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# Science and the Decline of the American Academy

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*The academic sciences are widely regarded as insulated from the financial and cultural dysfunction afflicting the American academy. In fact, the academic sciences have become as deeply corrupted and complicit in the decay as the rest of the academy through a tangled web of perverse incentives built into the funding structure of modern scientific research. The academic sciences are no longer bastions of free inquiry, but have now become a deeply entrenched cartel—"Big Science"—that has thoroughly politicized scientific research, and perverted the culture of science. Without serious reform, academic science will cease to make discoveries and innovate.*

The American academy is in crisis, and the symptoms are clear to anyone with eyes to see: relentlessly rising costs, administrative bloat, and a declining 18- to 24-year-old cohort of potential tuition-paying students who are increasingly reluctant to take on a crushing load of debt. Add to that the increasingly aggressive assaults, emanating from within the academy, on core institutional values like freedom of inquiry and expression, and you have a fulminating crisis.[1]

Fingers have been pointed at many pet *bêtes noires*: Marxism, Maoism, the campus liberal monoculture, post-modernism, identity politics, to name a few.[2] All are blameworthy to a degree. Yet all miss an important, even a principal, driver of the cultural rot permeating our universities: the academic sciences. Far from floating serenely above the miasma, the academic sciences are not only neck-deep in it, they have been, for many years, among the principal enablers.

At first glance, it seems almost delusional to say such a thing. The academic sciences, after all, are awash in money, scientists are avidly doing science, papers are being published, incipient scientists are being trained to provide the marvels of science to the generations to come. As the broader crisis afflicting the academy unfolds, it seems wrong-headed, churlish even, to attribute the decline to the sciences. Yet, the signs of a pernicious pathology are there, by now well-advanced, its roots traceable to the federalization of academic science that took place in the aftermath of World War II: "Big Science," in a phrase.[3] Prior to this massive federal involvement with science, America had lived through a two-century period of robust scientific development: "Small Science." By the mid-20th century, Small Science had built up a considerable stock of scientific "seed corn," which laid the foundation for Big Science later to come.[4]

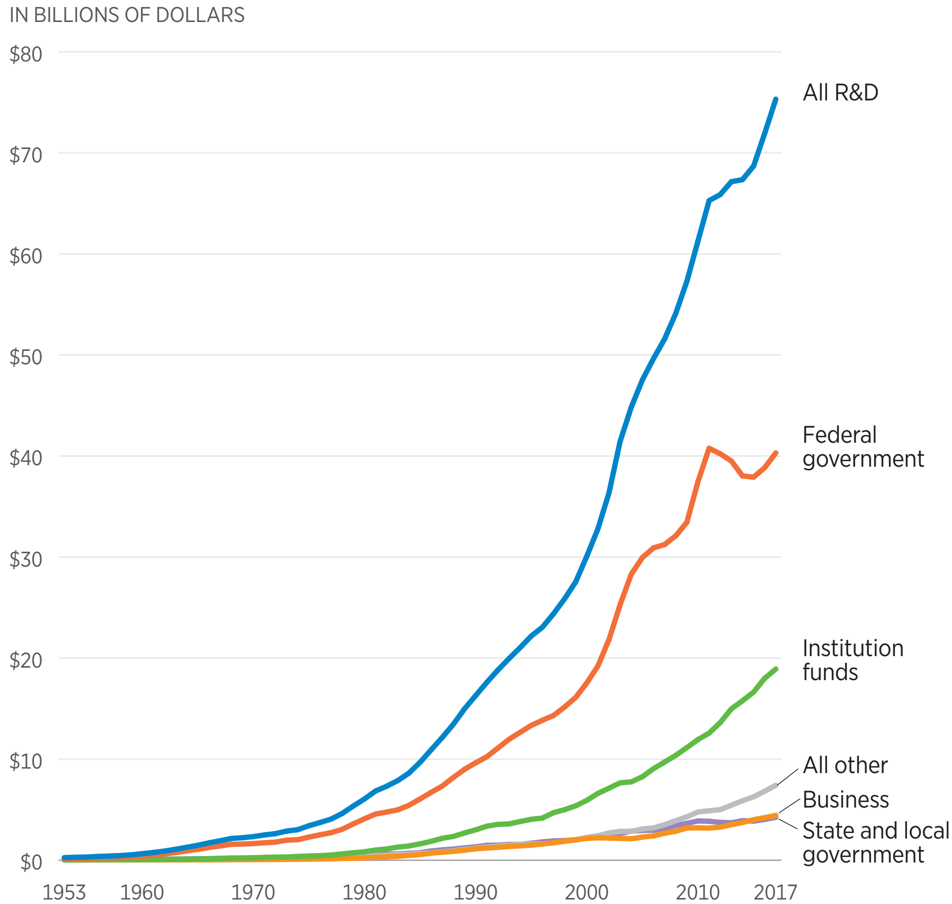
Big Science has been a funding bonanza for the academic sciences. From 1953 to 2017, total expenditures for academic research have risen exponentially, from $255 million in 1953 (in 2015 dollars), to more than $75 billion in 2017, doubling roughly every seven to eight years. This has been driven largely by the exponential increase of federal research dollars, which has drawn all other sources of research funding along with it (Chart 1).

Almost without exception, this pattern of research funding has enjoyed the enthusiastic support of academic researchers. If there are complaints to be heard, they are for more spending. Usually, these complaints are rewarded. What I am describing is a so-called positive-feedback loop,[5] in which an increase of something (say, temperature, population, or research funding) prompts higher demand for more of whatever is driving the increase (more heat, higher reproduction, growing funding for research).

1. Thomas D. Snyder, Cristobal de Brey, Sally A. Dillow, *Digest of Education Statistics 2017*, U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, NCES 2018-070, January 2019, p. 12. https://nces.ed.gov/pubs2018/2018070.pdf, (accessed June 8, 2020). Jason Brennan and Phillip Magness, *Cracks in the Ivory Tower: The Moral Mess of Higher Education* (New York: Oxford University Press, 2019); Camilo Maldonado, *Price of College Increasing Almost 8 Times Faster Than Wages*, *Forbes*, July 24, 2018, https://www.forbes.com/sites/camilomaldonado/2018/07/24/price-of-college-increasing-almost-8-times-faster-than-wages/#6e314b9e66c1 (accessed June 8, 2020); Benjamin Ginsberg, *The Fall of the Faculty: The Rise of the All-Administrative University and Why It Matters* (New York: Oxford University Press, 2011); Paul Fain, "College Enrollment Declines Continue," *Inside Higher Ed*, Vol. 2019, https://www.insidehighered.com/quicktakes/2019/05/30/college-enrollment-declines-continue (accessed May 30, 2019) .
2. E.g., Roger Kimball, *Tenured Radicals: How Politics Has Corrupted Our Higher Education* (Chicago: Ivan R. Dee, 2008), and Glenn Harlan Reynolds, *The Higher Education Bubble* (New York: Encounter Books, 2012).
3. Michael Hiltzik, *Big Science: Ernest Lawrence and the Invention that Launched the Military-Industrial Complex* (New York: Simon & Schuster, 2016).
4. This section draws heavily from Hunter Dupree's comprehensive work: A. Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities* (Baltimore: Johns Hopkins University Press, 1986).
5. John Dezendorf Trimmer, *Response of Physical Systems* (New York: John Wiley & Sons, 1950).

CHART 1

## Expenditures in Research in Higher Education




**SOURCE:** National Science Foundation, "Higher Education Research and Development Survey Fiscal Year 2017," https://ncsesdata.nsf.gov/herd/2017/ (accessed June 18, 2020).

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Positive feedback loops feed exponential growth, which is unstable, because the demand for growth inevitably exceeds the capacity to sustain it. Dire consequences inevitably follow.

The academic sciences are already far along that dangerous trajectory, and the dire consequence that is unfolding is the pernicious perversion of their purpose. No longer can the academic sciences claim to be devoted to the unfettered and dispassionate search for truth. Rather, they have become craven servants of political interests. How this came to be is the hidden story behind the sunny landscape of abundant and growing funding.

I write as an academic scientist at the end of a forty-year career in biological research. I have always been, and remain, a firm believer in the social value of both the academy and the sciences. I want to see both endure. But over the course of my career, I have witnessed a slow erosion of the core values that give the academic sciences, indeed the academy itself, its social worth. I have spent a lot of time over the years pondering the cause of that erosion. Regrettably, it is the academic sciences that are greatly accelerating the academy's decline.

## Small Science: Pre-Civil War

During the late 18th century, science was a form of Toquevillean civics, practiced through numerous self-motivated, local scientific and philosophical societies formed to advance "science" as an element of civic virtue. There was no such thing as a professional scientist, only citizens with the initiative and means to pursue scientific inquiry. Benjamin Franklin, for example, was a prominent scientist, but he did not make his living from it. He was also very civic-minded: He founded the American Philosophical Society to bring other scientific minds together to advance scientific inquiry.[6] His example was replicated throughout the American colonies and in the American republic to come.

