Preprint – version 2 (March 13, 2025)

Slashing NIH Funding: Trump's Gamble on Science and Health

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Funding support: None

Conflict of interest: The authors declare no conflict of interest. While this analysis received no funding, the authors disclose current and prior NIH funding. This work examines the effects of NIH funding but was conducted independently of any specific NIH grant or financial support.

Data Sharing Statement: This analysis relies solely on prior evidence from literature and policy reports, all of which are fully cited in the manuscript. No new data were generated or analyzed.

Acknowledgment: The authors thank Larissa Calancie, Arielle Deutsch, Huiru Dong, Lisa Robinson, and Erin Stringfellow, who provided constructive feedback on earlier versions of this report. They also thank Hannah Lee for her assistance with the literature search.

Word count: 2,995

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Key Points

Question: How do National Institutes of Health (NIH) budget cuts impact biomedical research, the biomedical workforce pipeline, and healthcare expenditures?

Findings: This systems modeling study, using causal loop diagrams grounded in literature, has identified feedback loops illustrating the unintended consequences of NIH budget cuts, including declining research output and innovation, workforce erosion, increased long-term healthcare expenditures, and reduced public health progress, which may offset the intended fiscal savings.

Meaning: NIH budget cuts pose economic and public health tradeoffs, potentially hindering scientific progress and increasing healthcare expenditures over time.

Abstract

Importance: Proposed National Institutes of Health (NIH) funding cuts under the second Trump administration raise concerns about their implications. As a key sponsor of foundational research and workforce training, NIH plays a vital role in biomedical innovation. Understanding the potential systemic consequences of these cuts is critical for policymakers.

Objective: To examine how NIH budget cuts interact with broader economic and research systems, identifying key tradeoffs and potential ripple effects.

Design, Setting, and Participants: This study applies a qualitative systems modeling approach, using causal loop diagrams to examine interconnected effects that result in feedback structures. Key variables and causal relationships were extracted from studies and reports. Having fiscal deficit management theories at the core, the model incorporates evidence from innovation economics, organizational sciences, and science and technology policy through a structured literature synthesis.

Main Outcomes and Measures: We identify feedback loops illustrating the broader effects of NIH budget cuts, including impacts on the scientific workforce capacity, private-sector innovation, and healthcare costs.

Results: The analysis highlights four vicious cycles that could amplify the effects of NIH budget cuts and potentially offset the intended fiscal savings. First, a reduction in fundamental research—which accumulates to drive discoveries—could slow future innovations. Second, the erosion of human capital due to fewer NIH-funded training opportunities may shrink the future biomedical workforce. Third, healthcare expenditures could rise as greater reliance on private-sector R&D increases the costs of medical innovations. Finally, decreased investment in public health and translational research may lead to missed opportunities for disease prevention, further increasing healthcare expenditures.

Conclusions and Relevance: NIH budget reductions may have far-reaching, unintended consequences for scientific progress, the biomedical innovation

environment, and healthcare costs. Beyond immediate budgetary impacts, systemic interactions shaping long-term biomedical research and public health must be considered in funding policies.

Introduction

The U.S. federal government plays a central role in funding biomedical research, with the National Institutes of Health (NIH) serving as a key driver of innovation. With the U.S. running annual deficits since 2001,[1] policymakers continue to grapple with balancing revenues and expenditures. Recent policy shifts under the second Trump administration have framed NIH budget reductions as a measure to reduce the federal deficit, while also aligning with efforts to decrease the government's role in research and encourage greater private-sector investment.

In January 2025, the administration proposed capping indirect costs (expenses for facilities, administration, and overhead, which are in addition to the direct costs of research) in NIH grants at 15%,[2] a major reduction from previous rates, which ranged between 30% and 70%. These payments support essential research infrastructure, including laboratory maintenance and administrative support, rather than functioning as excess funds or profit. The policy was set to take effect immediately and projected to retain approximately $4 billion annually for the federal government. However, the court temporarily blocked it, and many are concerned about its potential impact on biomedical research.[3] Meanwhile, uncertainty surrounding the federal budget for fiscal year 2025 could introduce additional near-term disruptions to NIH funding.

