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Evolutions of the U.S. Research Enterprise: Origins, Trends, and Future Directions

Dr. Quincy Quick *	Tennessee State University, Nashville, Tennessee, USA 0009-0001-3052-9672	qquick1@tnstate.edu
Dr. Xiaofei Wang	Tennessee State University, Nashville, Tennessee, USA 0000-0003-3832-5217	xwang@Tnstate.edu
Dr. Kimberley Sudler	Delaware State University, Dover, Delaware, USA 0009-0002-9946-9097	krsudler@desu.edu
Dr. Melissa Harrington	Delaware State University, Dover, Delaware, USA 0000-0002-6159-4477	mharrington@desu.edu
Dr. Neelam Azad	Hampton University, Hampton, Virginia, USA 0000-0001-6970-5867	neelam.azad@hamptonu.edu
Dr. Yalan Ning	Huston-Tillotson University, Austin, Texas, USA 0000-0001-9697-1650	yning@htu.edu
Dr. John Solomon	Tuskegee University, Tuskegee, Alabama, USA 0000-0003-3042-2071	jsolomon@tuskegee.edu
Dr. Jason Ikpatt	Huston-Tillotson University, Austin, Texas, USA 0009-0001-3864-9556	jeikpatt@htu.edu

* Corresponding author

Abstract

What is new?

This paper addresses the critical challenge of sustaining research innovation and productivity during periods of instability in federal funding by examining long-term U.S. research funding trends and behaviors. It is original in its

	integrated analysis of federal, industry, state, and philanthropic funding dynamics as a unified strategy for institutional resilience.
What was the approach?	The study employed a scholarly and policy literature review combined with secondary data analysis. It synthesized historical U.S. research funding trends using data from the National Center for Science and Engineering Statistics (NCSES), alongside. The analysis incorporated quantitative funding metrics and qualitative assessments across federal, industry, state, and philanthropic sectors to evaluate shifts in research investment patterns and ecosystem behavior.
What is the academic impact?	The findings demonstrate that while federal funding has historically underpinned the U.S. research enterprise, it is increasingly unstable and complemented by growing industry dominance and strategic philanthropic investment. Importantly, the study shows that research expenditures remain relatively stable despite federal budget fluctuations due to lag effects, institutional buffering, and diversified funding streams.
What is the wider impact?	This study is essential in assisting researchers and research administrators with understanding how to maintain research innovation and productivity during unstable periods of government funding by providing historic research funding trends and funding behaviors. Additionally, this review contributes to the field of Research Management and Administration by: • Providing a systems-level framework for understanding multi-sector research funding dynamics • Demonstrating the resilience mechanisms within the U.S. research ecosystem • Reframing funding diversification as a strategic necessity rather than an option • Offering evidence-based insight into how funding shifts toward applied and translational research are reshaping institutional strategies
Keywords	U.S. Federal Funding Trends, Research Funding Diversification, Public-Private Research Partnerships

Introduction

The inception of the United States research ecosystem occurred in the middle of the 20th century. Its development reflects a dynamic interplay between national priorities, public investment, private-sector engagement, and philanthropic support to improve the health, welfare, and protection of its citizens. To this end, early support and growth of the U.S. research enterprise was provided by the United States government and its supporting agencies to support academic and government research. In the 1980s, the enterprise expanded to commercialization and collaboration among government, industry, and academia leading to a research ecosystem where private investment now accounts for nearly three-quarters of total U.S. Research and Development (R&D) spending. Complementing federal and corporate investments, state governments and philanthropic foundations have become vital contributors to the research landscape. State agencies often align funding with regional economic priorities, while foundations provide flexible, high-risk capital that fosters innovation and interdisciplinarity—though often concentrated within elite institutions. Together, these forces have shaped a resilient and multi-tiered research ecosystem that balances discovery and application.

Moving forward, sustaining U.S. leadership in science and technology will require stabilizing federal funding, strengthening basic research capacity across diverse institutions, and enhancing linkages among public, private, and philanthropic sectors to ensure that research continues to drive inclusive innovation and societal advancement. The premise of this discussion is that although federal funding has been foundational and supportive, it is essential that strategic research funding approaches across the U.S. integrate corporate industry and philanthropic support to ensure institutional productivity and survival.

Origins and Funding Trends of U.S. Federal Research Agencies

Given the current federal research climate and realignment of national research priorities and funding, a discussion on the evolving research landscape in the United States is warranted. From a historical context, the inception of research in the United States initially evolved to address and meet several national priorities on disease, national security, and overall public welfare, as well as to decrease our dependency on European scientific discovery and innovation (Bush, 2020). The vision and strategy to address and meet these needs were developed and presented in 1945 in Vannevar Bush's report, "Science—The Endless Frontier", to President Roosevelt. This report consequently was the foundation for what we now know to be the National Science Foundation and the establishment and investment of basic research in the U.S. (Bush, 2020). Additionally, Bush's vision solidified the establishment and the role of other agencies in shaping the nation's R&D agenda, such as the National Institutes of Health (NIH), the Office of Naval Research (ONR), and the Atomic Energy Commission.

The United States emerged as a global leader in research and development (R&D) over the latter half of the 20th century, owing largely to transformative federal support. Prior to World War II, the U.S. lagged behind European nations in scientific output and infrastructure. Research was modestly funded by private sources, while federal investment in R&D was minimal and focused mainly on mission-oriented work in agriculture and defense. Furthermore, in the late 20th century, federal R&D policy responded to crises and opportunities related to the space race triggered by Sputnik, as well as environmental and energy challenges of the 1970s. During this time, new agencies and initiatives like NASA, ARPA, and later, the Department of Energy (DOE) were established, while programs such as the Small Business Innovation Research (SBIR) program discussed later, and various university-industry partnerships emerged to stimulate innovation and technology transfer (National Academy of Sciences, 1995). The federal investments in basic research largely at universities and non-profit research institutes led to discoveries that set the stage for a dramatic increase in R&D funded by industry. Federal investments not only advanced knowledge but also supported graduate education and helped launch transformative technologies, many of which stemmed from research whose applications were unforeseen at the time of discovery.

By the 1980s and 90s, concerns over global competitiveness led to stronger government-industry-academic collaborations. In support of this legislative acts such as the Bayh-Dole Act (1980) and the Stevenson-Wydler Technology Innovation Act (1980) incentivized commercialization of federally-funded research and expanded access to federal laboratories that led to Cooperative Research and Development Agreements (CRADAs), which became a key mechanism for public-private collaboration (National Academy of Sciences, 1995). Additionally in the late 1980s, business and the federal government provided about the same amount of R&D funding. However, in the 1990s R&D spending by businesses increased rapidly, and by 2022 about 76% of U.S. R&D spending came from businesses (Figure 1). Contrary to this, R&D spending by business has decreased from the previous year only twice since 1976, from 2001 to 2002 after the 9/11 attacks and from 2008 to 2009 during the Great Recession (National Center for Science and Engineering Statistics, 2024b).