Science, which is an Enlightenment virtue, engendered civic virtue because it offered hopeful, practical benefits to agriculture, manufacturing, natural resources, and other areas of civic concern. In the new American republic, this posed a dilemma: Given those practical benefits, should the Congress support science as a formal national concern? Up through the mid-19th century, the dilemma was resolved largely by Congress taking a hands-off approach. This reluctance stemmed not from any opposition to science *per se*. Why, the argument went, should the Federal government subsidize Enlightenment virtues, including science, when these already reposed with their proper custodians, the citizenry themselves? There were also concerns of states jealous of their political prerogatives vis-à-vis federal aims. Early ambitions to form a national university, or national academy along the lines of similar European institutions, consistently failed to win Congressional approval. Science was already well-served through

6. Modeled after the Lunar Society in Great Britain, which also included many self-motivated scientists and philosophers, such as Erasmus Darwin, James Watt, and others.

grass-roots philosophical societies like Franklin's and by universities, like the University of Virginia, founded specifically to advance the sciences.[7] Funding would just not be through federal support.

Even so, the federal government found clever ways to resolve this ambivalence. President Thomas Jefferson, for example, won Congressional support for the 1804–1806 Lewis and Clark expedition by cloaking its scientific aims behind other authority.[8] Congress was persuaded that the expedition would be promoting commerce. Jefferson, meanwhile, cloaked his scientific aims behind a strategic and diplomatic initiative to Britain, Spain, and Russia. Both sat comfortably within Constitutional authority.[9] This model of stealthy support for science persisted through the first half of the 19th century, albeit in different guises. The military academies, for example, were founded to educate military engineers, a clear military necessity. This allowed Congress to funnel money to scientific research, keeping it well within established federal authority for war and defense. Similarly, the United States Naval Observatory could be justified as a support for navigation and interstate commerce, also a clear federal prerogative. Congress also funded numerous other expeditions like Lewis's and Clark's, all with scientific aims carried out under the cloak of military necessity. Major Stephen Long's 1818 expedition to the Yellowstone River, for example, was supported officially as a surveying expedition to map out a string of forts along the Missouri River to protect western expansion. It carried out scientific exploration on the way, supported by an *ad hoc* commingling of private and public funds to support those aims.

The prevailing federal diffidence toward science is underscored by the reception given to British engineer James Smithson's 1829 bequest to the United States of $500,000 (contemporary)[10] "to found at Washington [an institution] for the increase and diffusion of knowledge among men." It took nearly 20 years of political wrangling for Congress to deal with Smithson's gift horse. At one point there was even a proposal to send the money back to England, as it was unclear how the federal government could legitimately

7. The University of Virginia was founded by Thomas Jefferson, James Madison, and James Monroe. Jefferson especially chafed at the religious orientation of colleges like the College of William and Mary, founded by royal patent in 1693, which required its students to master a catechism, and which did not include instruction in the sciences.

8. History.com Editors, "President Jefferson Requests Funding for Lewis and Clark Expedition," *This Day in History* (January 18, 1803), A&E Television Networks, November 16, 2009, https://www.history.com/this-day-in-history/jefferson-requests-funding-for-lewis-and-clark-expedition (accessed June 9, 2020). The formal appropriation requested was $2,500, about $55,000 in current dollars. See https://www.in2013dollars.com/.

9. Stephen E. Ambrose, *Undaunted Courage: Meriwether Lewis, Thomas Jefferson, and the Opening of the American West* (New York: Simon & Schuster, 2013).

10. Roughly $15 million in current U.S. dollars.

spend the money. When Smithson's bequest was finally realized, the new Smithsonian Institution was firmly fenced off from the Congress that chartered it.

## Small Science: Post-Civil War

The Civil War inaugurated a dramatic shift in this diffident federal attitude toward science, under the impetus of two acts of Congress, both passed in 1862. The Morrill Act established a system of state-based land-grant colleges dedicated to education, research, and outreach in agriculture and practical engineering.[11] The Homestead Act, also passed in 1862, was intended to facilitate western settlement and exploitation. Both acts drew the federal government more formally into supporting science, but with different aims and with different consequences.

The land-grant college system provided a handy funnel to direct federal and state money to support scientific research, albeit limited to "practical" science, that is, closely tied to the needs of farmers. The land-grant colleges were intended to be the responsibility of the states, but the federal government planted its foot firmly in the door through the simultaneous creation of a new federal Department of Agriculture. This new department supported agricultural research through a network of Agricultural Research Stations, housed in the land-grant colleges and staffed by Federal employees.[12]

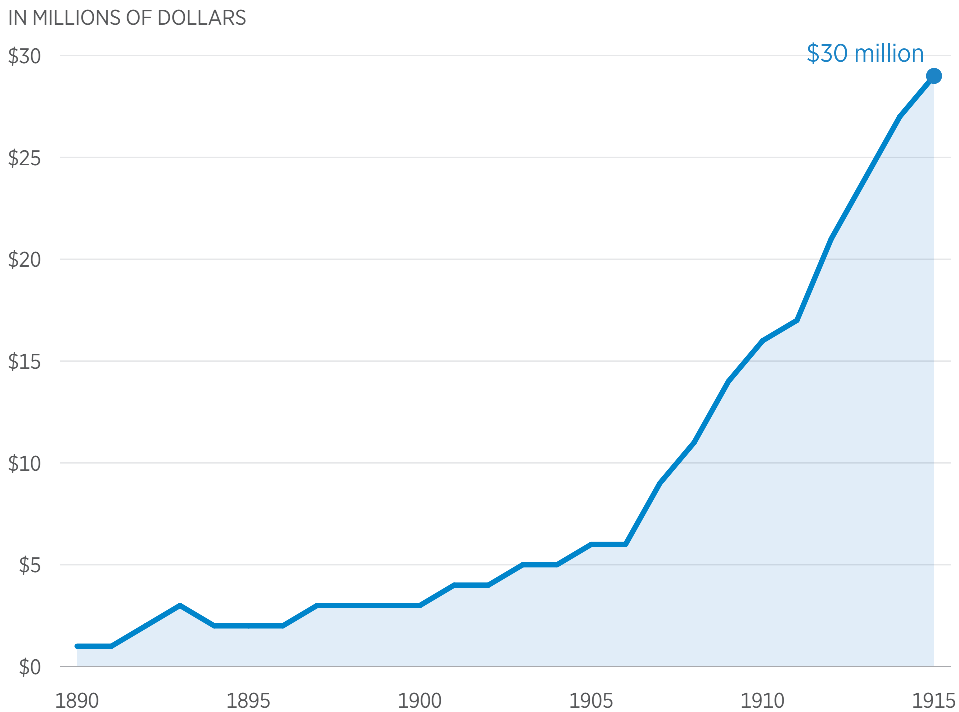
Considerable federal support flowed into the agricultural research stations. From 1862 to 1915, for example, total expenditures of the United States Department of Agriculture grew from less than $100,000 to about $30 million, doubling roughly every five years (Chart 2).This pattern of spending should look familiar: It replicates the exponentially rising expenditures seen in later years for Big Science (Chart 1), and it similarly indicates a positive feedback driver at work. In this instance, it was political patronage that drove the increase. Both the land-grant colleges, and the agricultural research stations, were political creations, which provided numerous positions with which to reward political supporters. This is reflected in what those exponential increases of funding paid for. By 1915, 88 percent of the staff of the

11. The Morrill Land-Grant College Act of 1862, July 2, 1862, https://www.senate.gov/artandhistory/history/common/civil_war/MorrillLandGrantCollegeAct_FeaturedDoc.htm. The "A&M" acronym, retained by several land grant colleges to the present day, means "Agricultural and Mechanical." In the 20th century, many of these A&M colleges changed their names. In 1957, for example, Colorado A&M became Colorado State University.

12. The Homestead Act of 1862, May 20, 1862, https://www.senate.gov/artandhistory/history/common/image/Homestead_Act.htm. Prior to 1862, federal interest in agriculture had sat orphaned in the Patent Office, which itself sat stranded in the Department of the Interior. In 1862, the Department of Agriculture was formed as an advisory committee to the President. The Department of Agriculture became a cabinet department in 1889.

CHART 2

### Total Appropriations of the U.S. Department of Agriculture, 1890–1915




**SOURCE:** A.Hunter Dupree, *Science in the Federal Government: A History of Policies and Activities* (Baltimore: Johns Hopkins University Press, 1986), p. 182.

