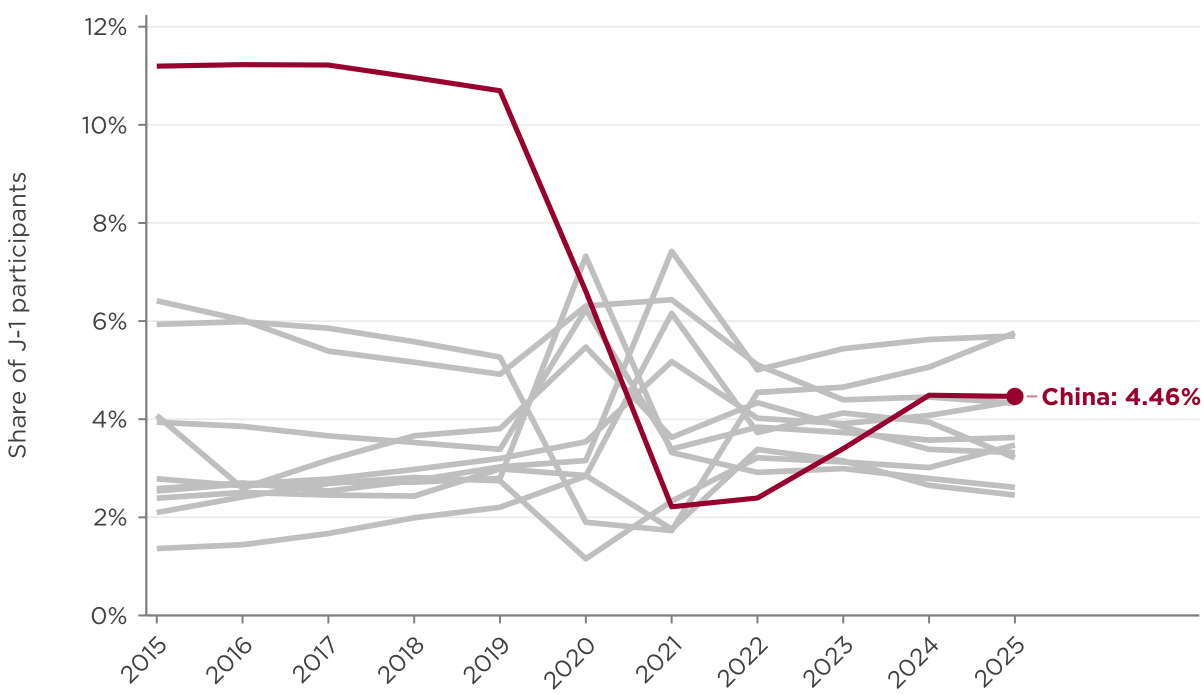
The student-to-OPT-to-H-1B pathway is not the only channel into American science or engineering. Many postdoctoral researchers and visiting scholars enter through the J-1 exchange-visitor program, a parallel route built for circulation rather than retention.

The J-1 exchange visitor visa, created by the Mutual Educational and Cultural Exchange Act of 1961, carries scholars and postdoctoral researchers into American laboratories, and it comes with a Cold War inheritance: Many J-1 holders are bound by a two-year home-residency requirement, written so that exchange visitors would return home and seed their own countries with American-gained knowledge.[20]

The 1961 act consolidated the scattered exchange programs the United States had run since World War II into a single framework, and the residency rule was aimed outward, at protecting the sending countries.[21] Its purpose was to keep the United States from draining the talent of allies and developing nations by guaranteeing that a scholar trained here carried the training home. The rule that once safeguarded other countries against brain drain now works against the country that wrote it. That logic, sensible for cultural diplomacy, now functions as a barrier to retaining the researchers who staff the labs.

The channel is also the most exposed to geopolitics, and one country's collapse shows how fast a source can drain (See Figure 6.06).[22] China supplied 11.2 percent of J-1 participants in 2015 and held near that level through 2019. Then it fell—to 6.6 percent in 2020 and to 2.2 percent in 2021. By 2025 it had recovered only to 4.5 percent, less than half its former share. Pandemic travel restrictions began the decline, but geopolitical friction sustained it.

Figure 6.06 How Far Has China's Share of J-1 Participants Fallen?



Data from US Department of State, "Facts and Figures," BridgeUSA, 2025.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The consequence connects to two earlier findings at once. Chapter 3 showed that international researchers hold two-thirds of American engineering postdoctoral positions, so a contraction in the exchange channel falls on the research workforce directly. And Chapter 5 showed China actively bringing its scientists home, through the Thousand Talents recruitment program and in labs like DeepSeek, staffed overwhelmingly by domestically trained researchers. The scholars who once would have spent postdoctoral years in American labs, and might have stayed, are increasingly staying home or going to European ones. The channel that fed the frontier is narrowing at the same moment the competitor is building the labs to receive them.

Retention is not the only national interest at stake. Policymakers also have legitimate reasons to protect sensitive research, prevent undisclosed transfers, and restrict access to technologies with military or intelligence applications. Critics of expansive scientific exchange argue that American institutions have underestimated these risks, particularly in collaborations involving China. They also note a concerning asymmetry: American researchers do not always receive the access in China that Chinese researchers have historically received in the United States.

However, research security and talent retention are not opposing goals. The policy challenge is to distinguish more effectively between the people and work that present genuine risks and the international talent that should be attracted and retained to contribute to the American innovation ecosystem, economic dynamism, and national security.

What Competitors Have Built

American immigration policy has changed, but its central numerical constraints have remained strikingly durable. The H-1B cap has not kept pace with demand, and the per-country ceiling continues to generate deep backlogs. Other countries, meanwhile, have built systems that evaluate skilled immigrants more directly on education, experience, age, or demonstrated achievement.

Canada, which has run a points-based skilled-migration system since 1967, launched Express Entry in 2015 to score a candidate's degree, experience, and age and return a permanent-residence decision within six months, for a fee near one percent of the new H-1B charge.[23] The United Kingdom's Global Talent visa treats an endorsement from a research body as the application itself, decides in weeks, requires no job offer, and opens a path to settlement in as little as three years.[24] Australia, Germany, and Singapore have all reformed toward the same end.[25]

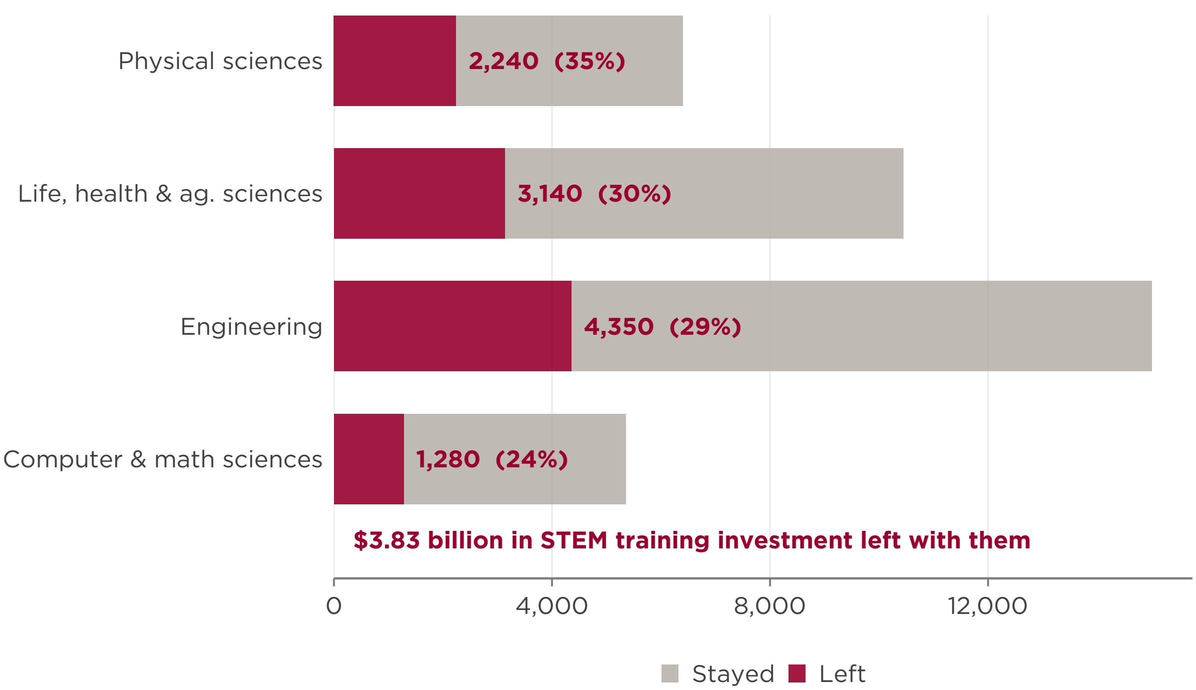
These systems are not unqualified successes. Faster legal admission does not guarantee that highly skilled immigrants will find jobs matching their qualifications, and several European countries continue to show sizable labor-force-participation gaps between immigrants and native-born workers. America presents the inverse problem: It often integrates skilled immigrants exceptionally well once they arrive, but makes admission and permanence unusually uncertain.

Estimating Economic Costs

What does the immigration gap cost the United States? The chapter has used two stay-rate measures, and they should be reconciled before the final number, because they do not quite agree and the disagreement is instructive. Figure 6.02's National Science Board series, which tracks graduates forward through tax and survey records, puts the ten-year stay rate at 67.8 percent. The cohort figure below draws on a different National Science Foundation product—the Survey of Earned Doctorates' own tabulation of stay outcomes by field—which yields a ten-year retention of roughly 70 percent for STEM fields specifically. The two differ because they are built from different data and different denominators: One is a longitudinal panel across all international STEM doctorates, the other a field-weighted cohort table that excludes the lower-retaining social sciences. Despite their differences, they agree on shape: A third of each cohort is gone within a decade. The closing figure uses the cohort measure.

Applied to the pooled 2012–14 STEM doctorate cohorts—about 37,200 international graduates—a ten-year retention near 70 percent means roughly 11,000 people had left the United States within a decade (See Figure 6.07).[26] Valued at the National Science Foundation's own per-student average support rate, about \$53,000 a year across a median STEM doctorate of just under seven years, that departure represents on the order of \$3.8 billion in training investment—public and institutional money spent to educate scientists—lost.

Figure 6.07 **How Much STEM Talent Does the US Train and Then Lose?**



Data from NCSES, Survey of Earned Doctorates (2012-14 cohorts); authors' calculation.
Chart by Emerson Johnston and Amy Zegart, Stanford University

The loss is not uniform across fields: The physical sciences shed about 35 percent of their cohort, computer and mathematical sciences the least at around 24 percent, with engineering and the life sciences between. These are the fields Chapter 5 showed converging fastest with China's, losing their people at the moment the competition for them is intensifying.

But these numbers count only doctorates, not the master's graduates and skilled workers who face the same lottery and queue. And they count only training cost. It cannot measure the patents, companies, discoveries, or students those graduates might have trained had they remained. Nor can it measure benefits that may continue to flow back through international collaboration once they depart. The net economic and scientific loss will never be completely knowable, but the scale of departure appears to be significant.

This is the fracture. The United States develops too little technical talent at home, as Chapter 4 showed, and does not retain all the international talent it trains. The desire to stay is at a two-decade high. Yet intention and outcome diverge: Approximately three-quarters intend to remain at graduation, but about two-thirds remain ten years later—a gap of about 10 percentage points. Immigration rules do not explain every departure. Better opportunities abroad, family ties, and personal choice matter too. But the system introduces scarcity, delay, cost, and uncertainty precisely where many of America's allies and rivals increasingly offer speed and predictability.

Arjun wanted to stay. In the cycle he entered, his publications, patents, and citations did not improve his odds. He was not selected, so the longer green-card queue never became his problem. Merit brought him to America and helped him succeed here. It did not give him a reliable way to remain. The machinery that determines whether he stays in the United States was assembled from a 1961 exchange rule, a 1965 quota, a 1990 cap, and other measures designed for a bygone geopolitical, technological, and economic era.

America's talent challenge comes from weaknesses in two talent pipelines that reinforce each other. The country develops too little technical talent at home while making it difficult to retain the top talent it attracts from abroad. What those weaknesses add up to—and what Jane and Arjun reveal when their stories are placed side by side—is the question we address in the concluding chapter.

Chapter 6 Endnotes

1 National Center for Science and Engineering Statistics (NCSES), "Survey of Earned Doctorates Data Tables," data for 2010–2024 (US National Science Foundation), https://ncses.nsf.gov/surveys/earned-doctorates.

2 US Department of Labor, Employment and Training Administration, "Permanent Labor Certification (PERM)," Foreign Labor Application Gateway (FLAG), https://flag.dol.gov/programs/perm; US Department of State, Bureau of Consular Affairs, "Final Action Dates for Employment-Based Preference Cases," *Visa Bulletin* 15, no. 9 (June 2026), https://travel.state.gov/content/travel/en/legal/visa-law0/visa-bulletin/2026/visa-bulletin-for-june-2026.html.

3 Immigration, Refugees and Citizenship Canada, "How Express Entry Works," Government of Canada, https://www.canada.ca/en/immigration-refugees-citizenship/services/immigrate-canada/express-entry/works.html; UK Home Office, "Global Talent Visa," GOV.UK, https://www.gov.uk/global-talent.

4 Dworsky Law, "The New H-1B Lottery: How the Wage-Weighted System Changes Your Chances for FY 2027," https://dworskylaw.com/blog/the-new-h-1b-lottery-how-the-wage-weighted-system-changes-your-chances-for-fy-2027/.

5 Immigration and Nationality Act Amendments of 1965 (Hart–Celler Act), Pub. L. No. 89-236, 79 Stat. 911 (1965), https://www.govinfo.gov/content/pkg/STATUTE-79/pdf/STATUTE-79-Pg911.pdf; Mae M. Ngai, *Impossible Subjects: Illegal Aliens and the Making of Modern America* (Princeton University Press, 2004), 227–64, https://press.princeton.edu/books/paperback/9780691160825/impossible-subjects. The uniform per-country limit dates to 1965; the current 7 percent ceiling was set by the Immigration Act of 1990, Pub. L. No. 101-649, 104 Stat. 4978 (1990).

6 Mutual Educational and Cultural Exchange Act of 1961 (Fulbright–Hays Act), Pub. L. No. 87-256, 75 Stat. 527 (1961), https://www.congress.gov/bill/87th-congress/house-bill/8666/text. The two-year home-residency requirement is codified at Immigration and Nationality Act § 212(e), 8 U.S.C. § 1182(e). On the requirement's brain-drain-prevention rationale, see US Citizenship and Immigration Services, "Chapter 1 — Purpose and Background," *USCIS Policy Manual*, vol. 2, pt. D, https://www.uscis.gov/policy-manual/volume-2-part-d-chapter-1.

7 Data in Figure 6.01 and Tables 6.01, 6.02, and 6.03 are drawn from NCSES, "Survey of Earned Doctorates Data Tables," data tables compiled by the authors across available survey years.