While the 15% cap on indirect costs has been a major focus, broader budget reductions for NIH research are already raising concerns. One example is the uncertainty around vaccine development funding, particularly in light of Robert F. Kennedy Jr.'s appointment as Secretary of Health and Human Services.[4] NIH recently terminated at least 33 grants studying vaccine hesitancy and uptake.[5] Additionally, the House's approval of the fiscal year 2026 budget resolution on February 25, 2025—which serves as a broad fiscal framework guiding future spending decisions but does not determine final appropriations for NIH and other agencies—outlines over $1.5 trillion in cumulative spending cuts through 2034.[6] This has heightened concerns about further cuts to NIH research funding. Additionally, if the courts ultimately strike down the indirect cost cap, alternative measures to curtail NIH spending—direct reductions to research budgets—may become more likely. This underscores the need to examine the full scope of NIH funding constraints beyond the 15% indirect rate cap. While other federal policies, such as FDA approvals and Medicare/Medicaid reimbursement policy, also shape the impact of biomedical research, this analysis focuses specifically on NIH funding constraints.

NIH budget reductions would affect both intramural—projects conducted by NIH scientists in its laboratories (11%) and their support, administrative, maintenance, or operational costs (6%)—and extramural funding (83%), which supports over 300,000 researchers at more than 2,500 universities, hospitals, and research institutions across the country. While most extramural funding is awarded through over 50,000 competitive grants annually, NIH funding extends beyond research grants to include training programs, infrastructure support, and small business innovation grants.[7]

Overall, reductions in NIH funding raise important questions about their effects on scientific progress and public health. The implications of these changes are multifaceted, necessitating a systematic approach to capture their broader impacts. This article applies a systems modeling approach, incorporating economic theories and public-private research dynamics to assess how NIH funding policy shifts may reshape the biomedical innovation ecosystem.

This work does not seek to quantitatively evaluate specific policies or prescribe solutions; it provides a systems perspective to highlight structural tradeoffs. This qualitative framework serves as a starting point for researchers interested in further studying these dynamics.

Methods

We developed a causal loop diagram, integrating findings from a structured literature synthesis. This systems science-based, qualitative framework identifies broad feedback loops that shape funding dynamics rather than attempting to capture every possible interaction.

We conducted a targeted search of studies and policy reports on NIH funding, biomedical innovation, and economic impacts. Searches were performed in PubMed and Google Scholar, in English, with no time restrictions, using combinations of relevant terms such as NIH budget and policies, biomedical research funding and innovation, public-private investment in biomedical science, and economic impact of science funding. We also reviewed reference lists of articles included to identify additional sources. Studies were selected based on their focus on NIH funding and relevant effects. Policies have been evolving rapidly; therefore, we also reviewed news media coverage from January to March 13, 2025.

We first structured the model around broad macroeconomic theories on fiscal deficit management, as this framework aligns with the administration’s stated rationale for budget cuts. We then identified additional feedback loops specific to NIH budget reductions, integrating theories from our search process, including innovation economics, organizational sciences, and science and technology policy. Following best practices for causal loop diagram development and reporting,[8,9] we extracted key variables and causal relationships from included studies and reports. The model structure was iteratively refined to ensure consistency and alignment with included studies and reports.

The model contains reinforcing loops (R), which drive either growth or decline, and balancing loops (B), which counteract change to stabilize the system. While the feedback loops we present can operate in both directions, e.g., a reinforcing loop can be either virtuous or vicious, our analysis primarily focuses on the effects based on rising deficits. The reverse dynamics are important but beyond the scope of this analysis.

We used software Vensim. This study does not involve human subjects and did not require Institutional Review Board (IRB) approval. We followed the Consolidated Criteria for Reporting Qualitative Research (COREQ) reporting guideline.

Results

We first outline key fiscal strategies for managing budget deficits, then examine how NIH funding cuts interact with these dynamics and create tradeoffs.