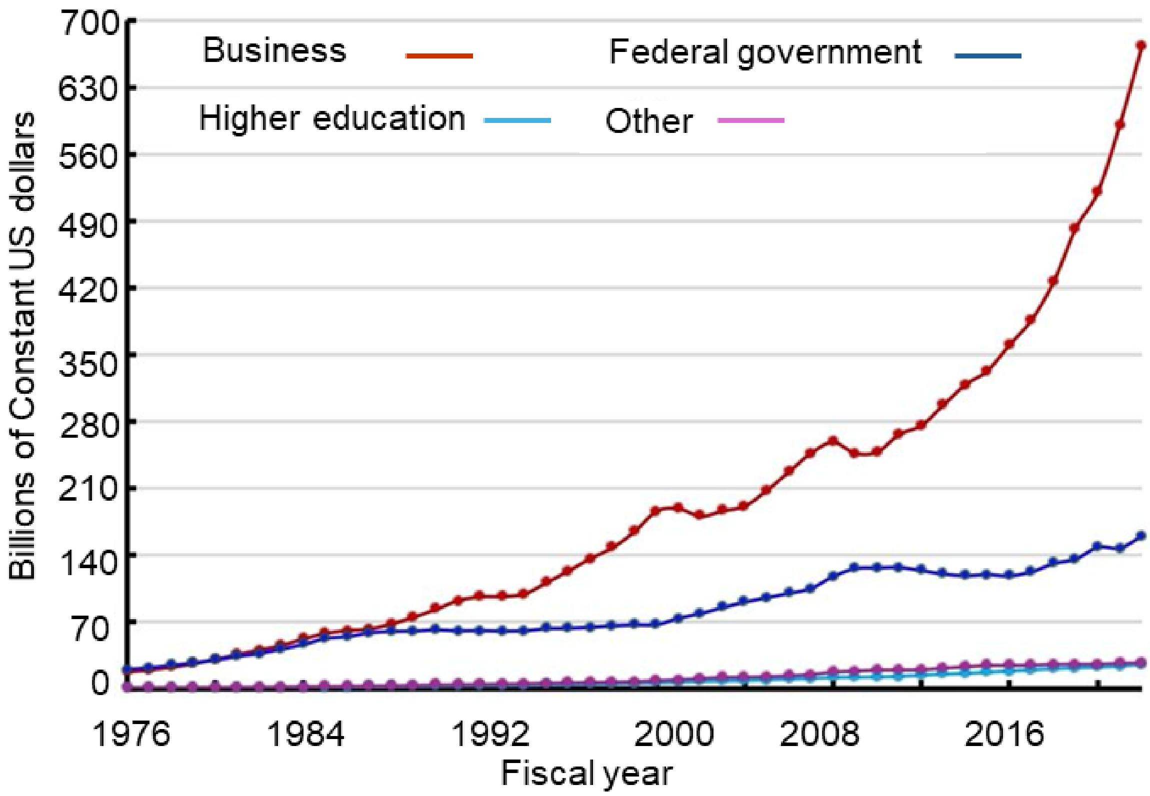

Figure 1: U.S. R&D expenditures, by source of funds: 1976–2022.
Federal R&D includes federal agencies and federally-funded research centers. "Other" combines data from nonfederal governments (state and local) and nonprofit organizations. "Higher education" represents research expenditures by universities and colleges from institutional sources.
Source: Data from National Center for Science and Engineering Statistics, National Patterns of R&D Resources (2021–22 edition). Science and Engineering Indicators (National Center for Science and Engineering Statistics, 2024b).

The rapid growth of R&D funding by businesses in the 21st century has been partly driven by a structural transformation of the economy in intangible fields as described by the Board on Science, Technology, and Economic Policy and Global Affairs Committee on National Statistics, who described the transition from the industrial economy to the knowledge economy (National Research Council, 2009; National Academies of Science, Engineering, and Medicine, 2009; National Science Board, 2018). Intangible fields such as software, digital services, biotech, genomics, and artificial intelligence are inherently R&D-intensive and have made considerable R&D investments. For example, software had an increase of 18% or $7 billion dollars in private investment between 2000-2015 (National Research Council, 2009; National Academies of Science, Engineering, and Medicine, 2009; National Science Board, 2018).

Furthermore, because firms face more intense competitive pressure globally and must continuously innovate to maintain their competitive edge, improved policies designed to increase innovation, such as R&D tax incentives and other fiscal incentives, have also made R&D more financially attractive for businesses. Another contributor to industrial innovation is the knowledge of federally-funded basic science research that firms can utilize. For example, the "crowd in" approach in which federally-funded basic research investments provide a theoretical and foundational knowledge base for applied research by private companies that consequently enhance their innovation, efficiency, and profitability.

Moreover, basic science (funded by NIH, NSF, DoE and other agencies) expands knowledge that firms convert into patents and products, while mission agencies (e.g. DoD/DARPA) create early demand and de-risk technology trajectories. Consequently, the result is ever growing R&D investment as documented in NSF's Business Enterprise Research & Development Survey (BERD) series, with public and private R&D playing complementary roles in the modern innovation system (National Center for Science and Engineering Statistics [NCSES], 2025; Azoulay et al., 2019; Kortum & Lerner, 2000; Pallante et al., 2023; David et al., 2000). Collectively, the investment of corporate R&D, a strong university research environment, and evolving federal funding agency missions resulted in a research ecosystem marked by diverse funding streams and laid the foundation for the United States to maintain global preeminence in science and innovation.

From 1945 to 2025, concerns about pandemics, cancer, brain health, mental health, addiction, climate change, electrical vehicles, computing, the information superhighway, and homeland security rise as priorities. Commitment to these concerns has enabled the U.S. to continue to be a world leader in just about every aspect of science and medicine and maintain its military dominance (Knezo, 1998). Figure 2 shows the growth in federal budget allocations for research in total and across different functions from 1976 to 2024. Defense-targeted research makes up the largest single area of research funding, and also shows the largest variations in budgeted funding. Continuing support of research and technological development can be observed in recent research and development budget allocation across federal agencies for basic and applied research. More specifically, six federal agencies received 95% of research and development funding in 2025; these were the Department of Health and Human Services, NASA, Department of Energy, Department of Defense, National Science Foundation, and the U.S. Department of Agriculture. It is worth noting that in FY25 the R&D budget had an increase of 3.3% compared to FY24, with the largest increases being distributed to the Department of Health and Human Services, Department of Defense, Department of Energy, and National Science Foundations with increases of $50.3 billion, $23.4 billion, and $322 million respectively (Harris, 2024).

