NATIONAL ACADEMIES *Sciences Engineering Medicine*

The Economic Future of the U.S. Research Enterprise: From Vision to Value — A Workshop

April 1, 2026

Government-University-Industry-Philanthropy Research Roundtable (GUIPRR)

The Economic Future of the U.S. Research Enterprise: From Vision to Value

Contents

WEDNESDAY, APRIL 1, 2025

8:30 *Registration opens and breakfast available.*

9:00-9:10 **Welcome**

- **Darryll Pines**, GUIPRR Council Co-Chair, President, University of Maryland

9:10-9:55 **Morning Fireside: Designing the U.S. Research Enterprise for National Capability and Return** **Moderator: Heather Boushey,** Professor of Practice at the Kleinman Center for Energy Policy, University of Pennsylvania

- **Stuart Buck**, Executive Director, Good Science Project

10:00-11:15 **Designing a New Capital Stack for a National Research Economy**

Moderator: Erica Goldman, Director of Policy Entrepreneurship, Federation of American Scientists

- **Sandeep Patel**, Chief Executive Officer, Catalyze R&D
- **Steven Lehmann,** Principal, Marram Grass LLC & Venture Partner, BCM Legacy Fund
- **Yan Zheng,** Executive Vice President for Strategic Engagements, IQT
- **Amy Beaird,** Co-Founder, Ecosystem Edge

11:15-11:30 **BREAK**

11:30-12:45 **The Macroeconomics of Research Investment**

Moderator: **Maryann P. Feldman,** Professor, Public Policy and Management, Watts College of Public Service and Community Solutions, Arizona State University

- **Charles Eesley,** Professor of Management Science & Engineering, Stanford University
- **Brian Darmody,** Chief Strategy Officer, Association of University Research Parks
- **Susan Helper,** Carlton Professor of Economics at the Weatherhead School of Management, Case Western Reserve University
- **Laura Appenzeller,** University of Illinois Research Park Executive Director, Assistant Vice Chancellor for Innovation

12:45-1:45 **Networking Lunch**

1:50-2:35 **Afternoon Fireside: The Economic Purposes of Publicly Funded R&D**

Moderator: Walter Copan, Vice President for Research & Technology Transfer at Colorado School of Mines

- **Arati Prabhakar**, Former Director, White House Office of Science and Technology Policy; Former Director, DARPA and NIST [Virtual]

2:35-2:50 **BREAK**

2:50-4:05 **Measuring What Matters: ROI, Opportunity Cost, and the Price of Delay**

Moderator: Charles Johnson-Bey, Chief Technology Officer, Demostrata

- **Tim Lieuwen,** Executive Vice President for Research, Georgia Tech
- **Julius Maina,** Senior Vice President & Chief Strategy Officer, Baltimore Development Corporation
- **Jeffrey Alexander**, Director, Innovation Policy, RTI International
- **Linda Bixby**, Chief Research Partnerships Officer, University of Arizona

4:05-4:30 **Closing Remarks**

- **Danielle Merfeld**, GUIPRR Council Co-Chair, Global Chief Technology Officer, Hanwha Qcells

MEETING ADJOURNS

Speaker Biographies

Laura Appenzeller is the Executive Director of the University of Illinois Research Park and the Assistant Vice Chancellor for Innovation at the University of Illinois Urbana-Champaign supporting research commercialization and industry partnerships. The Research Park is located on the campus with mixed-use development of more than 800K square feet of constructed buildings, 120 companies (large corporations and startup companies), 2,000 employees including 700 students working year-round in internships. EnterpriseWorks incubator startup companies have raised more than $1.4 billion in venture capital and $200 million in SBIR/STTR awards since the incubator opened. Laura is on the leadership team of the EDA iFAB Tech Hub, which was awarded $51 million for the growth of precision fermentation and bioprocessing in Central Illinois. Laura was the founding Chief Operating Officer of the Illinois Quantum and Microelectronics Park, working to facilitate the development and commercialization of quantum technologies in Chicago. Laura is active in numerous regional organizations and board roles.

Jeffrey Alexander, is director of innovation policy at RTI International's Center for Applied Economics and Strategy, with more than 30 years of experience in science and technology policy, strategy consulting, and innovation research. He specializes in applying advanced analytics and "big data" to inform policy and management decisions, with expertise in technology forecasting, R&D investment analysis, and regional innovation systems. Dr. Alexander has led projects on corporate innovation management, evaluation of public R&D programs, and technology commercialization, and is currently involved in assessments of federal initiatives at agencies including NIST and the Federal Highway Administration. Prior to joining RTI in 2016, he was associate director for research and analytics at SRI International. He is also an adjunct professor in the School of Business at The George Washington University and serves on the Polaris Council advising the U.S. Government Accountability Office.

Amy Beaird, PhD, is Co-Founder and Managing Partner of Ecosystem Edge, where she helps regional innovation ecosystems assess and strengthen their partnership infrastructure. A nationally recognized innovation strategist with over 20 years of experience spanning research, entrepreneurship, and ecosystem building, Amy brings a rare blend of analytical rigor, systems savvy, and facilitation expertise to every engagement. She previously served as Chief Strategy Officer at Florida High Tech Corridor and has supported NSF Regional Innovation Engines and hundreds of organizations in aligning vision with action. Amy serves as an Advisor to The Builder Platform.

Heather Boushey is a professor of practice at the Kleinman Center where she runs the EconClimate Lab. Boushey is one of the nation's most influential voices on economic policy and a leading economist who focuses on the intersection between economic inequality, growth, and public policy. She served in the Biden administration as a member of the Council of Economic Advisers and chief economist to the President's Investing in America Cabinet. She is also a non-resident fellow at the Reimagining the Economy Project at the Harvard Kennedy School. Boushey co-founded the Washington Center for Equitable Growth and served as the President & CEO and a Steering Committee member from its launch in 2013 until she joined the Biden-Harris Transition Team in 2020. Her latest book, *Unbound: How Economic Inequality Constricts Our Economy and What We Can Do About It* (Harvard University Press), which was called "outstanding" and "piercing" by reviewers, was on the *Financial Times* list of best economics books of 2019. She is also the author of *Finding Time: The Economics of Work-Life Conflict*, and co-edited a volume of 22 essays about how to integrate inequality into economic thinking called *After Piketty: The Agenda for Economics and Inequality*.She previously served as chief economist for Secretary of State Hillary Clinton's 2016 presidential transition team and as an economist for the Center for American Progress, the Joint Economic Committee of the U.S. Congress, the Center for Economic and Policy Research, and the Economic Policy Institute.

Dr. Linda Bixby brings more than 35 years of leadership experience spanning government, industry, academia and nonprofits. She joins us from the NobleReach Foundation, where she served as executive vice president for academic partnerships, designing and leading national programs that connect emerging technologies and talent with critical public missions. Her career reflects a strong record of building high-impact partnerships, developing innovation ecosystems and guiding cross-sector strategy. She has also held senior roles in the intelligence community, federal consulting, higher education and corporate environments, positioning her well to navigate the complexities of research partnerships at scale.

Stuart Buck is the Executive Director of the Good Science Project, a non-partisan think tank focused on improving science. Previously, he led a large metascience initiative as Vice President of Research at the philanthropy Arnold Ventures.

Brian Darmody is Chief Strategy Officer for Association of University Research Parks (AURP) and former CEO. Previously he worked at UMD College Park and University System of Maryland in a variety of economic development and research administration roles, including forming public-private partnerships, creating the University's tech transfer office and incubator, and earlier served as a staff member for a U.S Congresswoman, member of Maryland House of Delegates and in the U.S Health Care Financing Administration Office of Attorney Advisor. He holds a Juris Doctor degree.

Charles "Chuck" Eesley is a Professor of Management Science & Engineering at Stanford and Faculty Co-Director of the Stanford Technology Ventures Program, where he studies how institutional environments and industrial policy — from export controls to the IRA and CHIPS Act — shape entrepreneurial outcomes and the flow of capital through the innovation pipeline. His research, published in Nature, Strategic Management Journal, and Organization Science, includes landmark studies on the economic impact of university alumni entrepreneurs at Stanford, MIT, and Tsinghua, as well as work on how China's industrial policies and institutional environment shape venture formation and technology commercialization. He brings both scholarly rigor and firsthand founder experience, having co-founded NovoEd and worked with entrepreneurs across six continents.

Erica Goldman currently serves as the Director of Policy Entrepreneurship at the Federation of American Scientists (FAS). She has served in various roles spanning the boundaries between science and policy throughout her 20+-year career, including in the White House Council on Environmental Quality, Congress, Science Magazine, and multiple non-profit organizations. In her current role at FAS, she works to imbue the culture and practice of policy entrepreneurship throughout the organization, catalyzing, cultivating, and executing work that embeds science, technology, innovation, and experience into government and public discourse in order to build a healthy, safe, prosperous and equitable society. Erica received her Ph.D. in Biology from the University of Washington and her Bachelor's of Science degree from Yale University.

Susan Helper is the Carlton Professor of Economics at the Weatherhead School of Management at Case Western Reserve University. She has served as Senior Advisor for Industrial Strategy at the White House Office of Management and Budget, and as Chief Economist of the U.S. Department of Commerce. Her research focuses on the impacts of organization and supply chain structure on innovation, job quality, and sustainability. She is a Research Associate of the National Bureau of Economic Research. She has a BA from Oberlin College and a PhD in Economics from Harvard University.

Steven Lehmann, Principal, Marram Grass LLC & Venture Partner, BCM Legacy Fund, is a venture builder and investor who specializes in commercializing early life sciences research; he brings fifteen years of experience leading teams that surface scientific discoveries and advance them toward clinical and societal impact. Steve was a founding member of Portal Innovations, where he built and led the venture investments practice, deployed investments that have catalyzed over $200 million, and served on the boards of March Biosciences and Cardiosense. Prior to Portal, he led the University of Chicago's $20M Innovation Fund, and continues to teach graduate-level courses on biomedical venture creation. Steve holds an MBA from the University of Notre Dame and a BS in Mechanical Engineering from Valparaiso University.