Fiscal Strategies for Deficit Management

We outline four primary policy approaches governments use to manage budget deficits: tax hikes, increasing borrowing, financial incentives for economic growth, and expenditure reduction. These strategies, captured in four balancing feedback loops (B1-B4), are shown in Figure 1.

Adjusting tax rates through hikes, captured in loop B1 (Tax Hikes), serves as a key policy lever for addressing deficits, a strategy used by Clinton (1993), Obama (2012), and Biden (2022). Loop B2 (Increasing Borrowing) highlights another key approach to addressing budget shortfalls. When deficits rise, governments can turn to increased borrowing rather than immediate tax hikes. The Keynesian view of fiscal policy[10] supports that increased public spending and strategic deficit financing are not inherently harmful; rather, they can stimulate economic growth and drive long-term prosperity when used effectively.

An alternative approach to raising taxes is to increase the tax base—the total pool of taxable corporate earnings and wages—through targeted incentives. Loop B3 (Incentives for Economic Growth) represents a strategy where the government seeks to foster economic growth, including the biomedical sector, via incentives such as R&D tax credits,[11] accelerated depreciation for capital investments,[12] and patent box regimes that lower tax rates on income derived from intellectual property.[13] For instance, President Trump has proposed allowing businesses to deduct 100% of investments in new factory construction and other capital expenditures,[14] aligning with the administration's emphasis on reducing government intervention in favor of tax cuts and incentives to stimulate private investment.[15]

While the administration seeks to implement tax incentives that reduce short-term revenue, it also aims to offset these losses through spending cuts (loop B4; Expenditure Reduction). Among the current discretionary spending reductions, the NIH budget is one of the targets, as shown in loop B4.

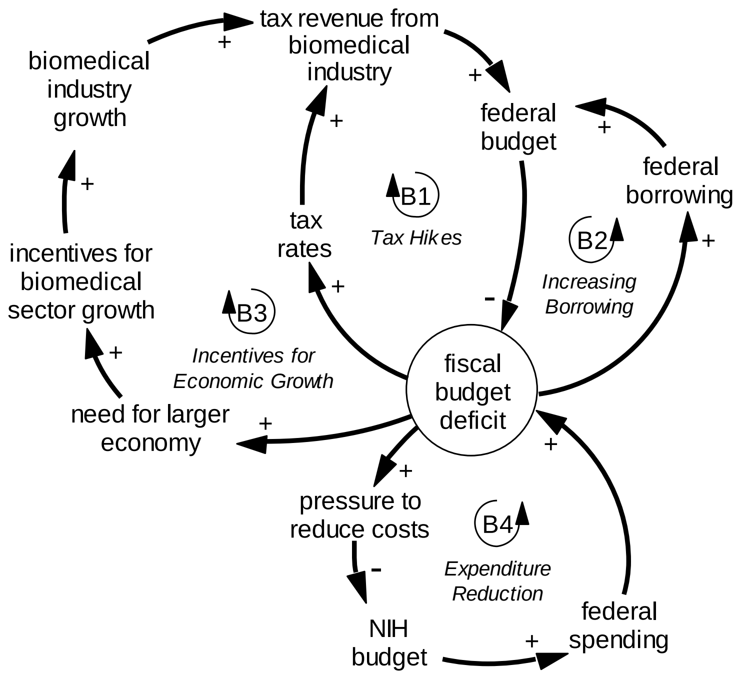

Figure 1: Causal loop diagram depicting four fiscal strategies for deficit management.
Note: Arrows indicate causal relationships: positive polarity means variables move in the same direction, while negative means they move in opposite directions. Reinforcing loops (R) amplify change—an increase in one variable leads to further increases through the loop, and vice versa. Balancing loops (B) counteract change, pushing the system toward stability.