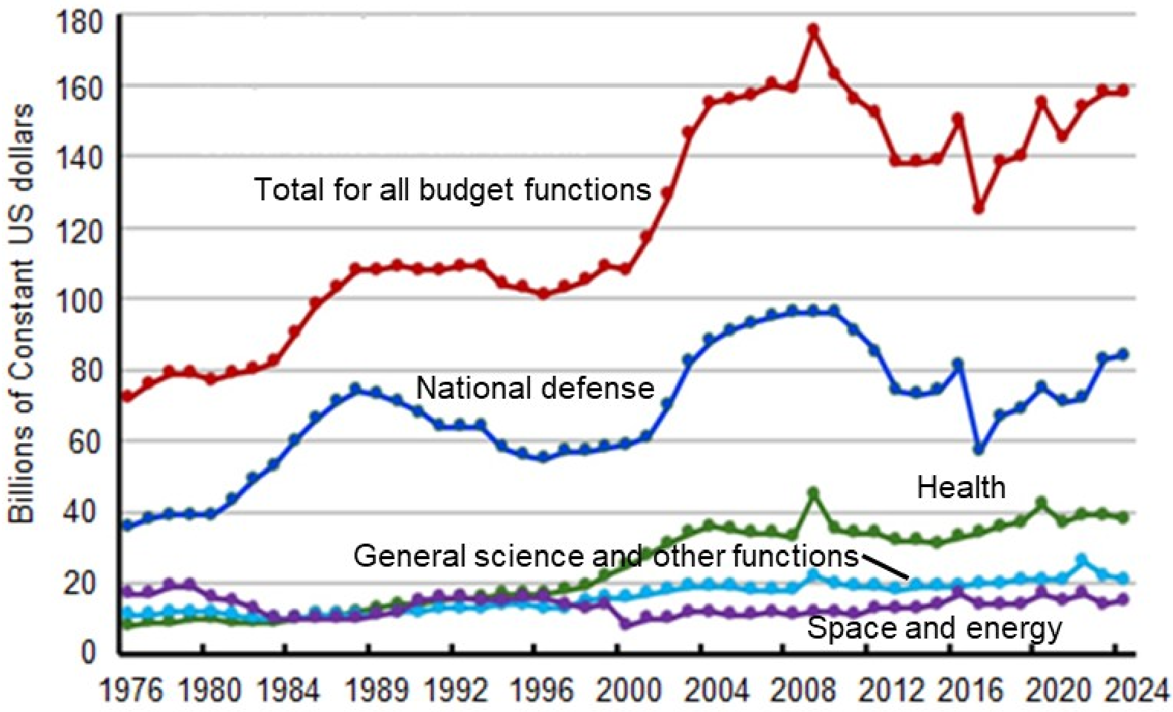

Figure 2: Federal budget for research from fiscal year 1976 to 2024.
Funds are presented as billions of constant dollars.
Source: National Center for Science and Engineering Statistics Federal R&D Funding, by Budget Function: Fiscal Years 2023–25.

Between 1976 and 2024, total Federal R&D funding as indicated by budget allocations experienced multiple periods of year-over-year decreases, reflecting broader fiscal trends, shifting national priorities, and varying policy approaches across presidential administrations. These declines, though intermittent, offer insight into how research investment has fluctuated over time (Figure 3). The first recorded decrease occurred in 1980, with a modest reduction of $0.19 billion (-0.19%). This was followed by two consecutive declines in 1982 and 1983, when funding dropped by $2.98 billion (-2.96%) and $0.94 billion (-0.96%), respectively, and likely reflects efforts to reduce federal spending during the early 1980s economic recession (Harris, 2024; National Center for Science and Engineering Statistics, 2024a).

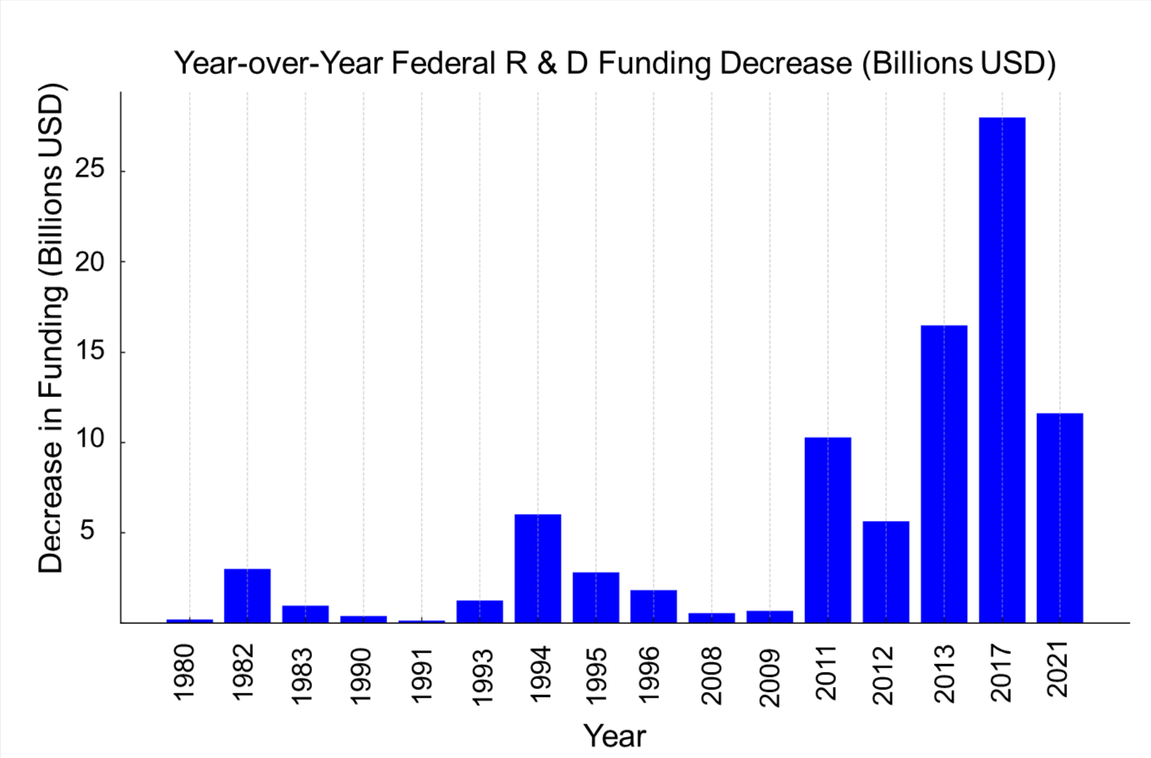

Figure 3: Year-over-year decreases in Federal R&D funding.
Specific years between 1976 and 2022 when Federal R&D funding decreased from the previous year. Amount of decrease shown in billions of constant dollars.
Source: Zimmermann A. FY 2026 R&D Appropriations: Summary of Major Decreases in the Presidential Budget Request. Washington (DC): American Association for the Advancement of Science; June 30, 2025.

In the early 1990s, R&D funding saw minor back-to-back decreases of $0.38 billion (-0.29%) in 1990 and $0.12 billion (-0.09%) in 1991. A more sustained contraction came, with four consecutive years of reductions from 1993 to 1996. Funding declined by $1.25 billion (-0.95%) in 1993, $6.00 billion (-4.61%) in 1994, $2.81 billion (-2.27%) in 1995, and $1.80 billion (-1.48%) in 1996. These cuts occurred in the context of budget negotiations and deficit-reduction efforts during the post–Cold War transition (Harris, 2024; National Center for Science and Engineering Statistics, 2024a; Zimmermann, 2025).

In 2008 a small decrease was observed—a $0.55 billion (-0.29%) drop—coinciding with the onset of the global financial crisis and followed by a slight dip of $0.66 billion (-0.35%) in 2009. A more dramatic contraction occurred between 2011 and 2013, amid the aftermath of the Great Recession and federal sequestration. Funding declined by $10.28 billion (-5.38%) in 2011, $5.63 billion (-3.12%) in 2012, and $16.47 billion (-9.41%) in 2013 (Harris, 2024; National Center for Science and Engineering Statistics, 2024a; Zimmermann, 2025).