8 Data in Figure 6.02 are drawn from National Center for Science and Engineering Statistics, "Foreign-Born STEM Workers," in *The STEM Labor Force: Scientists, Engineers, and Skilled Technical Workers, Science and Engineering Indicators,* NSB-2024-5, 42–48 (National Science Foundation, 2024), https://ncses.nsf.gov/pubs/nsb20245/foreign-born-stem-workers; and Michael G. Finn, *Stay Rates of Foreign Doctorate Recipients from US Universities, 2011* (Oak Ridge Institute for Science and Education, 2014), https://doi.org/10.2172/1303351.

9 "Improving and Expanding Training Opportunities for F-1 Nonimmigrant Students With STEM Degrees and Cap-Gap Relief for All Eligible F-1 Students," 81 Fed. Reg. 13040 (March 11, 2016) (codified at 8 C.F.R. pts. 214, 274a), https://www.federalregister.gov/documents/2016/03/11/2016-04828/improving-and-expanding-training-opportunities-for-f-1-nonimmigrant-students-with-stem-degrees-and.

10 Washington Alliance of Technology Workers v. U.S. Department of Homeland Security, 50 F.4th 164 (D.C. Cir. 2022), cert. denied, No. 22-1071 (U.S. Oct. 2, 2023), https://www.courtlistener.com/opinion/8246336/wa-alliance-of-tech-workers-v-dhs/.

11 Washtech, 50 F.4th 164.

12 Data in Figure 6.03 are drawn from US Citizenship and Immigration Services (USCIS), Form I-765, "Application for Employment Authorization: All Receipts, Approvals, Denials Grouped by Eligibility Category and Filing Type" (USCIS, 2003–2025), drawn from three reports covering FY2003–2021, FY2022, and FY2023, https://www.uscis.gov/sites/default/files/document/data/I-765_Application_for_Employment_FY03-21.pdf, https://web.archive.org/web/20250202082421/https://www.uscis.gov/sites/default/files/document/data/I-765_Application_for_Employment_FY22.pdf, and https://web.archive.org/web/20250211085540/https://www.uscis.gov/sites/default/files/document/data/I-765_Application_for_Employment_FY23.pdf; data for FY2024 and FY2025 are drawn from the fiscal-year Q4 "Form I-765, Application for Employment Authorization, Eligibility Category and Filing Type" reports (XLSX), https://www.uscis.gov/sites/default/files/document/data/i765_application_for_employment_fy24.xlsx and https://www.uscis.gov/sites/default/files/document/data/i765_application_for_employment_fy2025_q4_v1.xlsx.

13 US Citizenship and Immigration Services (USCIS), "Form I-765, Application for Employment Authorization," reports covering FY2003–2021, FY2022, and FY2023; FY2024 and FY2025 from fiscal-year Q4 reports (XLSX).

14 Data in Figures 6.04 and 6.05 are drawn from USCIS, H-1B Employer Data Hub, data for 2009–2026, data downloaded by the authors across all available fiscal years, https://www.uscis.gov/tools/reports-and-studies/h-1b-employer-data-hub.

15 National Foundation for American Policy, "H-1B Approved Petitions and Denial Rate for FY 2019," NFAP Policy Brief, February 2020, https://nfap.com/wp-content/uploads/2020/02/H-1B-Denial-Rates-Analysis-of-FY-2019-Numbers.NFAP-Policy-Brief.February-2020-1.pdf.

16 Exec. Order No. 13788, 3 C.F.R. 370 (2018), reprinted in 82 Fed. Reg. 18837 (April 21, 2017), https://www.federalregister.gov/documents/2017/04/21/2017-08311/buy-american-and-hire-american.

17 Donald J. Trump, “Restriction on Entry of Certain Nonimmigrant Workers,” proclamation, September 19, 2025, White House, https://www.whitehouse.gov/presidential-actions/2025/09/restriction-on-entry-of-certain-nonimmigrant-workers/.

18 The Immigration Act of 1990, Pub. L. No. 101-649, 104 Stat. 4978 (1990), 6, https://www.govinfo.gov/content/pkg/STATUTE-104/pdf/STATUTE-104-Pg4978.pdf.

19 Data in Table 6.04 are drawn from US Department of State, Bureau of Consular Affairs, *Visa Bulletin* (US Department of State, 2002–2026), data compiled by the authors from individual annual *Visa Bulletin* publications, https://travel.state.gov/content/travel/en/legal/visa-law0/visa-bulletin.html.

20 Mutual Educational and Cultural Exchange Act of 1961 (Fulbright–Hays Act), Pub. L. No. 87-256, 75 Stat. 527 (1961), https://www.congress.gov/bill/87th-congress/house-bill/8666/text, which consolidated the exchange authorities of the Smith–Mundt Act of 1948 and related postwar programs into a single framework. The two-year home-residency requirement is codified at Immigration and Nationality Act § 212(e), 8 U.S.C. § 1182(e).

21 Mutual Educational and Cultural Exchange Act; INA § 212(e).

22 Data in Figure 6.06 are drawn from US Department of State, “Facts and Figures 2015–2025” (BridgeUSA, 2024), data extracted by the authors, https://j1visa.state.gov/facts-and-figures-2015-2025/.

23 Immigration, Refugees and Citizenship Canada, “How Express Entry Works,” Government of Canada, https://www.canada.ca/en/immigration-refugees-citizenship/services/immigrate-canada/express-entry/works.html. Canada’s points-based selection dates to 1967; the Express Entry management system launched in January 2015, with a service standard of six months for most applications.

24 UK Home Office, “Global Talent Visa,” GOV.UK, https://www.gov.uk/global-talent. Settlement is available after three years on the “exceptional talent” route and five on “exceptional promise.”

25 On Germany, see Skilled Immigration Act (Fachkräfteeinwanderungsgesetz), as amended 2023, and the points-based Opportunity Card (Chancenkarte) established under Residence Act §§ 20a–20b, effective June 1, 2024, which permits qualified non-EU nationals to enter for up to a year to seek work without a prior job offer. Bundesministerium des Innern, “Points System for the ‘Opportunity Card’ (Chancenkarte),” press release, May 31, 2024, https://www.bmi.bund.de/SharedDocs/pressemitteilungen/EN/2024/05/chancenkarte-feg.html.

26 Data in Figure 6.07 are drawn from NCSES, ten-year stay rates of US-trained doctorate recipients (2012–14 cohorts); cost per PhD benchmarked to the NSF Graduate Research Fellowship support rate and the median STEM time to degree in the Survey of Earned Doctorates; authors’ calculation.

The 2026 US Talent Report

CONCLUSION

Growing Less, Keeping Less

Conclusion

Growing Less, Keeping Less

Arjun did not win the H-1B lottery. Jane did not graduate with a STEM degree. One is an internationally trained scientist whom a Texas company wanted to hire and a lottery turned away. The other is an American honors graduate who reached college unable to do middle-school math despite her dreams of being an engineer. This report opened with both of them because they stand at opposite ends of the same system.

Their stories lead to one verdict: The United States cultivates too little domestic STEM talent and keeps too little of the international talent it attracts. Worse, it is losing ground on both fronts as the two pipelines face significant, and rising, vulnerabilities. These vulnerabilities are more connected than many assume.

The United States cultivates too little domestic STEM talent and keeps too little of the international talent it attracts.

The domestic shortfall begins early. American fifteen-year-olds scored 7 points below the OECD average in mathematics in 2022, after falling below that average in 2003 and remaining there in every cycle since.[1] That decline is visible against the country's own past as well: US PISA math scores fell 28 points between 2000 and 2022. The United States reached this position while spending significantly more per pupil in K–12 education than the OECD average.[2]

The weak pipeline has downstream effects. Only about four in ten American students who enter a US college intending to major in STEM graduate with a STEM degree; most switch to non-STEM fields instead.

Jane's remedial classroom is not proof that the pipeline is broken in every school or state. But it illustrates a national problem the broader data document: too many American students reach college without the preparation required to complete majors or move into graduate study in quantitatively demanding fields.

International talent has compensated for this weakness so successfully, and for so long, that it has gone largely overlooked. International students now earn 51.3 percent of US STEM master's degrees and 36.4 percent of STEM doctorates. Their shares are highest in fields closest to today's technological competition: 64.9 percent of computer science master's degrees and 54.9 percent of computer science doctorates, along with majorities of graduate degrees in engineering and mathematics. The reliance deepens after graduation. Temporary visa holders occupy 68.0 percent of engineering postdoctoral positions and 57.3 percent across the sciences. Immigration policy is not separate from science policy. It is one of science policy's central instruments.

This dependence on international STEM talent flows is highly concentrated in two countries: India and China. India surpassed China as the largest source of international students in 2023 and now supplies 36.4 percent of all international graduate students, compared with China's 24.6 percent and South Korea's 3.0 percent.

Immigration policy is not separate from science policy. It is one of science policy's central instruments.

India's rise shifted the concentration but did not reduce it. A political rupture, economic shock, or major expansion of attractive opportunities in India could affect the US graduate pipeline just as China's partial withdrawal already has. The risk is not that talent comes from India or China. It is that a system this important rests so heavily on flows from so few places.

America's Edge Is Still Real—and Narrowing

The United States remains a scientific superpower. Its universities dominate the top ranks, its firms lead in market value, and its research ecosystem still attracts extraordinary people. But the measures that describe current momentum are moving in the wrong direction.

Between 2015 and 2025, the US share of the most-cited publications in emerging technologies fell from 14.2 percent to 8.4 percent, while China's rose from 11.5 percent to 20.8 percent. The share of the world's top 1 percent most-cited researchers working at American institutions fell from 52.9 percent to 37.4 percent even as the absolute American count increased, because other countries added elite researchers faster. China's share rose from less than 4.9 percent to 22.0 percent.

At NeurIPS, one of machine learning's most selective conferences, the US-affiliated share of oral presentations fell from 69.1 percent in 2013 to 34.0 percent in 2025, while China's rose from 1.8 percent to 33.6 percent. Similar convergence appears across twenty major AI conferences. The number of US universities in the global STEM top 100 also declined, from 40 to 34.

China's rise is visible in inputs as well as outputs. According to the OECD, its gross R&D spending increased from about $14 billion in 1991 to $859 billion in 2024, edging past the US figure of $848 billion.[3] These figures rest on self-reported national statistics and a purchasing-power adjustment that determines exactly when the two lines cross, so the precise year of parity is uncertain. What is certain is the trajectory—which patent, publication, and researcher counts independently confirm.

China now files far more patents than the United States in several critical technologies. Patent counts do not measure quality by themselves, and spending does not guarantee discovery. But taken together with citation impact, elite-researcher growth, and conference performance, they make one conclusion difficult to avoid: China is not imitating. It is innovating and increasingly producing consequential work at the frontier.

But taken together with citation impact, elite-researcher growth, and conference performance, they make one conclusion difficult to avoid: China is not imitating. It is innovating and increasingly producing consequential work at the frontier.

The Retention Gap

The United States still attracts people who want to stay. Three-quarters of international doctorate recipients report plans to remain, up from 67 percent in 2002 to 75.8 percent in 2024. But intention measures demand for an American future, not whether the system supplies one: only about 67.8 percent of international doctorate recipients remain after ten years. The gaps between intention and retention rates, and between five-year and ten-year retention rates, show that leakage continues long after graduation, when many observers assume intention and retention have been settled. Top STEM talent that expressed a desire to stay and contribute to the American innovation ecosystem but ended up leaving can be seen as “the ones that got away.”

What accounts for individual departures is, of course, impossible to discern from aggregate data. But we do know that the US immigration system was built with outdated rules from a different era, that it has not been modernized, and that the politics surrounding technological competition and talent are becoming more charged. The result is greater uncertainty about immigration rules and practices—and that uncertainty itself could generate disincentives for international STEM talent to remain.

Despite improvements, the H-1B selection process still does not guarantee the most distinguished STEM researchers will receive priority for visas. What’s more, a per-country ceiling on green cards, first imposed in 1965 and fixed at 7 percent in 1990, imposes radically different wait times on similarly qualified applicants from different countries. An Indian advanced-degree holder filing today faces an estimated wait of more than twelve years, compared with roughly four to five years for many other nationalities.

Policy volatility adds another cost: uncertainty. The spike in H-1B denial rates from 2017 through 2020 and the $100,000 fee attached to certain new H-1B petitions in 2025 differed in design and reach. But to prospective scientists and employers, they carried a common signal: the price and rules governing the main bridge from an American degree to an American career can change abruptly. Canada, the United Kingdom, Australia, Germany, and Singapore have moved in the opposite direction, offering skilled migrants clearer criteria, faster decisions, or more direct routes to permanent residence. America is no longer competing only on the quality of its universities and laboratories. It is competing on the predictability of the path that follows them.

America is no longer competing only on the quality of its universities and laboratories. It is competing on the predictability of the path that follows them.

How The Parts Compound

The central finding of this report is not any single number. It is the way the numbers interact. Weak domestic preparation increases reliance on international recruitment. Narrowing research advantages make recruitment harder. Immigration bottlenecks reduce retention. Every highly trained scientist who leaves takes knowledge and potential with them to a world in which competing research systems are becoming stronger. Those systems then give the next generation more reasons to study and work somewhere else.

Domestic and international talent are complements, not substitutes. Foreign-born STEM doctorate holders work in STEM occupations at substantially higher rates than US-born doctorate holders—about 75.9 percent compared with 56.7 percent. This does not mean foreign-born scientists are inherently more capable or committed. Visa rules, selection effects, and different career options help explain the gap. But it does mean that replacing each departing international doctorate holder with one additional domestic doctorate holder would not produce a one-for-one replacement in the STEM workforce. The country needs to develop more talent at home as well as attract and retain more of the best talent it trains from abroad.

The same logic applies to entrepreneurship. Immigrants founded or co-founded 65.1 percent of the companies named to Forbes AI 50 in 2025, and every top AI company valued at $100 billion or more has at least one immigrant founder. These figures do not show that immigration alone caused those firms to succeed. They do show that immigrant talent has been, and still is, deeply embedded in the American innovation system. Long green-card waits restrict job mobility and can make it harder to start a company during the years when many founders take their biggest risks. The cost of losing talent is therefore not limited to vacancies in existing laboratories. It includes companies, jobs, and discoveries that may arise elsewhere—or never arise at all.

What the Data Do—and Do Not—Show

The United States has not lost the talent competition. American universities still hold most of the top positions in STEM, American firms still lead in market value, and the 76 percent rate at which foreign-born PhDs work in STEM is a resource no competitor matches. Immigrants who clear the American system integrate and work at high rates, and across the OECD, the United States is one of the few countries where immigrants participate in the labor force at a higher rate than the native-born.[4]

But a head start only matters if you keep it. Nearly every major American advantage is either stable or eroding while major competitors are improving. Trends matter. And they are not moving in the right direction.