Tradeoffs of Borrowing and Investment in a Constrained Fiscal Landscape

The strategies described above are not without broader economic consequences. While borrowing (B2) can provide immediate budgetary relief, excessive borrowing can trigger a debt spiral loop R1 (Rising Debt and Interest Payments), where higher debt levels drive up interest payments, further straining the budget in the following fiscal years. According to the debt spiral theory,[16] unchecked borrowings can create a self-reinforcing cycle, where rising debt necessitates further borrowing just to cover interest obligations, gradually reducing fiscal flexibility. In fiscal year 2024, the government paid $1.1265 trillion in interest on its national debt, an increase of $251 billion from the prior year.[17] The interest payment surpassed the $883.7 billion allocated for national defense in the same fiscal year.[18]

Additionally, while tax hikes (B1) can support economic activity, they can discourage private-sector investment (loop R2; Hindered Investment Growth) and may lead firms to cut back on long-term R&D, prioritizing short-term gains. This aligns with the “capability trap” theory, where immediate financial pressures drive decisions that undermine future growth.[19,20] Reduced R&D investment slows industry expansion, limiting future tax revenue and weakening the very tax base fiscal policies aim to strengthen. Relatedly, the debt overhang theory[21] suggests that even the anticipation of a tax rate increase can dampen economic growth by discouraging investment, as businesses expect higher future taxes to service government debt (R1-R2). Figure 2 presents the two reinforcing loops, R1-2.

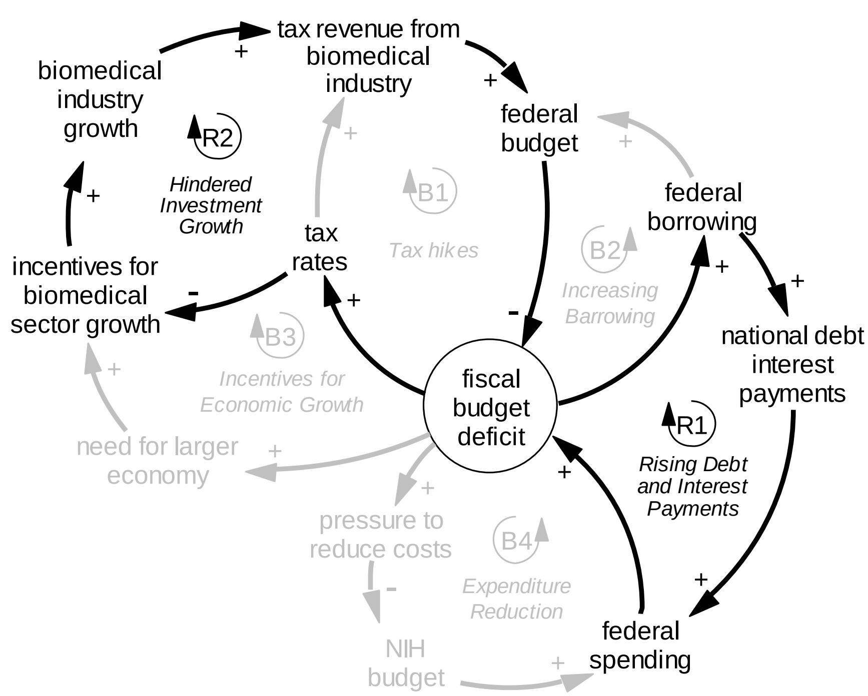

Figure 2: Tradeoffs of borrowing and investment in a constrained fiscal landscape, with a focus on the biomedical industry in the U.S. **Note**: the variables under discussion are shown in black, while previous parts of the model appear faded.

Below the Surface: The Hidden Consequences of NIH Budget Cuts

Cutting spending is often seen as a practical way to reallocate resources, but this approach can overlook deeper consequences. It is akin to focusing only on the visible tip of an iceberg—while immediate savings may seem beneficial, the consequences lie beneath the surface.