The most significant single-year decrease came in 2017, with R&D funding dropping by $28.00 billion (-16.18%). This sharp reduction reflected major changes in federal discretionary spending priorities, particularly reductions in non-defense research programs. Most recently, federal R&D funding decreased in 2021 by $11.62 billion (-6.63%), marking a contraction following pandemic-era stimulus-driven highs. These decreases spanned both Democratic and Republican presidencies, illustrating that federal R&D funding is subject to a complex interplay of political, economic, and strategic considerations. Notable clusters of reductions occurred in the early 1990s, and early and mid-2010s, suggesting that transitions in policy direction or economic constraints can significantly affect the federal research investment landscape (Harris, 2024; National Center for Science and Engineering Statistics, 2024a; Zimmermann, 2025).

Interestingly, while funding for research allocated in the federal budgets has declined from the previous year's allocation 16 times in the last 48 years, the negative impact of these budget reductions on R&D growth has been minimal. To that end, although declines in allocated funds for research and development were observed over four decades as described above, a corresponding decline in federally-funded research expenditures in a current budget year or the subsequent year was not reflected. In fact, as shown in Table 1, actual research expenditures funded with federal dollars have declined only six times in 48 years, and those declines were much smaller than the declines in the budgeted funds (Zimmermann, 2025).

Table 1: Instances of year-over-year decline in federally-funded research expenditures from 1976 to 2024.

Source: Zimmermann A. FY 2026 R&D Appropriations: Summary of Major Decreases in the Presidential Budget Request. Washington (DC): American Association for the Advancement of Science; June 30, 2025 (Zimmermann, 2025).

Fiscal year	Research expenditures (billions of constant dollars)	Percent decline from previous year
1993	60.5	0.4
2012	123.8	3.2
2013	120.1	3.7
2014	118.4	1.7
2016	118.2	1.3
2021	147.5	0.7

This discrepancy partially reflects the lag between the budget authority that authorizes an agency to obligate funds for R&D, to agencies committing the funds to specific projects and grants, and when the money is actually spent by universities and laboratories. Agencies can often carry forward unobligated balances from prior years, and frequently extend this flexibility to their awardees, smoothing short-term fluctuations and keeping expenditure levels steady even when new appropriations fall. Furthermore, research institutions and organizations (universities, laboratories, contractors, etc.) can absorb small or brief federal funding shocks by using internal resources or deferred cost adjustments such as bridge funds, overhead reserves, and/or institutional matching. However, it should be noted that when budget declines span multiple years, as between 2011-2013, significant declines in research expenditures have been observed.

NAVIGATING THE CHANGING U.S. FEDERAL FUNDING LANDSCAPE

Over the last four decades there have been 16 budget reductions in research and development funding, with at least five budget reductions in R&D funding of 5% or more (1994, 2011, 2013, 2017, 2021), providing evidence that adapting to R&D budget reductions is not a new phenomenon and that the United States research ecosystem has adapted to and managed funding cuts before. Information on the 2026 Presidential budget request for research and development funding was made available in June 2025. As expected, the Presidential budget requested significant cuts to all major federal agencies and included the consolidation and triage of 19 NIH institutes down to eight (Harris, 2024; National Center for Science and Engineering Statistics, 2024a; Zimmermann, 2025). In general, the following cuts were requested: NIH (-43.5%), NSF (-55.8%), Department of Energy (-14%), NASA (-24%), EPA (-54%), NIFA and Research and Education Programs (-38%) each in the Department of Agriculture. Despite these reductions, the Department of Transportation was not affected as much, with a 2% and 19% budget request increase for research and technology and transportation R&D, respectively (Harris, 2024; National Center for Science and Engineering Statistics, 2024a; Zimmermann, 2025).

The U.S. research enterprise is undergoing a profound transformation, shaped by global competition, national security priorities, and the accelerating pace of technological advancement. Not only has the level of R&D spending by businesses taken off, industries are also investing more in basic research than before. As shown in Figure 4A, federal funding accounted for almost 55% of total U.S. basic research expenditures in 2011, but by 2021, the percentage had dropped to about 40%. In 2011, Federal funding accounted for about 35% of applied research and 21% of development, but by 2021, those numbers had dropped to 30% and 11%, respectively (Figure 4A). At the same time, while the proportion of U.S. R&D funded by the federal government has declined, there has been a shift in funding priorities for federal funds (American Association for the Advancement of Science [AAAS], 2025; National Academies of Sciences, Engineering, and Medicine, 2016; National Academies of Sciences, Engineering, and Medicine, 2020).

From 2011 to 2021 there was little change in the percentage of federal funding supporting basic research, but the proportion of federal R&D dollars going to applied research increased (Figure 4B). This change indicated that federal agencies are reorienting their research investments toward applied science and mission-driven outcomes, marking a strategic shift from an emphasis on experimental development to a push for innovations with direct societal and economic impact (American Association for the Advancement of Science [AAAS], 2025; National Academies of Sciences, Engineering, and Medicine, 2016; National Academies of Sciences, Engineering, and Medicine, 2020). This shift is likely to become even more pronounced during the Trump Administration, which has announced an intention to prioritize:

- Industry collaboration
- Use-inspired research
- Scalable innovation with clear translational pathways

This strategic shift in federal R&D funding aligns with broader policy objectives to accelerate the commercialization of research and reinforce the link between academic discovery and industrial application. Opportunities of use-inspired industry collaboration can be observed in several grant programs supported by the National Science Foundation and the National Institutes of Health. Specifically, the NSF Accelerating Research Translation (ART), NSF-Innovation Corps (ICorps), and NIH Clinical and Translational Science Awards (CTSA) initiatives support institutional research seed funding programs, that aim to bridge the gap between academic discovery and societal application. These programs provide pilot funding and infrastructure to advance translational, use-inspired, and applied research toward real-world commercialization (National Science Foundation, 2025; Zhang et al., 2013; National Science Foundation, 2024b).