A Competition Without a Referee

Washington has built much of its technology-competition strategy around hardware: advanced chips, fabrication equipment, supply chains, and infrastructure. Those tools are important. But every chip, laboratory, model, and production line depends on people who know how to invent, build, and use them. Talent is not a fixed input. It is a strategic capability that must be developed, attracted, and retained.

The talent challenge is not one problem. It is many. And the authorities to address them are scattered. K–12 mathematics falls to state education departments and local boards. Undergraduate STEM persistence answers to university provosts and faculty. H-1B caps and per-country green card limits require an act of Congress. OPT is an executive branch regulation. And university competitiveness runs on research funding spread across executive branch departments and agencies under separate authorizations and appropriations. No single committee, agency, or statute governs even half of the system this report describes.

A challenge that runs from a middle-school math class to a green card queue crosses every jurisdictional line the government draws, but a system organized by jurisdiction has no place to see it as a whole. Each authority can look only at its own piece and may find it defensible. The school board is not responsible for the visa backlog, the Labor Department does not set K–12 standards, and Congress does not staff university faculty searches. The competition this report describes falls into the space between them, where it registers as no one's mandate and therefore no one's failure. That is how a competition gets lost without anyone deciding to lose it.

That is how a competition gets lost without anyone deciding to lose it.

What this report measures, end to end, is a country that depends on foreign talent for most of its advanced technical workforce in the fields that matter most, that is already seeing the inflow of new talent contract at the graduate entry point even as competition for it intensifies, that is losing ground in its ability to keep the talent it trains, and that has no domestic substitute available on any timescale that matters. The system still works, held together by institutional inertia and the residual pull of American universities, industries, and opportunities, but the margin by which it works is shrinking on nearly every dimension.

Conclusion Endnotes

1 Organisation for Economic Co-operation and Development (OECD), *PISA 2022 Results*, 5 vols., and *Technical Report* (OECD Publishing, 2023–2024), https://doi.org/10.1787/53f23881-en.

2 OECD, *Education at a Glance 2025: OECD Indicators* (OECD Publishing, 2025), https://doi.org/10.1787/1c0d9c79-en.

3 OECD, Main Science and Technology Indicators (MSTI) Database, gross domestic expenditure on R&D (GERD), converted to US dollars at purchasing power parity, data for 1991–2024, OECD Data Explorer, http://data-explorer.oecd.org/.

4 OECD, *International Migration Outlook 2025* (OECD Publishing, 2025), https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/11/international-migration-outlook-2025_355ae9fd/ae26c893-en.pdf.

The 2026 US Talent Report

APPENDICES AND BIBLIOGRAPHY

Appendix A

Key Terms

A.1 The Path from Student to Permanent Resident

Arjun and other international graduates move through a system most domestic graduates never see. It is not one process but a sequence of separate visa categories, each with its own rules, its own clock, and its own way of failing. Every graduate has to clear all of them in order, and the time they spend in one does not carry over to the next. Here is a short overview of that path stage by stage.

International students start in one of two statuses. The vast majority arrive on the **F-1 student visa**, which authorizes full-time study and little else. The F-1 is tied to enrollment, so it lasts as long as the degree and ends shortly after graduation, following a short grace period, and on its own it offers no route to staying.[1] A smaller number come on the **J-1 exchange visitor visa**, which covers many visiting scholars and postdoctoral researchers, and which follows a different logic described at the end of this section.

After international students graduate, they can move to Optional Practical Training, which authorizes up to twelve months of work in the student's field while the graduate remains under F-1 status. OPT can also be used before graduation, though any months used then are deducted from the twelve available after.[2] A graduate in a STEM field can apply to extend that authorization by another twenty-four months, for thirty-six in total (making this the one stage where a STEM degree buys additional time).[3] For students like Arjun, though, OPT is a bridge rather than a destination, because when it runs out, a graduate who has not moved onto another status has to leave. In practice, the STEM extension gives a graduate more chances to enter the H-1B visa lottery, which occurs once a year.

The **H-1B** is a temporary work visa for "specialty occupations," meaning jobs that require at least a bachelor's degree in a specific field, and three features shape it. First, an employer has to petition for it, so a graduate cannot pursue it alone. Second, Congress caps new H-1Bs at 85,000 a year, made up of 65,000 general visas and 20,000 reserved for holders of American master's or doctoral degrees. USCIS runs the general selection first, drawing from everyone, then runs a second draw for the 20,000 among only advanced-degree registrations that weren't selected in the first round, so a US master's or PhD effectively buys two chances rather than one.[4]

The ceiling has not moved since 2004, and because far more people want the visa than the cap allows, the government fills it by lottery—over-selecting each year, since many who are picked never file a complete petition. In fiscal year 2025, 470,000 registrations competed for roughly 85,000 visas. USCIS selected about 135,000, calibrating the over-selection to yield 85,000 approvable petitions rather than running a second round of cuts.[5]

Until 2026 the draw was random, weighing nothing about the applicant; a highly cited researcher and a first-year programmer drew the same odds. A rule first applied to the FY 2027 lottery changed that, giving higher-paid positions more entries in the draw. All wage levels remain eligible and the cap is unchanged, so the weighting shifts who is likely to win without easing the scarcity.[6]

Third, an H-1B lasts three years and can renew once, for a maximum of six years—though a worker caught in the green-card backlog can extend beyond that, as described below—and it ties the worker to the employer who sponsored it, so changing jobs requires a new employer to file a new petition.

An H-1B does not grant anyone permanent residence. It buys time to pursue one, and the path to becoming a permanent resident is a separate process with two hurdles.

The first is **PERM**, a labor certification in which the Department of Labor requires the sponsoring employer to test the labor market and show that no qualified American worker is available for a job.[7]

The second hurdle is obtaining a **green card**, and it is where the longest waits accrue. Employment-based green cards are capped at 140,000 a year and divided across five tiers:

- EB-1 for people with extraordinary ability;
- EB-2 for advanced-degree holders, where most STEM PhDs fall;
- EB-3 for other skilled workers;
- EB-4 for "special immigrants," such as certain religious workers; and
- EB-5 for investors who make a qualifying capital investment.[8]

A per-country ceiling set in 1990 adds a second limit on top of that annual cap. No single country may take more than 7 percent of the green cards issued in a year.[9] For most nationalities the combined wait runs about four to five years, which is survivable within an H-1B's six-year term. For Indian nationals, who make up the largest share of applicants, demand so far exceeds the 7 percent allotment that the wait now runs past twelve.

That is longer than the H-1B is meant to last, but a worker with an approved petition stuck in a backlogged queue can renew in three-year increments, without limit, until a green card comes available.[10] This is the queue behind Arjun's thirteen-year line, and it is why a graduate can spend a decade in the country with no permanent status.

The **J-1** track sits apart from all of this. It was built to bring scholars and researchers to the United States temporarily and then return them home, and many J-1 holders are bound by a rule requiring two years back in their home country before they can come back on a work visa.[11] It moves talent into American laboratories and then, by design, pushes it out.

Every transition this report measures is one of these gates: enrollment on the F-1, the move to OPT, the H-1B lottery, PERM certification, and the green card queue that varies so sharply by country. Each is a point where a graduate who fully intends to stay can be stopped, and Chapter 6 examines each in detail.

A.2 Who Counts as Foreign Talent

This report uses four terms for people born abroad or studying in the United States: **foreign-born**, **noncitizen**, **temporary visa holder**, and **international student**. They sound interchangeable. They are not. The datasets used in this report draw their boundaries in different places. A figure showing the foreign-born share of the STEM workforce cannot be read as the share working on temporary visas. A count of international students cannot be read as the number of foreign-born students. The categories overlap, but they do not measure the same people.

Start with the widest category: **foreign-born**.

Foreign-born means exactly what it sounds like. It includes anyone living in the United States who was born abroad and was not an American citizen at birth. It says nothing about that person's status today.

Arjun is foreign-born while he is studying on an F-1 visa. He remains foreign-born if he moves onto OPT, wins an H-1B, receives a green card, or becomes an American citizen twenty years from now. Birthplace does not change when immigration status does.

That makes foreign-born a much larger category than the phrase "foreign worker" often implies. In 2021, roughly seven million foreign-born workers held STEM jobs in the United States, accounting for about one in five STEM workers. But that does not mean one in five STEM workers depended on a visa. The total includes naturalized citizens and permanent residents alongside people on temporary statuses.

The next category is **noncitizen**.

Noncitizens are foreign-born people who have not become American citizens. This removes naturalized citizens from the count, but it still combines people with very different relationships to the United States.

A green card holder is a noncitizen. So is an H-1B worker. So is an F-1 student. Depending on the survey, the category may also include people without authorized immigration status.

Consider two engineers born in India. The first came to the United States thirty years ago and became a citizen. She is foreign-born, but not a noncitizen. The second has held a green card for ten years but has not naturalized. He is both foreign-born and a noncitizen, even though he has the right to live and work in the country permanently.

That distinction is large in practice. In 2024 the foreign-born labor force split almost evenly between naturalized citizens and noncitizens—roughly 51 percent to 49 percent—close to the split of the foreign-born population as a whole.[12] Treating "foreign-born" as another name for "noncitizen" therefore misclassifies nearly half of all foreign-born workers in the United States.

The category narrows again at **temporary visa holder**.

Temporary visa holders are noncitizens admitted to the United States for a limited purpose and under a status that expires. This includes students on F-1 and J-1 visas and workers on H-1B and other employment visas.

Green card holders drop out at this point. They are noncitizens, but they are permanent residents, not temporary visa holders.

The distinction is especially important in the graduate education data used throughout this report. National Science Foundation surveys generally divide students into two groups: **temporary visa holders** on one side, and **US citizens and permanent residents** on the other.[13] A doctoral student born abroad who holds a green card is therefore grouped with American citizens, not with students on F-1 visas.

Finally, there are **international students**.

International students are the student portion of the temporary population: foreign nationals studying in the United States primarily on F-1 or J-1 statuses. IPEDS, the federal higher education database used in this report, generally calls them **US nonresidents**.[14] Older tables use the term **nonresident alien**.

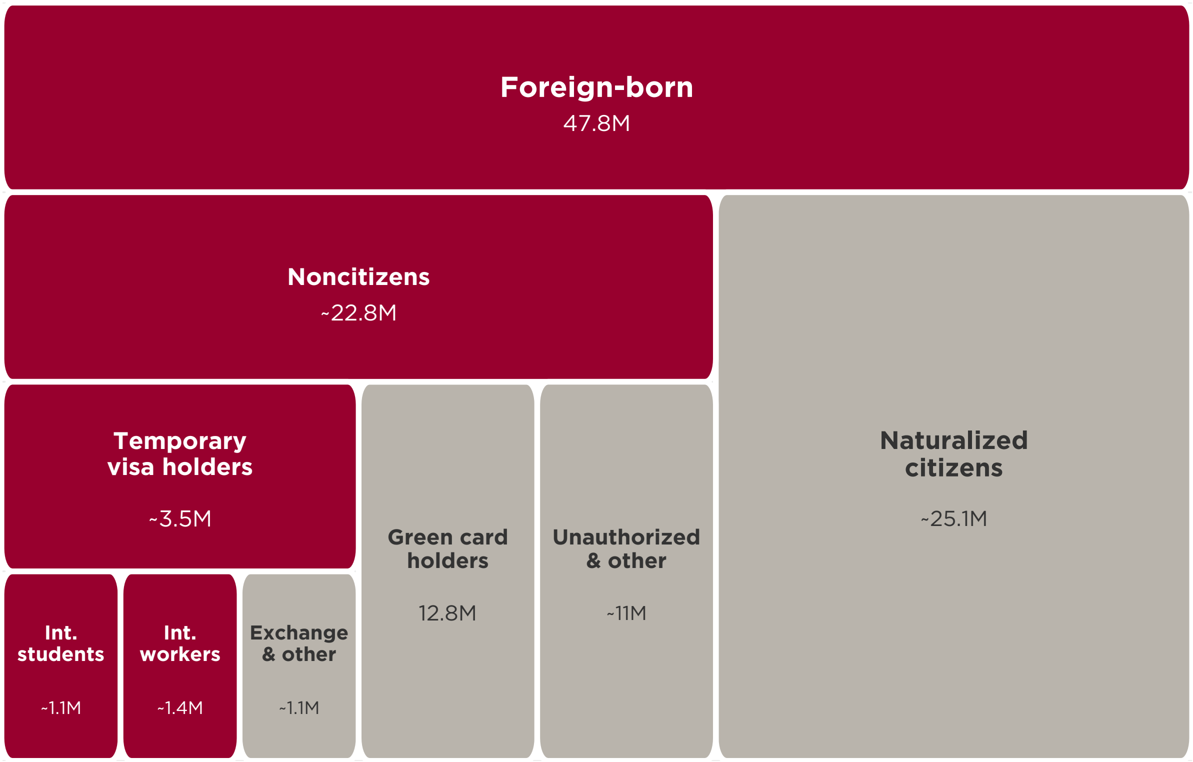
They are the population behind the headline that the United States hosts roughly 1.18 million international students.[15] But even that number needs a boundary around it. Some widely cited international student totals include recent graduates working through Optional Practical Training, even though those graduates may no longer be enrolled in classes. IPEDS enrollment tables, NSF graduate surveys, and Open Doors therefore produce related but not identical counts.

The four categories can be understood through four versions of Arjun:

- While studying on an F-1 visa, he is **foreign-born**, a **noncitizen**, a **temporary visa holder**, and an **international student**.
- While working on OPT, he remains **foreign-born**, a **noncitizen**, and a **temporary visa holder**. Some international education datasets still count him, but a standard enrollment table may not.
- If he receives a green card, he remains **foreign-born** and a **noncitizen**, but is no longer a temporary visa holder.
- If he later naturalizes, he is still **foreign-born**, but none of the other three terms applies.

The relationship is therefore a funnel:

This changes what the numbers can support. Suppose a study finds that 73 percent of foreign-born STEM PhDs remain in the United States five years after graduation. That population may include graduates who already received green cards or became citizens. It is not automatically the stay rate for graduates still on temporary visas.



Not to scale. Census (ACS) and DHS/OHSS estimates, 2023-24; sources differ and do not sum.

Or suppose a workforce table finds that about 19 percent of STEM workers are foreign-born. That does not mean 19 percent of the workforce could be lost through a change to H-1B policy. Many are already citizens. Others are permanent residents. Only a portion are working on temporary visas.

The same caution runs in the other direction. A table of international students captures the people entering through the student visa system, but misses foreign-born students who have already naturalized or received green cards. It therefore measures legal status, not simply whether a student came from abroad.

For that reason, every chart and table in this report names the population it measures. **Foreign-born** figures describe birthplace. **Noncitizen** figures describe citizenship. **Temporary visa holder** figures describe immigration status. **International student** figures describe a particular part of the education pipeline.

Appendix A Endnotes

1 US Citizenship and Immigration Services (USCIS), "Students and Employment," https://www.uscis.gov/working-in-the-united-states/students-and-exchange-visitors/students-and-employment.