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Department of Agriculture worked in administrative and regulatory functions, while staffing for agricultural research accounted for only 12 percent. And this number is probably an exaggeration: Appointments to scientific posts in the Agricultural Research Stations were often handed out as favors to political supporters, not scientists.[13] The pattern continues to this day: Agricultural research through the land-grant colleges is now largely driven by well-monied political interests, less so for service to farmers.[14]

13. A. Hunter Dupree, *Science in the Federal Government*.

14. Gerard Middendorf and Lawrence Busch, "Inquiry for the Public Good: Democratic Participation in Agricultural Research," *Agriculture and Human Values*, Vol. 14, No. 1 (March 1997), pp. 45–57, at https://link.springer.com/journal/10460/14/1 (accessed June 9, 2020), and Joel M. Guttman, "Interest Groups and the Demand for Agricultural Research," *Journal of Political Economy*, Vol. 86, No. 3 (June 1978), pp. 467–484, at https://www.jstor.org/stable/1833163?seq=1 (accessed June 9, 2020).

The Homestead Act also drew in greater federal involvement in science, but in different ways and with different consequences. Settlement of the American West went hand-in-hand with expeditions to provide maps and surveys for agricultural, mineral, and water resources. Such expeditions required accomplished leaders with both military and scientific experience. Notable among these was Major John Wesley Powell, who dramatically shifted the terms of the relationship between federal support of science and political aims: While scientific aims previously had been cloaked behind political aims, Powell advanced political interests behind a cloak of science.[15] This set the precedent for the later expansion of federal involvement in scientific research.

Powell was a famous war hero (having lost his right arm at the Battle of Shiloh) and a charismatic explorer (who was the first to navigate the Grand Canyon, the "last blank spot on the map," as he adroitly put it). He took as his mission the rational settlement of the arid west, which he could undertake as head of the recently-established United States Geological Survey (1879). Powell was not deterred by the niceties that had long held science and the federal government at arms-length. Rather, he enthusiastically kicked down the barriers: Science was a national necessity, which the federal government was simply obliged to support, no questions asked. In modern terms, Powell shifted the Overton window on what were, and were not, permissible ways of thinking about the relationship of government to science.

The major problem in settling the arid West was scarcity of water. To Powell, this posed a complex problem of management: Who would get water, how would water be delivered, how much water could people get and when, and who would decide? Powell argued that such decisions could not be left in the hands of the ranchers and farmers who had already settled in the West. Rather, water had to be managed through benevolent, objective, disinterested—and federal—science, implemented through large-scale public works projects of irrigation and storage reservoirs, along with the federal authority to govern them. In this, Powell was the first technocrat.

## Small Science: Progressivism and the Expansion of Federal Science

The rise of Progressivism in the late 19th and early 20th centuries saw Powell's technocratic legacy expand dramatically. The Progressives

15. "John Wesley Powell: Soldier, Explorer, Scientist," Washington, D.C., U.S. Government Printing Office, 1969.

regarded themselves as a "Party of Science," and they looked to harness science to solve societal ills, through establishing a new gamut of scientific regulatory agencies, such as the Food and Drug Administration (FDA) in 1906, the National Institutes of Health (NIH) in 1930, and others. Conservation of natural resources was another favored Progressive cause (as it is presently), which spawned still more agencies like the United States Forest Service (USFS), the National Park Service (NPS), the Fish and Wildlife Service (FWS), and several others. The rise of Progressivism was a bipartisan affair: The technocratic presidency of the ostensibly Republican Herbert Hoover was cast as much in the Progressive mold as was the Democratic Woodrow Wilson's.

The Progressive agenda for science was finally cemented into place with the triumph of New Deal Progressivism in the 1930s. Franklin Roosevelt, like Powell, was not restrained by Constitutional niceties, and he jumped into funding science with federal dollars with as much improvisational gusto as Powell. Roosevelt's quintessential New Deal initiative, the Works Progress Administration (WPA), founded in 1935, for example, employed scientists in substantial numbers on scientific research projects in mathematics, biology, medical sciences, and technology, usually through direct grants to the state university (land-grant) colleges. WPA funds also flowed to government research agencies, including pet progressive agencies like the National Park Service and Forest Service. The *ad hoc* support of science through the WPA eventually gave way to a more formal structure in the form of the Office of Scientific Research and Development (OSRD), which brought to fruition the age-old dream of bringing science under federal control. We shall return to the OSRD momentarily.

## Small Science: The Emergence of the Professional Scientist

The latter half of the 19th century was a period of vigorous economic growth, stemming largely from technological innovation in emerging industries in manufacturing, telecommunications, transportation, and electricity. The American system of higher education at that time was not equipped to provide scientists in sufficient numbers to match these new industries' demands, however. The land-grant colleges could provide some of this talent, but not all, and not always with the right talents. Neither could the mostly sectarian system of private colleges that existed then. Meeting the demand for highly skilled scientists could only be done through a radical transformation of higher education, which came at the behest of the new technology-oriented industries.

Ready at hand was the German "research university" model that had provided the technological and scientific know-how for Germany's own economic expansionism.[16] Importing the research university model into the American system of higher education began with the 1876 founding of the eponymous Johns Hopkins University, established by the prominent railroad industrialist, Johns Hopkins.[17] Hopkins' own motivation was not to foster new technology, but to improve public health: Recurrent yellow fever epidemics had been sweeping the south, and Hopkins thought a research university (along with a research hospital, also endowed by him) might help solve the problem.

The research university model utterly transformed American higher education.[18] The Johns Hopkins model was rapidly adopted by several private (e.g., Harvard) and public university systems (e.g., the University of California). Other philanthropists also got into the act. Leland Stanford, who, like Hopkins, had made a fortune in railroads, established his own research university in California. Andrew Carnegie, John D. Rockefeller, Alexander Graham Bell, and others endowed private foundations that could channel research funding into the ever-growing network of research universities. Presently, every state has parallel systems of private, public, and land-grant colleges, all converging on the research university model.

Research enterprises independent of the research universities were also established through private philanthropy. The Carnegie Foundation, for example, fully funded the Station for Experimental Evolution at Cold Spring Harbor, New York, which carried out pioneering research on human genetics.[19] Industries also established their own research enterprises, the most famous of which was AT&T's Bell Labs, from which came some of the most momentous scientific discoveries of the 20th century.[20]

The research university was the final piece of the "science ecosystem" of Small Science and, arguably, was the engine of its glory. Through innovations such as graduate school training for researchers, funding of scientists'

16. Timothy Lenoir, "Revolution from Above: The Role of the State in Creating the German Research System," 1810–1910, *The American Economic Review*, Vol. 88, No. 2 (May 1998), pp. 22–27, at https://www.jstor.org/stable/116886?seq=1 (accessed June 9, 2020).

17. Hugh Hawkins, *Pioneer: A History of the Johns Hopkins University, 1874–1899* (Ithaca, NY: Cornell University Press, 1960).

18. This includes primary and secondary education as well. The U.S. system of public schools also drew on German state schools for inspiration. See for example Glenn Harlan Reynolds, *The New School: How the Information Age Will Save American Education from Itself* (New York: Encounter Books, 2014).

19. Including (infamously) the Eugenics Records Office, which provided the allegedly "scientific" case for public policies on eugenics. See, Thomas C. Leonard, *Illiberal Reformers: Race, Eugenics, and American Economics in the Progressive Era* (Princeton, N.J.: Princeton University Press, 2016) and Thomas C. Leonard, "Retrospectives: Eugenics and Economics in the Progressive Era," *Journal of Economic Perspectives*, Vol. 19, No. 4 (Fall 2005), pp. 207–224, at https://www.aeaweb.org/articles?id=10.1257/089533005775196642 (accessed June 9, 2020).

20. Jon Gertner, *The Idea Factory: Bell Labs and the Great Age of American Innovation*, (New York: Penguin Press, 2013).

salaries and research, and employment secured through rigorous tenure policies, research universities fostered the growth of a new class of professional scientists. These scientists could find support in diverse ways, including the deep pockets of private foundations, commercial laboratories for research and development, institutional and private contributions, and a modicum of support from government sources. This conferred upon scientists, for the first time, a considerable intellectual autonomy. In turn, scientists could, also for the first time, make a career out of being a scientist, which often entailed a fluid migration between the academy, commercial research and development, and government service.

Creativity and innovation made scientists valuable in each of these contexts. The Small Science ecosystem was shaped largely around protection of that crucial attribute. In the research universities, academic freedom came to be the governing principle. Companies like AT&T fostered freedom of thought in their own research and development endeavors; Bell Labs put few constraints on their scientists' activities, paid them well, and shared their patents openly.[21] Government agencies could not attract researchers if bureaucratic constraints overburdened them. The result was the growth of a considerable stock of "intellectual seed corn": a large stock of professional scientists operating in a science ecosystem that was structured around their flourishing.