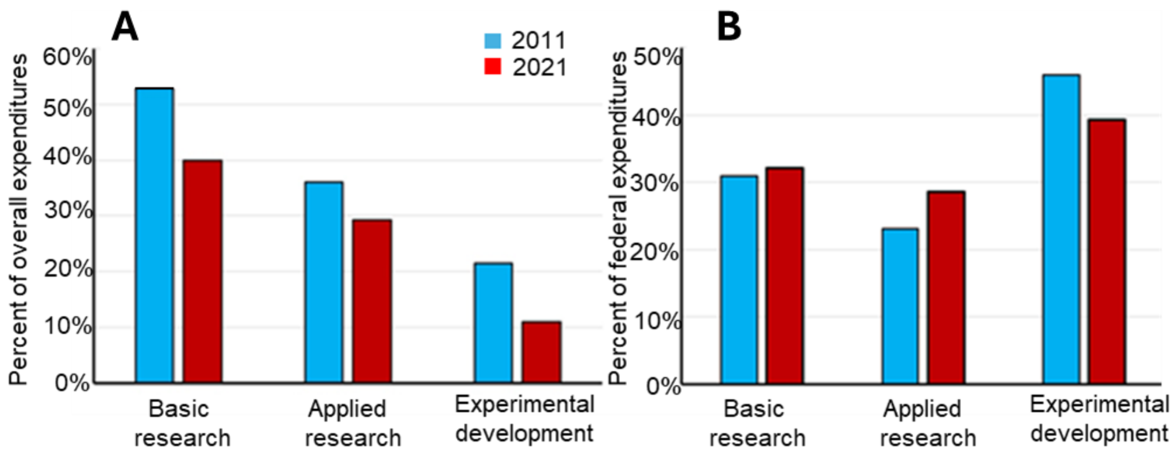

Figure 4: Changes in the proportion of types of research expenditures supported with federal funds 2011-2021. (A) Federal funding as a percentage of overall U.S. research expenditures for different types of research in 2011 and 2021. (B) Percent of federally-funded research expenditures allocated to different types of research in 2011 and 2021. Source: Anderson G; National Center for Science and Engineering Statistics (NCSES). National Patterns of R&D Resources (2024). U.S. R&D NSF 24 - 317. Alexandria, VA: National Science Foundation. (Anderson, 2024).

Applied science is no longer a peripheral priority; it is now a central criterion in federal funding decisions. Proposals that articulate clear end-use applications, especially in areas tied to national competitiveness or defense, are receiving enhanced attention and support. DARPA, the Defense Advanced Research Projects Agency, has long been a model of research application and translation, tasked with creating breakthrough technologies for national security and serving as a high-risk, high-reward, "idea factory" that funds research in AI, biotechnology, and robotics to maintain U.S. technological superiority (DARPA National Research Council, 2023). As the U.S. navigates a rapidly shifting global landscape, institutions that position themselves at the intersection of scientific excellence, commercial relevance, and national interest will be best poised to lead in this new era. Research administrators, faculty, and research centers must align their strategies with this evolving paradigm to fully leverage the expanding opportunities in the modern R&D ecosystem.

In response to the growing emphasis on applied science, commercialization, and national competitiveness, the federal government offers the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs as powerful mechanisms for advancing research aligned with priority areas such as biosecurity, artificial intelligence, space exploration, and technological sovereignty. These highly competitive, three-phase grant programs are designed to support U.S.-based small businesses and research institutions in developing innovative technologies that meet federal mission needs while possessing strong potential for commercialization. SBIR grants provide direct funding to small businesses for early-stage R&D that has the potential to be commercialized (Audretsch et al., 2002; Bearse & Link, 2010; Qian & Haynes, 2014). STTR grants require formal collaboration between a small business and a research institution (such as a university), encouraging the transfer of scientific and technological innovation from the lab to the marketplace (Gallo, 2022; Link, 2023). The Small Business Innovation Development Act of 1982 (Public Law 97-219) established the SBIR program after policymakers noticed that small, high-technology firms were producing major innovations but struggled to access federal R&D funding, which was largely going to large corporations, national labs, and universities (National Academies of Sciences, Engineering, and Medicine, 2016; National Academies of Sciences, Engineering, and Medicine, 2020; Anderson, 2024). The law requires all federal agencies with extramural R&D budgets over $100 million to set aside a small portion (initially 0.2%) of those funds for small-business research projects (Audretsch et al., 2002; Bearse & Link, 2010; Qian & Haynes, 2014). The SBIR program encompasses three phases:

> Phase I – Feasibility Study: Small, short-term awards to explore scientific and technical merit (typically ~$150k for 6 months).
>
> Phase II – R&D Development: Larger, longer awards to expand on Phase I results and develop prototypes (up to ~$1 million over 2 years).
>
> Phase III – Commercialization: Use of non-SBIR funds (private or other federal) to bring the technology to market or operational use.

The goals of the SBIR/STTR programs are to: 1) Stimulate technological innovation; 2) Use small businesses to meet federal R&D needs; 3) Increase private-sector commercialization of innovations derived from federal R&D; 4) Encourage participation by socially and economically disadvantaged small businesses. As shown in Figure 5, the programs have grown and continue to grow rapidly, both in the number of SBIR/STTR awards made and in the funding committed to these grants (Gallo, 2022). Since the inception of these grants, over 170,000 awards have been made supporting tens of thousands of firms and contributing to technologies in biotech, aerospace, defense, energy, information technology, and advanced manufacturing. Eleven federal agencies participate in SBIR and five in STTR. Table 2 below shows the participating agencies and their funding priorities for these awards.

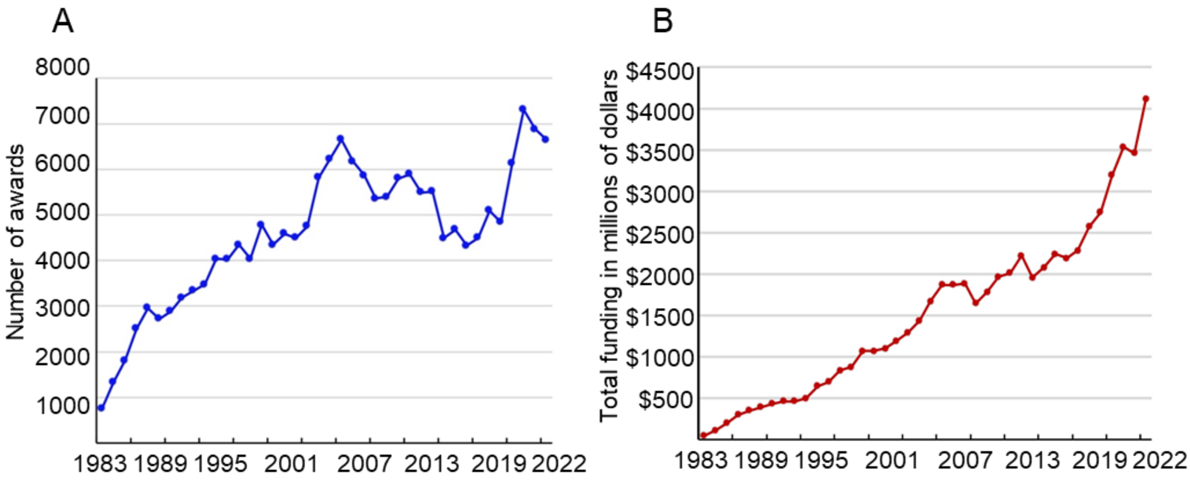

Figure 5: Growth of SBIR/STTR programs 1982-2022.
(A) Total number of SBIR/STTR awards (all phases) by fiscal year. (B) Total SBIR/STTR program funding (all agencies) by fiscal year.
Source: Gallo, Marcy, E; Congressional Research Service. Small Business Research Programs: SBIR and STTR (October 2022) CRS - R43695. Washington, DC. Available at https://www.congress.gov/crs-product/R43695 (Gallo, 2022).