Dr. Tim Lieuwen is the Executive Vice President for Research (EVPR) at the Georgia Institute of Technology. In this role, he oversees the Institute's $1.37 billion portfolio of research, economic development, and sponsored activities. This includes leadership of the Georgia Tech Research Institute (GTRI), the Enterprise Innovation Institute, nine interdisciplinary research institutes (IRIs), and related research administrative support units. In his 25-plus years at Georgia Tech, Lieuwen earned his master's and Ph.D. degrees in mechanical engineering (1996 and 1999, respectively) and has held multiple leadership positions. He has been the executive director of the Strategic Energy Institute (SEI) and served as the interim chair of the Daniel Guggenheim School of Aerospace Engineering in 2023. Lieuwen has received numerous honors and recognition for his work in clean energy systems and policy, national security, and regional economic development. Additionally, he has been awarded the titles of Regents' Professor and the David S. Lewis, Jr. Chair in AE. He is also a member of the National Academy of Engineering and is a fellow of the American Society of Mechanical Engineers and the American Institute of Aeronautics and Astronautics.

Julius Valentine Maina serves as Senior Vice President and Chief Strategy Officer at the Baltimore Development Corporation (BDC), where he is rewriting the economic narrative of a city too often defined by its challenges rather than its assets. Through strategic planning, data analytics, research, and knowledge management, he is leading Baltimore's next Comprehensive Economic Development Strategy (CEDS)—positioning the city as a national destination for business growth, activating investable commercial corridors, and building lasting wealth in SEDI communities. He is guided by a simple conviction: data, deployed well, can change how a city sees itself—and how the world sees Baltimore.

Danielle Merfeld, GUIPRR Council Co-Chair, Qcells, As Global Chief Technology Officer, Danielle leads Qcells' research and development for advanced solar products and complete energy solutions. She is focused on accelerating the company's efforts to enhance technology capability as it builds the United States' first fully integrated solar supply chain.Prior to this role, Danielle led technical efforts in GE Renewable Energy to develop differentiated products and services across the broadest renewable energy portfolio in the industry, including onshore wind, offshore wind, solar PV, batteries, hydro and grid solutions. Danielle was elected to the National Academy of Engineering in 2021. She received her Ph.D. in Electrical Engineering from Northwestern University. Danielle is on the Board of Trustees at the University of Notre Dame and serves on the National Academy of Engineering's President's Business Advisory Committee. She also co-chairs the National Research Roundtable (GUIPRR), and serves on the Executive Advisory Board of the Strategic Energy Institute at Georgia Tech.

Sandeep Patel is an independent consultant and entrepreneur with expertise at the intersection of science, business, and global health security. From 2020 to March 2024, he served as the founding director of BARDA's Division of Research, Innovation, and Ventures (DRIVe) at the U.S. Department of Health and Human Services, where he led over $700 million in investments in translational science and early-stage companies to strengthen preparedness for health threats. He also established the U.S.'s first public-private venture capital fund at BARDA. At HHS, Patel played a key role in the Immediate Office of the Secretary, founding and leading KidneyX, a public-private partnership advancing breakthrough therapies for kidney disease. He also helped spearhead the Advancing American Kidney Health Initiative and led efforts to use innovative tools such as incentive prizes and crowdsourcing to address complex health challenges.Patel is a recipient of the American Society of Nephrology's President's Medal and the HHS Secretary's Distinguished Service Award. He previously served as a Mirzayan Science and Technology Policy Fellow at the National Academy of Sciences. He holds a Ph.D. in physical chemistry from the Georgia Institute of Technology and a B.A. in chemistry from Washington University in St. Louis.

Darryll J. Pines serves as the 34th president of the University of Maryland and the Glenn L. Martin Professor of Aerospace Engineering. Pines' research focuses on structural dynamics, including structural health monitoring and prognosis, smart sensors, and adaptive, morphing and biologically inspired structures as well as the guidance, navigation and control of aerospace vehicles. He holds seven co-authored patents with his students and collaborators. A member of the National Academy of Engineering, he is a fellow of the American Institute of Aeronautics and Astronautics, American Society of Mechanical Engineers and Institute of Physics; chairs the Engineering Advisory Committee for NSF's Engineering Directorate; sits on the Board of Trustees for Underwriters Laboratory not-for-profit arm; and serves as a member of the MIT Corporation, the board of trustees for the Massachusetts Institute of Technology. Pines also serves on the Big 10 Conference's Council of President and Chancellors, and as an at-large member of the Association of Public and Land-grant Universities' Board of Directors. Pines received a BS in Mechanical Engineering from the University of California, Berkeley, and MS and PhD in Mechanical Engineering from the Massachusetts Institute of Technology.

Arati Prabhakar served in President Biden's cabinet as his science and technology advisor and as Director of the White House Office of Science and Technology Policy (OSTP). Her work spanned artificial intelligence, health outcomes, climate and clean energy, and innovation for a prosperous and secure America. She previously served as Director of the Defense Advanced Research Projects Agency (DARPA) and as Director of the National Institute of Standards and Technology (NIST). In the private sector, she was chief technology officer for a specialty materials manufacturer, a venture capitalist investing in startups in semiconductors and cleantech, and the founder of an innovation nonprofit. Today she advocates for federally funded R&D to achieve our nation's aspirations.

Dr. Yan Zheng, is the Executive Vice President for Strategic Engagements at IQT, aligns priorities across IQT's leadership team, coordinates engagements across the USG, and implements business strategies designed to execute IQT's mission and vision. Prior this role, Dr. Zheng served as VP, Technology leading investments in microelectronics, semiconductors, and quantum technologies to solve critical mission challenges facing the U.S. National Security and Intelligence Community. Prior to IQT, Dr. Zheng was at Booz Allen Hamilton where he provided technical advising for the Defense Advanced Research Projects Agency (DARPA) including developing technical goals across a diverse set of technology areas such as thermal management, directed energy, RF communications, microelectronics, and photonics. While at DARPA, Dr. Zheng was the lead coordinator for the Electronics Resurgence Initiative (ERI) a large-scale, multibillion-dollar effort to boost U.S microelectronics innovation. In addition, Dr. Zheng served as an IEEE congressional fellow in the office of Senator Chris Coons where he focused on developing policy to boost U.S. R&D, support domestic manufacturing, and spur innovation and economic growth. Dr. Zheng helped draft a bill to establish a non-profit foundation for the Department of Energy to commercialize innovative technologies which later became law in the CHIPS and Science Act of 2022 as the Foundation for Energy Security and Innovation (FESI). Dr. Zheng holds a bachelor's degree in electrical engineering from the University of California, San Diego, and a doctorate in electrical engineering from the University of California, Santa Barbara

Workshop Planning Committee Roster

Maryann P. Feldman, Chair
Professor of Public Policy
Consortium for Science, Policy and Outcomes
Arizona State University

Charles Johnson-Bey (NAE)
Co-Principal Investigator
Engineering Research Visioning Alliance

Megan Anderson
Executive Vice President of Capabilities
IQT

Isabel Wen
Co-Founder
Aurelius

Walter G. Copan
Vice President for Research and Technology Transfer
Colorado School of Mines

Workshop Committee Biographies

Maryann P. Feldman, *Chair*
Maryann P. Feldman is a leading scholar in innovation, entrepreneurship, and regional economic development. She is the Watts Professor of Public Policy and Management at Arizona State University's Watts College of Public Service and Community Solutions. Her work focuses on how research institutions, firms, and entrepreneurs translate scientific knowledge into economic growth, productivity, and regional competitiveness. She serves on the advisory board of the Canadian Institute for Advanced Research (CIFAR) global program on Innovation, Equity, and the Future of Prosperity and is a board member of the Ontario Brain Institute. She is also an editor of Research Policy, the leading journal in innovation studies. Internationally recognized for her scholarship, Dr. Feldman is a recipient of the Global Award for Entrepreneurship Research and the Academy of Management's Distinguished Scholar Award. She holds a PhD in economics and management from Carnegie Mellon University. She has served as co-chair on five congressionally mandated National Academies of Sciences, Engineering, and Medicine (NASEM) studies of the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, providing rigorous analysis of program performance, economic impact, and policy design.

Megan Anderson, *Member*
Megan Anderson is the Executive Vice President of Capabilities at IQT. In this role she is responsible for implementing a strategic roadmap to deliver high impact technical solutions across the national security community. Previously, Megan ran each of the technology practices responsible for identifying and executing investments across a range of technologies including artificial intelligence, analytics, infrastructure, cybersecurity, communications, materials, energy, sensors, and commercial space. Additionally, Megan is on the Board of Directors for the Intelligence and National Security Alliance and serves on the National Academies council for the Government-University-Industry-Philanthropy Research Roundtable. Dr. Anderson was also selected as a founding member of Chief, the premier private network for women executives. Prior to joining IQT, Megan worked in the biotechnology sector as a Senior Scientist at Fluidigm Corporation. Dr. Anderson holds a bachelor's degree in both applied mathematics and general biology from the University of California, San Diego, and a doctorate in biochemistry and molecular biophysics from the California Institute of Technology. She serves on the Government-University-Industry-Philanthropy Research Roundtable Council.

Walter G. Copan, *Member*
Walter G. Copan is Vice President for Research & Technology Transfer at Colorado School of Mines, where he advances the university's research enterprise, industry partnerships, and pathways to commercialization. Dr. Copan is a distinguished leader with wide-ranging experience spanning large company, entrepreneurial tech start-up, U.S. government, nonprofit, and other public sector settings. For the U.S. government, he also served with two of the Department of Energy national laboratories: the National Renewable Energy Laboratory and Brookhaven National Laboratory. Copan has led innovation organizations across government, academia, and industry, including service as Director of the National Institute of Standards and Technology (NIST) and as the U.S. Under Secretary of Commerce for Standards and Technology. His career has emphasized technology translation, standards, and policy approaches that strengthen U.S. competitiveness. Copan holds a PhD in physical chemistry and a BS/BA dual degree in chemistry and music, all from Case Western Reserve University. He serves on the Government-University-Industry-Philanthropy Research Roundtable Council.