## Big Science Emerges

At the end of the 1930s, the United States was therefore well-positioned to respond to the technical and scientific challenges of the looming crisis of world war. The Office of Scientific Research and Development (OSRD), already in place, provided the vehicle for mobilizing *en masse* the entire quasi-informal ecosystem of Small Science to victory in war, under the direction of the government and the military. The Manhattan Project, the most well-known mobilization, drew heavily on scientists from all corners of the Small Science ecosystem: academia, industry, and government.[22] Private industries also were mobilized. Bell Labs, for example, was drafted into a "Manhattan Project" of its own, to develop new telecommunications, encryption, and detection technologies. Expenditures for this effort exceeded those of the Manhattan Project.[23]

21. Ibid.

22. Leslie M. Groves, *Now It Can Be Told: The Story of The Manhattan Project* (New York: Hachette Books, 2009).

23. Jon Gertner, *The Idea Factory*.

During the war, academic scientists provided a large pool of scientific talent from which to draw. They had been generously supported and had responded in kind, and the success of that mobilization is well-known.[24] Once World War II was won, though, the question arose: What should be done with all the demobilized scientists? Scientists employed in private entities, like Bell Labs, could simply go back to industrial, commercial, and government-contracted research and development. Scientists already employed by the government could likewise return to their pre-war agencies, or be redeployed to new government agencies, such as the Atomic Energy Commission. Academic scientists posed a particular problem, however. The solution was to continue providing generous federal support, and the model for doing so would be the National Science Foundation (NSF), established in 1950.

Through roughly 11,000 research grants awarded each year, the NSF is the principal funder of academic research today. The NSF has also been the model for other government agencies to fund academic research (so-called extramural research) to complement their in-house (or intramural) research programs. Presently, 16 agencies have programs for funding extramural research: the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA), Agricultural Research Service (ARS), and National Institutes for Health (NIH), to name a few. In 2017, these agencies accounted for 60 percent of the $125 billion in total federal research expenditures. The federal government is now, by far, the largest funder of academic research in the United States, dwarfing all other sources of support (Chart 1).

The NSF's stated mission is "[to] promote the progress of science ...."[25] But there is another agenda lurking behind the mission statement: The NSF represents the imposition of New Deal ideology onto the enterprise of science.[26] Some history of how the NSF came to be will be informative.

The NSF owes its founding to a protracted political debate, not over whether the federal government *should* have a role in the funding of science, but what role the government *would* play. There were two major

24. Leslie M. Groves, *Now It Can Be Told*.

25. National Science Foundation Act, "Statutory Mission and Vision," https://www.nsf.gov/pubs/2014/nsf14002/pdf/02_mission_vision.pdf.

26. Jessica Wang, "Liberals, the Progressive Left, and the Political Economy of Postwar American Science: The National Science Foundation Debate Revisited," *Historical Studies in the Physical and Biological Sciences*, Vol. 26, No. 1 (January 1995), pp. 139–166, at https://doi.org/10.2307/27757758 accessed June 9, 2020, and Daniel J. Kevles, "The National Science Foundation and the Debate Over Postwar Research Policy, 1942–1945: A Political Interpretation of Science—The Endless Frontier," *Isis*, Vol. 68, No. (March 1977), pp. 4–26, at https://www.jstor.org/stable/230370 (accessed June 9, 2020).

protagonists in the debate: On one side, Senator Harvey Kilgore (D–WV), a staunch New Dealer, and on the other side, Vannevar Bush, who had been appointed by President Roosevelt to head the OSRD. Kilgore brought to the debate the quintessential New Deal suspicion of the private sector, coupled with an inordinate faith in government's ability to accomplish things. His major concern was what would become of the substantial wartime federal investment in military, industrial, and academic research? The stakes were high: New technologies and new knowledge had come out of this investment. Why, Kilgore wondered, should companies like AT&T become rich because of federally-funded innovation at Bell Labs? Why, for that matter, should academic scientists just skate off to their academic homes, newly equipped with knowledge and skills developed at federal expense? Kilgore's position was that a return to the *antebellum* status quo would amount to theft of public intellectual property, and he was determined to oppose it. His plan moving forward was to convert science (and scientists) into public assets to be managed for the public good.

Vannevar Bush, on the other side, was a distinguished scientist and engineer who had occupied all corners of the Small Science ecosystem. He was a professor at the Massachusetts Institute of Technology (MIT), and so was familiar with the academic traditions of science. He was also a skilled administrator who became vice president at MIT. As President of the Carnegie Foundation, Bush also had had substantial prewar engagement with philanthropic funding of science. As director of the OSRD, Bush was placed at the heart of the wartime mobilization of science, and it placed him at the center of the debate over science's post-war transition.

Bush's main concern was that Kilgore's proposals would forever subordinate science to politics. Far better for science, Bush thought, if a way could be found to preserve scientists' intellectual independence and autonomy. Bush made his case through a position paper prepared at the behest of President Roosevelt, submitted in 1945 shortly after Roosevelt's death, entitled *Science: The Endless Frontier.*[27] That paper set the opposite pole to Kilgore's position. Bush's congressional champion in this was Senator Warren Magnuson, (D–WA). It took several years of political haggling for the debate to finally settle on the National Science Foundation Act, which established the NSF, and was signed by President Truman into law in 1950.[28]

27. Vannevar Bush, "Science: The Endless Frontier; A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July, 1945," United States Government Printing Office, Washington, D.C., July 1945, https://www.nsf.gov/about/history/nsf50/vbush1945.jsp (accessed June 9, 2020).

28. National Science Foundation Act, December 19, 2002, https://www.congress.gov/107/plaws/publ368/PLAW-107publ368.pdf.

The tangled politics behind the establishment of the National Science Foundation has largely been subsumed under the "foundational myth" that the NSF is a result of the victory of Bush's high-minded idealism over Kilgore's populist vision.[29] In fact, Kilgore and Bush had more in common than the myth allows. Both Kilgore and Bush felt it not just natural but necessary that scientists in all sectors—academic, industrial, and governmental—be mobilized toward national needs and priorities, and under federal leadership. Their solution was not a high-minded triumph of scientific ideals over populism. Rather, the NSF Act was a complicated political compromise between two mutually incompatible aims: free scientific inquiry (Bush), or politically-governed science (Kilgore). To have both, there had to be rules to navigate the conflict.[30] The National Science Foundation Act set those rules in what we may term the Bush–Kilgore compromise.

## How Big Science Works: The Indirect Cost Scam

Compromises are inherently unstable, but can hold as long as all parties adhere to the rules. When any party decides otherwise, the compromise fails, with unpredictable and often undesirable consequences. After three decades, for example, the fundamental incoherency (that slavery could exist within a republic of free citizens) of the Missouri Compromise caused the compromise to unravel. We are now seven decades into the Bush–Kilgore compromise, and it too is unraveling, and in some very unpleasant ways. As is usually the case, "follow the money" is a useful guide.

Academic scientists are funded through research grants, for which they apply through research proposals sent to a federal funding agency, such as the NSF. Research proposals comprise two major parts. The *project description* is where the intellectual case for support is made. The *project budget* outlines the costs of doing the research. The budget, in turn, comprises two main spending categories, and that is where the problem lies. *Direct costs* are the costs of actually doing the research: equipment, supplies, travel, and salaries and benefits for the scientists and students. *Indirect costs* are a bit of budgetary arcana set by the university that employs the scientist.[31] These supposedly compensate the institution for enabling a scientist to do research there: building maintenance, laboratories, the library, the IT infrastructure,

29. Jessica Wang, "Liberals, the Progressive Left, and the Political Economy of Postwar American Science."
30. The German research universities had had to negotiate a similar compromise a century earlier. See, Timothy Lenoir, "Revolution from Above."
31. Linda G. Sundro, "Federally Sponsored Research: How Indirect Costs Are Charged by Educational and Other Research Agencies," Office of Inspector General, National Science Foundation, OIG-91-2, September 1991, https://www.nsf.gov/pubs/1997/oig912/oig912.pdf (accessed June 9, 2020).

etc. Indirect costs are generally charged as a percentage of direct costs: Around 50 percent is the norm. This means that for every $100,000 spent on direct costs, an additional $50,000 is added to the total costs. This surcharge goes directly to university coffers. The scientist does not see any of it.

Indirect costs represent a substantial stream of revenue for colleges and universities. Given the roughly $40 billion in 2017 federal spending on academic research (Chart 1), a 50 percent indirect cost rate would channel $13 billion directly to universities. Add to this research revenues from other sources, which are also assessed indirect costs, and the stream of indirect cost money expands to $25 billion. To put this into perspective, the 2017 federal spending on Pell grants, which is earmarked for students' tuition, was roughly $28 billion.[32] More to the point, indirect cost monies represent a large stream of essentially discretionary funds, and here is the first point of conflict. What scientists either do not know, or choose to ignore, is that it is the institution's interests that matter to institutions: The science itself is irrelevant. To institutions, the scientist is merely the turnkey to what really matters: the indirect-cost money spigot.