Table 2: Federal Agencies with SBIR/STTR Programs

Federal Agency	Priority Research Areas / Notes
Department of Defense (DoD)	National security, advanced manufacturing, autonomous systems, AI, space tech
Department of Health and Human Services (HHS)	Biotechnology, diagnostics, health informatics, pharmaceuticals
National Institutes of Health (NIH)	Medical devices, therapeutics, genomics, public health
Centers for Disease Control and Prevention (CDC)	Epidemiology tools, surveillance, health data systems
Food and Drug Administration (FDA)	Regulatory science, medical product development

Federal Agency	Priority Research Areas / Notes
Department of Energy (DOE)	Clean energy, grid tech, batteries, advanced manufacturing
National Science Foundation (NSF)	AI, quantum, semiconductors, advanced computing, STEM education
National Aeronautics and Space Administration (NASA)	Space exploration, robotics, remote sensing, propulsion
Department of Homeland Security (DHS)	Cybersecurity, biosecurity, threat detection, infrastructure resilience
Department of Agriculture (USDA)	Precision agriculture, food safety, climate resilience, bio-based products
Department of Education (ED)	EdTech, personalized learning, data systems for education
Department of Transportation (DOT)	Smart mobility, infrastructure, safety systems
Environmental Protection Agency (EPA)	Water quality, emissions reduction, environmental monitoring
Department of Commerce	Cybersecurity, quantum computing, advanced measurement systems

Diversifying Research Funding: The Role of State, Corporate, and Philanthropic Investment in R&D

An essential research resource and partnership for academic research institutions during periods of reduction in federal research and development support are state government entities. Because state government agencies often serve as pass-through entities for federal funding agencies and often have significant collaborations with corporate industries across all sectors, an understanding of the availability of support and resources at the state government level is paramount. However, it should be noted that state-supported R & D is primarily supported by state sources of funds. Specifically, in 2023 state governments' source of funds for state R&D totaled $2.3 billion, while federal funds contributing to state R&D totaled $742 million (Pece, 2024; National Science Foundation, 2024a; Anderson, 2022). Furthermore, priority focus areas for R&D support and expenditures at the state level are agriculture, energy, environment and natural resources, with health-related R & D accounting for the majority of state R&D expenditures at 43% (Bearse & Link, 2010; Qian & Haynes, 2014; Gallo, 2022).

Given the various needs and corporate economic drivers across the country, a broad range of R&D related to state government functions was reported in FY2023. From a strategic perspective, evaluating state R&D expenditures provides an approach for higher education research institutions to align their priorities with their home state's broad interests. To that end, a valuable resource to identify R & D state allocations and expenditures is the Survey of State Government R&D conducted by the National Center for Science and Engineering Statistics within the National Science Foundation that assesses R&D activities performed and funded by government agencies in each state (Pece, 2024; National Science Foundation, 2024a; Anderson, 2022). The survey provides the following information and data on: 1) state government R&D expenditures; 2) type of R&D performers that received the most funding in each state; 3) state departments and agencies funded R&D performers; and 4) federal funds to state governments for R&D.

As shown in the funding comparison in Figure 6, currently corporations and business account for a large majority of research funding in total, and for every type of research except basic research. For universities wishing to grow their research enterprises it would be wise to find ways to tap into this large source of research funding. In alignment with SBIR and STTR mechanisms and the extraordinary growth of corporate research expenditures since the turn of the century (see Figure 1), public-private partnerships will play an increasing role in shaping the U.S. research enterprise. These collaborations combine the discovery power of academic research with the commercialization drive of industry, an alignment that directly supports the federal government's evolving emphasis on applied science, translational outcomes, and technological competitiveness.

To that end, in 2022, industry funded 37% of all U.S. basic research and was the leading funder of applied research (Figure 6), marking a significant evolution in how research is resourced and translated (Harris, 2024). This level of industry investment underscores a transformative shift: the private sector is no longer just a downstream beneficiary of federally-funded innovation; it is now a co-architect of the research agenda. An example of industry-academic collaborative partnerships is HALO. a digital platform designed to streamline collaboration between academic researchers and corporate R&D teams. It functions as a centralized marketplace where companies post research challenges and scientists respond with targeted proposals. By reducing traditional barriers to industry-sponsored research funding, HALO accelerates the pace of innovation, particularly in high-impact areas such as sustainability, biotechnology, and advanced technologies. This trend is highly advantageous and aligns closely with evolving federal priorities. Agencies such as the NSF, NIH, DOE, DoD, and Commerce are emphasizing applied and translational research, where the goal is not only to generate knowledge but to deploy that knowledge through new technologies, therapies, and systems that serve national needs. They bring together the scientific rigor of academic research with the agility, scale, and problem-solving orientation of industry, creating fertile ground for innovation that is both high risk and high reward.

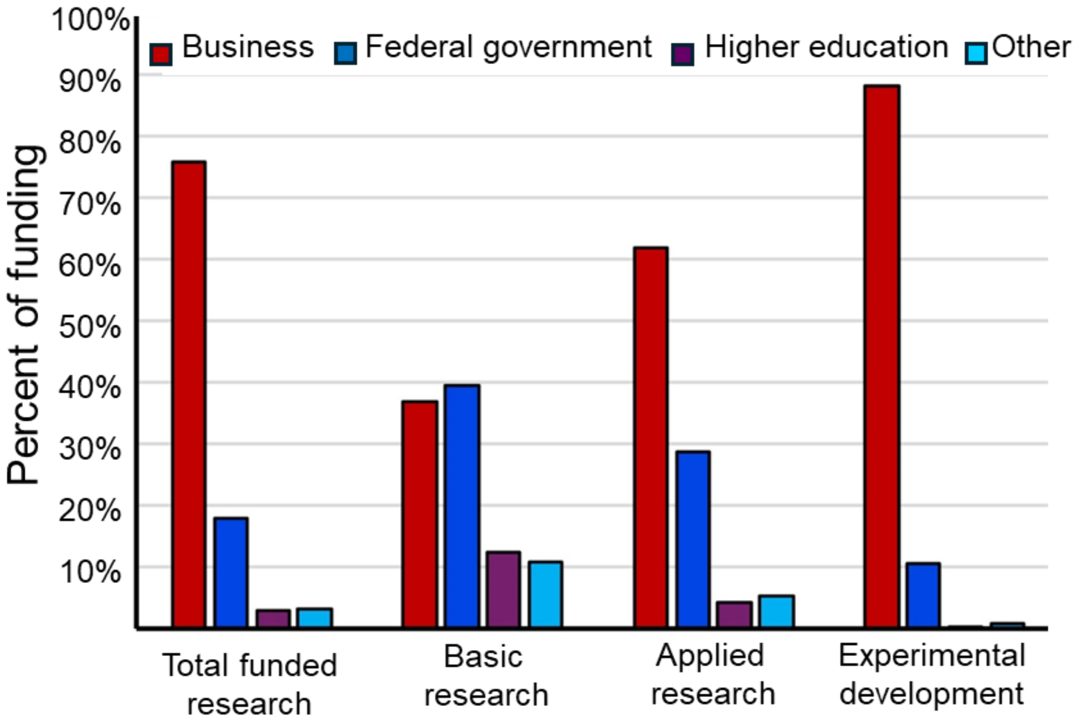

Figure 6: Percentage of different types of research funded by different sectors in 2022. Total expenditure for all research was $885.6 billion; for applied research $160 billion; for development $596 billion; and for basic research $129 billion.
Figure adopted from data provided in (Harris, 2024) and (Anderson, 2024).