Charles Johnson-Bey, *Member*
Charles Johnson-Bey co-leads the National Science Foundation sponsored Engineering Research Visioning Alliance (ERVA), helping to shape national engineering research agendas. He is a former Partner and Senior Vice President at Booz Allen Hamilton, where he led engineering and advanced technology strategy. Prior to Booz Allen, he had a distinguished career at Lockheed Martin Corporation. As the Open Innovation Program Manager, he led the technology portfolio that supported nine of Lockheed's Focus Programs. Johnson-Bey is a nationally recognized engineering executive known for translating emerging technologies into real-world impact across defense, academia, and industry. He has expertise spanning artificial intelligence, cyber resilience, quantum computing, and advanced manufacturing. He is member of the National Academy of Engineering. Johnson-Bey received a BS in electrical and computer engineering from Johns Hopkins University, a PhD in electrical engineering from the University of Delaware, and a Chief Technology Officer Professional

Certificate from the Massachusetts Institute of Technology. Johnson-Bey serves as a member of the National Academies On Being a Scientist Panel on Openness and Security as well as the U.S.-Africa Frontiers of Science, Engineering, and Medicine committee.

Isabel Wen, *Member*
Isabel is Co-Founder of Aurelius, a boutique communications strategy firm for technical entrepreneurs, and serves as a Resource Navigator for the Greater Baltimore Committee. She previously served as the Growth Director of Venture Development at the Maryland Technology Development Corporation (TEDCO), a state-led venture fund and economic development agency, where she led programs to support entrepreneurs. Isabel serves as an Advisory Board member for SXSW 2026 Pitch and a Tech Pitching Judge for SelectUSA Investment Summit 2026. She previously served as an Advisory Board Member for Torrey Project, Founder of NEXT San Diego, and Chair of the MAPS program for Women In Bio Southern California chapter.A former nanotechnology scientist and nonprofit leader, she brings over a decade of experience in deep tech commercialization and regional innovation ecosystem building. Her expertise lies in entrepreneur development, focusing on translating innovation into economic value through business strategy and communications. Isabel received the 2021 Ignite Respect Award from the Center for Respectful Leadership, and is a member of the Maryland Economic Development Association. She received her BS in Chemistry from University of California San Diego, and is a graduate of the Next Economy MBA, Lift Economy (2021); Rising Leaders, Leadership Greater Washington (2025); and VC University (2024).

Advanced Reading

Papers:

Unleashing American Innovation. NIST Green Paper (2019)
https://www.nist.gov/unleashing-american-innovation/green-paper

Assessing the Potential to Improve Grants Management Using Blockchain Technology. MITRE (2019)
https://www.mitre.org/sites/default/files/2021-11/prs-19-1654-MITRE-grants-mgt-blockchain-study-report.pdf

Harnessing Blockchain in the Federal Government. The Joint Financial Management Improvement Program (2023)
https://www.cfo.gov/assets/files/JFMIP-24-01.pdf

Websites:

Can Decentralized Science Be the Next Frontier of Scientific Research? California Review Management (2025)
https://cmr.berkeley.edu/2025/11/can-decentralized-science-be-the-next-frontier-of-scientific-research/

Launching the Genesis Mission
https://www.whitehouse.gov/presidential-actions/2025/11/launching-the-genesis-mission/

Grant Opportunity: The Genesis Mission: Transforming Science and Energy with AI
https://www.grants.gov/search-results-detail/361526

National Security Commission on Emerging Biotechnology
https://www.biotech.senate.gov/

AURP Power of Place and Power of Place 2.0
https://aurp.org/wp-content/uploads/2025/08/The_Power_of_Place.pdf
https://aurp.org/wp-content/uploads/2025/08/AURPPowerofPlace2.pdf

AURP Economic Impact of University Research Parks and Innovation Districts in North America (page 7 most relevant)
https://aurp.org/wp-content/uploads/2025/09/AURP2025_Stiletto_Econ_Impact_RE_FINAL.pdf

AURP CHIPS + Science Act (much of the funding while authorized was never appropriated at the expected levels)
https://aurp.org/wp-content/uploads/2025/08/AURP-CHIPS-WhitePaper_FINAL-1.pdf

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Partner Institutions

- Agilent Technologies
- IBM
- Idaho National Laboratory
- Intel
- John Deere
- Lawrence Livermore National Laboratory
- MITRE
- Onconova Therapeutics
- Pacific northwest National Lab
- Riverside Research
- RTI International
- STREAMLYNE
- Universities Research Association
- Clarivate
- Kavli Foundation
- Argonne National Laboratory
- Dana Foundation
- Casey Privacy Contracting
- Springer Nature
- Hampton roads Biomedical Research Consortium
- Burroughs Wellcome Fund
- Connecticut Invention Convention
- Dell Technologies
- Elsevier
- L3Harris
- Mars Incorporated
- RTX
- UL Research Association
- Venturewell
- Siemens
- Gordon and Betty Moore Foundation
- The Kavli Foundation
- Arizona State University
- Auburn University
- California Institute of Technology
- Florida Atlantic University
- Drexel University
- George Mason University
- George Washington University
- Georgia Institute of Technology
- Kennesaw State University
- Northeastern University
- Princeton University
- Stanford University
- Temple University
- Texas A&M University
- Texas State University
- Tufts University
- University of Arizona
- University of Arkansas | Institution for Integrative and Innovative Research
- University of California Davis
- University of Florida
- University of Idaho
- University of Illinois Urbana-Champaign
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- University of Nevada, Reno
- University of Southern California
- University of Texas at El Paso
- University of Texas at San Antonio
- Washington State University
- Wayne State University
- West Virginia University

GUIPRR STAFF (2024)

MICHAEL NESTOR, Board Director

JENNIFER GRIFFITHS, Senior Program Officer

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SIERRA JACKSON, Program Officer

DELANEY BOND, Senior Program Assistant

For more information about GUIPRR visit our website at www.national-academies.org/guirr

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Government University Industry Philanthropy Research Roundtable (GUIPRR)

MESSAGE FROM THE CO-CHAIRS

Recognizing the importance of philanthropy in supporting and shaping the U.S. innovation ecosystem, we are pleased to announce that GUIRR is changing its name to the Government-University-Industry-Philanthropy Research Roundtable (GUIPRR).

GUIRR has long been an established forum in which senior appointees of federal research agencies, joined by select industry and university leaders, gather to discuss promising new opportunities and deliberate issues that challenge and build bridges between government, university, and industry sectors centered on the productivity and dynamism of the nation's research enterprise. The name and mission change from GUIRR to GUIPRR will invite new conversations, relationships, and collaboration among leaders within the research community and more accurately reflect the diversity of the U.S. research enterprise. Ultimately, this milestone will help GUIPRR better serve the strategic goals of established U.S. research and innovation institutions while welcoming new perspectives and institutions into the Roundtable to support future U.S. scientific leadership.

GUIPRR's purpose and mission remains intact: To provide a setting for the nation's science and technology leaders and decision-makers to meet and interact, share perspectives and insights to discover new ways of interpreting issues, and collaborate on effective solutions. At this time of extraordinary research opportunities and multiple stresses on the research and innovation enterprise, GUIPRR's discussions on strategy, policy, and multilateral implementation are vital.

We are grateful to the National Academies, particularly the three Presidents, Dr. Marcia McNutt (Sciences), Dr. Victor Dzau (Medicine), and Dr. John Anderson (Engineering), for their enthusiastic support of this big transition. We would also like to thank GUIPRR Council member Dr. France Córdova, President of the Science Philanthropy Alliance, who has been both a driver and facilitator for GUIPRR's engagement with the philanthropic community.

And finally, thank you to the GUIPRR Membership, without whom the roundtable could not exist. We look forward to many more years of conversations and activities that will help improve and maintain the vibrancy of the nation's research enterprise.

Warmest regards,

Danielle Merfeld
Co-chair

Darryll Pines
Co-Chair

Introduction to the Roundtable

In 1984, the National Research Commission on Research published a report, which called for an institutionalized forum to facilitate dialogue among the top leaders of government and non-government research organizations, that led to the creation of the Government-University-Industry Research Roundtable (GUIRR), now the Government-University-Industry-Philanthropy Research Roundtable (GUIPRR). 40 years later, GUIPRR continues to further its formal mission, revised in 1995, "to convene senior-most representatives from government, universities, and industry to define and explore critical issues related to the national and global science and technology agenda that are of shared interest; to frame the next critical question stemming from current debate and analysis; and to incubate activities of on-going value to the stakeholders. This forum will be designed to facilitate candid dialogue among participants, to foster self-implementing activities and, where appropriate, to carry awareness of consequences to the wider public" and continues to build upon it.

The Roundtable has three categories of membership: (1) individual Council members (representing all facets of GUIPRR membership to have a balance of voices); (2) Ex-Officio appointments; (3) University-Industry-Philanthropy Partners. With sponsorship from the National Academy of Sciences, Engineering, and Medicine, Federal Agencies, and Partnership Contributions, GUIPRR utilizes these funds to help respond to pressing issues within the S&T Research Enterprise through three-annual meetings, the webinar series, and various special projects.

Webinars

GUIPRR's webinar series are open to the public and help fill gaps in discussion not held at the tri-annual meetings. They bring together a larger audience, and this year the webinar "Philanthropy and Basic Research: Partnerships and New Pathways for Sustainable Funding" helped lay the groundwork for the major name change. These webinars not only allow for deeper public engagement with GUIPRR's work, but also for partner institutions to help shape the discussions from GUIPRR.