Because it is institutional (not scientific) interests that are advanced through indirect cost monies, expenditures of these funds have become disconnected from the science they are intended to support. The disconnect has led to some audacious institutional scams. One brazen scheme in the mid-1990s involved alleged abuse of indirect cost monies by Stanford University,[33] which was at the time assessing indirect costs at nearly 75 percent of direct costs. In other words, for every $100,000 spent on research, Stanford slapped on an additional $75,000 fee to support its ostensible expenses. This was lucrative from Stanford's point of view. From one federal agency alone (the Office of Naval Research, ONR), indirect cost monies brought in nearly $200 million per year. Among the expenditures charged to this money gusher were: flowers for the Stanford President's office, expenses for an administrator's wedding, fine china and silverware, even a yacht. Stanford and the ONR eventually settled for a slap on the wrist and a promise to sin no more.[34] In the aftermath, numerous other research universities ponied up "good faith" refunds of indirect cost funds, just to forestall scrutiny. One wonders what was (and remains?) hidden under those rocks.

32. CollegeBoard.com Editors, "Pell Grants: Recipients, Maximum Pell and Average Pell," College Board Research, https://research.collegeboard.org/trends/student-aid/figures-tables/pell-grants-recipients-maximum-pell-and-average-pell (accessed June 9, 2020). See Figure 20b.

33. Linda G. Sundro, "Federally Sponsored Research."

34. David Folkenflick, "What Happened to Stanford's Expense Scandal?" *The Baltimore Sun,* November 20, 1994, https://www.baltimoresun.com/news/bs-xpm-1994-11-20-1994324051-story.html (accessed June 8, 2020).

Following the Stanford scandal, tighter federal rules and audits for indirect costs were put in place, but these reforms did little to rein them in, or to blunt the potential for abuse. There remains, for example, the practice of allowing individual universities (not scientists) to negotiate indirect cost rates with federal funding agencies, and they are renegotiated every three years.[35] Inevitably, these negotiations are conducted in a climate of relentless upward pressure from universities for ever more money. Restraint is barely evident in the resulting hodge-podge of indirect cost rules. Two decades following the Stanford debacle, a survey of 50 U.S. research universities showed indirect cost rates ranging from 47 percent to nearly 90 percent (indirect cost rates exceeding 100 percent are not unheard of), little changed from the 1990s.[36] Those touted reforms are merely tissue paper tigers.

Nor have the reforms opened up indirect cost expenditures to scrutiny, whether by the alleged beneficiaries of indirect cost expenditures (the scientists), by the benefactors (the public), or by the protectors of the public finances (the auditors). Opacity made the Stanford scam possible, and it remains a widespread practice throughout academia, open to abuse on a scale ranging from the petty to the epic.

At the epic end is a State University of New York (SUNY) initiative in nanotechnology, SUNY Polytechnic Institute, which used elaborate kickback schemes tying political campaign contributions to bid-rigging of state contracts. These awarded roughly $855 million to companies and quasi-government entities to "invest" in SUNY Polytechnic—a kind of indirect costs on steroids. While the designated fall guys are headed to prison for this,[37] it is noteworthy that SUNY Polytechnic had the enthusiastic support of the supposed stewards of the public interest, right up to the point that indictments were being handed down. No transparency there, clearly.

At the petty end of the spectrum are perplexing institutional patterns of indirect cost spending, where, for instance, things that a reasonable person would assume support research, like IT infrastructure or research libraries, turn out not to receive any indirect cost monies at all. Where is the money

35. Linda G. Sundro, "Federally Sponsored Research."

36. Datahound Editor, "Indirect Cost Rate Survey," Datahound, May 10, 2014, https://datahound.scientopia.org/2014/05/10/indirect-cost-rate-survey/ (accessed June 8, 2020).

37. Robert Gavin, "Kaloyeros Sentenced to Over 3 Years in SUNY Poly Scandal," *Albany Times Union*, December 11, 2018, https://www.timesunion.com/news/article/Kaloyeros-sentencing-13457293.php (accessed June 8, 2020).
Gronewald, A. (2018); Anna Gronewold, "After Months of Tumult, a Turning Point at SUNY Poly," *Politico*, July 2, 2018, https://www.politico.com/states/new-york/albany/story/2018/07/02/after-months-of-tumult-a-turning-point-at-suny-poly-495239 (accessed June 8, 2020); and Corinne Ramey, "Ex-SUNY President Convicted in 'Buffalo Billion' Scandal Gets 3½ Years in Prison, *The Wall Street Journal*, December 11, 2018, https://www.wsj.com/articles/ex-suny-president-convicted-in-buffalo-billion-scandal-gets-3-years-in-prison-11544574718 (accessed June 8, 2020).

going? Good question. Ask that of your local university and see where it gets you. Years of grudgingly granted Freedom of Information Act (FOIA) requests later, you might still be interested in the answer, but most people would have given up long before then.

## The Systemic Corruption of the Academy

If indirect cost scams were mere administrative duplicity, the solution would be simple: better management of funds, overseen by audits and enforced by indictments. They are, rather, only the most visible indicators of systemic corruption in the academic science ecosystem. Seventy years of Big Science has turned the enterprise of science into something resembling a self-serving and self-perpetuating cartel, organized not around oil or cocaine, but around skimming indirect cost monies. Scientists, far from being the hapless victims of administrative malfeasance, have become the cartel's enthusiastic enablers.[38] There is corruption there to be confronted as well.

The Big Science cartel has emerged gradually, driven by three long-term and intertwined trends. First is the rise of the administrative university and the consequent marginalization of "frontline" faculty.[39] Second is the fulminating financial crisis that is enveloping the entire higher education sector. And third is the gradual degradation of academic culture, seen most alarmingly in the erosion of core values such as freedom of inquiry and academic freedom. These trends have been feeding one another for years, each simultaneously cause and effect, all linked into a kind of triple helix of mutual reinforcement: positive feedback, in other words. While the degradation is seen most vividly among the humanities disciplines, it is Big Science and the relentless pursuit of indirect cost monies that has been turning the screw.[40]

Consider, for example, the principal marker for higher education's rapidly-rising costs: administrative bloat.[41] It was once common on college campuses for faculty to outnumber administrators. Now the reverse is common. Building the administrative university costs money, lots of it, for administrators are commonly paid far more handsomely than faculty typically are.[42] Where does the money come from? Revenue streams from tuition, charitable contributions, and state funding are all poor options for

38. Geoffrey A. Clark, "How Academic Corporatism Can Lead to Dictatorship," Letter to the Editor, *Nature*, Vol. 452, No. 7184 (2008), p. 151, at https://doi.org/10.1038/452151c (accessed June 9, 2020).
39. Benjamin Ginsberg, *The Fall of the Faculty*.
40. Geoffrey A. Clark, "How Academic Corporatism Can Lead to Dictatorship."
41. Benjamin Ginsberg, *The Fall of the Faculty*.
42. Ibid.

funding administrative bloat. This leaves the Willie Sutton option: Go to where the money is, and the money is in indirect costs from research grants.

Scientists are thus placed under relentless pressure to generate ever more research funding to pay for ballooning administrative costs. It does not matter to institutions what the actual research is, or its scientific value or necessity. All that matters is more indirect cost revenue. No amount is ever enough, of course: This is a positive feedback system, remember.

The traditional defense of academic scientists against such administrative aggrandizement has been robust protection of freedom of inquiry and thought. It is in the natural interests of administrations to see those protections disappear, and those efforts have been succeeding to an alarming degree.[43] Dismayingly, it has been faculty, not administrations, that have emerged as the most enthusiastic enablers of this pernicious trend. The reason for this is quite simple: self-interest. Rewards in the Big Science ecosystem no longer flow to the innovative and independent thinker, they now flow to those who serve the cartel. These rewards include promotion to administrative posts that confer money, status, and power over academic colleagues. Once ensconced, a faculty member in this position becomes an enforcer of the cartel's interests, often through co-opting faculty into adopting systems of reward and promotion that serve the cartel's interests rather than the fundamental interests of the scientist. Promotion and tenure, for example, is increasingly based on dubious "metrics" of scientific "productivity," with supposedly measurable "outcomes" that can bring "accountability" to the practice of science: all favorite buzzwords of the administrative mind, you will notice. Promotion and tenure decisions increasingly turn on matrices of conformity to such administrative imperatives. The evaluation of actual ideas and creativity is fading from consideration: Decisions on promotion and tenure no longer require reading or engaging a scientist's actual body of creative work. Those who conform to this phony regime find rewards aplenty flowing to them. Those maverick scientists who do not conform increasingly find themselves being shown the door.[44] The essentially creative nature of scientific inquiry, supposedly the whole point of Big Science, has been coming out the loser.[45]

43. E.g., Nikita Vladimirov, "Profs Blast Proposal to Weaken Tenure at U of Arkansas," Campus Reform, The Leadership Institute, October 31, 2017, https://www.campusreform.org/?ID=10080 (accessed June 8, 2020).

44. David Kaiser, *How the Hippies Saved Physics: Science, Counterculture, and the Quantum Revival*, (New York: W. W. Norton, 2011). Philip Hunter, "Is Political Correctness Damaging Science? Peer Pressure and Mainstream Thinking May Discourage Novelty and Innovation," *EMBO Reports*, Vol. 6, No. 5 (May 2005): pp. 405–407, at https://www.embopress.org/doi/full/10.1038/sj.embor.7400395 (accessed June 9, 2020); and Roger Kimball, *Tenured Radical*.