2 USCIS, "Optional Practical Training (OPT) for F-1 Students," https://www.uscis.gov/working-in-the-united-states/students-and-exchange-visitors/optional-practical-training-opt-for-f-1-students; USCIS, "Practical Training," *Policy Manual*, vol. 2, Part F, Chapter 5, https://www.uscis.gov/policy-manual/volume-2-part-f-chapter-5.

3 "Improving and Expanding Training Opportunities for F-1 Nonimmigrant Students with STEM Degrees and Cap-Gap Relief for All Eligible F-1 Students," 81 Fed. Reg. 13040 (March 11, 2016) (codified at 8 C.F.R. pts. 214, 274a), https://www.federalregister.gov/documents/2016/03/11/2016-04828/improving-and-expanding-training-opportunities-for-f-1-nonimmigrant-students-with-stem-degrees-and; USCIS, "Optional Practical Training (OPT) for F-1 Students."

4 USCIS, "H-1B Cap Season," https://www.uscis.gov/working-in-the-united-states/temporary-workers/h-1b-specialty-occupations/h-1b-cap-season.

5 USCIS, "H-1B Electronic Registration Process," https://www.uscis.gov/working-in-the-united-states/temporary-workers/h-1b-specialty-occupations/h-1b-electronic-registration-process.

6 Department of Homeland Security, "Weighted Selection Process for Registrants and Petitioners Seeking to File Cap-Subject H-1B Petitions," final rule, 90 Fed. Reg. 60864 (December 29, 2025), https://www.federalregister.gov/d/2025-23853.

7 US Department of Labor, Employment and Training Administration, "Permanent Labor Certification (PERM)," Foreign Labor Application Gateway (FLAG), https://flag.dol.gov/programs/perm.

8 Immigration and Nationality Act § 203(b), 8 U.S.C. § 1153(b); the 140,000 employment-based cap and the EB-1 through EB-5 preference structure were established by the Immigration Act of 1990, Pub. L. No. 101-649, 104 Stat. 4978 (1990), https://www.govinfo.gov/content/pkg/STATUTE-104/pdf/STATUTE-104-Pg4978.pdf.

9 Immigration and Nationality Act Amendments of 1965 (Hart–Celler Act), Pub. L. No. 89-236, 79 Stat. 911 (1965); the current 7 percent per-country ceiling was set by the Immigration Act of 1990, Pub. L. No. 101-649, 104 Stat. 4978 (1990).

10 American Competitiveness in the Twenty-First Century Act of 2000, Pub. L. No. 106-313, 114 Stat. 1251 (2000); 8 C.F.R. § 214.2(h)(13)(iii)(D)–(E).

11 Mutual Educational and Cultural Exchange Act of 1961 (Fulbright–Hays Act), Pub. L. No. 87-256, 75 Stat. 527 (1961); the two-year home-residency requirement appears at Immigration and Nationality Act § 212(e), 8 U.S.C. § 1182(e).

12 Authors' analysis of US Census Bureau, "American Community Survey," 2024 1-Year Estimates. Tables "B05001 (Nativity and Citizenship Status in the United States)" and "S0501 (Selected Characteristics of the Native and Foreign-Born Populations)" (2024), https://data.census.gov.

13 National Center for Science and Engineering Statistics, "Survey of Earned Doctorates," and "Survey of Graduate Students and Postdoctorates in Science and Engineering" (National Science Foundation), https://ncses.nsf.gov/surveys/earned-doctorates and https://ncses.nsf.gov/surveys/graduate-students-postdoctorates-s-e/2024.

14 National Center for Education Statistics, "Integrated Postsecondary Education Data System (IPEDS)," data for 1995–2024 (US Department of Education, Institute of Education Sciences), https://nces.ed.gov/ipeds/.

15 Institute of International Education, "International Student: Enrollment Trends," data for 1948/49–2024/25, *Open Doors Report on International Educational Exchange*, 2025, https://opendoorsdata.org/data/international-students/enrollment-trends/.

Appendix B

Data Sources

This report draws on primary data from federal statistical agencies, immigration and labor administrative records, international education and demographic series, and bibliometric, patent, and R&D databases. The tables below list each source, the series used, how it was processed into a figure or table, the chapters that rely on it, and the exhibits it feeds. Every statistic traces to a primary source rather than secondary reporting, and the tables below cover sources that supply data used in this report. Works cited only for argument or background are not listed here. Statistics the authors computed from raw files are labeled *'Authors' analysis of'* in the endnotes. Each source ends the same way, as one clean CSV per exhibit that the R charts read. The processing column describes how the raw data reached that point.

B.1 Federal statistical agencies (NCES, NCSES, NSF)

US Department of Education (NCES) and National Science Foundation (NCSES / NSB).

Source	Series used	Processing pipeline	Chs	Figures / tables
IPEDS Completions	Integrated Postsecondary Education Data System, annual degree-completion files, 1995–2025; degrees by field (CIP), award level, and control of institution.	Annual Completions files downloaded in full from the IPEDS Data Center. The raw files were cleaned, harmonized across years, crosswalked across CIP vintages, and flagged for STEM in Python (pandas), producing one CSV per exhibit that the R charts read (see C.3.1).	1, 2, 4	Figs 1.02, 1.03, 1.05, 1.06; Tab 1.01
Survey of Earned Doctorates (SED)	NCSES; doctorate recipients by field, citizenship, origin, 2010–2024, plus US Doctorates in the 20th Century (NSF 06-319).	Full data tables downloaded from the NCSES site and reduced to each exhibit's cut with Excel pivot tables, then saved as a CSV that the R charts read.	1, 2, 6	Figs 1.01, 1.05, 1.06, 6.01, 6.07; Tabs 6.01–6.03
Graduate Students & Postdocs (GSS)	NCSES; graduate enrollment and postdoc counts by field and citizenship, 1994–2024.	Full data tables downloaded and pivoted in Excel, then saved as a CSV for the R charts.	3	Fig 3.02
Postdocs at FFRDCs	NCSES; postdoctoral appointments at federally funded R&D centers, 2010–2023.	Full data tables downloaded and pivoted in Excel, then saved as a CSV for the R charts.	3	Fig 3.03
National Survey of College Graduates (NSCG)	NCSES; foreign-born share and outcomes of the STEM workforce.	Full data tables downloaded and pivoted in Excel, then saved as a CSV for the R charts.	3	Fig 3.04; Tabs 3.01, 3.02
BPS: 96/01, BPS: 04/09, BPS: 12/17	Beginning Postsecondary Students Longitudinal Studies; entry-cohort persistence, remediation, STEM attrition.	Tabulated in NCES DataLab and PowerStats, then saved as a CSV for the R charts. The two cohorts are read as a before-and-after comparison.	4	Figs 4.07–4.09; Tabs 4.01, 4.02
S&E Indicators (NSB)	Biennial Science and Engineering Indicators: higher ed (NSB-2023-32), STEM labor force (NSB-2024-5, -2026-1), cross-national R&D (NSB-2024-6).	Published tables transcribed into a CSV for the R charts; the attainment figures add an author projection (see B.4).	1, 5, 6	Figs 1.07, 1.08, 5.05, 5.07; Tab 5.03

B.1 Federal statistical agencies (NCES, NCSES, NSF) (cont.)

US Department of Education (NCES) and National Science Foundation (NCSES / NSB).

Source	Series used	Processing pipeline	Chs	Figures / tables
NAEP Long-Term Trend (LTT)	NCES; mathematics average scale scores, age 9 (1996–2022) and age 13 (1996–2023).	Tabulated in the NAEP Data Explorer, then saved as a CSV for the R charts.	4	Fig 4.01
Trends in International Mathematics and Science Study (TIMSS)	IEA; US average mathematics scores, grades 4 and 8, 1995–2023 (grade 4 not tested in 1999).	Published US average scores transcribed into a CSV for the R charts.	4	Fig 4.01

B.2 Immigration and labor administrative records

DHS/USCIS, Department of Labor, and Department of State.

Source	Series used	Processing pipeline	Chs	Figures / tables
USCIS H-1B Employer Data Hub	Approved H-1B petitions by employer and fiscal year, 2009–2026.	Annual employer files downloaded in full and combined in Python (pandas), with each employer's NAICS code mapped to a sector and the fiscal year read from the filename, producing a CSV for the R charts.	3, 6	Figs 3.05, 3.06, 6.04, 6.05; Tab 3.03
USCIS Form I-765	Employment authorization receipts, approvals, and denials by eligibility category, FY2003–2025 (nine reports: FY03–21, FY22, FY23, FY24, and FY 2025 quarterly files).	The nine reports were combined into a single series in Python, then saved as a CSV for the R charts.	6	Fig 6.03
State Dept. Visa Bulletin	Final action dates for employment-based preference categories, 2002–2026.	Monthly bulletins compiled into a single panel and saved as a CSV for the R charts.	6	Tab 6.04
State Dept. J-1 / BridgeUSA	Exchange-visitor facts and figures, 2015–2025.	Figures extracted into a CSV for the R charts.	6	Fig 6.06
DHS SEVIS	Student and Exchange Visitor Information System; active F-1 counts by state, level, gender, citizenship.	Monthly extracts reshaped to long form in Python, split into a latest-available-date snapshot and the remaining months, with a log-transformed count added, then saved as a CSV for the R map layer.	2	context
NCSES foreign-born STEM / Finn stay rates	NSB STEM labor-force indicators (NSB-2024-5) and Finn stay-rate reports; doctorate retention.	Published tables transcribed into a CSV for the R charts.	6	Fig 6.02, Fig 6.07

B.3 International education and demographics

IIE, OECD, UNESCO, and the United Nations.

Source	Series used	Processing pipeline	Chs	Figures / tables
IIE Open Doors	Data tables downloaded in full across international students, study abroad, and international scholars: enrollment trends (1948/49–2024/25), origin, level, field of study, US study abroad, Fall 2025 Snapshot.	All Open Doors data tables downloaded and reduced to each exhibit's cut with Excel pivot tables, then saved as a CSV for the R charts.	1, 2, 4	Figs 1.04, 2.01–2.04, 2.06–2.08, 3.01, Tabs 2.01, 2.02, 4.03, 4.04
OECD PISA 2022	All five volumes plus Technical Report; 15-year-old mathematics, reading, science.	Published tables transcribed into a CSV for the R charts.	4	Figs 4.01–4.04
OECD Education at a Glance 2025	Per-pupil expenditure and attainment (Table C1.1).	Transcribed into a CSV for the R charts.	4	Figs 4.05, 4.06
UNESCO UIS.Stat	Outbound mobile tertiary students and net flows, 2000–2023.	Extracted into a CSV that the R choropleth reads, joined to a Natural Earth basemap.	4	Figs 4.10, 4.11
BEA International Services	US trade in services, education exports (Table 2.1, line 21).	Extracted into a CSV for the R charts.	2	Fig 2.05

B.4 Research output, patents, and R&D

Bibliometric, patent, and R&D-expenditure sources.

Source	Series used	Processing pipeline	Chs	Figures / tables
OpenAlex API	Author affiliation and citation data by field; most-cited-paper authorship; company research staffing.	Works for each field pulled through the OpenAlex API, then built in Python into institution co-authorship networks and summarized with graph metrics (see C.3.6), producing a CSV for the R charts.	3, 5	Figs 3.10, 5.02, 5.03
Paper Copilot	NeurIPS and conference acceptance and submission statistics.	Conference statistics extracted into a CSV for the R charts.	5	Fig 5.01; Tab 5.01
Clarivate Highly Cited Researchers	Highly Cited Researchers lists, 2014–2025.	Annual lists extracted and assembled into a CSV for the R charts.	5	Fig 5.04
Times Higher Education	By-field World University Rankings, 2011–2026 (CS 2017–2026).	Subject rankings compiled across years into a CSV for the R table.	5	Tab 5.02
OECD MSTI + NSB	R&D expenditure (USD, PPP); cross-national R&D performance.	Extracted and transcribed into a CSV for the R charts.	5	Figs 5.05-5.08; Tabs 5.03, 5.04
WIPO IP Statistics	Patents granted by technology field (indicator 5), 2024.	Extracted and assembled into a CSV for the R charts.	5	Tab 5.05
Patent 300 + USPTO PatentsView	Top organizations granted US utility patents, 2005/2015/2025; gaps filled from PatentsView.	The union of the three years' top-ten lists compiled into a CSV, with missing company-years filled from PatentsView, for the R table.	5	Tab 5.06

B.5 AI-talent-specific sources

Source	Series used	Processing pipeline	Chs	Figures / tables
Forbes AI 50 (2019–2025)	Annual AI 50 lists with PitchBook data; founder origin and immigration status.	Annual lists compiled into a CSV for the R charts.	3	Figs 3.07–3.09

B.6 Data Bibliography

Authors' analysis of "Beginning Postsecondary Students Longitudinal Study" BPS: 96/01, BPS: 04/09, and BPS: 12/17. National Center for Education Statistics, US Department of Education. Compiled from NCES PowerStats.

Authors' analysis of "Foreign Labor Certification Performance Data." US Department of Labor, 2008–2025. https://www.dol.gov/agencies/eta/foreign-labor/performance.

Authors' analysis of H-1B Employer Data Hub. US Citizenship and Immigration Services, 2009–2026. https://www.uscis.gov/tools/reports-and-studies/h-1b-employer-data-hub.

Authors' analysis of "Highly Cited Researchers, Past Lists," 2014–2025. Clarivate Analytics. https://clarivate.com/highly-cited-researchers/past-lists/.

Authors' analysis of "Integrated Postsecondary Education Data System (IPEDS) Completions Component." National Center for Education Statistics, US Department of Education, 1995–2024. Compiled using Python from annual IPEDS Completions survey files. https://nces.ed.gov/ipeds/datacenter/DataFiles.aspx.

Authors' analysis of "Main Science and Technology Indicators (GERD by sector of performance, converted to US dollars at purchasing power parity)." Organisation for Economic Co-operation and Development, 1991–2024. OECD Data Explorer. http://data-explorer.oecd.org/.

Authors' analysis of "National Survey of College Graduates Data Tables." National Center for Science and Engineering Statistics, US National Science Foundation. https://ncses.nsf.gov/surveys/national-survey-college-graduates.

Authors' analysis of OpenAlex (Jason Priem, Heather Piwowar, and Richard Orr). OurResearch, 2022–2025. Citation statistics by field accessed via the OpenAlex API. https://openalex.org.

Authors' analysis of "Patents Granted by Technology (indicator 5)." World Intellectual Property Organization, WIPO IP Statistics Data Center, 2024. https://www3.wipo.int/ipstats.

Authors' analysis of "Postdocs at Federally Funded R&D Centers Data Tables." National Center for Science and Engineering Statistics, US National Science Foundation, 2010–2023. https://ncses.nsf.gov/surveys/ffrdc-postdocs.