Industry Forums

GUIPRR hosted a series of webinars that brought senior leaders to consider workforce issues and development. Both "Future STEM Workforce skills, gaps, and staffing demand reflecting new student dynamics" and "Current STEM Labor Markets: Upstream Consequences for Industry and Innovation" helped identify and discuss these issues in depth. This webinar series considered upstream consequences, student needs, and economic influence all needed to create and maintain a robust workforce.

Collaboration with FDP

At the annual May FDP meeting, GUIPRR hosted a panel titled "Entrepreneurial Partnerships Between National Laboratories and Regional Institutions of Higher Education" which allowed panelists to discuss the need to foster engaged relationships between institutions and underrepresented individuals in the entrepreneurial space. The panel also clarified the needs of both National Laboratories and regional universities to facilitate partnerships that would support and drive innovations to market more efficiently.

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GUIPRR Impact Survey

2025

FROM THE DIRECTOR: WHY WE MEASURE IMPACT

Every two years, GUIPRR surveys its members to understand how our work helps translate ideas into collaboration and policy insight with impact across the national research enterprise. The results help us see where we are making progress and where we need to do better.

The 2025 findings show steady growth in both engagement and depth. The transition from GUIRR to the Government–University–Industry–Philanthropy Research Roundtable (GUIPRR) reflects how our community has matured. Adding philanthropy as a full partner has strengthened the network and allowed us to explore topics that sit at the intersection of investment, science, and public value.

Over the past two years, GUIPRR has also experimented with new ways of working. We reshaped the format of our meetings to focus on practical exchange with some breakout sessions at meetings fostering early-stage collaboration rather than just presentation. We introduced interest groups that link members around shared priorities, which has generated new energy and consistent follow-up between sessions.

We also piloted virtual breakout Council meetings that created space for more candid dialogue among members. Those sessions directly informed the development of the **Decadal Review of the U.S. Research Ecosystem**, and the recent rapid movement on the **Strategic Assessment of the National Research Landscape**, demonstrating how agile engagement can yield tangible results.

The data shows that members rely on GUIPRR for perspective and connection. They point to our unique role as a neutral space for honest, cross-sector conversations about science, technology, and policy. The continuing annual **"Coffee with…"** series helped make those conversations more personal and connected, giving members a way to stay in dialogue between meetings.

Participation has remained strong across all formats. The workshops on **AI Infrastructure to Accelerate Convergence and Catalyze U.S. Scientific Innovation** and **Bolstering National Science and Technology Competitiveness through Effective Science Communication** had the greatest impact in this survey period, drawing broad cross-sector engagement and strong participation from senior leaders. The workshop on **Incentivizing Urgency, Speed, and Scale to Support Future U.S. Innovation** also stood out for its candid discussion of funding models and research culture, and "Urgency, Speed, and Scale" has become a tagline for GUIPRR in the past few years.

Among webinars, **Data-Informed Decision-Making, Research Quality, Transparency, Rigor, and Innovation in a Changing Scientific Landscape**, and A**dvancing University–Philanthropy Partnerships for Sustainable Research** reached the largest audiences and generated the most follow-up interest from participants.

Members describe GUIPRR as an environment that allows them to think strategically, test ideas without pressure, and find partners who share a long-term view of the national research enterprise. Many have been involved for more than five years, while newer participants continue to expand our reach and challenge us to evolve.

Our purpose is clear: to bring together the leaders and institutions that drive American science and technology forward and secure our national place in global innovation.

GUIPRR will continue to adapt as science and policy evolve, helping government, universities, industry, and philanthropy and new institutions work together to strengthen the systems that sustain innovation and public confidence in science.

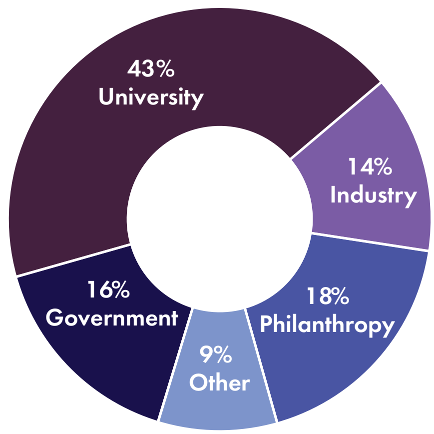
Thank you for being part of this community and for helping us carry this work forward.

Michael W. Nestor, Ph.D.
Director, Government–University–Industry–Philanthropy Research Roundtable

WHO RESPONDED

A total of 44 members completed the 2025 impact survey, representing every sector of GUIPRR's network.

- 43% University
- 18% Philanthropy
- 16% Government
- 14% Industry
- 9% Other

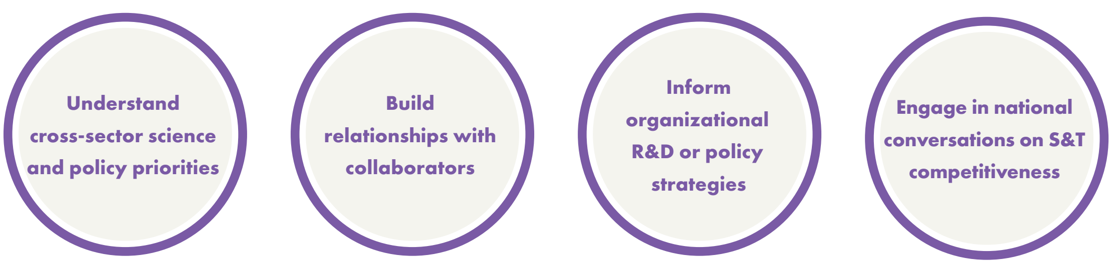


Nearly half have engaged with GUIPRR for more than five years. Most participate through roundtable meetings and webinars, with many contributing as speakers, supporters, or working group members.

> "41% of respondents have been with GUIPRR for over five years."

WHAT GUIPRR HELPS MEMBERS DO

Participants report that GUIPRR significantly strengthens their ability to:



Over 60 percent rate GUIPRR's influence as significant or exceptional in at least one of these areas.

> "GUIPRR has been a valuable platform for us to share our work and our vision for a new science paradigm." *(Philanthropy)*

INFLUENCE AND COMMUNICATION

Members credit GUIPRR events with shaping how their organizations communicate science to policymakers, the public, and global partners.

58%
report new or improved approaches to public engagement

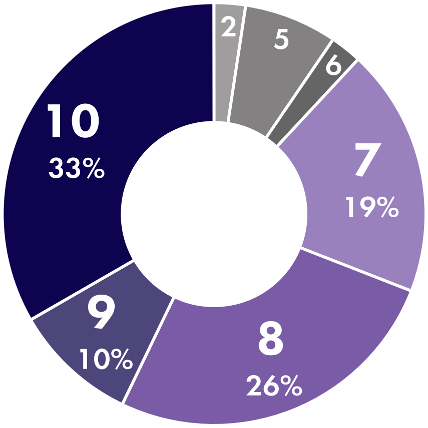
61%
say GUIPRR strengthened their communication with decision-makers

47%
have advanced open science or collaboration practices as a result

> GUIPRR provides a space to discuss how to responsibly and effectively address the new big R&D system challenges before us.
> *(Government)*

SATISFACTION AND ADVOCACY

Members continue to recommend GUIPRR to peers and partners. Over 85% rated their likelihood to recommend at 7 or higher on a 10-point scale.



> GUIPRR is exceptional and needs to continue in spite of the challenging budget environment.
> *(Industry)*

CONNECTIONS AND OUTCOMES

61% of respondents made new professional connections through GUIPRR. Of those, most led to tangible outcomes:

82% **shared resources, data, or tools**

22% **began new research collaborations**

15% **developed policy recommendations or pilot projects**

11% **recruited or joined new organizations**

> "We really value the Roundtable and see its value in shaping how science happens in the future." *(University)*

PRIORITIES FOR 2025–2026

Respondents emphasized that GUIPRR should:

- Convene targeted, smaller meetings focused on specific challenges
- Strengthen working groups that connect federal, academic, and philanthropic efforts
- Support new partnership models for funding and innovation
- Continue to explore AI, capital flow, and the future research workforce

> "We very much appreciate GUIPRR's recent inclusion of philanthropy. It is so important, especially at this time." *(Philanthropy)*

LOOKING AHEAD

Across government, universities, industry, and philanthropy, GUIPRR remains a place where people can think strategically about the nation's research enterprise.

In 2026, we will:

1. Expand thematic convenings around capital flow, workforce, and trust in science.
2. Build tools that translate roundtable insights into brief, usable formats.
3. Strengthen collaboration among our member organizations.
4. Continue to serve as a neutral space where cross-sector leaders can work through complex problems together.

> "GUIPRR has been a critically important convening and asset for the National Academies and the U.S."
> *(Academia)*

Have GUIPRR programs influenced how you or your organization:

	Not at all	Somewhat	Moderately	Significantly	Not applicable
Communicate research to policymakers?	6.8%	22.7%	29.5%	27.3%	13.6%
Engage the public or communities in scientific work	6.8%	15.9%	43.2%	31.8%	2.3%
Approach global science collaboration	13.6%	29.5%	29.5%	22.7%	4.5%
Adopt or explore open science practices?	11.4%	27.3%	36.4%	22.7%	2.3%

To what extent has GUIPRR helped you:

	Not at all	Somewhat	Moderately	Significantly	Exceptionally
Understand cross-sector science policy priorities?	0.0%	6.8%	29.5%	45.5%	18.2%
Build relationships with collaborators across sectors?	6.8%	15.9%	29.5%	29.5%	18.2%
Inform or influence your organization's R&D or policy approach?	6.8%	20.5%	40.9%	18.2%	13.6%
Engage in national conversations on S&T competitiveness?	6.8%	11.4%	20.5%	36.4%	25.0%

ABOUT GUIPRR

The Government–University–Industry–Philanthropy Research Roundtable (GUIPRR) of the National Academies convenes senior leaders from every sector of the U.S. research enterprise. Together, they identify shared challenges, test collaborative models, and promote national competitiveness built on integrity, trust, and innovation.