45. Adrian Currie, "Does Science Need Mavericks?" *Aeon*, October 16, 2017, https://aeon.co/essays/does-science-need-mavericks-or-are-they-part-of-the-problem (accessed June 8, 2020).

## Moral Panics and Big Science

The Bush–Kilgore compromise held for many years because the newly instituted Big Science ecosystem was populated by holdovers from the Small Science ecosystem: the "seed corn" that had, by mid-20th century, been built up so painstakingly. These took for granted Vannevar Bush's essential assumption that scientists' autonomy and independence had to be respected for there to be science at all. As the Bush–Kilgore compromise has come unraveled, that seed corn has been consumed, with the result that the Big Science ecosystem is now completely governed by politics and conformity. Kilgore has won, in other words. Dismayingly, it is scientists who have been the principal instruments of his victory.

This is vividly illustrated by recent patterns of spending on research, which are often driven by ginned-up moral panics that serve political, not scientific, interests. The motivation is simple: Moral panics allow more money to be squeezed from federal funding agencies to feed the panic, inflating the indirect cost money stream to colleges and universities, and prompting rewards to the scientists who bring in more: a positive feedback loop.

Here is how this works for the most visible of these moral panics, climate change. The NSF is an enthusiastic funder of climate change research. In addition to its established research directorates, the NSF last year put out 53 special calls for proposals to study climate change.[46] These involve big money. In 2018, the NSF spent roughly $1.4 billion on climate change research (out of its total $7.8 billion budget for the same year), distributed among roughly 1,400 research grants awarded.[47]

Climate change is many things, of course, but it is also a political agenda, ripe with opportunities for political power and career advancement. Historical spending by NSF on climate change reflects this. In 1989, for example, the NSF supported 19 research proposals on climate change, allocating a total of $6 million among them. By 2019, those numbers had grown to 547 research grants and a total of $812 million in expenditures. Since 1989, the NSF has allocated a total of more than $3 billion to more than 3,400 research grants on climate change.[48] Assuming a 50 percent indirect cost rate, this represents

46. National Science Foundation, "Advanced Funding Search," https://www.nsf.gov/funding/advanced_funding_search.jsp (accessed June 8, 2020). Search terms "climate change" and "active."

47. National Science Foundation, "Award Search," https://www.nsf.gov/awardsearch/simpleSearch.jsp, (accessed June 8, 2020). Search term "climate change."

48. National Science Foundation, "Award Search," https://www.nsf.gov/awardsearch/simpleSearch.jsp, (accessed June 8, 2020). Search term "climate change."

a revenue stream of roughly $1 billion of indirect cost monies to colleges and universities. This figure is only for the NSF. If expenditures by other federal research agencies are included, as well as monies from various tax incentive programs for private foundations like the Sierra Club, total spending on climate change research reaches into the trillions of dollars, all of it potential sources for indirect cost assessments.[49] For cash-strapped universities, tapping into this lush money stream is an irresistible temptation. To slake that thirst, academic scientists are pressured to direct their research toward studying climate change, whether they are inclined to or not.

By contrast, research into the world's deadliest disease—malaria[50]—has not enjoyed the exponential growth in funding that climate change research has. Since 1956, the NSF has spent $130 million on malaria research, allocated to a total of 274 research grants.[51] Since a spike in funding around 1999,[52] annual spending on malaria research has ticked along at a steady rate of about $6 million on average. (In the 2019 fiscal year, it was $4.5 million.) To be fair, the NSF is not on the front line of malaria research: the National Institutes of Health (NIH) is the more logical funder. Even so, NIH funding for malaria research shows a similar pattern of steady—not exponentially rising—annual expenditures, averaging around $200 million per year.[53]

What explains the difference? The answer is cynical, but unavoidable. Malaria research offers only modest indirect cost returns. Climate change offers a more lucrative stream, prompting a positive feedback loop. Universities look to climate change research to bring in large streams of indirect cost monies. The NSF and other research agencies look to politicians, who themselves seek rewards, power, and votes by showing wealthy donors how responsive they are to an urgent crisis. The positive feedback loop is closed by academic scientists who shape their research programs to tap that growing stream of money, eager to glean the rewards that follow from bringing in more indirect cost monies to their home institutions. Everyone in this system has an interest in driving up expenditures. In this way, climate change "science" is completely transformed into an instrument of political

49. Stephen Moore, "Follow the (Climate Change) Money," Heritage Foundation *Commentary*, December 18, 2018, https://www.heritage.org/environment/commentary/follow-the-climate-change-money.

50. Worldwide annual mortality from malaria infection is roughly 450,000 out of roughly 228 million infections, most of them in Africa. See Centers for Disease Control and Prevention, "Malaria," CDC 24/7: Saving Lives, Protecting People, Parasites-Malaria, (page last reviewed, April 24, 2020), https://www.cdc.gov/parasites/malaria/index.html (accessed June 9, 2020).

51. National Science Foundation, "Advanced Funding Search," https://www.nsf.gov/awardsearch/simpleSearch.jsp, (accessed June 8, 2020). Search term "malaria."

52. The spike in funding was prompted by discoveries about the parasite's own immune system, which raised hopes for a malaria vaccine.

53. "Estimates of Funding for Various Research, Condition, and Disease Categories (RCDC)," NIH, Research Portfolio Online Reporting Tools, February 24, 2020, https://report.nih.gov/categorical_spending.aspx (accessed June 9, 2020).

activism, driven by a moral panic over a non-existent "climate emergency." No reward accrues to those who insist on skepticism, critical thinking, and free thought, all essential attributes of the scientific enterprise. Scientists who insist on these norms, like MIT's Richard Lindzen, or Georgia Tech's Judith Curry, are simply dismissed as "deniers," in the present illiberal lexicon.[54] At the receiving end of all this are the hapless taxpayers, who must pony up the money, whether they like it or not.

Another moral panic that has been even more corrosive to academic ideals has been the supposed diversity and inclusion (D&I) crisis, which has seized enormous power on American campuses.[55] As with climate change, the political agenda of D&I is being advanced behind a cloak of science, in this instance, the essentially noble cause of expanding opportunities for budding scientists. Behind the cloak is a raw pursuit of political power.

The rise of the D&I agenda on campuses has been bad for the universities and bad for science. Diversity and inclusion officers are presently the fastest growing sector of academic administration, and account for most of the administrative bloat driving academic costs up.[56] As they have gathered political power unto themselves, D&I administrators have not been shy about entangling skeptics and dissenters in a web of speech codes and other "safe space" rules.[57] They clamp down upon tenured faculty through threats of administrative sanction, often carried out in secret HR proceedings, to bring the scientist into line with their political agenda. College campuses are now very illiberal places.

This expensive D&I takeover of the academy is being paid for largely through the fungible pool of monies provided by indirect cost revenues. The principal vehicle for doing so has been research grants for STEM education (Science, Technology, Engineering, and Mathematics).[58] The stated aim of

54. E.g., Christopher Booker, "Climate Change: This Is the Worst Scientific Scandal of Our Generation," *The Telegraph*, November 28, 2009, https://www.telegraph.co.uk/comment/columnists/christopherbooker/6679082/Climate-change-this-is-the-worst-scientific-scandal-of-our-generation.html (accessed June 9, 2020).

55. Anthony Kronman, "The Downside of Diversity," *The Wall Street Journal*, August 2, 2019, https://www.wsj.com/articles/the-downside-of-diversity-11564758009 (accessed June 8, 2020); Christian Schneider, "Secular Universities Now Demand a 'Profession of Faith,'" *The New York Post*, April 26, 2019, https://nypost.com/2019/04/26/secular-universities-now-demand-a-profession-of-faith/ (accessed June 8, 2020); Philip Carl Salzman, "Canadian Government Imposes 'Social Justice' on All Universities," PJ Media, May 15, 2019, https://pjmedia.com/news-and-politics/canadian-government-imposes-social-justice-on-all-universities/ (accessed June 8, 2020); and Sarah George, "This Public University Will Spend Nearly $3 Million on Diversity This Year Alone," *The College Fix*, May 10, 2019, https://www.thecollegefix.com/this-university-will-spend-nearly-3-million-on-diversity-this-year-alone/ (accessed June 8, 2020).