These partnerships also support federal goals related to:

- National competitiveness and technological sovereignty
- Workforce development and job creation
- Supply chain resilience and domestic manufacturing capacity

In this new era of collaborative research, public-private partnerships are not merely a funding strategy, they are a strategic imperative. However, to fully realize their potential, institutions must proactively address and overcome longstanding barriers related to intellectual property (IP), patent ownership, and conflicts of interest. Establishing clear, transparent, and mutually beneficial frameworks for IP development and commercialization is essential to fostering trust among academia and industry. This includes streamlining technology transfer processes, standardizing IP agreements, and ensuring equitable distribution of rights and revenues. Equally important is the implementation of robust conflict of interest policies that both safeguard research integrity and enable productive engagement with external partners.

Philanthropic foundations have emerged as pivotal actors in the landscape of university research funding. Philanthropic foundations play a critical role in filling funding gaps, particularly for research areas that are perceived as too early-stage, high-risk, or interdisciplinary for traditional funding bodies. By offering seed funding for novel concepts, they empower researchers to pursue promising yet unproven lines of inquiry.

In many instances, this support enables scholars to generate the preliminary data needed to secure subsequent government or industry grants.

Empirical evidence suggests that their financial contributions are both significant and strategically influential. In one of the few rigorous examinations of philanthropic funding, it was found that gifts and grants from philanthropic foundations provided over 30% of total research funding at leading U.S. universities (Murray, 2015). This substantial investment positions foundations not merely as supplemental sources of revenue, but as key enablers of scientific innovation, infrastructure development, and academic independence. Beyond sheer dollar value, philanthropic foundations bring distinctive characteristics to the research funding ecosystem that differentiate them from federal and industrial sources. Unlike government agencies, which often favor established methodologies and conservative research trajectories through peer-reviewed processes (Nicholson & Ioannidis, 2012; Carson et al., 2023), foundations are more likely to embrace risk, fund unconventional ideas, and prioritize innovation. Notably, some foundations pursue alternative funding models, investing in people rather than specific projects. This person-centric, flexible funding approach, as epitomized by the Howard Hughes Medical Institute (HHMI) shifts scientists toward riskier, more novel trajectories, yielding more breakthrough research outcomes and top-1% most cited papers. However, it also results in more null/low-impact outputs as part of a higher-variance discovery portfolio. Traditional project-centered funding models produce a higher publication output with the impact of the publications rising mainly with experience and time (Sampat, 2023; Xu et al., 2025; Azoulay et al., 2011). Foundations also make strategic investments in infrastructure, such as laboratory construction, core facilities, or high-end instrumentation, all of which are vital for sustained scientific progress. Their ability to provide long-term, flexible funding gives researchers the freedom to pursue ambitious questions without the constraints of short-term milestones. This stability is especially important in fields where breakthroughs may require years of iterative exploration.

Philanthropic foundations do not simply fund research; they actively shape research priorities. With a unique capacity to respond swiftly to emerging societal challenges, foundations frequently identify knowledge gaps or urgent needs and mobilize resources to address them. Their independence from political cycles enables them to promote interdisciplinary collaborations, often connecting fields that are traditionally siloed within academic institutions. Through targeted grants and commissioned studies, foundations can influence public discourse and inform policy decisions. By investing in areas such as climate resilience, public health, or education equity, they not only contribute to academic knowledge but also drive tangible social impact. Major philanthropic organizations such as the Gates Foundation and the Chan Zuckerberg Initiative have demonstrated that investments in areas such as public health, education equity, and biomedical research can generate both scientific advancement and measurable societal impact (McCoy et al., 2009; Nature Editor, 2023; Bargmann, 2018). For example, Gates Foundation–supported vaccine initiatives have prevented millions of deaths globally, while the Chan Zuckerberg Initiative has committed billions toward advancing disease research and improving education systems (Lancet Editor, 2010). These efforts are often structured around long-term, data-driven strategies and cross-sector partnerships, ensuring that research outputs translate into real-world solutions. Collectively, this model of strategic philanthropy reinforces the principle that investments in research not only expand academic knowledge but also drive tangible social outcomes.

The role of foundations extends beyond direct financial support. Many are deeply invested in building research capacity by funding fellowships, training programs, and early-career mentorship initiatives. This ensures a sustainable pipeline of skilled researchers prepared to tackle the next generation of scientific questions. In addition, foundations often support public engagement with science, backing initiatives that promote scientific literacy, transparency, and trust. As conveners, they bring together academics, practitioners, and policymakers, creating collaborative platforms for dialogue, knowledge exchange, and co-creation of solutions to complex global challenges.

While the contributions of philanthropic foundations are overwhelmingly positive, several caveats warrant consideration. First, the strategic priorities of foundations, often shaped by donor intent, can influence research agendas in ways that may inadvertently narrow the scope of inquiry. For instance, overemphasis on high-profile or "popular" issues may divert attention from equally pressing but less visible topics. Second, philanthropic support for research in the U.S. tends to be strongly weighted toward elite research universities characterized by high prestige, large research capacity, and major endowments. Because philanthropic funds are often discretionary and oriented toward cutting-edge or high-prestige work, they often favor institutions that already have major research infrastructure and visibility. The institutional reputation and large existing funding base appear to act as a magnet for further philanthropic funding in a kind of positive feedback. Philanthropy's skew toward top-tier universities (e.g. Harvard, Stanford, MIT, etc.) deepens existing disparities and reinforces institutional and geographic inequities and limits diversity of perspectives, problem selection, and innovation approaches, all critical drivers of discovery (Nicholson & Ioannidis, 2012; Shekhtman et al., 2024). A third concern is that transparency and accountability remain ongoing challenges. In some cases, the nature and extent of industry involvement in foundation-backed research have been obscured, raising questions about bias, conflicts of interest, and the objectivity of results. Ensuring clarity in funding sources and governance structures is essential to maintaining public trust.

Philanthropic foundations are increasingly indispensable to the vitality and versatility of academic research. Their willingness to fund high-risk, high-reward ideas; their strategic investments in people, infrastructure, and interdisciplinary collaborations; and their role as societal change agents position them as critical partners in the future of research. While challenges around influence and transparency remain, thoughtful engagement with philanthropic foundations offers an opportunity to accelerate discovery, democratize knowledge, and translate research into real-world impact.