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DRAFT

Local Returns to Federal Innovation Investment: Evidence from the National Laboratories

Susan Helper, Resem Makan, and Daniel Shoag

Case Western Reserve University, March 7, 2026

Draft for NBER conference/volume, Entrepreneurship and Innovation Policy and the Economy, Washington DC, May 7, 2026.

1. Introduction

That the social returns to innovation in general are very high is well established: knowledge spillovers and appropriability problems mean that private markets underinvest in research (Arrow 1962; Nelson 1959), and quantitative estimates confirm large gaps between social and private returns (Jones and Summers 2020). But it's less clear whether federal innovation investments can reliably spark new ideas and economic activity, especially in places far from the existing technological frontier. Answering this question is empirically difficult because federal R&D dollars typically flow to elite research universities and existing clusters — places where complementary human capital and institutions are already present and where innovation would likely have grown even absent the investment (Howell 2024). Moreover, public funding can crowd out private effort, political incentives can distort targeting, and resources directed to one institution or place may come at the expense of another (Bloom, Van Reenen, and Williams 2019).

This paper uses the U.S. national laboratories to make progress and suggest future research on this question. The laboratories combine three features rarely observed together: large federal research investments, plausibly exogenous location decisions, and long-run data spanning several decades. Evidence from newly digitized historical data shows that counties in which laboratories were located experienced large and persistent increases in innovation and economic activity — including patenting by non-laboratory-affiliated inventors, shifts in local invention toward laboratory research fields, and sustained growth in retail sales, income, and educational attainment (Helper, Makan, and Shoag 2025).

The national laboratories provide a particularly informative setting precisely because they sidestep the usual identification problem. Laboratory locations were not chosen to maximize economic spillovers —

they were chosen for security and secrecy, pushing facilities toward remote or lightly populated areas with no prior research capacity, and sometimes almost no population. Given that substantial innovation ecosystems emerged even under these conditions, the resulting effects likely represent a lower bound on the local spillover returns to federal research infrastructure deliberately designed to leverage local institutions and human capital. Moreover, because knowledge is nonrival and diffuses beyond the county, the local economic gains we measure capture only part of the total social return.

In this chapter, we review the evidence that federal investment generated large local spillovers, even starting from near-zero innovative capacity, drawing on our work on national labs. Next, we examine what predicts the largest returns across laboratories. The most consistent finding is that university connections and institutional embeddedness amplify spillovers. Finally, we provide suggestive evidence that local gains are not merely offset by losses elsewhere. Wage gains for residents who lived in treated counties before laboratory establishment indicate genuine productivity increases for incumbents. Unlike gains driven by in-migration — which can bid up local prices and draw workers from other locations — productivity increases for people already in place are more naturally interpreted as direct output gains than as spatial reallocation. This is the component of local effects that, in the spatial equilibrium framework of Kline and Moretti (2014), most reliably translates into aggregate welfare improvement. Similarly, we do not find a decline in the research productivity of scientists' former collaborators. We discuss one possible mechanism for this, a "big push" interpretation where federal investment triggered self-sustaining innovation trajectories rather than merely reallocating activity across space.

These findings connect to a growing body of evidence that federal R&D generates positive returns across multiple institutional channels. Gross and Sampat (2023) document how World War II R&D contracts fueled the postwar growth of technology clusters. Azoulay et al. (2019) show that NIH funding spurs private-sector patenting without displacing research in other areas. Moretti, Steinwender, and Van Reenen (2025) find that government-financed R&D crowds in private R&D across OECD countries. Within the innovation policy framework developed by Howell (2024) — which organizes government interventions by arena (firms, intermediaries, universities, government laboratories) and instrument (supply-push, demand-pull, legal) — national laboratories represent direct federal provision of mission-oriented research infrastructure: a policy arena central to the history of American science but comparatively understudied relative to university funding or firm-level subsidies (Siegel et al. 2023). Guzman, Murray, Stern, and Williams (2024), in a previous volume of this series, analyze the design of the NSF Regional Innovation Engines program and emphasize that place-based interventions succeed when they reshape how knowledge is distributed and translated within regional ecosystems. Our paper provides the historical empirical evidence that their framework calls for.

The paper proceeds as follows. Section 2 lays out a simple conceptual framework. Section 3 introduces the national laboratories. Section 4 summarizes our main empirical findings. Section 5 examines heterogeneity. Section 6 discusses crowd-out and equilibrium dynamics. Section 7 draws implications for current policy.

2. Conceptual Framework

To organize the analysis, we present a simple framework for thinking about how federal research investments translate into innovation and economic outcomes.

Innovation production. Consider a location that receives a federal research investment, *G*. Total local innovation has two components: the laboratory's own output and spillover innovation by non-lab actors. The spillover component — which is what matters for evaluating the broader returns to federal investment — depends on *G* together with local human capital *H* , complementary assets *X* (universities, private firms, supplier networks), and information transmission A. Denoting non-lab spillover innovation as I^{Ext}:

$$I^{Ext} = A \cdot G^{\alpha} \cdot H^{\beta} \cdot X^{\gamma}$$

The parameter *A* captures the productivity of the local innovation environment — management quality, effectiveness of collaboration mechanisms, the degree to which research is classified or freely diffused. The key feature is complementarity: the marginal return to *G* is higher when A, *H,* and *X* are also present. This complementarity is central to the lower-bound interpretation. The national laboratories were located in places with low *l*evels of all three variables (A, H, and X) yet still generated large increases in I^{Ext}. Federal investments in locations with higher levels of these variables would generate even larger innovation responses for the same *G*.

One might worry about the opposite — that laboratories generated outsized local effects precisely *because* they were the only game in town, and that the same investment in a dense research environment would get lost in the noise. This is an argument for diminishing returns to *G* in *H* and *X*. We address it empirically in Section 5: university-affiliated laboratories, which operated in environments with higher *H* and *X*, generated *larger* spillovers per dollar, not smaller ones. The cross-laboratory evidence supports increasing returns from complementarity, not diminishing returns from saturation. We have less direct evidence from our study about the causes and consequences of A ; we review the literature and suggest future research on this topic in Section xx.

From innovation to economic activity. We express local economic outcomes as:

$$Y = f(I, S, N)$$

where *Y* is local economic output, *I* is innovation as above, *S* is direct federal spending (payroll, construction), and *N* is population. The distinction matters: gains driven by *S* alone represent a standard fiscal multiplier, while gains driven by *I* represent innovation spillovers with potentially much larger long-run returns.

Dynamics. If *G* raises *I*, which raises *H* (through human capital accumulation) and *X* (through firm entry), which further raises *I*, the system can exhibit multiple equilibria. A sufficiently large federal investment can serve as a "big push" that transitions a region from a low-innovation to a high-innovation state. We return to this mechanism in Section 6.

This framework highlights three questions that guide the empirical discussion:

(i) Does federal research infrastructure increase local innovation output (*I*)?

(ii) Through what channels does innovation translate into economic outcomes (*Y*)?

(iii) Which complementary inputs (A, H and X) amplify or limit these effects?

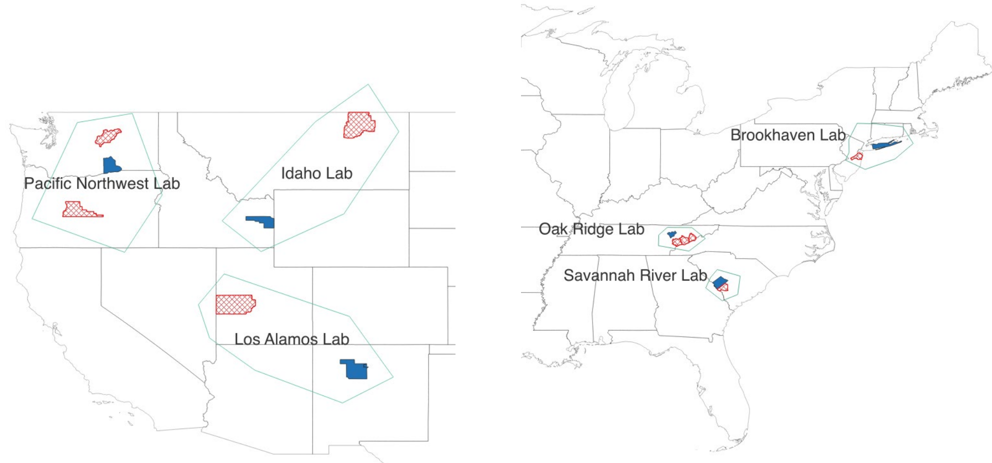
In Sections 4–6 we use this notation as an organizing device, not a structural model. Laboratory operating budgets and facilities proxy for G. Education responses proxy for changes in H. University ties and surrounding industrial or research infrastructure proxy for X. Differences in openness, classification, and collaboration norms map into A. This mapping clarifies why heterogeneity across laboratories is informative for policy: it helps identify which complementary inputs raise the marginal return to federal research capital.

3. The National Laboratories

The U.S. national laboratory system grew out of the Manhattan Project and expanded during the early Cold War. Today seventeen major laboratories operate under the Department of Energy, with combined annual budgets exceeding $25 billion. Most are organized as government-owned, contractor-operated (GOCO) facilities — Federally Funded Research and Development Centers designed to insulate research from short-run market pressures while allowing flexibility in management and hiring (Jaffe and Lerner 2001). Within Howell's (2024) taxonomy of innovation policy arenas, laboratories represent the most direct form of government intervention: public provision of mission-oriented research, often at scales and time horizons difficult to achieve through grants, tax credits, or procurement contracts alone.

The critical feature for our analysis is how laboratories were sited. Historical records indicate that locations were chosen primarily for security, logistical, and political reasons — criteria largely orthogonal to local innovation capacity. Los Alamos was placed in a county with roughly 200 residents; Oak Ridge was built as a secret city in rural Tennessee; the Idaho National Laboratory site was selected in part because it was at least 50 miles from any city of 50,000 people. Brookhaven's location in Suffolk County, New York, was chosen because it was, as one early account put it, equally inaccessible to the consortium of northeastern universities that would manage it. Because these locations were not chosen to maximize economic spillovers, they provide an unusually credible setting for studying the causal impact of federal research infrastructure.