Authors' analysis of "Survey of Earned Doctorates Data Tables." National Center for Science and Engineering Statistics, US National Science Foundation, 2010–2024. https://ncses.nsf.gov/surveys/earned-doctorates.

Authors' analysis of "Survey of Graduate Students and Postdoctorates in Science and Engineering Data Tables." National Center for Science and Engineering Statistics, US National Science Foundation, 1994–2025. https://ncses.nsf.gov/surveys/graduate-students.

Authors' analysis of "Total Outbound Internationally Mobile Tertiary Students Studying Abroad" and "Net Flow of Internationally Mobile Students (Inbound – Outbound)." UNESCO Institute for Statistics, UIS.Stat Database, 2026. https://data.uis.unesco.org/.

Authors' analysis of US utility patents granted by organization. Union of the top-ten recipients in 2005, 2015, and 2025, drawn from Intellectual Property Owners Association, "Top 300 Organizations Granted US Patents in 2005" and "…in 2015," and Harrity & Harrity, "Patent 300," 2026; missing company-years filled from USPTO PatentsView.

Authors' analysis of *Visa Bulletin*. US Department of State, 2002–2026. https://travel.state.gov/content/travel/en/legal/visa-law0/visa-bulletin.html.

Authors' analysis of "World University Rankings by Subject." Times Higher Education, 2011–2026 (Computer Science, 2017–2026). https://www.timeshighereducation.com/world-university-rankings/by-subject.

Baer, Julie, and Sumeyra Ekin. *Fall 2025 Snapshot on International Student Enrollment*. Institute of International Education, 2025. https://iie.widen.net/s/xd9xrsft6q/iie_fall-2025-snapshot_full-report.

Forbes AI 50 Lists, 2019–2025. Compiled by the authors; individual lists by Jillian D'Onfro (2019), Alan Ohnsman (2020, 2021), Helen A. S. Popkin (2022), Konstantine Buhler (2023), Kenrick Cai (2024), and Rashi Shrivastava (2025). https://www.forbes.com/lists/ai50/.

Institute of International Education. *Open Doors Report on International Educational Exchange*. 2025. Data tables for international student enrollment trends (1948/49–2024/25), totals and academic level by place of origin (2001/02–2024/25), field of study (1998/99–2024/25), fields of study by place of origin (2009/10–2024/25), and academic level (1999/00–2024/25). https://opendoorsdata.org/.

Institute of International Education. *Open Doors Report on International Educational Exchange*. 2024. Data tables for US study abroad by field of study (2000/01–2022/23) and host region (2004/05–2022/23). https://opendoorsdata.org/data/us-study-abroad/.

National Center for Education Statistics. "Table 318.10: Degrees Conferred by Postsecondary Institutions, by Level of Degree and Sex of Student: Selected Years, 1869–70 through 2031–32." *Digest of Education Statistics*. US Department of Education, Institute for Education Sciences. 2023. https://nces.ed.gov/programs/digest/d23/tables/dt23_318.10.asp.

National Center for Science and Engineering Statistics. "Foreign-Born STEM Workers." In *The STEM Labor Force: Scientists, Engineers, and Skilled Technical Workers*, Science and Engineering Indicators, NSB-2024-5, 42–48. National Science Foundation, 2024. https://ncses.nsf.gov/pubs/nsb20245/foreign-born-stem-workers.

National Science Board. "Cross-National Comparisons of R&D Performance." Science and Engineering Indicators 2024. National Science Foundation, 2024. https://ncses.nsf.gov/pubs/nsb20246/cross-national-comparisons-of-r-d-performance.

National Science Board. "International Comparisons of S&E Higher Education." In *Higher Education in Science and Engineering*, NSB-2023-32, Science and Engineering Indicators 2024, 53–62. National Science Foundation, 2023. Author projections beyond the reported figures. https://ncses.nsf.gov/pubs/nsb202332/international-comparisons-of-s-e-higher-education.

Organisation for Economic Co-operation and Development. *Education at a Glance 2025: OECD Indicators*. OECD Publishing, 2025. https://doi.org/10.1787/1c0d9c79-en.

Organisation for Economic Co-operation and Development. *International Migration Outlook 2025*. OECD Publishing, 2025. https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/11/international-migration-outlook-2025_355ae9fd/ae26c893-en.pdf.

Organisation for Economic Co-operation and Development. *Programme for International Student Assessment (PISA) 2022 Results.* 5 vols., and *Technical Report*. OECD Publishing, 2023–2024. https://doi.org/10.1787/53f23881-en and https://www.oecd.org/en/publications/pisa-2022-technical-report_01820d6d-en.html.

Thurgood, Lori, Mary J. Golladay, and Susan T. Hill. *US Doctorates in the 20th Century*. NSF 06-319. National Science Foundation, 2006. https://www.nsf.gov/statistics/nsf06319/.

US Bureau of Economic Analysis. "Table 2.1. US Trade in Services, by Type of Service," line 21. International Transactions, International Services, and International Investment Position Tables. BEA, July 3, 2025. https://apps.bea.gov/iTable/.

US Citizenship and Immigration Services. Form I-765, "Application for Employment Authorization: All Receipts, Approvals, Denials Grouped by Eligibility Category and Filing Type." USCIS, 2003–2023. https://www.uscis.gov/sites/default/files/document/data/I-765_Application_for_Employment_FY03-21.pdf.

US Department of State. "Facts and Figures 2015–2025." BridgeUSA. US Department of State, 2024. https://j1visa.state.gov/facts-and-figures-2015-2025/.

Appendix C

Methodology

C.1 Approach

This piece relies on two toolchains. Data are cleaned, harmonized, and computed in Python with pandas, and every figure and table is then rendered in R under a shared house-style system so type, color, sizing, and export width match across exhibits. The two stages communicate through one flat CSV per exhibit. Two sources sit outside the Python path: The NSF/NCSES surveys and the IIE Open Doors tables were downloaded in full and worked up in Excel with pivot tables. Both routes end in the same per-exhibit file the R layer reads. Wherever possible, the longest consistent series each source permits is used, and administrative counts and censuses are preferred over sample surveys when both exist. Sample-based estimates (PISA, the NSCG, the BPS studies) are used only where a survey instrument is the sole source, and their sampling limits are noted at the point of use.

C.2 Reproducibility

Raw source files are never edited in place. Sources on the Python path are transformed by a script that reads the raw download and writes a cleaned output, so any figure can be regenerated from the original files. Sources on the Excel path (the NSF/NCSES surveys and the Open Doors tables) were downloaded in full and reduced with pivot tables to the specific cut each exhibit needs, then saved as a flat CSV. Encodings on the Python path are handled defensively: The immigration and SEVIS combine scripts try UTF-8, UTF-16, and Latin-1 in turn and fall back across comma, tab, and semicolon delimiters, because the federal files are inconsistent across years. Column names are trimmed on load, numeric coercion is explicit rather than inferred, and missing values are filled with zero only where a zero is the correct count.

C.3 Data construction by domain

C.3.1 Degree production (IPEDS)

The IPEDS completion counts pass through a four-stage Python pipeline.

1. **Dictionary unification.** IPEDS renamed its demographic variables during the 2008–2010 race-category transition, so the same concept appears under several codes across years. A first script parses every annual data dictionary (HTML and Excel) and builds one codebook. Where the old CRACE* codes, the new C* codes, and the derived DVC* codes coexist, it keeps the modern variable and drops the older and derived ones, so each concept resolves to a single column.

2. **Codebook application.** A second script applies that codebook to each annual file, renames columns to their unified names, and combines columns that map to the same concept. When men and women counts exist but a total does not, or a total and one sex exist but the other does not, the missing field is derived by addition or subtraction rather than left blank.

3. **Cleaning and award levels.** A third script attaches institution names, labels detailed and consolidated award levels, and resolves the doctoral-code overlap: Where modern doctoral codes (20, 21, 22) appear in an institution-year-field group, the legacy codes (17, 18, 19) are dropped so the same degree is not counted twice. Resident totals are computed directly as grand total minus nonresident, never by summing race categories, to avoid rounding drift.

4. **CIP normalization and STEM flagging.** Field-of-study codes span four CIP vintages (1990, 2000, 2010, 2020). A fourth script crosswalks all four to a common scheme with a full-code-then-two-digit fallback, then flags each field STEM or non-STEM. IPEDS summary rows and grand-total lines that equal the sum of the real field rows in their group were dropped before saving so that summing across fields does not double-count.

Degrees are counted on first majors only, retaining rows from earlier years that predate the first-or-second-major variable, so each graduate is counted once. Because IPEDS is institution-level aggregate data rather than person-level records, a dual-major student whose STEM field is recorded as a second major is not captured in the STEM count. STEM field groupings follow the NSB Science and Engineering Indicators definitions so the domestic counts stay comparable to the international benchmarks.

C.3.2 Persistence and attrition (BPS)

Entry-cohort persistence, remediation exposure, and STEM attrition come from the Beginning Postsecondary Students Longitudinal Studies, BPS:04/09 and BPS:12/17, tabulated through NCES DataLab and PowerStats. The two cohorts are read as a before-and-after comparison rather than a continuous series, because the sampling frames and instruments differ.

C.3.3 Doctorate production and stay rates

Doctorate counts and characteristics come from the NCSES Survey of Earned Doctorates website and archives, 2010-2024, downloaded in full and reduced with Excel pivot tables, and extended backward with US Doctorates in the 20th Century for the long historical series in Figure 1.01. Stay rates draw on the NSB Science and Engineering Indicators series and the Finn stay-rate reports from Oak Ridge. Two stay-rate figures rest on different NSF products with different denominators; the difference is explained in the chapter prose rather than reconciled into a single number, because the products measure different populations.

C.3.4 Foreign students and the STEM workforce

International enrollment, origin, level, and field come from Institute of International Education's Open Doors reports, whose data tables were downloaded in full and reduced with Excel pivot tables, including the Fall 2025 Snapshot for the most recent year. Foreign-born shares of the STEM workforce come from the NCSES National Survey of College Graduates and the Survey of Graduate Students and Postdoctorates, both worked up the same way, and are cross-checked against the NSB STEM labor-force indicators.

C.3.5 Immigration machinery

The retention analysis reconstructs the OPT, H-1B, PERM, and employment-based green-card pathways from administrative records. H-1B volumes come from the USCIS H-1B Employer Data Hub, 2009-2026, which reports approved petitions by employer and fiscal year. A combine script standardizes the singular and plural column-name variants across years, maps each employer's NAICS code to a broad sector, and stamps the fiscal year from the filename. OPT and employment-authorization volumes come from USCIS Form I-765 data spanning FY2003 through FY2025. Priority-date backlogs come from the monthly State Department *Visa Bulletin*, available from 2002 to 2026.

C.3.6 Research output, collaboration networks, and R&D

Publication and citation measures come from the OpenAlex API; conference activity comes from Paper Copilot; the most-cited-researcher counts come from Clarivate's Highly Cited Researchers lists; institutional strength comes from the Times Higher Education by-field rankings. Each of these except OpenAlex was extracted by hand into a clean CSV before charting. R&D expenditure and sector shares come from OECD MSTI in US dollars at purchasing-power parity. Patent counts come from WIPO, with organization-level US grants in Table 5.06 assembled from the IPO Association and Harrity Patent 300 lists and completed from USPTO PatentsView.

C.4 Normalization, comparison, and author estimates

Cross-country comparisons hold constant whatever the underlying question requires. Monetary values are compared at purchasing-power parity, not market exchange rates. Where per-capita framing matters, counts are normalized using UN World Population Prospects 2024. Bibliometric and patent measures are compared within field and, where the series allows, within year, because field mix and publication conventions differ across countries. The report does not chain incompatible series, and when a definition or instrument changes, the break is shown rather than smoothed.

Percentage-point and relative-change columns are computed from unrounded source values and then rounded for display, while the level columns beside them are rounded independently. Differencing the printed levels will therefore sometimes give a result 0.1 above or below the printed change. The same applies to absolute counts shown at three significant figures. Where the two disagree, the change column is the more accurate figure.

Three exhibits extend published data. The attainment projections in Figures 1.07 and 1.08 extend NSB international-comparison data beyond the last reported year using the authors' own projection, with observed and projected segments drawn as solid and dotted lines from the same series. Figure 6.07's return-on-investment estimate benchmarks the cost per US-trained doctorate to the NSF Graduate Research Fellowship average support rate and the median time to degree for STEM graduates from the Survey of Earned Doctorates, applied to ten-year stay rates for the 2012–14 cohorts. Every such estimate is labeled as an author calculation at the point of use, and the inputs are stated so the calculation can be reproduced.

C.5 Sourcing and verification standard

Every quantitative claim traces to a primary source. Statistics computed from microdata or raw files are labeled as the authors' analysis and name the underlying dataset. Claims that could not be verified against a primary source before drafting were flagged rather than asserted, and those flags were resolved before publication. Citations follow the Chicago Manual of Style, 18th edition, notes system, with full citations on first appearance and shortened forms thereafter.

C.6 Known limitations

Two limitations bear on how the findings should be read. First, several key instruments are sample surveys with their own error and periodicity; PISA runs on a three-year cycle, the BPS cohorts are years apart, and the NSCG is a periodic sample, so short-run movements should not be over-read. Second, IPEDS is institution-level aggregate data, so first-major counting undercounts STEM dual majors whose STEM field is listed second, and administrative immigration counts capture petitions and approvals rather than people (the H-1B Employer Data Hub is used precisely because it reduces, though it does not eliminate, that duplication). These limitations constrain precision at the margin. They do not affect the direction of the findings, which rest on large and consistent gaps across independent series.

C.7 About Jane and Arjun

Two composite figures, Jane and Arjun, run through the chapters as narrative devices. Jane is a domestic student; Arjun is a foreign-born researcher. Both are built from documented pathways rather than drawn from real individuals, and no claim in the analysis rests on them.

Bibliography

Aiken, Catherine, James Dunham, and Remco Zwetsloot. *Career Preferences of AI Talent*. Center for Security and Emerging Technology, 2020. https://cset.georgetown.edu/publication/career-preferences-of-ai-talent/.

American Competitiveness in the Twenty-First Century Act of 2000. Pub. L. No. 106-313, 114 Stat. 1251 (2000); 8 C.F.R. § 214.2(h)(13)(iii)(D)–(E).

Amnesty International. "China: Overseas Students Face Harassment and Surveillance in Campaign of Transnational Repression." Amnesty International, May 13, 2024. https://www.amnesty.org/en/latest/news/2024/05/china-overseas-students-face-harassment-and-surveillance-in-campaign-of-transnational-repression/.

Arora, Ashish, V.S. Arunachalam, Jai Asundi, and Ronald Fernandes. "The Indian Software Services Industry." *Research Policy* 30, no. 8 (October 2001): 1267–87. https://doi.org/10.1016/S0048-7333(00)00148-7.

Baer, Julie, and Mirka Martel. *Fall 2020 Snapshot on International Student Enrollment*. Institute of International Education, 2020. https://www.iie.org/wp-content/uploads/2022/12/Fall-2020-Snapshot-Report-Full-Report.pdf.