56. Benjamin Ginsberg, *The Fall of the Faculty*.

57. Anthony Kronman, "The Downside of Diversity."

58. E.g., "NSF Awards $50M in Grants to Improve STEM Education," National Science Foundation, News Release 18-105, November 15, 2018, https://www.nsf.gov/news/news_summ.jsp?org=NSF&cntn_id=297236&preview=false (accessed June 8, 2020).

these programs—again, noble on its face—is justified by a so-called "STEM crisis," a supposed shortage of prospective scientists and engineers in the education "pipeline" that, unless corrected immediately, will put the nation into some sort of jeopardy.[59]

Naturally, ample funding will be required to solve the STEM crisis, which will conveniently generate an abundant stream of indirect cost monies.[60] If anything, however, there is no STEM crisis: Universities are presently churning out STEM graduates in numbers far greater than jobs that can gainfully employ them.[61] In fact, the STEM "crisis" has been built into the Big Science regime from its inception: Vannevar Bush's *Endless Frontier* invoked a STEM crisis as justification for increased federal involvement in science.[62] The crisis has therefore been ongoing for 70 years: All that has changed has been the politically-favored beneficiaries. In the post-war years, these were the demobilized scientists, engineers, and soldiers. In the 1960s and 1970s, racial minorities were the new beneficiaries.[63] As the number and scope of officially protected groups has expanded, the range of beneficiaries has expanded apace. The STEM crisis is thus revealed for what it is: a political patronage scheme. It is a false moral panic being used to channel taxpayer monies toward politically-favored constituencies. Because the STEM crisis is to be "solved" through research grants (though it never will be "solved"[64]), it can also generate an indirect cost money stream to skim, the more substantial the better. The real beneficiaries are, as always, administrative (including D&I) officers, who are put in position to enforce conformity to the D&I agenda on the now subservient scientists.

The signs of this are evident in the historical patterns of STEM research funding. In 1987, the NSF funded only two grants in STEM education, for a total expenditure of $681,000. In 2019, 693 grants were funded, for a total

59. John F. Sargent, Jr., "The U.S. Science and Engineering Workforce: Recent, Current, and Projected Employment, Wages, and Unemployment," Congressional Research Service *Report for Congress*, November 2, 2017, https://fas.org/sgp/crs/misc/R43061.pdf (accessed June 8, 2020).

60. The National Science Foundation currently has 96 special solicitations for proposals for various aspects of STEM education. National Science Foundation, "Find Funding Search," https://www.nsf.gov/funding/index.jsp. Search term "STEM." There are currently zero special solicitations for "malaria."

61. Robert N. Charette, "The STEM Crisis Is a Myth," *IEEE Spectrum*, August 30, 2013, https://spectrum.ieee.org/at-work/education/the-stem-crisis-is-a-myth (accessed June 9, 2020), and Emma Smith and Patrick White, "The Employment Trajectories of Science, Technology, Engineering, and Mathematics Graduates," Executive Summary, University of Leicester School of Education, June 2013–August 2018, https://www2.le.ac.uk/departments/education/research/projects/the-employment-trajectories-of-science-technology-engineering-and-mathematics-stem-graduates-1 (accessed June 8, 2020).

62. Vannevar Bush, "Science: The Endless Frontier."

63. Mark Sanders, "STEM, STEM Education, STEMmania," *The Technology Teacher*, Vol. 68, No. 4 (December 2008–January 2009), pp. 20–26, at https://eric.ed.gov/?id=EJ821633 (accessed June 8, 2020).

64. John Williams, "STEM Education: Proceed with Caution," *Design and Technology Education: An International Journal* Vol. 16, No. 1 (February 2011), pp. 26–35 at https://ojs.lboro.ac.uk/DATE/article/view/1590 (accessed June 9, 2020).

expenditure of $475 million.[65] In 2019, the NSF spent $1.39 billion on various STEM programs.[66] The total spending on STEM education research has been even more impressive than for the climate panic. Since 1987, the NSF has allocated a total of roughly $5 billion to STEM research (compared to about $3.5 billion for climate change).[67] Assuming a 50 percent standard for indirect cost rates, STEM research grants have provided a revenue stream of about $1.7 billion to colleges and universities. Again, this is for the NSF only. In 2018, the Department of Education spent $279 million on STEM research grants, compared to the NSF's $691 million. This can fund a lot of handsomely-compensated diversity and inclusion administrators.[68]

Academic scientists, for their parts, have little choice but to jump on board the diversity and inclusion agenda, and dissenters will find no friends. The NSF, for example, now requires all grant applicants to address how their proposal will advance diversity and inclusion aims.[69] Universities are now requiring applicants for faculty positions to include statements outlining their loyalty to the diversity and inclusion agenda.[70] How one actually meets those demands is left vague and uncertain. Scientists now find themselves inhabiting a Kafkaesque landscape, kept off-balance and not knowing what will satisfy the inscrutable demands of the D&I state. The new message is clear: We, the diversity and inclusion administrators, not you the scientists, decide what science, and which scientist, deserves support.

65. 2019 was actually a bad year for STEM funding. The high point of stem funding was in 2016, when the NSF allocated $758 million to 645 grants.

66. Summary Tables 18, "Education and Human Resources Funding by Division and Program FY 2021 Budget Request to Congress," in National Science Foundation, *FY 2021 Budget Request to Congress*, February 10, 2020, https://www.nsf.gov/about/budget/fy2021/pdf/fy2021budget.pdf (accessed June 8, 2020). This was allocated among four categories: K-12 STEM education, $187 million; undergraduate STEM education, $617 million; graduate and professions STEM education, $431 million; outreach and informal STEM education, $156 million.

67. National Science Foundation, "Award Search," https://www.nsf.gov/awardsearch/simpleSearch.jsp. Search term "STEM." These figures are actually underestimates: The NSF searchable database limits downloads of data to 6,000 current and expired research grants.

68. Benjamin Ginsberg, *The Fall of the Faculty*.

69. All National Science Foundation proposals include in their evaluation two "merit criteria": "intellectual merit," and "broader impacts," which include diversity and inclusion aims. See the National Science Foundation, Proposal and Award Policies and Procedures Guide, NSF 19-1, February 25, 2019, https://www.nsf.gov/pubs/policydocs/pappg19_1/pappg_3.jsp#IIIA, (accessed June 8, 2020).
In addition, NSF currently lists 90 special solicitations for proposals concerned explicitly with advancing "diversity and inclusion" aims. The NSF program solicitation for Engineering Research Centers (e.g., NSF 18-549) lists four "pillars" of a successful application, of which "cultural inclusion" is one. Successful proposals will be required to meet all four, i.e., proposals that are excellent in all other areas, but do not conform to "cultural inclusion" standards, will be declined. See, Engineering Research Centers, ERC Planning Grants Program Soliciation NSF 18-549, Webinar, April 16, 2018, https://www.nsf.gov/attachments/244916/public/ERC_Planning_Grants_Webinar_FINAL-508.pdf (accessed June 8, 2020).

70. E.g., Christian Schneider, "Secular Universities Now Demand a 'Profession of Faith.'"

## Conclusion

When I began my research career, scientists still enjoyed a modicum of freedom of thought and autonomy. No more: Seventy years of massive federal support have taken two of the glories of our civilization—science and the academy—and made them shallow, doctrinaire, and corrupt.[71] Our society is paying a dear price for this, and will continue paying it for many years. Is there any way to fix it?

The present corruption of the academy flows ultimately from the breakdown of the Bush–Kilgore compromise that inaugurated the era of Big Science. Over the years, the breakdown has shifted the practice of science decisively toward blatantly political aims. Scientists who insist upon their traditional prerogatives of autonomy and freedom of thought find themselves increasingly marginalized and disempowered. It is the funding structure of Big Science, with its commingled interests of scientists and institutions, that is at fault here. Perhaps disentangling these interests somehow might restore the balance of political power? Scientists, for example, could submit funding proposals for direct costs only—or as individuals, rather than representatives of institutions. Institutions, if they have legitimate needs to build a research infrastructure (the whole point of indirect costs), could apply for funds independently of the scientists they employ.

Would such a simple fix work? Probably not. Big Science has now become a deeply-entrenched cartel, and cartels are extremely hard to dislodge. A small case in point: President Trump's 2017 budget for the NIH proposed that indirect cost rates for extramural research be capped at 10 percent, about a fifth of current rates.[72] This would have enabled a reduction of overall spending for the NIH while still increasing the money available to fund direct costs, that is, to fund science itself. This was hotly contested, and in the end, the indirect cost stream was preserved, even at the expense of monies to do actual science. There have been other imaginative attempts to decouple conflicting interests of scientists and institutions.[73] These have all failed: There is too much money and power at stake, and little incentive

71. E.g., Philip Hunter, "Is Political Correctness Damaging Science?"; Mike Nayna, "Part One: Bret Weinstein, Heather Heying and the Evergreen Equity Council," YouTube, December 9, 2019, https://youtu.be/FH2WeWgcSMk (accessed June 8, 2020); Mike Nayna, "Part Two: Teaching to Transgress," YouTube, March 6, 2019, https://youtu.be/A0W9QbkX8Cs (accessed June 8, 2020); Mike Nayna, "Part Three: The Hunted Individual," YouTube, April 24, 2019, https://youtu.be/2vyBLCqyUes (accessed June 8, 2020); and Flagg Taylor, "The Meaning of Middlebury," *The American Interest*, March 29, 2017, https://www.the-american-interest.com/2017/03/29/the-meaning-of-middlebury/ (accessed June 8, 2020).