CONCLUSION

In this review we show that since 1976 the United States has financed a steadily expanding, yet periodically volatile, research enterprise by shifting weights among federal appropriations, business investment, and private philanthropy. Federal support, while still foundational for basic science and research training, has oscillated in real terms and is increasingly targeting specific missions, especially in biomedicine and defense. Business R&D has grown to dominate overall R&D spending, but with a persistent tilt toward later-stage development, amplifying the need for public dollars to underwrite early-stage discovery. Philanthropic funding, though small in aggregate, exercises outsized influence through funding some of the most innovative, boundary-spanning research; however, the sector's reputation-sensitive gifts can concentrate capacity at the most elite institutions. Against this backdrop, SBIR/STTR have broadened participation by channeling federal priorities through small firms and linking research to commercialization pathways. Additionally, state-supported R&D will play an increased role in translational and applied research as well as in U.S. innovation competitiveness. Taken together, these trends suggest that portfolio composition – across sectors, stages, and institutions – matters as much as total spending. Future policy should focus on smoothing federal volatility, strengthening basic research capacity beyond elite hubs, sharpening data on outcomes, and sustaining on-ramps (like SBIR/STTR) that translate discovery into use. In short: who funds, how they fund, and to what end now jointly determine the pace, direction, and inclusiveness of American science.

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BIOGRAPHIES

Dr. Quincy A. Quick, serves as Vice President for Research and Chief Research Officer at Tennessee State University, where he leads the Division of Research and Sponsored Programs and oversees the institution's research enterprise, that include pre-award administration, research development, compliance, and strategic initiatives. With his experience in research administration, grant development, and institutional strategy, Dr. Quick has played a central role in advancing the University's research capacity, securing external funding, and positioning the institution toward Carnegie R1 status. He manages a broad portfolio of research centers and programs, including initiatives focused on biomedical sciences, artificial intelligence, entrepreneurship, and workforce development. Dr. Quick has led efforts to strengthen public-private partnerships, expand federal and industry-sponsored research, and enhance infrastructure to support faculty and student research engagement. His work also includes the development of innovative research administration solutions and regional collaboration models aimed at improving research competitiveness.

Dr. Xiaofei Wang, is a professor in the Department of Biological Sciences at Tennessee State University. He is trained as a molecular biology scientist, earned his PhD degree at the University of Hong Kong. His research is mainly focused on the genome and epigenome of vertebrates. He has led research projects as a principal investigator supported by over 2 million dollars of grants from National Institute of Food and Agriculture, National Science Foundation, Nation Institute of Health. He currently leads a genomics laboratory at Tennessee State university. He is passionate about improving institutional research capabilities, training next generation of researchers at undergraduate and graduate levels.

Dr. Melissa Harrington, is the Associate Vice President for Research at Delaware State University and directs the Delaware Institute of Science and Technology. Currently, Dr. Harrington leads two NIH-funded research centers and is the co-director of the NIMHD-supported Interdisciplinary Health Research Center and the director of the NIGMS-funded Delaware Center for Neuroscience Research. She also directs two NIH-funded training grants, one that supports a summer neuroscience research program for undergraduates and a T32 grant that supports students in DSU's Neuroscience PhD program.

Dr. Kimberley R. Sudler, serves as Associate Vice President for Academic Operations at Delaware State University, bringing nearly 25 years of experience in institutional research, data analytics, and decision support. She has advanced from an entry-level reporting analyst to a senior leadership role, where she has led high-performing institutional research teams responsible for external reporting, institutional analytics, and data-informed strategy. Dr. Sudler specializes in leveraging data infrastructure to support operational reporting, strategic analysis, and process improvement, including managing data for multimillion-dollar grant initiatives and developing institutional tools such as Individual Development Plans (IDPs). She currently leads a data-driven university program focused on performance management, quality improvement, and advanced analytics to support strategic priorities and student success. Her work includes the development of comprehensive dashboard systems that provide actionable insights for academic and administrative leaders, as well as extensive projects in enrollment management, advising, faculty productivity, and program prioritization. A principal investigator on two federal grants totaling over $2 million, Dr. Sudler's research focuses on student retention and operations management, reflecting her commitment to enhancing institutional effectiveness through data and technology.

Dr. Neelam Azad, is the University Endowed Professor of Pharmacy and Vice President for Research at Hampton University. In this role, Dr. Azad oversees the University's research enterprise, managing sponsored programs, ensuring compliance with research and regulatory standards, and advancing the development of interdisciplinary research centers. Over the past decade, Dr. Azad has held key leadership roles, including Assistant Vice President for Research, Director of the Cancer Research Center, and Chair of the Department of Pharmaceutical Sciences. A seasoned academic leader, Dr. Azad serves on Virginia's Commonwealth Health Research Board and is an active member of the Universities Space Research Association (USRA) HBCU Science and Technology Council. Throughout her career, Dr. Azad has secured funding for investigator-initiated research, interdisciplinary collaborations, student training programs, and community engagement initiatives. She is widely published and recognized for her pharmaceutical innovation, including co-inventing a U.S. patent on fatty acid synthase inhibitors. Her leadership in building strategic partnerships and interdisciplinary teams has enhanced institutional research capacity and fostered innovative training pipelines. Dr. Azad's contributions have earned her numerous honors, including induction into the West Virginia University School of Pharmacy Hall of Fame, Hampton University's Academic Excellence Faculty Award, AACR Faculty Scholar Awards, and multiple accolades as Professor of the Year and for research excellence, underscoring her dedication to both scientific advancement and education.

Dr. Yalan Ning, is an associate professor at Huston-Tillotson University in the position of academic advisor and head of the Chemistry program. She obtained her PhD from Colorado State University and worked as a postdoctoral associate at Northwestern University. She later served as a summer visiting faculty in the Air Force and the Department of Energy from 2019. Dr. Ning has served as research and teaching mentor to more than 40 undergraduates and 12 faculty, respectively. She is also the PI of various external research grants.

Dr. John Solomon, is a Tenured Full Professor in the Mechanical Engineering department at Tuskegee University, Alabama. He received a Ph.D. from Florida State University in 2010. Dr. Solomon's research interests include high-speed flow control, actuator development, experimental fluid mechanics, micro-scale flow diagnostics, and engineering education. He holds three U.S. patents on high-frequency micro actuator technologies developed for high-speed flow control applications. Dr. Solomon received the Faculty Achievement Award from Tuskegee University in 2023, and has published and presented 60 technical papers in various journals and conferences.

Dr. Jason Ikpatt, is a Fulbright Fellow and early-career faculty member at Huston-Tillotson University. Dr. Ikpatt's research interests lie at the intersection of genomics, machine learning, and human social behavior. His background is in gene expression, neurobiology, and sociosexual behavior.

Authors' Contribution Statement

Dr. Quincy Quick, qquick1@tnstate.edu, 0009-0001-3052-9672: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Writing – original draft

Dr. Xiaofei Wang, xwang@Tnstate.edu, 0000-0003-3832-5217: Writing – review & editing

Dr. Kimberley Sudler, krsudler@desu.edu, 0009-0002-9946-9097: Funding Acquisition, Writing – review & editing

Dr. Melissa Harrington, mharrington@desu.edu, 0000-0002-6159-4477: Data Curation, Formal Analysis, Funding Acquisition, Writing – review & editing

Dr. Neelam Azad, neelam.azad@hamptonu.edu, 0000-0001-6970-5867: Writing – review & editing

Dr. Yalan Ning, yning@htu.edu, 0000-0001-9697-1650: Writing – review & editing

Dr. John Solomon, jsolomon@tuskegee.edu, 0000-0003-3042-2071: Writing – review & editing

Dr. Jason Ikpatt, jeikpatt@htu.edu, 0009-0001-3864-9556: Writing – review & editing

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