For a subset of laboratories, archival sources identify runner-up locations that narrowly lost the siting competition — sometimes for arbitrary reasons. These provide close counterfactuals for causal inference, and our companion paper (Helper, Makan, and Shoag 2025) uses them alongside synthetic control methods to estimate the effects of laboratory establishment.



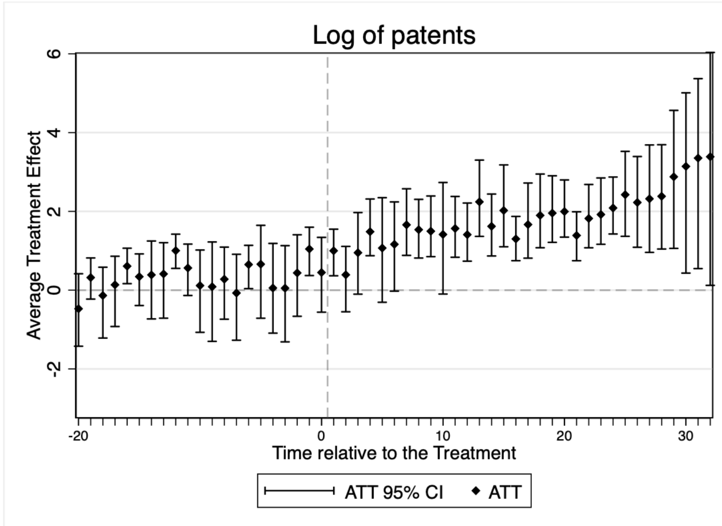
[FIGURE 1: Map of National Laboratory Locations and Runner-Up Sites] *Source: Helper, Makan, and Shoag (2025).*

4. Evidence: Local Returns to Federal Research Infrastructure

We summarize findings from newly digitized historical patent records, county-level economic data from the Survey of Buying Power (1936–1971), and linked 1940–1950 Census records, drawing on multiple identification strategies: synthetic controls, runner-up comparisons, and pooled event-study estimators. We organize the evidence around the framework's three questions.

Does federal research infrastructure increase local innovation (*I*)?

Counties hosting national laboratories experienced dramatic increases in patent activity. Anderson County, Tennessee — site of Oak Ridge National Laboratory — rose from the bottom quintile of the U.S. patent distribution in 1940 to near the top 5 percent by 1975. Crucially, these increases extend well beyond laboratory-affiliated patents. Patenting by non-lab inventors rises sharply, with a lag of roughly five to ten years — consistent with gradual knowledge diffusion rather than an immediate demand shock. Non-laboratory patents shift toward the technological fields in which laboratories are active, and citation patterns show that nearby inventors disproportionately build on laboratory research, consistent with the classic finding that knowledge flows are meaningfully localized (Jaffe, Trajtenberg, and Henderson 1993).

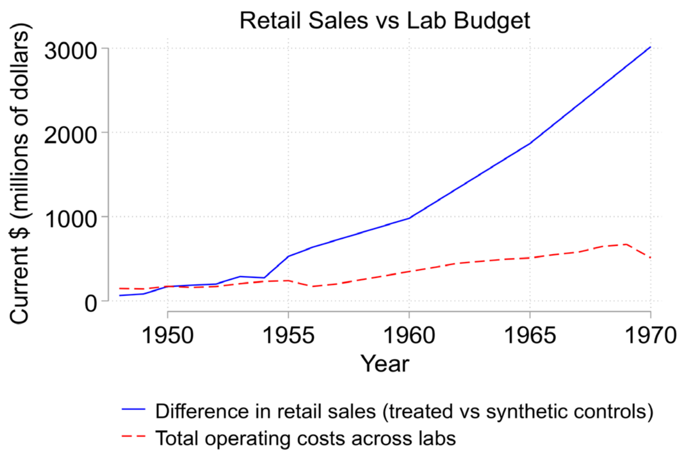


[FIGURE 2: Pooled Event Study — Non-Lab Patenting in Laboratory vs. Control Counties] *Source: Helper, Makan, and Shoag (2025).*

Through what channels does innovation translate into economic outcomes (*Y*)?

Innovation spillovers translated into broader economic gains. We find sustained increases in retail sales and household income relative to synthetic controls. The most striking pattern is the trajectory of the relationship between laboratory budgets and local activity. In 1948, every dollar of lab operating budget was associated with roughly 48 cents in local retail sales impact — a ratio below one, consistent with direct spending effects alone. By 1970, every dollar was associated with more than five dollars of local economic activity. We emphasize that this is a descriptive ratio, not a spatial general equilibrium–adjusted fiscal multiplier; we use it as a transparent summary statistic for how local effects evolve over time since founding, not as an estimate of the causal fiscal multiplier. In a pure spending model, this ratio should remain roughly constant; its dramatic growth suggests that laboratories catalyzed broader innovation ecosystems whose economic effects compound over time.

These growing ratios substantially exceed the typical local fiscal multiplier of roughly 1.8 (Chodorow-Reich 2019). They also contrast with the experience of NASA's Space Race spending, where Kantor and Whalley (2025) estimate a fiscal multiplier of about 0.3 and find limited spillovers beyond directly contracted firms. The two estimates are not directly comparable — Kantor and Whalley's is a spatial GE-corrected estimate while ours is a simple ratio — but the contrast in trajectories is striking: NASA's effects are flat over time while the laboratories' grow. The difference is consistent with evidence that sustained research infrastructure generates larger and more persistent spillovers than applied procurement (Akcigit, Hanley, and Serrano-Velarde 2020; Fieldhouse and Mertens 2024).



[FIGURE 3: Loc **al Activity-to-Budget Ratio Over Time — Lab Operating Budget vs. Retail Sales]** *Source: Helper, Makan, and Shoag (2025).*

The human capital channel further explains these growing returns. Cohorts exposed to laboratory establishment during school-age years attained more education and were substantially more likely to complete high school, with effects appearing within four to seven years of laboratory founding. In the language of our framework, laboratories raise H in surrounding areas, increasing absorptive capacity for future spillovers and creating the feedback loop ($G \rightarrow I \rightarrow H \rightarrow I$) that may explain why the activity-to-budget ratio compounds.

Finally, using linked Census records, we find that male residents who lived in treated counties before laboratory establishment experienced wage gains of roughly 5 percent relative to comparable residents of runner-up counties, with substantially larger effects for college-educated workers (approximately 25 percent) and professionals (approximately 14 percent). We discuss the aggregate implications of these incumbent wage gains in Section 6.

5. What Predicts High Returns?

The cross-laboratory variation in spillovers is substantial — and understanding what drives it is the most policy-relevant question we can address. We examine heterogeneity using patent data matched to laboratory operating budgets, computing adjusted patents above the synthetic control per million dollars of budget.

Year	Actual	Synthetic	Diff	Budget ($1,000)	Raw Patents per $1M	Adjusted[a]
Panel A: University-Operated Laboratory Counties						
1957	157.0	105.0	52.0	29,132	5.39	1.79
1965	307.0	143.0	164.0	77,942	3.94	2.10
1970	295.0	113.0	182.0	105,483	2.80	1.73
Panel B: Privately Operated Laboratory Counties						
1957	26.0	7.6	18.4	5,239	4.96	3.51
1965	16.0	10.3	5.7	7,364	2.17	0.77
1970	18.0	8.6	9.4	8,935	2.01	1.05

[a] Adjusted patents per $1M = (Actual − Synthetic) / Budget × 1,000,000.
[b] University-operated laboratories: Ames Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, and SLAC National Accelerator Laboratory.
[c] Privately operated laboratories: Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Savannah River National Laboratory.

(a)

Year	Actual	Synthetic	Diff	Budget ($1,000)	Raw Retail per $1M	Adjusted[a]
Panel A: University-Operated Laboratory Counties						
1957	4,520,170.9	3,336,529.0	1,183,641.9	126,595	35.70	9.35
1965	6,508,960.5	4,531,019.4	1,977,941.1	320,249	20.33	6.18
1970	6,572,923.0	4,843,429.7	1,729,493.3	213,481	30.79	8.10
Panel B: Privately Operated Laboratory Counties						
1957	138,012.0	39,815.2	98,196.8	105,021	1.31	0.94
1965	193,826.0	61,571.7	132,254.3	121,953	1.59	1.08
1970	322,549.0	108,533.0	214,016.0	175,656	1.84	1.22

[a] Adjusted retail per $1M = (Actual − Synthetic) / Budget × 1,000,000.
[b] University-operated laboratories: Ames Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, and SLAC National Accelerator Laboratory.
[c] Privately operated laboratories: Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and Savannah River National Laboratory.

(b)

[TABLE 1: Innovation and Economic Returns by Lab Contractor Type] *Subfigure a: Adjusted patents per $1M of budget by university affiliation (managing entity) and lab size (1957, 1965, 1970). Subfigure b: Adjusted retail sales per $1 of budget by university affiliation and lab size. Data from Helper, Makan, and Shoag (2025).*

The results map directly onto the framework's terms:

University connections (*X*). The most consistent predictor of high returns is whether a laboratory has an institutional connection to a university — specifically, whether its GOCO managing entity is a university or university consortium. University-affiliated labs — Argonne (University of Chicago), Brookhaven (Associated Universities), Ames (Iowa State) — generated about 2.1 adjusted patents per million dollars of budget in 1965, compared to about 0.8 for labs without university ties. Universities supply skilled researchers (*H*), create collaborative networks, and maintain cultures of open publication rather than classification (raising *A*). Jaffe and Lerner (2001) find a similar pattern: among national laboratories, those managed by universities produced higher-quality patents and maintained quality even as volumes increased after the Bayh-Dole reforms. This finding also addresses the "only game in town" concern raised in Section 2: if isolation were the driver, rural labs should outperform university-affiliated ones. They do not[1].