72. Jocelyn Kaiser, "NIH Plan to Reduce Overhead Payments Draws Fire," *Science*, June 2, 2017, https://www.sciencemag.org/news/2017/06/nih-plan-reduce-overhead-payments-draws-fire (accessed June 8, 2020).

73. E.g., Jop de Vrieze, "With This New System, Scientists Never Have to Write a Grant Application Again," *Science*, April 13, 2017, https://www.sciencemag.org/news/2017/04/new-system-scientists-never-have-write-grant-application-again (accessed June 8, 2020).

to change.[74] About the only refuge to be found is to not seek support from grants at all, and that is increasingly tenuous ground to defend.[75]

At the heart of the problem sits a radical question: What is it that we, as a society, expect the university, and in particular academic science, to be? What are the benefits we expect it to provide? Usually, asking this question will bring forth a torrent of studies, justifications, and analyses showing the numerous benefits—educational, cultural, and economic—that Big Science has brought us. I have delved into these at some depth. Limitations of space allow me only to say that there is less there than meets the eye.

In the early 19th century, when the research university model was being introduced into the German universities, there was an interesting debate that illuminates the question.[76] The research university was an initiative of Bismarck's German Confederation, with the explicit aim to foster and harness science to commercial and governmental aims. In opposition to this trend was the notion that universities' proper social role should be as "bearers of culture" rather than servants to state and industry. The German research university could only arise when a workable compromise was found between the same competing interests that bedevil our modern research universities. When the American research universities could operate in the Small Science ecosystem, that compromise mostly held. In the Big Science ecosystem, that compromise has failed, with the result that science has become a wholly invested servant of the state, just one of many political interest groups competing to feed at the public trough.

What was it that made the Small Science ecosystem succeed, while the Big Science ecosystem has failed? Arguably, the diverse and fluid nature of the Small Science ecosystem was better able to provide internal checks against science being captured by detrimental interests. Big Science has proven itself unable to check itself in this way, with moral panics, large and small, being the prime example of this. Of course, moral panics occurred during the Small Science era. The eugenics scare of the 1920s, for example, was the climate panic of its day, with virtual scientific "consensus" feeding bogus narratives of "pure" bloodlines being degraded by miscegenation.[77] Eugenics research then was funded almost entirely by the Carnegie Foundation. Many unpleasant

74. The Human Frontier Science Program funds imaginative and ground-breaking research, but caps indirect costs at 10 percent. Its biggest challenge is awardees being forbidden by their institutions to accept awards because indirect cost revenues are too low. "Review of the Human Frontier Science Program 2018 (Science Metrix)," Human Frontier Science Program *Final Report*, December 6, 2018, https://www.hfsp.org/node/12547#book/ (accessed June 8, 2020).

75. E.g., Jon Cohen, "Scientists Who Fund Themselves," *Science*, Vol. 279, No. 5348 (January 9, 1998), pp. 178–181 at https://science.sciencemag.org/content/279/5348/178/tab-figures-data (accessed June 9, 2020).

76. Timothy Lenoir, "Revolution From Above."

77. Thomas C. Leonard, *Illiberal Reformers*, and Thomas C. Leonard, "Retrospectives: Eugenics and Economics in the Progressive Era.

outcomes followed from this, including forced sterilization of "imbeciles," "morons," and other supposedly defective individuals. When the American eugenics movement began to get too cozy with similar aims in Nazi Germany, the Carnegie Foundation simply pulled the plug on its support of eugenics research.[78] One cannot even conceive of something similar happening with the climate panic, which has taken on a political life of its own.

On balance, Small Science seemed better disposed to the fostering of scientific inquiry than Big Science. Is the solution a return to Small Science? This also would be a political nightmare. It would mean, for example, dismantling the entire edifice of federal support of academic research. This would not mean ending government support of scientific research that is critical to national needs—the alphabet soup of agencies that help predict the weather, fly the satellites, keep airplanes flying, manage energy, and ensure the health of individuals and the environment. It would mean, however, that these agencies' extramural research programs would end. The National Science Foundation would be shuttered.

Such a suggestion would, of course, elicit protest from doomsayers about the end of science. But a return to Small Science would mean no such thing: It would simply mean returning science to the loose confederation of public, private, philanthropic, and industrial support that prevailed during the Small Science era. Great science came out of that era. Great science has come out of the Big Science era, too, but it is not at all clear that it is *academic* science that has provided the leavening.

To illustrate, let me invite participation in a thought experiment. Make a list of three transformative scientific achievements of the Big Science era. Here is my list: (1) the physics of semiconductors leading to the invention of the transistor[79]; (2) the polymerase chain reaction (PCR), which has led to efficient and rapid DNA sequencing[80]; and (3) Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR),[81] which supports new

78. Although eugenics was discredited as a science by the 1930s, the eugenics panic endured. Forced sterilizations, for example, continued in some states until 1979. See Lutz Kaelber, "Eugenics: Compulsory Sterilization in 50 American States," in a Presentation About 'Eugenic Sterilizations' in Comparative Perspective at the 2012 Social Science History Association, Parts 1 and 2, http://www.uvm.edu/-lkaelber/eugenics/VA/VA.html (accessed June 9, 2020). Daren Bakst, *North Carolina's Forced-Sterilization Program: A Case for Compensating the Living Victims*, The John Locke Foundation *Report*, July 5, 2011, p. 28, https://carolinapublicpress.org/wp-content/uploads/2011/07/North-Carolinas-Forced-Sterilization-Program-A-Case-for-Compensating-the-Living-Victims-policy-report.pdf (accessed June 9, 2020). See also, Thomas C. Leonard, *Illiberal Reformers*.

79. Jon Gertner, *The Idea Factory*.

80. Nancy Smyth Templeton, "The Polymerase Chain Reaction: History, Methods, and Applications," *Diagnostic Molecular Pathology*, Vol. 1, No. 1 (March 1992), pp. 58–72 at https://pubmed.ncbi.nlm.nih.gov/1342955/ (accessed June 9, 2020).

81. Ishino Yoshizumi, Mart Krupovic, and Patrick Forterre, "History of CRISPR-Cas from Encounter with a Mysterious Repeated Sequence to Genome Editing Technology," *Journal of Bacteriology* Vol. 200, No. 7 (April 2018), at https://jb.asm.org/content/200/7/e00580-17 (accessed June 9, 2020), and Eric S. Lander, "The Heroes of CRISPR," *Cell*, Vol. 164, No. 1-2 (January 2016), pp. 18–28, at https://www.cell.com/fulltext/S0092-8674%2815%2901705-5#secsectitle0010 (accessed June 9, 2020).

gene-editing technology that presents great promise (and peril) for modifying genes in living organisms.[82]

Of my three examples, two (the invention of the transistor and the polymerase chain reaction) were products of private sector research (Bell Labs and Cetus Pharmaceuticals, respectively). Both innovations were driven by rebel scientists. William Shockley at Bell Labs, who was central to the invention of the transistor, was a brilliant, if unconventional physicist.[83] Kary Mullis, who invented the polymerase chain reaction, was a biochemist who, prior to joining Cetus, had had a checkered career that involved, among other things, stints as a novelist, surf bum, and manager of a bakery. Both Shockley and Mullis drifted in and out of institutionalized science. Yet, both rank high among the greatest creative geniuses of the Big Science era. Both were Nobel Prize winners, and neither depended on the Big Science cartel for their discoveries and success.[84] Neither would have found a congenial home in today's universities.

My third example, CRISPR, has roots more firmly embedded in academic science. The two scientists who discovered CRISPR, Francisco Mojica, from Spain, and Yoshizima Ishino, from Japan, were not looking for a gene-editing method. They were trying to understand something entirely unrelated: bacterial immunity. The gene-editing method CRISPR would not have happened without Mojica's and Ishino's serendipitous discovery. Does the politicized American university have a place for serendipity? It is a good question, but one with no certain answer.

The problem with academic science today (and for the academy as a whole) is that universities are systematically crushing the essential aspects of great science: Complete intellectual freedom, room for the serendipitous, and respect for the unpredictable process of creativity. Not only are the universities crushing these virtues, they are being paid handsome rewards for doing so. Fix that, and the academy may yet have a chance at recovery.

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82. A similar list could be made for transformative scientific achievements of the Small Science era, although comparisons with the current Big Science regime are irrelevant, since Big Science did not then exist. These are: (1) steam power, which fueled the industrial revolution; (2) telecommunications, either through telegraphy or radio waves; and (3) the antibiotic revolution, which allowed physicians, probably for the first time in the history of medicine, to save more patients than they killed.

83. Jon Gertner, *The Idea Factory*.

84. "William B. Shockley: Biographical," NobelPrize.org, Nobel Media AB 2020, https://www.nobelprize.org/prizes/physics/1956/shockley/biographical/ (accessed June 8, 2020), and The Nobel Prize in Chemistry 1003, NobelPrize.org, Nobel Media AB 2020, https://www.nobelprize.org/prizes/chemistry/1993/summary/ (accessed June 8, 2020).