Baer, Julie, and Sumeyra Ekin. *Fall 2025 Snapshot on International Student Enrollment*. Institute of International Education, 2025. https://iie.widen.net/s/xd9xrsft6q/iie_fall-2025-snapshot_full-report.

Binkley, Collin. "College Students Are Still Struggling with Basic Math. Professors Blame the Pandemic." Associated Press, August 31, 2023. https://apnews.com/article/college-math-test-help-6cca6a5e873d5aeb5e75b4f94125d48c.

Bound, John, Gaurav Khanna, and Nicolas Morales. "Understanding the Economic Impact of the H-1B Program on the US." NBER Working Paper 23153. National Bureau of Economic Research, February 2017. https://www.nber.org/papers/w23153.

Brainard, Jeffrey, and Dennis Normile. "China Rises to First Place in Most Cited Papers." *Science*, August 17, 2022. https://www.science.org/content/article/china-rises-first-place-most-cited-papers.

Bundesministerium des Innern (Federal Ministry of the Interior), Germany. "Points System for the 'Opportunity Card' (Chancenkarte)." Press release. May 31, 2024. https://www.bmi.bund.de/SharedDocs/pressemitteilungen/EN/2024/05/chancenkarte-feg.html.

Bush, Vannevar. *Science, the Endless Frontier: A Report to the President*. US Government Printing Office, 1945. https://nsf-gov-resources.nsf.gov/2023-04/EndlessFrontier75th_w.pdf.

Cai, Kenrick. "AI 50 2023 Methodology: Our New, Improved Process for Selecting Honorees." *Forbes*, April 11, 2023. https://www.forbes.com/sites/kenrickcai/2023/04/11/ai-50-2023-methodology-judges/.

Chen, Xianglei. *STEM Attrition: College Students' Paths into and out of STEM Fields*. NCES 2014-001. National Center for Education Statistics, 2013. https://nces.ed.gov/pubs2014/2014001rev.pdf.

ChinaPower Project. "Is China a Global Leader in Research and Development?" Center for Strategic and International Studies, January 31, 2018, updated January 28, 2021. https://chinapower.csis.org/china-research-and-development-rnd/.

CHIPS and Science Act of 2022, Pub. L. No. 117-167, 136 Stat. 1366 (2022). https://www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf.

Clarivate Analytics. "Highly Cited Researchers 2025 Analysis." Clarivate Analytics, 2025. https://clarivate.com/highly-cited-researchers/analysis/.

Clarivate Analytics. "Highly Cited Researchers, Past Lists." Clarivate Analytics, 2014–2025. https://clarivate.com/highly-cited-researchers/past-lists/.

Clarivate Analytics. Web of Science. "Highly Cited Papers in Emerging Technologies." Clarivate Analytics. https://www.webofscience.com/.

Cohen, Jeremy, Jennifer Causey, Bea Randolph, Matthew Holsapple, and Doug Shapiro. Some College, No Credential Student Outcomes: Annual Progress Report — Academic Year 2023/24. National Student Clearinghouse Research Center, June 2025. https://nscresearchcenter.org/some-college-no-credential/.

Coleman, James, Ernest Campbell, Carol Hobson, James McPartland, Alexander Mood, Frederic Weinfeld, et al. *Equality of Educational Opportunity*. US Government Printing Office, 1966. https://eric.ed.gov/?id=ED012275.

Commission on the Abraham Lincoln Study Abroad Fellowship Program. *Global Competence and National Needs: One Million Americans Studying Abroad*. Abraham Lincoln Commission, 2005. https://www.aplu.org/wp-content/uploads/global-competence-and-national-needs-one-million-americans-studying-abroad.pdf.

Communist Party of China Central Organization Department. "Detailed Rules for the 'Thousand Talents Program' High-Level Foreign Expert Project." 2011. Trans. Etcetera Language Group and Ben Murphy. Center for Security and Emerging Technology, 2020. https://cset.georgetown.edu/publication/detailed-rules-for-the-thousand-talents-program-high-level-foreign-expert-project/.

Congressional Research Service. *National Institutes of Health (NIH) Funding: FY1996–FY2026*, CRS Report R43341. Congressional Research Service, 2026. https://www.congress.gov/crs-product/R43341.

Diamond, Larry, and Orville Schell, eds. *China's Influence & American Interests: Promoting Constructive Vigilance*. Hoover Institution Press, 2019.

Dworsky Law Firm. "The New H-1B Lottery: How the Wage-Weighted System Changes Your Chances for FY 2027." Dworsky Law Firm, 2026. https://dworskylaw.com/blog/the-new-h-1b-lottery-how-the-wage-weighted-system-changes-your-chances-for-fy-2027/.

Eberstadt, Nicholas, and Evan Abramsky. "America's Education Crisis Is a National Security Threat: A Smarter World Is Changing the Balance of Power." *Foreign Affairs*, April 28, 2022. https://www.foreignaffairs.com/world/america-education-crisis-national-security-threat.

Ellis, Jessica, Bailey Fosdick, and Chris Rasmussen. "Women 1.5 Times More Likely to Leave STEM Pipeline After Calculus Compared to Men: Lack of Mathematical Confidence a Potential Culprit." *PLOS ONE* 11, no. 7 (2016): e0157447. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157447.

Exec. Order No. 13788. 3 C.F.R. 370 (2018). Reprinted in 82 Fed. Reg. 18837 (April 21, 2017). https://www.federalregister.gov/documents/2017/04/21/2017-08311/buy-american-and-hire-american.

Finn, Michael G. *Stay Rates of Foreign Doctorate Recipients from US Universities*. Biennial series. Oak Ridge Institute for Science and Education, 2014. https://doi.org/10.2172/1303351.

Flattau, Pamela Ebert, Jerome Bracken, Richard H. Van Atta, Ayeh Bandeh-Ahmadi, Rodolfo de la Cruz, and Kay Sullivan. The National Defense Education Act of 1958: Selected Outcomes. IDA Document D-3306. Institute for Defense Analyses, Science and Technology Policy Institute, 2005. https://www.ida.org/research-and-publications/publications/all/t/th/the-national-defense-education-act-of-1958-selected-outcomes.

"Forbes AI 50," data for 2019–2025. Individual lists: Jillian D'Onfro (2019), Alan Ohnsman (2020, 2021), Helen A. S. Popkin (2022), Konstantine Buhler (2023), Kenrick Cai (2024), and Rashi Shrivastava (2025). Forbes. https://www.forbes.com/lists/ai50/.

Fulbright Act, ch. 723, Pub. L. No. 79-584, 60 Stat. 754 (1946) (amending the Surplus Property Act of 1944).

Goldin, Claudia, and Lawrence F. Katz. The Race Between Education and Technology. Belknap Press of Harvard University Press, 2008. https://www.nber.org/system/files/working_papers/w12984/w12984.pdf.

Gorokhovskaia, Yana, and Grady Vaughan. "Addressing Transnational Repression on Campuses in the United States." Freedom House, 2024. https://freedomhouse.org/report/transnational-repression/2024/addressing-transnational-repression-campuses-united-states.

Hanushek, Eric A. "Putting Pandemic Learning Loss in Perspective." Education Next 26, no. 2 (2026). https://www.educationnext.org/putting-pandemic-learning-loss-in-perspective-achievement-declines-21st-century-america-naep/.

Harmon, Lindsey. "Career Achievements of the National Defense Education Act (Title IV Fellows), 1959–1973." ERIC ED150929. National Academy of Sciences, 1977. https://files.eric.ed.gov/fulltext/ED150929.pdf.

Harris, Laurie A. The National Science Foundation: An Overview. CRS Report R46753. Congressional Research Service, April 9, 2021. https://www.congress.gov/crs-product/R46753.

Harrity & Harrity. "The 2025 Patent 300® List." Harrity & Harrity, 2026. https://harrityllp.com/patent300/.

Hira, Ronil. Statement Before the US Congress, Senate, Committee on the Judiciary, Subcommittee on Immigration and the National Interest of the Senate. The Impact of High-Skilled Immigration on US Workers, 114th Cong. (2016). https://www.epi.org/files/2016/ron-hira-testimony-022516.pdf.

Horwitz, Nathan. "More Students Are Struggling with Math, Professors Say." Temple News, April 7, 2026. https://temple-news.com/more-students-are-struggling-with-math-professors-say/.

Huang, Futao. "From Expansion to Governance: China's Higher Education at a Strategic Turning Point." International Higher Education, no. 126 (2026). https://doi.org/10.6017/895b9e0d.25b5a5f5.

IEA. "Trends in International Mathematics and Science Study (TIMSS)." Data for 1995–2023. https://www.iea.nl/studies/iea/timss.

Immigration Act of 1990, Pub. L. No. 101-649, 104 Stat. 4978 (1990). https://www.govinfo.gov/content/pkg/STATUTE-104/pdf/STATUTE-104-Pg4978.pdf.

Immigration and Nationality Act Amendments of 1965 (Hart–Celler Act), Pub. L. No. 89-236, 79 Stat. 911 (1965). https://www.govinfo.gov/content/pkg/STATUTE-79/pdf/STATUTE-79-Pg911.pdf.

Immigration and Nationality Act § 203(b), 8 U.S.C. § 1153(b).

Immigration and Nationality Act § 212(e), 8 U.S.C. § 1182(e).

Immigration and Nationality Act, Pub. L. No. 82-414, 66 Stat. 163 (1952). https://www.congress.gov/bill/82nd-congress/house-bill/5678/text.

Immigration, Refugees and Citizenship Canada. "How Express Entry Works." Government of Canada. https://www.canada.ca/en/immigration-refugees-citizenship/services/immigrate-canada/express-entry/works.html.

Improving and Expanding Training Opportunities for F-1 Nonimmigrant Students, 81 Fed. Reg. 13,040 (Mar. 11, 2016) (codified at 8 C.F.R. pts. 214, 274a). https://www.federalregister.gov/documents/2016/03/11/2016-04828/improving-and-expanding-training-opportunities-for-f-1-nonimmigrant-students-with-stem-degrees-and.

Institute of International Education. *Fall 2015 Snapshot Survey of International Student Enrollment*. Institute of International Education, 2015. https://www.iie.org/wp-content/uploads/2023/02/Fall-Enrollment-2015-Report_Final.pdf.

Institute of International Education. "International Students: Academic Level." *Open Doors Report on International Educational Exchange*. Data for 1999/00–2024/25. Institute of International Education, 2025. https://opendoorsdata.org/data/international-students/academic-level/.

Institute of International Education. "International Students: Academic Level and Place of Origin." *Open Doors Report on International Educational Exchange*. Data for 2001/02 - 2024/25. Institute of International Education, 2025. https://opendoorsdata.org/data/international-students/academic-level-and-places-of-origin/.

Institute of International Education. "International Students: All Places of Origin." *Open Doors Report on International Educational Exchange*. Institute of International Education, 2025. https://opendoorsdata.org/data/international-students/all-places-of-origin/.

Institute of International Education. "International Student: Enrollment Trends." Data for 1948/49–2024/25. *Open Doors Report on International Educational Exchange*. Institute of International Education, 2025. https://opendoorsdata.org/data/international-students/enrollment-trends/.

Institute of International Education. "International Students: Fields of Study." *Open Doors Report on International Educational Exchange*. Data for 1998/99–2024/25. Institute of International Education, 2025. https://opendoorsdata.org/data/international-students/fields-of-study/.

Institute of International Education. "International Students: Fields of Study of Students by Place of Origin." Data for 2009/10–2024/25. *Open Doors Report on International Educational Exchange*. Institute of International Education, 2025. https://opendoorsdata.org/data/international-students/fields-of-study-by-place-of-origin/.

Institute of International Education. "US Study Abroad for Academic Credit Trends." Data for 1989/90–2023/24. *Open Doors Report on International Educational Exchange*. Institute of International Education, 2024. https://opendoorsdata.org/data/us-study-abroad/u-s-study-abroad-for-academic-credit-trends/.

Institute of International Education. "US Study Abroad Students: Field of Study." Data for 2000/2001–2022/23. *Open Doors Report on International Educational Exchange*. Institute of International Education, 2024. https://opendoorsdata.org/data/us-study-abroad/fields-of-study/.

Institute of International Education. "US Study Abroad Students: Host Regions." Open Doors Report on International Educational Exchange. Data for 2004/05–2022/23. Institute of International Education, 2024. https://opendoorsdata.org/data/us-study-abroad/host-regions/.

Institute of International Education. Open Doors Report on International Educational Exchange. Institute of International Education, 2024. https://www.iie.org/publications/open-doors-2024/.

Institute of International Education. Open Doors Report on International Educational Exchange. Institute of International Education, 2025. https://www.iie.org/publications/open-doors-2025/.

Intellectual Property Owners Association. "2005 Top 300 Patent Owners." Intellectual Property Owners Association, 2005. https://ipo.org/index.php/2005-top-300-patent-owners/.

Intellectual Property Owners Association. "2015 Top 300 Patent Owners." Intellectual Property Owners Association, 2015. https://ipo.org/index.php/2015-top-300-patent-owners/.

Jia, Ruixue, Gaurav Khanna, Hongbin Li, and Yuli Xu. The Ripple Effects of China's College Expansion on American Universities. NBER Working Paper No. 34391. National Bureau of Economic Research, October 2025. https://doi.org/10.3386/w34391.

Johnston, Emerson and Amy Zegart. A Deep Peek into DeepSeek AI's Talent and Implications for US Innovation. Technology Policy Accelerator, Hoover Institution and the Stanford Institute for Human-Centered Artificial Intelligence, April 2025. https://doi.org/10.64576/9001.

Johnston, Emerson, and Amy Zegart. Update: DeepSeek AI and the Great Talent Competition. Technology Policy Accelerator, Hoover Institution and the Stanford Institute for Human-Centered Artificial Intelligence, June 2026. https://doi.org/10.64576/0626.

Kane, Thomas, Daniel Dewey, Erin Fahle, Sean Reardon, and Douglas Staiger. "From Learning Recession to Learning Recovery: Understanding the Sources of US K–12 Improvement." Center for Education Policy Research at Harvard University and Stanford Graduate School of Education, May 13, 2026. https://educationscorecard.org/wp-content/uploads/2026/05/Education_Scorecard_May_2026_Report.pdf

Kochhar, Rakesh. A Global Middle Class Is More Promise than Reality. Pew Research Center, July 8, 2015. https://www.pewresearch.org/global/2015/07/08/a-global-middle-class-is-more-promise-than-reality/.

Kratsios, Michael. Science: A New Golden Age. White House Office of Science and Technology Policy, 2026. https://www.whitehouse.gov/science/.

Kuehn, Daniel, and Hal Salzman. "The Engineering Labor Market: An Overview of Recent Trends." In US Engineering in a Global Economy, edited by Richard B. Freeman and Hal Salzman. University of Chicago Press, 2018. https://www.nber.org/system/files/chapters/c12684/c12684.pdf.