Slower Scientific Progress Amid NIH Budget Cuts

Without NIH investment in fundamental research, breakthrough discoveries might have been significantly delayed or deprioritized due to the lack of immediate profitability.[22] For example, 30-year-long basic science research in the Human Genome Project paved the way for immunotherapy,[23] recognized as "breakthrough of the year" in 2013 by Science Magazine.[24] Similarly, ongoing NIH efforts like the Brain Initiative could push forward Alzheimer's treatments or antibiotic resistance research[25,26] could help in curbing the estimated 40 million deaths by 2050[27]—two areas from which major pharmaceutical companies have backed out.[28,29]

Empirical evidence also shows that a $10 million increase in NIH funding results in approximately 2.3 additional private-sector patents,[30] which serve as drivers of innovation. This underscores how public investment in research contributes to downstream commercial applications and industry growth. Indeed, the NIH contributed to the research of nearly all (354 out of 356) drugs approved between 2010 and 2019.[31] NIH budget cuts affect this scientific progress, leading to loop R3 (Fundamental Research Contraction), where declining funding limits the research that serves as the foundation for long-term innovation.

Workforce Impact: Erosion of Scientific Talent

A shrinking NIH budget also activates loop R4 (Human Capital Erosion) by limiting research institutions' training capacity, reducing trained researchers, and weakening the innovation ecosystem in both private and public institutions. Evidence suggests that federally funded researchers frequently transition into industry, particularly in high-tech and R&D sectors.[32] NIH budget cuts leading to skilled workforce shortages risk further slowing biomedical advancements and reducing future innovations. Even temporary disruptions in NIH funding have been shown to increase research personnel unemployment by 40% in single-grant labs and drop their publication rates by 90%.[33] The outright budget cuts would likely be even more damaging, shrinking the domestic talent pool and diminishing long-term research output. This aligns with the endogenous technological change theory,[34] which links economic growth and the advancement of new ideas to the size and stability of the knowledge workforce. At a time when the U.S. remains a top destination for the world's leading scientists and medical professionals,[35] undermining this advantage risks losing talent to countries that continue to prioritize stable public investment in research.

Additionally, NIH budget constraints limiting indirect cost support weaken both research capacity (R3) and workforce development (R4). Indirect costs help institutions maintain facilities, retain staff, and sustain lab operations—without them, institutions face challenges in running training programs. Moreover, research institutions often serve as major employers, supporting local economies and expanding the tax base, especially in regions where universities are key economic drivers. At the national level, in 2024, NIH funding is estimated to generate $94.58 billion in new economic output with a $2.56 return per dollar awarded and support 407,782 jobs.[36]

Rising Costs and Market Shifts in Medical Innovation

Loop R5 (Price Surge of Novel Treatments) highlights another potential consequence: as private-sector R&D plays a large role in medical innovation, the cost of new treatments may rise. While pharmaceutical innovation has contributed to reduced healthcare costs in the long run, e.g., by decreasing the need for expensive hospitalizations, this effect is not immediate. New drugs tend to have lower utilization in their early years post-approval and can be costly at launch, contributing to near-term spending increases before potential savings materialize over a decade or more.[37] Also, private firms may concentrate on high-revenue treatments,[38] which can further drive healthcare costs up. While this approach may accelerate some breakthroughs, the growing financial burden on public healthcare programs, and consumers, may offset intended cost savings from NIH budget reductions.

Public Health and Prevention: A Costly Tradeoff

NIH funding supports not only drug development but also innovations in medical devices, screening tools, clinical protocols, surgical procedures, and public health interventions across the translational, disease, and age spectrum. These advances shape nearly every aspect of healthcare, influencing both individual patient care and broader public health outcomes. One direct consequence of NIH funding reductions appears in loop R6 (Lost Savings from Prevention), where reducing NIH funding for public health research may lead to higher long-term healthcare costs.

Overall, public health advances, including NIH-funded research, have played a crucial role in driving improvements in life expectancy, accounting for approximately 44% of the gains observed between 1990 and 2015, while pharmaceutical innovation contributed 35%.[39] As an example of screening enhancements, NIH has recently launched a clinical trials network to evaluate emerging cancer screening technologies, aiming to detect cancers earlier when they may be more treatable.[40] NIH also funds translational research, which accelerates the movement of biomedical discoveries into real-world therapies and public health interventions. Without this bridge, promising innovations may stall before reaching patients. These investments in public health improve well-being, enabling individuals to live healthier lives and, from an economic perspective, contribute more productively to the economy.[41]

Without these innovations, cost-saving medical advancements—including early detection methods and preventive treatments—may be delayed or deprioritized, forcing the healthcare system to rely more on expensive, late-stage interventions and driving up overall expenditures. Over time, this cycle places additional strain on public healthcare budgets and further reinforces pressures to cut spending, perpetuating a cycle of rising costs.