An important distinction: the per-dollar patent returns are sometimes higher at rural laboratories, partly reflecting small budgets and low baselines. But the *absolute* volume of additional non-lab patents is concentrated overwhelmingly at university-affiliated laboratories. Argonne alone generated 182 excess patents by 1970, compared to a combined total of roughly 59 across all four rural laboratories in our sample (Ames, Oak Ridge, Pacific Northwest, and Savannah River). Both facts are policy-relevant: federal research investments can stimulate measurable innovation even in places far from the frontier, but complementary institutions multiply the total output.

Laboratory scale (*G*). Medium-budget laboratories generate the highest adjusted patent returns — about 1.1 adjusted patents per million dollars, compared to 0.7 for the largest facilities — outperforming both large and small labs. Very large facilities may function as self-contained campuses with less interaction with surrounding firms and inventors; very small ones lack critical mass. The inverted-U suggests a tension between scale and embeddedness that is relevant for designing new investments.

The university and scale patterns are not artifacts of the patent measure. Retail sales data tell a parallel story: university-affiliated laboratory counties generated roughly \$8–9 of local retail activity per dollar of laboratory budget, compared to about \$1 per dollar for rural laboratory counties. The consistency across innovation and economic outcomes strengthens confidence in the underlying mechanism.

Collaboration effectiveness (A). We don't have evidence from our study about the differential effectiveness of labs in collaborating with other partners in their innovation eco-system, though research suggests institutional features may be important (Lerner et al. 2024).. As noted above, several features of the labs may hinder their performance on this score, such as their focus on classified and dangerous research. Indeed Stern and Tartari (2021) found that, compared to universities, "the more cloistered nature of national laboratories is associated with a much more muted, perhaps even negative, impact" on entrepreneurship that leads to local spillovers.

Not every laboratory generated large spillovers. Lawrence Berkeley and SLAC show negative adjusted patent returns by 1970, though in both cases this reflects the extraordinary growth of their control regions — the Bay Area and the Stanford corridor — rather than laboratory failure. These were among the most innovative places in the country and would have been regardless of laboratory presence. Similarly, several small and remote laboratories generated modest effects. These cases reinforce the identification logic: treatment effects are hardest to detect where control regions are independently dynamic, and they are most visible where the laboratory represents a genuine departure from the counterfactual trajectory.

[1] In general, labs with university affiliation are not in rural locations; the only exception is Ames. Ames performs better than other rural labs, but worse than the non-rural labs with or without universities.

Growing returns over time. The strongest laboratories show growing effects: Argonne's treatment effect rises from 52 excess patents in 1957 to 182 by 1970; Brookhaven moves from a negative difference of 60 to a positive gap of 75; Oak Ridge's excess patents grow from 25 to 40. This trajectory is consistent with the dynamic feedback ($G \rightarrow I \rightarrow H \rightarrow X \rightarrow I$): as laboratories build local human capital and attract complementary firms, the ecosystem becomes progressively more productive.

The heterogeneity results reinforce the lower-bound interpretation. The features that predict the largest returns — university ties, embeddedness, time to develop feedback loops — are precisely the features the national laboratories were not designed to maximize. Investments that deliberately select on these margins should generate local spillover returns at least as large.

6. Crowd-Out, Displacement, and the Big Push

A natural concern about place-based innovation policy is that local gains may come at the expense of activity elsewhere. If laboratories attract scientists who would have been equally productive in existing clusters, local spillovers could overstate aggregate returns. We take this concern seriously.

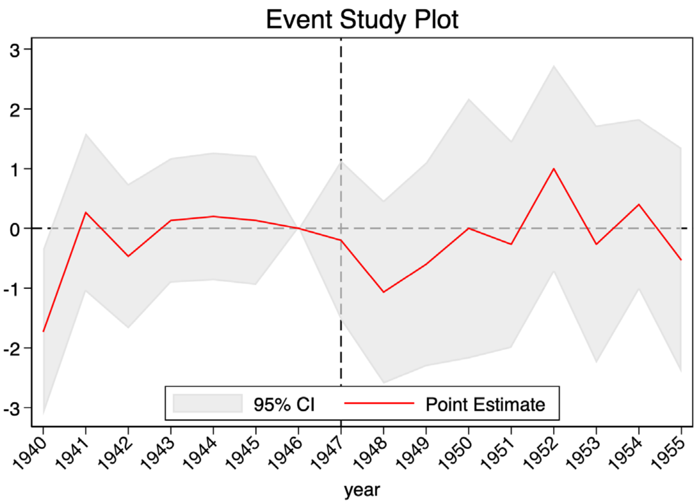
Incumbent productivity gains and aggregate welfare. Our most analytically informative evidence comes from stayer wage gains. Residents who lived in treated counties before laboratory establishment experienced significant wage increases — roughly 25 percent for college-educated workers and 14 percent for professionals.

In the spatial equilibrium framework of Kline and Moretti (2014), local effects decompose into a *reallocation* component (workers and firms move toward treated locations, with offsetting losses elsewhere) and a *direct productivity* component (the location becomes genuinely more productive). Wage increases for pre-existing residents who do not relocate are evidence of the direct productivity component. These patterns are difficult to reconcile with a pure composition effect from in-migration: the laboratories made incumbent workers more productive, particularly those best positioned to absorb knowledge spillovers. Unlike wage gains driven by in-migration — which can bid up local prices and draw workers from other regions — productivity increases for people already in place are more naturally interpreted as direct output gains rather than spatial reallocation.

Co-author networks. We examine whether relocating scientists to laboratory locations disrupted productive research networks. If relocation destroys valuable collaborations, local innovation gains could be offset by losses in origin locations. To get a better understanding of this we first identify authors who published with Brookhaven Lab shortly after its founding (list obtained from the *Annual Report, Brookhaven National Lab,1949-1951*).[2] From this list we then construct a panel publication dataset of their co-authors prior to their—the scientists—joining the lab. This is our treated group. The control group is a list of scientists who never co-authored with a lab scientist but who published in similar journals as the former lab co-authors. Using the number of publications as the outcome variable, Figure 4 plots the difference-in-difference estimates of the treatment variable interacted with year dummies (1946

[2] So far we were able to obtain detailed budget and publication records for Brookhaven Lab only, via the Hathitrust Repository (https://catalog.hathitrust.org/Record/011573296). We have less detailed data for other labs, which we will incorporate into the next draft.

being the reference year). With the exception of a brief initial dip we do not find evidence of medium to longer term losses in co-author productivity.



[FIGURE 4: Co-Author Productivity Before and After Scientist Departure to Lab Counties]

Elastic scientist supply. The postwar period saw an enormous expansion of the scientific workforce — university enrollments surged under the G.I. Bill, federal funding for graduate education grew dramatically, and the supply of trained scientists expanded rapidly through the 1950s and 1960s. In a period of elastic supply, the relevant margin is expansion of research capacity, not reallocation of a fixed pool.

The big push interpretation. One possibility is that the sizeable injection of new demand and innovation infrastructure from lab investments helped their regions jump out of low- or moderate-income equilibrium traps. **(Rosenstein Rodan, 1943; Sachs and Warner 2019; Jaramillo and Kim 2024).** The temporal pattern of laboratory effects — gradual emergence, growing activity-to-budget ratios, long-run persistence — is more consistent with atransition to a new equilibrium than with a simple resource transfer. Before a laboratory arrives, a remote county has low G, H, and X; there is insufficient activity to sustain spillovers. Federal establishment of a laboratory raises G, which over time builds H and X through education effects and firm entry, generating a self-reinforcing cycle. Garg (2025) provides a formal framework for distinguishing fundamental improvements from equilibrium selection in settings with strong complementarities.

If this interpretation is correct, it has a crucial implication: equilibrium transitions create new economic activity rather than merely relocating it. A county that shifts from a low-innovation to a high-innovation trajectory is expanding the total stock of innovation-supporting infrastructure, not pulling it from elsewhere. Taken together, the stayer wage gains, the co-author null, the elastic supply context, and the big push dynamics do not prove that all local gains map one-for-one into national welfare. But they shift interpretation away from a pure spatial reshuffling story and toward direct productivity improvements and ecosystem formation.

7. Implications for Current Policy

Catalyzing innovation-based regional ecosystems that deliver broad economic and societal benefits has been a major focus of academic and policy discussions in recent years. There have been two motivations for this focus. First is a view that the United States has not done well at transitioning its historic strength in basic research into products and processes that are globally competitive. That is, the U.S.suffers in managing the transition of technologies from lab to market, and generating complementary and geographically proximate institutions is key to improving performance (Pisano and Shih; Bonvillian). Second is a view that while “the innovation sector has generated significant technology gains and wealth [it] has also helped spawn a growing gap between the nation’s dynamic “superstar” metropolitan areas and most everywhere else.” (Atkinson, Muro, Whiton 2013 Full-Report-Growth-Centers_PDF_BrookingsMetro-BassCenter-ITIF.pdf .

Scholars such as Atkinson et al, Guzman et al (2024) and Gruber and Johnson have proposed that investments in new regional innovation ecosystems can address both commercialization and regional inequality issues. In part as a result, the U.S. federal government has significantly expanded its place-based innovation spending, through the CHIPS and Science Act, the NSF Regional Innovation Engines, and various proposals for new technology laboratories. Fieldhouse and Mertens (2025) estimate that if the R&D provisions of the CHIPS Act were fully funded, the resulting expansion in nondefense R&D would boost U.S. productivity by 0.2–0.4 percent within several years — with direct effects eventually exceeding total outlays[3]. Our results provide complementary, microeconomic evidence on the local mechanisms through which such investments generate returns. To put the magnitudes in context: the roughly $476,000 required to generate an additional non-lab patent at university-affiliated laboratories compares to approximately $3.6 million per private-sector patent induced by NIH funding (Azoulay et al. 2019), approximately $150,000 per additional patent from DOE SBIR grants (Howell 2017), and substantial cluster-level effects from World War II OSRD contracts, where a doubling of wartime R&D intensity was associated with 30 percent higher patenting by 1970 (Gross and Sampat 2023). These figures are not directly comparable — they measure different patent types, at different margins, over different time horizons, and using different identification strategies. But they suggest that the per-dollar innovation returns to national laboratory infrastructure fall within the range of other well-studied federal programs, despite the laboratories' unfavorable siting conditions. We highlight five lessons.