Lederman, Josh. "US to Shorten Length of Some Visas for Chinese Citizens." Associated Press, May 29, 2018. https://apnews.com/united-states-government-82a98fecee074bfb83731760bfbce515.

Lindquist, Clarence. "NDEA Fellowships for College Teaching, 1958–1968: Title IV, National Defense Education Act of 1958. (ERIC ED054739)." US Department of Health, Education, and Welfare, Office of Education, 1971. https://eric.ed.gov/?id=ED054739.

MacroPolo. "The Global AI Talent Tracker 2.0." Paulson Institute. https://archivemacropolo.org/.

Matloff, Norman. "On the Need for Reform of the H-1B Non-Immigrant Work Visa in Computer-Related Occupations." University of Michigan Journal of Law Reform 36, no. 4 (2003): 815–913. https://heather.cs.ucdavis.edu/Mich.pdf.

Miao, Hannah, and Jon Emont. "China's Best and Brightest Tech Talent Is Going Back to China." Wall Street Journal, May 2026. https://www.wsj.com/business/china-silicon-valley-sea-turtles-tech-ai-talent-46385d38.

Ministry of Education of the People's Republic of China. "'211 Project' and '985 Project'" (中华人民共和国教育部). Ministry of Education of the People's Republic of China, 2015. http://www.moe.gov.cn/jyb_xwfb/xw_zt/moe_357/jyzt_2015nztzl/2015_zt15/15zt15_mtbd/201511/t20151106_217950.html.

Ministry of Education of the People's Republic of China. "China to Further Promote the Double First-Class Initiative." Press release. February 16, 2022. http://en.moe.gov.cn/news/press_releases/202203/t20220301_603547.html.

Moonshot AI. "Kimi K3." Model release. 2026. https://platform.kimi.ai/.

Moonshot AI. "Kimi K3: Open Frontier Intelligence." Technical report. 2026. https://arxiv.org/abs/2607.24653.

Mutual Educational and Cultural Exchange Act of 1961 (Fulbright–Hays Act), Pub. L. No. 87-256, 75 Stat. 527 (1961). https://www.congress.gov/bill/87th-congress/house-bill/8666/text.

National Bureau of Statistics of China. "China's Expenditure on Research and Experimental Development (R&D) Exceeded 3.6 Trillion Yuan in 2024." February 7, 2025. https://www.stats.gov.cn/english/PressRelease/202502/t20250207_1958579.html.

National Center for Education Statistics. "1996/01 Beginning Postsecondary Students Longitudinal Study (BPS:96/01)." US Department of Education, Office of Educational Research and Improvement, 2002. https://nces.ed.gov/pubs2002/2002171.pdf.

National Center for Education Statistics. "2004/09 Beginning Postsecondary Students Longitudinal Study (BPS:04/09)." US Department of Education, Institute of Education Sciences, 2009. https://nces.ed.gov/pubs2009/200901.pdf.

National Center for Education Statistics. "2012-2017 Beginning Postsecondary Students Longitudinal Study (BPS:12/17)." US Department of Education, Institute of Education Sciences, 2019. https://nces.ed.gov/surveys/bps/.

National Center for Education Statistics. Common Core of Data. National Public Education Financial Survey. Data for 2010–2021. US Department of Education, Institute of Education Sciences. https://nces.ed.gov/ccd/files.asp.

National Center for Education Statistics. Digest of Education Statistics. US Department of Education, Institute of Education Sciences. https://nces.ed.gov/programs/digest.

National Center for Education Statistics. "Integrated Postsecondary Education Data System (IPEDS)." Data from completions component, 1995–2025. US Department of Education, Institute of Education Sciences. https://nces.ed.gov/ipeds/datacenter/DataFiles.aspx.

National Center for Education Statistics. "Mathematics Literacy: Average Scores." In Program for International Student Assessment (PISA): 2015 Results. US Department of Education, Institute of Education Sciences, 2015. https://nces.ed.gov/surveys/pisa/pisa2015/pisa2015highlights_5.asp.

National Center for Education Statistics. "The National Assessment of Educational Progress (NAEP)." US Department of Education, Institute of Education Sciences. https://nces.ed.gov/nationsreportcard/.

National Center for Education Statistics. "National Postsecondary Student Aid Study (NPSAS:20) 2019–20." US Department of Education, Institute of Education Sciences, 2023. https://nces.ed.gov/surveys/npsas/.

National Center for Education Statistics. "Public School Revenue Sources." In Report on the Condition of Education 2024. NCES 2024-144. US Department of Education, Institute of Education Sciences, 2024. https://nces.ed.gov/programs/coe/pdf/2024/cma_508c.pdf.

National Center for Education Statistics. "Table 236.55. Total and Current Expenditures per Pupil in Fall Enrollment in Public Elementary and Secondary Schools, by Function and State or Jurisdiction: Selected Years, 1969–70 through 2016–17." Digest of Education Statistics 2019. US Department of Education, Institute of Education Sciences, 2021. https://nces.ed.gov/programs/digest/d19/tables/dt19_236.55.asp.

National Center for Education Statistics. "Table 318.10. Degrees Conferred by Postsecondary Institutions, by Level of Degree and Sex of Student: Selected Years, 1869–70 through 2031–32." Digest of Education Statistics. US Department of Education, Institute of Education Sciences, 2023. https://nces.ed.gov/programs/digest/d23/tables/dt23_318.10.asp.

National Center for Science and Engineering Statistics. "Foreign-Born STEM Workers." In The STEM Labor Force: Scientists, Engineers, and Skilled Technical Workers. Science and Engineering Indicators. NSB-2024-5. National Science Foundation, 2024. https://ncses.nsf.gov/pubs/nsb20245/foreign-born-stem-workers.

National Center for Science and Engineering Statistics. "National Survey of College Graduates Data Tables." National Science Foundation, 2023. https://ncses.nsf.gov/surveys/national-survey-college-graduates.

National Center for Science and Engineering Statistics. "Survey of Earned Doctorates." Data for 1995–2024. National Science Foundation, 2026. https://ncses.nsf.gov/surveys/earned-doctorates.

National Center for Science and Engineering Statistics. "Survey of Earned Doctorates Data Tables." Data for 2010–2024. National Center for Science and Engineering Statistics, National Science Foundation, 2024. https://ncses.nsf.gov/surveys/earned-doctorates.

National Center for Science and Engineering Statistics. "Survey of Earned Doctorates, Doctorate Recipients from US Universities: 2024 Data Tables." National Science Foundation, 2024. https://ncses.nsf.gov/surveys/earned-doctorates/.

National Center for Science and Engineering Statistics. "Survey of Graduate Students and Postdoctorates in Science and Engineering Data Tables." Data for 1994–2025. National Center for Science and Engineering Statistics, National Science Foundation, 2024. https://ncses.nsf.gov/surveys/graduate-students-postdoctorates-s-e/2024.

National Center for Science and Engineering Statistics. "Survey of Postdocs at Federally Funded R&D Centers Data Tables." Data for 2010–2023. National Center for Science and Engineering Statistics, National Science Foundation, 2023. https://ncses.nsf.gov/surveys/ffrdc-postdocs.

National Commission on Excellence in Education. A Nation at Risk: The Imperative for Educational Reform. US Government Printing Office, 1983. https://e4e.org/sites/default/files/a_nation_at_risk_1983.pdf.

National Defense Education Act of 1958, Pub. L. No. 85-864, title III, 72 Stat. 1580, 1588–90, https://www.govinfo.gov/content/pkg/STATUTE-72/pdf/STATUTE-72-Pg1580.pdf.

National Examination Board (Nepal). "Secondary Education Examination (SEE) Results 2080 BS (2024)." Sanothimi, Bhaktapur: National Examination Board, June 2024. https://edusanjal.com/news/see-result-2080-published/.

National Foundation for American Policy. "H-1B Approved Petitions and Denial Rate for FY 2019." NFAP Policy Brief, February 2020. https://nfap.com/wp-content/uploads/2020/02/H-1B-Denial-Rates-Analysis-of-FY-2019-Numbers.NFAP-Policy-Brief.February-2020-1.pdf.

National Science Board. "Cross-National Comparisons of R&D Performance." Research and Development: US Trends and International Comparisons. NSB-2024-6. Science and Engineering Indicators 2024. National Science Foundation, 2024. https://ncses.nsf.gov/pubs/nsb20246/cross-national-comparisons-of-r-d-performance.

National Science Board. "Higher Education in Science and Engineering." NSB-2023-32. Science and Engineering Indicators 2023. National Science Foundation, 2023. https://ncses.nsf.gov/pubs/nsb202332/.

National Science Board. "International Comparisons of S&E Higher Education." In "Higher Education in Science and Engineering." NSB-2023-32. Science and Engineering Indicators 2023, National Science Foundation, 2023. https://ncses.nsf.gov/pubs/nsb202332/international-comparisons-of-s-e-higher-education.

National Science Board. "Publications Output: US Trends and International Comparisons." Science and Engineering Indicators 2020. NSB-2020-6. National Science Foundation, 2019. https://ncses.nsf.gov/pubs/nsb20206/.

National Science Board. "Publications Output: US Trends and International Comparisons." Science and Engineering Indicators 2024, NSB-2023-33. (National Science Foundation, December 2023). https://ncses.nsf.gov/pubs/nsb202333/.

National Science Board. Science and Engineering Indicators. Biennial series. National Science Foundation. https://ncses.nsf.gov/indicators.

National Science Board. "STEM Talent: Education, Training, and Workforce." Science and Engineering Indicators 2026. NSB-2026-1. National Science Foundation, 2026. https://ncses.nsf.gov/pubs/nsb20261/.

National Science Foundation. "NSF Graduate Research Fellowship Program Solicitation" (NSF 25-547). National Science Foundation, 2025. https://www.nsf.gov/funding/opportunities/grfp-nsf-graduate-research-fellowship-program/nsf25-547/solicitation.

Ngai, Mae M. Impossible Subjects: Illegal Aliens and the Making of Modern America. Princeton University Press, 2004. https://press.princeton.edu/books/paperback/9780691160825/impossible-subjects.

Nuñez, Michael. "China's Moonshot AI Releases Kimi K3, the Largest Open-Source Model Ever, Rivaling Top US Systems." VentureBeat, July 16, 2026. https://venturebeat.com/technology/chinas-moonshot-ai-releases-kimi-k3-the-largest-open-source-model-ever-rivaling-top-u-s-systems.

Office of the United States Trade Representative. Findings of the Investigation into China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation Under Section 301 of the Trade Act of 1974. Executive Office of the President, 2018. https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF.

OpenAlex API. https://openalex.org.

Opportunity Card (Chancenkarte) established under Residence Act §§ 20a–20b (Federal Law Gazette 2024 1 No. 152), effective June 1, 2024. https://www.gesetze-im-internet.de/englisch_aufenthg/englisch_aufenthg.html.

Organisation for Economic Co-operation and Development. Education at a Glance 2025: OECD Indicators. OECD Publishing, 2025. https://doi.org/10.1787/1c0d9c79-en.

Organisation for Economic Co-operation and Development. International Migration Outlook 2025. OECD Publishing, 2025. https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/11/international-migration-outlook-2025_355ae9fd/ae26c893-en.pdf.

Organisation for Economic Co-operation and Development (OECD). "Main Science and Technology Indicators (MSTI) Database." Data for 1991–2024. OECD Data Explorer. http://data-explorer.oecd.org/.

Organisation for Economic Co-operation and Development. Programme for International Student Assessment (PISA): 2022 Results. 5 vols. OECD Publishing, 2023. https://www.oecd.org/en/about/programmes/pisa.html.

Organisation for Economic Co-operation and Development. Technical Report. OECD Publishing, 2024. https://www.oecd.org/en/publications/pisa-2022-technical-report_01820d6d-en.html.

Paper Copilot. "Accepted Papers and Submissions Statistics." 2026. https://papercopilot.com/.

Patent and Trademark Law Amendment Act (Bayh-Dole Act). Pub. L. No. 96-517, 94 Stat. 3015 (1980). https://www.govinfo.gov/content/pkg/STATUTE-94/pdf/STATUTE-94-Pg3015.pdf.

Phillips, Christopher J. The New Math: A Political History. University of Chicago Press, 2014. https://press.uchicago.edu/ucp/books/book/chicago/N/bo18991075.html.

PitchBook Data. 2026. https://pitchbook.com.

Priem, Jason, Heather Piwowar, and Richard Orr. "OpenAlex: A Fully-Open Index of Scholarly Works, Authors, Venues, Institutions, and Concepts." arXiv preprint arXiv:2205.01833, May 2022. https://doi.org/10.48550/arXiv.2205.01833.

Proclamation No. 10043. "Suspension of Entry as Nonimmigrants of Certain Students and Researchers from the People's Republic of China." 85 Fed. Reg. 34353 (June 4, 2020). https://www.federalregister.gov/documents/2020/06/04/2020-12217/suspension-of-entry-as-nonimmigrants-of-certain-students-and-researchers-from-the-peoples-republic.

Redden, Elizabeth. "Chinese Officials Warn Students of Visa Problems If They Come to US." Inside Higher Ed, June 3, 2019. https://www.insidehighered.com/news/2019/06/04/chinese-officials-warn-students-visa-problems-if-they-come-us.

Schoenfeld, Alan H. "The Math Wars." Educational Policy 18, no. 1 (2004): 253–86. https://eric.ed.gov/?id=EJ690082.

Senate-Administration Workgroup on Admissions. Final Report. UC San Diego Academic Senate, updated January 8, 2026. https://senate.ucsd.edu/media/740347/sawg-report-on-admissions-review-docs.pdf.

Seymour, Elaine, and Anne-Barrie Hunter, eds. Talking about Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education. Springer, 2019. https://casa.colorado.edu/~dduncan/wp-content/uploads/2019_Book_TalkingAboutLeavingRevisited.pdf.

Seymour, Elaine, and Nancy M. Hewitt. Talking about Leaving: Why Undergraduates Leave the Sciences. Westview Press, 1997. https://sites.lsa.umich.edu/math-lcit/wp-content/uploads/sites/1398/2025/04/talkingAboutLeavingSeymourHewittOverview.pdf.

Sheehan, Matt, and Sophie Zhuang. "Have Top Chinese AI Researchers Stayed in the United States?" Emissary (blog). Carnegie Endowment for International Peace, December 2025. https://carnegieendowment.org/emissary/2025/12/china-ai-researchers-us-talent-pool.

Shi, Dongbo, Weichen Liu, and Yanbo Wang. "Has China's Young Thousand Talents Program Been Successful in Recruiting and Nurturing Top-Caliber Scientists?" Science 379, no. 6627 (2023): 62–65. https://doi.org/10.1126/science.abq1218.

Shu, Fei, Cassidy Sugimoto, and Vincent Larivière. "The Institutionalized Stratification of the Chinese Higher Education System." Quantitative Science Studies 2, no. 1 (2021): 327–44. https://doi.org/10.1162/qss_a_00104.