Figure 3 presents the unintended consequences of NIH budget cuts through four reinforcing loops (R3-6). Public goods theory[42] also provides a framework for understanding these dynamics, emphasizing that government investment in areas like healthcare and scientific research is crucial because they yield broad societal benefits but face underinvestment from the private sector.

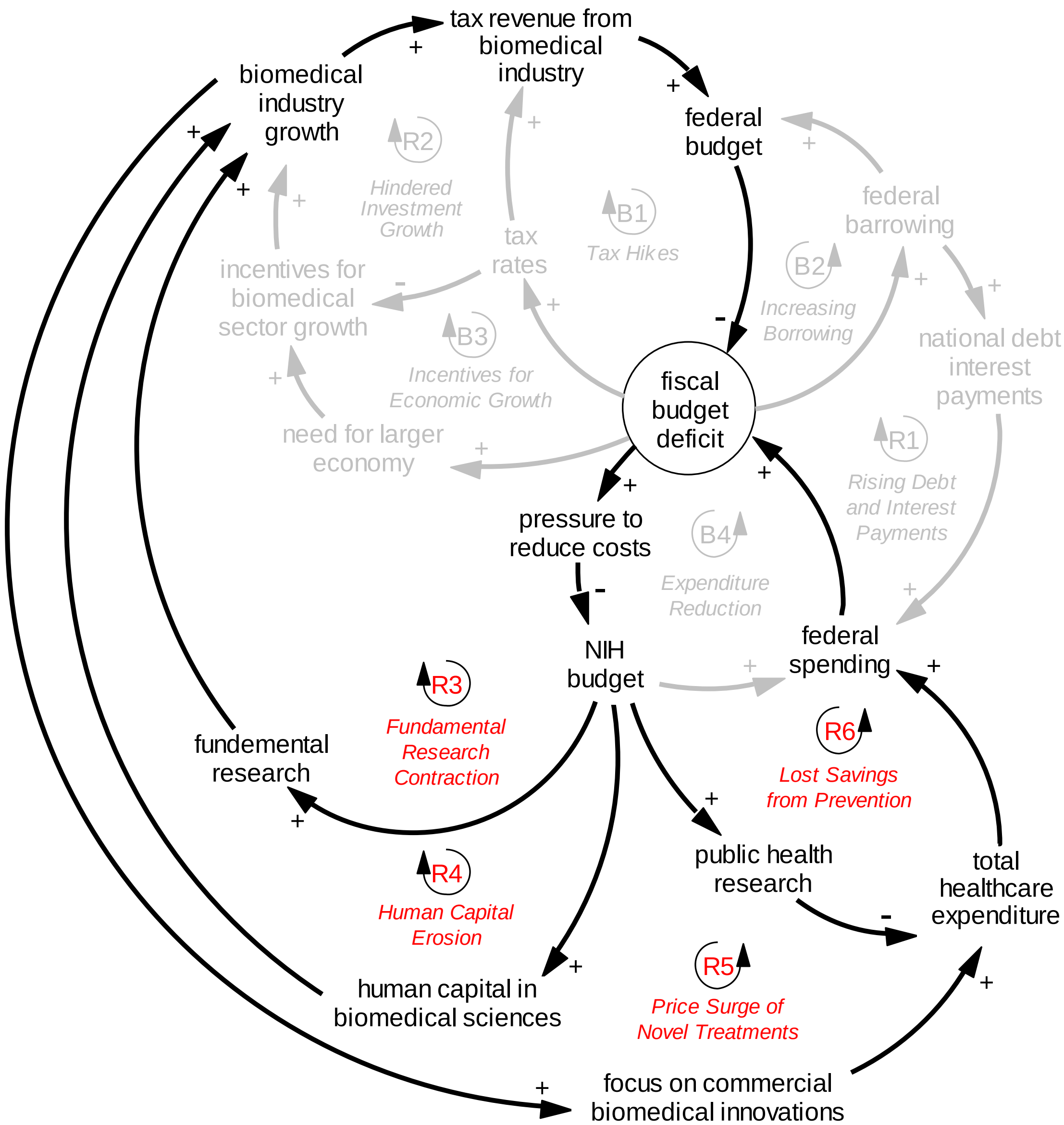

Figure 3: Unintended consequences of NIH budget cuts

Discussion

Four key insights from this analysis are captured in the reinforcing feedback loops (R3-R6) that are triggered by NIH budget cuts, each highlighting a distinct yet interconnected, potential consequence. Cutting NIH funding weakens foundational research, limiting the scientific groundwork needed for future biomedical research and reducing the pipeline of discoveries that fuel private-sector innovation. This, in turn, constrains industry growth, shifting investment priorities further toward market-driven, high-revenue treatments while deprioritizing exploratory and preventive medicine that translates into reduced healthcare costs and improved health outcomes. Additionally, reduced investment in public health and preventive research limits the development of cost-saving interventions, shifting the burden toward more expensive, late-stage treatments and exacerbating long-term healthcare costs.

Without careful consideration of these dynamics, efforts to reduce federal spending could ultimately erode the very systems that make the U.S. a global leader in scientific breakthroughs and could lead to long-term cost savings in healthcare. Sustained public R&D funding plays a key role in maintaining economic and scientific leadership. Evidence from various sectors, including artificial intelligence, suggests that nations cutting such investments often struggle to regain lost ground.[43]

A broader concern is whether these budget cuts represent a short-term fiscal strategy or a structural shift in the role of government in scientific research. Historically, public-sector investment has provided the foundation for many transformative innovations, including vaccines and gene therapies.