In addition, the Trump Administration proposed in December 2025 to fund “Tech Labs”, which are organizations “operating outside of existing academic, start-up, and industry constraints,” according to NSF’s accompanying request for information. The Tech Labs Initiative will support teams to “move

[3] This activity is by no means limited to the United States. For example, the European Union has developed a methodology for “Regional Innovation Strategies for Smart Specialisation” over the last decade and continues to invest in “Innovation for place-based transformations”.3 4 A significant part of the ongoing 7-year, 94 billion euro “Horizon Europe” program is devoted to building “excellence hubs” and a “European Innovation Ecosystems (EIE) programme that strengthens innovation ecosystems.5 Individual nations continue to invest in such programs, such as the Catapult network in the United Kingdom, and the 800 clusters that make up the European Cluster Alliance.6,7

beyond traditional research outputs," such as publications and datasets, to focus instead on transitioning critical technology from early concept or prototypes to commercially viable platforms.

Our research suggests some implications for the design of this new program.

Federal research investments generate the largest spillovers when embedded in broader institutional ecosystems, especially including universities. University-affiliated laboratories generated about 2.1 adjusted patents per million dollars of budget, compared to 0.8 for rural labs without university ties (Table 1). This does not mean investments should flow only to places that already have strong universities — doing so would defeat the purpose of place-based policy. But new investments should be designed with explicit attention to building institutional connections: co-location with universities, formal collaboration agreements, joint appointments, and student pipelines are central determinants of whether an investment generates spillovers or operates as an enclave. Research has shown that high-impact knowledge production increasingly depends on team-based and cross-institution collaboration (Jones, Wuchty, and Uzzi 2008)

Embeddedness matters more than scale. The inverted-U between laboratory size and adjusted patent returns suggests that bigger is not always better. Medium-scale investments deeply embedded in local economies may generate more spillovers per dollar than mega-facilities, that often insulate themselves.

Mission-oriented research infrastructure generates larger spillovers than applied procurement. The contrast between the national laboratories and NASA's Space Race spending is instructive. NASA contracts involved largely applied development performed by existing firms and generated a fiscal multiplier of about 0.3 with limited broader spillovers (Kantor and Whalley 2025). Similarly, collaboration between Moderna and an existing vaccine research group at the U.S. National Institutes of Health that was able to quickly pivot its research expertise was critical in developing an mRNA-based COVID vaccine. (Traficonte, Yale Law Journal). The national laboratories, with their sustained investments in fundamental and mission-oriented research, generated growing returns that eventually reached multiples of their operating budgets. Sustained research infrastructure and applied procurement are different policy instruments with very different spillover profiles.

Be patient and design for dynamics. The five-to-ten-year lag before non-lab patenting takes off, the growing activity-to-budget ratio over decades, and the education effects in exposed cohorts all indicate that the full returns to federal research investments materialize over long horizons. Evaluation frameworks that judge success within a few years will systematically undervalue investments whose returns operate through ecosystem dynamics. This is a caveat for Tech Labs, which are designed to receive NSF funding only for 3-7 years. Many U.S. economic development and technology programs are designed (and sold to Congress) with the idea that only catalytic funding is needed. The case of the national labs shows that federal funding can indeed "crowd in" private investment (Boushey 2022) – but that such crowd in may be increased with on-going investment.
(https://www.nationalacademies.org/publications/18448)

Evaluate the right outcomes at the right horizons. Short-run metrics — jobs created within two years, immediate private co-funding — will systematically miss ecosystem effects. These effects can be substantial. We have been able to track some of these indicators ex-post (non-affiliated patenting, technological field-shifting, researcher mobility, and human capital formation over five-to-fifteen-year horizons, wages in the region). The national laboratories would have looked like expensive remote facilities on any short-run cost-benefit metric; their true returns became visible only over decades. These effects were largely serendipitous, especially in the early years of the national labs (Schrank 2015). To both maximize these impacts and publicize that they exist, programs should track diffusion indicators such as these, along with transparent counterfactual benchmarks. (See 'Future Research' below for more on this.)

Summarizing the above points, these lessons suggest concrete priorities for designing new research hubs, such as Tech Labs. Build formal bridges to universities and workforce pipelines — joint appointments, shared facilities, graduate fellowships — rather than excluding them, or relying on informal proximity. Researchers have found that such bridges increase patenting (Adams, Chiang, and Starkey 2001). Institutions can be designed for diffusion: open user facilities, publishing norms, and collaborative IP arrangements lower the cost of local firms accessing frontier knowledge (Bryan and Ozcan 2021, Helmers and Overman 2017). Avoid insularity by aligning procurement and vendor policies with local capability-building and innovation-system objectives (Lember, Kattel, and Kalvet 2014; Kähkönen et al. 2025). And evaluate on diffusion and human-capital indicators over long horizons, not only on near-term job counts.

8. Conclusion and Suggestions for Future Research

The national laboratories were created to promote national security, not regional development. Early research was classified, and surrounding communities often had no prior innovative capacity. Yet large and persistent innovation ecosystems emerged — ecosystems whose economic effects grew over decades and that raised wages for residents who were already there before the laboratories arrived. Not every laboratory generated large measurable spillovers, and the effects varied substantially with institutional context. But the overall pattern is striking, and the conditions under which it emerged make it especially informative.

We draw three conclusions. First, the measured local spillover returns to national laboratory investment are substantial and likely represent a lower bound on what the returns would be to public investments that were deliberately designed to leverage complementary institutions and human capital. Second, across laboratories, the strongest predictor of high returns is institutional connectivity (particularly university affiliations), not the dollar amount of investment. Third, evidence from incumbent wage gains, co-author networks, and the temporal dynamics of spillovers points toward creation of new higher-innovation local equilibria creation rather than mere resource reallocation.

As policymakers design the next generation of innovation investments, the historical lesson is clear: federal R&D can generate large spillovers, but the magnitude of those returns depends critically on institutional connections, long-run commitment, and the ability of investments to trigger self-reinforcing innovation dynamics. The national laboratories demonstrate that this is possible even when starting from nothing.

The possibilities for future research on the local returns to public innovation investment are rich. The topic remains important, as U.S. R&D spending is under threat, and its distribution remains highly skewed across regions (Ganong and Shoag 2017; Howard and Liebersohn 2025).

For example, researchers might integrate the two flavors of place-based research, one focused on poverty alleviation (eg, Neumark and Simpson 2015; Bartik 2020) and the other focused on building regional innovation ecosystems (eg, Guzman et al 2024). The national labs appear to have improved both sets of outcomes, but high levels of inequality in clusters such as Silicon Valley (Hendrickson, Muro, Galston 2018) suggest that this is not always the case. It would be valuable to know the types of agglomerations that promote both equity and efficiency.

A key aspect of effectiveness on both dimensions would seem to be information flow. A key learning for the first author from her time in the federal government was the value of convenings in overcoming information barriers that were surprisingly severe. For example, one aspect of the "Investing in Manufacturing Communities Partnership" (an Obama-era cluster-based competition that included both innovation and workforce criteria) was that economic development and workforce development folks were incentivized to meet each other for the first time. Applicants to the program (even those who didn't win) cited this feature of the program as highly beneficial. Relatively few economic studies look at the nature of information flow (or "ideas in the air" (Marshall, 1890; Helper and Stanley). It would be useful to add more, both qualitative studies of what makes networks effective such as Safford 2009,Feldman 2013, Feldman and Langford 2021), and studies using cell phone and other types of data now more readily available, such as Atkin, Chen, and Popov (2022), who study these interactions in Silicon Valley.

A central question, however, remains: Do efforts that seek explicitly to foster innovation ecosystems (such as NSF Engines, Tech Hubs, etc) actually result in meaningful and sustained economic gains for the regions they target? Since these outcomes often take years to materialize, answering this question benefits greatly from examining a program with a multi-decade history, as in the U.S. National Laboratories. These programs have in common a view (implicit or explicit) that a key determinant of the social return to federal R&D spending depends upon how well the research is made available to other partners whose actions are necessary for commercialization of a new product or process. Are firms that might use the technology aware of it; can they create the supply chain needed , are trained workers available?

In contrast to the labs, which have hundreds (sometimes thousands) of employees dedicated to a single technology all under the direction of a single contractor, these programs typically aim to build coalitions of existing institutions, such as firms (large and small), financial institutions, universities and community colleges, labor and community organization. Continued study of these programs would be valuable. These studies would be facilitated by agency efforts (such as one underway at the Department of Commerce [check that it is ongoing] to preserve and make available to researchers data needed to construct counterfactuals, such as information on runners-up.

These newer efforts explicitly ask applicants to form coalitions of diverse organizations, such as universities, labs, community colleges, labor and community organizations. Economists might apply the tools of organizational economics to understand the strengths and weaknesses of these different institutions and their interactions. What is it, for example, that makes universities such effective partners in amplifying the effects of national labs? A key factor may well be complementary incentives – academic freedom promotes the creative control valuable for early stage research, while labs (and private sector research) have an ability to direct focused resources that is valuable for later-stage research (Aghion, Dewatripont, Stein 2009). Audretsch et al (2024) provide empirical support for this model, in finding that increased academic freedom in a nation leads to significantly greater quantity and quality of patents. The flow of students into local employers is also important (Owen Smith, Lane).

This topic seems poised to grow in importance. Within the U.S., the Trump Administration is proposing perhaps the greatest reshaping of the federal role in innovation in 80 years. More broadly, the rapidly improving capability in artificial intelligence will likely have large impacts on both regional innovation and regional inequality,

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