Skilled Immigration Act (Fachkräfteeinwanderungsgesetz), Federal Law Gazette BGBl. 2023 I No. 217 (promulgated August 18, 2023).

Sokol, Marlene. "Foreign Students Face Money Woes as Their Nations' Currencies Suffer." Washington Post, May 11, 1983. https://www.washingtonpost.com/archive/local/1983/05/11/foreign-students-face-money-woes-as-their-nations-currencies-suffer/86572d1f-5096-45ba-bd4d-71e82b4e774a/.

Stankova, Zvezdelina, Mina Aganagic, John Lott, Svetlana Jitomirskaya, and Chris Hoofnagle. "Relationship Between Prerequisite Mastery and Failure/Attrition Rates in Calculus I at UC Berkeley: Fall 2021, 2022, 2023." Accessed July 29, 2026. https://drive.google.com/file/d/1LnxJlOqUUUS7VVDs5Vzo1PKTuDPVOXia/view.

Tedjasaputra, Vincent. "NSF 101: The Graduate Research Fellowship Program." National Science Foundation, 2021. https://www.nsf.gov/science-matters/nsf-101-graduate-research-fellowship-program.

Teitelbaum, Michael. Falling Behind? Boom, Bust, and the Global Race for Scientific Talent. Princeton University Press, 2014.

Teitelbaum, Michael. "The Myth of the Science and Engineering Shortage." Atlantic, March 19, 2014. https://www.theatlantic.com/education/archive/2014/03/the-myth-of-the-science-and-engineering-shortage/284359/.

Thurgood, Lori, Mary J. Golladay, and Susan T. Hill. US Doctorates in the 20th Century. NSF 06-319. National Science Foundation, 2006. https://www.nsf.gov/statistics/nsf06319/.

Times Higher Education. "World University Rankings by Subject." Times Higher Education [THE]. Data for 2011–2026. https://www.timeshighereducation.com/world-university-rankings/by-subject.

Tolley, William P. "Report of the Commission on Academic Freedom and Academic Tenure." Association of American Colleges Bulletin 32, no. 1 (March 1946). https://archive.org/details/sim_liberal-education_1946-03_32_1/page/95.

Trump, Donald J. "Restriction on Entry of Certain Nonimmigrant Workers." Proclamation. White House, September 19, 2025. https://www.whitehouse.gov/presidential-actions/2025/09/restriction-on-entry-of-certain-nonimmigrant-workers/.

UK Home Office. "Apply for the Global Talent Visa." GOV.UK. https://www.gov.uk/global-talent.

UNESCO Institute for Statistics. "Net Flow of Internationally Mobile Students (Inbound – Outbound), Both Sexes (UIS Estimate) (Number)." UNESCO Institute for Statistics Database (UIS.Stat), 2026. https://data.uis.unesco.org/.

UNESCO Institute for Statistics. "Total Outbound Internationally Mobile Tertiary Students Studying Abroad." UNESCO Institute for Statistics Database (UIS.Stat), 2026. https://data.uis.unesco.org/.

United Nations, Department of Economic and Social Affairs. "Population Division, World Population Prospects 2024." Online Edition. United Nations, 2024. https://population.un.org/wpp/.

University of California, Board of Regents. "Regents Policy 2109: Policy on Nonresident Student Enrollment." University of California, adopted May 18, 2017. https://regents.universityofcalifornia.edu/governance/policies/2109.html.

University of Delaware Institute for Global Studies. "Our Study Abroad History." University of Delaware. https://www.udel.edu/academics/global/study-abroad/history/.

University of North Carolina System, Board of Governors. "Policy on Nonresident Undergraduate Enrollment," effective fall 2025. University of North Carolina, updated 2026. https://www.northcarolina.edu/apps/policy/doc.php?id=789.

US Bureau of Economic Analysis. "Table 2.1. US Trade in Services, by Type of Service." International Transactions, International Services, and International Investment Position Tables. July 3, 2025. https://apps.bea.gov/iTable/.

US Bureau of Industry and Security. "Implementation of Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items; Supercomputer and Semiconductor End Use: Entity List Modification." 87 Fed. Reg. 62186 (October 13, 2022). https://www.federalregister.gov/documents/2022/10/13/2022-21658/implementation-of-additional-export-controls-certain-advanced-computing-and-semiconductor.

US Bureau of Labor Statistics. "Foreign-Born Workers: Labor Force Characteristics — 2025." News release USDL-26-0760. May 19, 2026. https://www.bls.gov/news.release/pdf/forbrn.pdf.

US Census Bureau. "American Community Survey, 2024 1-Year Estimates, table B05001 (Nativity and Citizenship Status in the United States)." 2024. https://data.census.gov.

US Census Bureau. "American Community Survey, 2024 1-Year Estimates, table S0501 (Selected Characteristics of the Native and Foreign-Born Populations)." 2024. https://data.census.gov.

US Citizenship and Immigration Services. "Chapter 1 — Purpose and Background." USCIS Policy Manual, vol. 2, pt. D. https://www.uscis.gov/policy-manual/volume-2-part-d-chapter-1.

US Citizenship and Immigration Services. Characteristics of H-1B Specialty Occupation Workers: Fiscal Year 2024 Annual Report to Congress. 2025. https://www.uscis.gov/sites/default/files/document/reports/ola_signed_h1b_characteristics_congressional_report_FY24.pdf.

US Citizenship and Immigration Services. "DHS Changes Process for Awarding H-1B Work Visas to Better Protect American Workers." News release. December 23, 2025. https://www.uscis.gov/newsroom/news-releases/dhs-changes-process-for-awarding-h-1b-work-visas-to-better-protect-american-workers.

US Citizenship and Immigration Services. "Form I-765. Application for Employment Authorization: All Receipts, Approvals, Denials Grouped by Eligibility Category and Filing Type FY2003–2021." Immigration and Citizenship Data Hub. 2021. https://www.uscis.gov/sites/default/files/document/data/I-765_Application_for_Employment_FY03-21.pdf.

US Citizenship and Immigration Services. "Form I-765, Application for Employment Authorization: All Receipts, Approvals, Denials Grouped by Eligibility Category and Filing Type FY2022." Immigration and Citizenship Data Hub. 2022. https://web.archive.org/web/20250202082421/https://www.uscis.gov/sites/default/files/document/data/I-765_Application_for_Employment_FY22.pdf.

US Citizenship and Immigration Services. "Form I-765, Application for Employment Authorization: All Receipts, Approvals, Denials Grouped by Eligibility Category and Filing Type FY2023." Immigration and Citizenship Data Hub. 2023 https://web.archive.org/web/20250211085540/https://www.uscis.gov/sites/default/files/document/data/I-765_Application_for_Employment_FY23.pdf.

US Citizenship and Immigration Services. "Form I-765, Application for Employment Authorization, Eligibility Category and Filing Type Fiscal year 2024, Q4." (XLSX). Immigration and Citizenship Data Hub 2024. https://www.uscis.gov/sites/default/files/document/data/i765_application_for_employment_fy24.xlsx.

US Citizenship and Immigration Services. "Form I-765, Application for Employment Authorization, Eligibility Category and Filing Type Fiscal year 2025, Q4." (XLSX). Immigration and Citizenship Data Hub. 2025. https://www.uscis.gov/sites/default/files/document/data/i765_application_for_employment_fy2025_q4_v1.xlsx.

US Citizenship and Immigration Services. "H-1B Cap Season." https://www.uscis.gov/working-in-the-united-states/temporary-workers/h-1b-specialty-occupations/h-1b-cap-season.

US Citizenship and Immigration Services. "H-1B Electronic Registration Process." https://www.uscis.gov/working-in-the-united-states/temporary-workers/h-1b-specialty-occupations/h-1b-electronic-registration-process.

US Citizenship and Immigration Services. H-1B Employer Data Hub. Data for 2009–2026. https://www.uscis.gov/tools/reports-and-studies/h-1b-employer-data-hub.

US Citizenship and Immigration Services. "Optional Practical Training (OPT) for F-1 Students." https://www.uscis.gov/working-in-the-united-states/students-and-exchange-visitors/optional-practical-training-opt-for-f-1-students.

US Citizenship and Immigration Services. "Practical Training." Policy Manual. Vol. 2, part F, chapter 5. https://www.uscis.gov/policy-manual/volume-2-part-f-chapter-5.

US Citizenship and Immigration Services. "Students and Employment." https://www.uscis.gov/working-in-the-united-states/students-and-exchange-visitors/students-and-employment.

US Citizenship and Immigration Services. "USCIS Strengthens Protections to Combat H-1B Abuses." News release. April 3, 2017, archived July 2024. https://www.uscis.gov/archive/uscis-strengthens-protections-to-combat-h-1b-abuses.

US Congress, House, Committee on Small Business, Subcommittee on Contracting and Workforce. Help Wanted: The Small Business STEM Workforce Shortage and Immigration Reform. 113th Cong., 1st sess., April 25, 2013. Small Business Committee Document No. 113-014. US Government Printing Office, 2013. https://www.congress.gov/event/113th-congress/house-event/LC631/text.

US Department of Homeland Security. "Weighted Selection Process for Registrants and Petitioners Seeking to File Cap-Subject H-1B Petitions." 90 Fed. Reg. 60864, (December 29, 2025). https://www.federalregister.gov/documents/2025/12/29/2025-23853/weighted-selection-process-for-registrants-and-petitioners-seeking-to-file-cap-subject-h-1b.

US Department of Homeland Security, "Student and Exchange Visitor Information System (SEVIS)." https://studyinthestates.dhs.gov/sevis-help-hub.

US Department of Labor, Employment and Training Administration. "Permanent Labor Certification (PERM)." Foreign Labor Application Gateway (FLAG). https://flag.dol.gov/programs/perm.

US Department of Labor. "Foreign Labor Certification Performance Data." Data for 2008–2025. https://www.dol.gov/agencies/eta/foreign-labor/performance.

US Department of State, Bureau of Consular Affairs. "Final Action Dates for Employment-Based Preference Cases." Visa Bulletin 15, no. 9 (June 2026). https://travel.state.gov/content/travel/en/legal/visa-law0/visa-bulletin/2026/visa-bulletin-for-june-2026.html.

US Department of State, Bureau of Consular Affairs. "Table XVI: Nonimmigrant Visas Issued by Classification and Nationality (Including Border Crossing Cards), Fiscal Year 2024." Report of the Visa Office. 2024. https://travel.state.gov/content/dam/visas/Statistics/AnnualReports/FY2024AnnualReport/Table%20XVI.pdf.

US Department of State, Bureau of Consular Affairs. "Table XVII: Nonimmigrant Visas Issued by Classification and Nationality, Fiscal Year 2019." Report of the Visa Office. 2019. https://travel.state.gov/content/dam/visas/Statistics/AnnualReports/FY2019AnnualReport/FY19AnnualReport-TableXVII.pdf.

US Department of State, Bureau of Consular Affairs. Visa Bulletin. US Department of State, 2002–2026. https://travel.state.gov/content/travel/en/legal/visa-law0/visa-bulletin.html.

US Department of State, Bureau of Educational and Cultural Affairs. "The Fulbright Program." https://www.state.gov/the-fulbright-program.

US Department of State. "Facts and Figures 2015–2025." BridgeUSA. 2024. https://j1visa.state.gov/facts-and-figures-2015-2025/.

US Information and Educational Exchange Act of 1948 (Smith–Mundt Act), Pub. L. 80–402 62 Stat. 6 (codified at 22 U.S.C. ch. 18 §1431 et seq.).

US Senate Permanent Subcommittee on Investigations. Threats to the US Research Enterprise: China's Talent Recruitment Plans. Majority and Minority Staff Report. Government Printing Office, 2019. https://www.hsgac.senate.gov/subcommittees/investigations/library/files/majority-and-minority-staff-report_-threats-to-the-us-research-enterprise-chinas-talent-recruitment-plans/.

US Senate. “Sputnik Spurs Passage of National Defense Education Act.” United States Senate, Senate Historical Office. https://www.senate.gov/artandhistory/history/minute/Sputnik_Spurs_Passage_of_National_Defense_Education_Act.htm.

US Patent and Trademark Office. PatentsView database. https://www.uspto.gov/ip-policy/economic-research/patentsview.

Wagner, Caroline, Lutz Bornmann, and Loet Leydesdorff. “Recent Developments in China-US Cooperation in Science.” Minerva 53, no. 3 (2015): 199–214. https://doi.org/10.1007/s11024-015-9273-6.

Washington Alliance of Technology Workers v. U.S. Department of Homeland Security. 50 F.4th 164 (D.C. Cir. 2022). Cert. denied, No. 22-1071 (U.S. Oct. 2, 2023). https://www.courtlistener.com/opinion/8246336/wa-alliance-of-tech-workers-v-dhs/.

Wight, David M. “The Petrodollar Era and Relations Between the US and the Middle East and North Africa, 1969–1980.” PhD diss., University of California, Irvine, 2014. https://escholarship.org/content/qt9m52q2hk/qt9m52q2hk.pdf.

World Intellectual Property Organization. WIPO Statistics Data Center. https://www.wipo.int/en/web/ip-statistics.

World Intellectual Property Organization. “Patents Granted by Technology (Indicator 5).” WIPO IP Statistics Data Center, 2024. https://www3.wipo.int/ipstats.

Wray, Christopher A. Opening Remarks at the Department of Justice China Initiative Conference, February 6, 2020. Center for Strategic and International Studies, 2020. https://www.csis.org/analysis/fbi-director-christopher-wrays-opening-remarks-china-initiative-conference.

Wray, Christopher A. Testimony Before the US Congress, Senate, Committee on the Judiciary, Oversight of the Federal Bureau of Investigation. 116th Cong., 1st sess., July 23, 2019. https://www.judiciary.senate.gov/imo/media/doc/Wray%20Testimony1.pdf.

Wray, Christopher A. Testimony Before the US Congress, Senate, Select Committee on Intelligence, Open Hearing on Worldwide Threats. 115th Cong., 2nd sess., February 13, 2018. https://www.intelligence.senate.gov/hearings/open-hearing-worldwide-threats-0.

Wyckoff, James. “Puzzling Over Declining Academic Achievement.” EdWorkingPaper No. 25-1197. Annenberg Institute at Brown University, 2025. https://edworkingpapers.com/policy-practice-series/ai25-1197.

Zegart, Amy. “The Crumbling Foundations of American Strength: Knowledge Is Power—and the United States Is Losing It.” Foreign Affairs, August 20, 2024. https://www.foreignaffairs.com/united-states/crumbling-foundations-american-strength-amy-zegart.

Zwetsloot, Remco, James Dunham, Zachary Arnold, and Tina Huang. Keeping Top AI Talent in the United States. Center for Security and Emerging Technology, 2019. https://cset.georgetown.edu/wp-content/uploads/Keeping-Top-AI-Talent-in-the-United-States.pdf.