[30] If NIH funding is scaled back, the long-term trajectory of biomedical research may shift toward a more fragmented, market-driven model that prioritizes short-term returns over high-risk and fundamental discoveries. This shift could increase reliance on private capital, venture funding, and philanthropic contributions to sustain early-stage research—mechanisms that tend to favor low-risk, high-reward projects. As a result, the U.S. research ecosystem may face increased volatility, where breakthrough discoveries become less predictable and more dependent on fluctuating market forces. In contrast, countries that continue to prioritize stable public investment in biomedical sciences may gain a strategic advantage, attracting toptier talent and accelerating advancements that could reshape the global biomedical landscape.

Finally, the Trump administration's shift to reduce NIH funding fundamentally challenges the role of health research in shaping societal well-being. Public investment in biomedical research is not merely a budgetary decision—it is an investment in human health, longevity, and quality of life. While NIH funding allocations and research strategies can always be improved for greater efficiency and effectiveness, the severity and speed of these cuts risk causing significant disruptions. If the U.S. deprioritizes public investment in science, it risks not only ceding global leadership in biomedical research but also undermining the principle that health is a universal and nonpartisan good—one that enables individuals to live full and meaningful lives, regardless of political or economic circumstance.[44]

This analysis has several limitations. First, the model simplifies complex relationships between NIH funding, scientific progress, and economic outcomes. Second, the extent to which private-sector investment can fully compensate for reductions in public funding remains uncertain and may not be fully captured. Third, this report does not quantify long-term tradeoffs, e.g., the lag between reductions in public research and downstream economic or health impacts. Fourth, our analysis does not account for global health impacts. Trump's cuts to the World Health Organization and other international health programs[45] suggest NIH reductions could further disrupt global research and cooperation. Future work should explore how these effects may compound. Finally, while our focus is on biomedical sciences, similar budgetary pressures and shifting federal priorities could have comparable effects in other fields, including environmental research, energy innovation, and advanced technology development. Understanding these broader dynamics is critical for assessing the full impact of public-sector disinvestment across multiple domains.

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