ABSTRACT

The US government's expanding role in assisting businesses with the development of new technologies has significantly increased corporate dependence on the state. This dependence creates new opportunities for social movements to extract significant concessions from capital.

ESSAY

The New Levers of State Power

Matthew R. Keller and Fred Block

The Left's standard theoretical tools are inadequate for making sense of US politics in the current period. They give us little leverage to explain the threat of authoritarian or neofascist politics from grassroots groups closely aligned with right-wing politicians. Concepts of monopoly capitalism do not help us understand a business class that is politically fragmented and fractured, and whose more moderate elements are under attack by Republicans for being "woke capitalists."[1] Finally, the Joe Biden administration has launched a surprisingly large program of state-led economic transformation to address climate change, infrastructure, and the

1 A useful source on this fragmentation is Mark S. Mizruchi, *The Fracturing of the American Corporate Elite* (Cambridge: Harvard University Press, 2013).

accelerated development of new industries. This effort goes well beyond the familiar terrain of corporate liberalism.

To make sense of this conjuncture, new concepts and new analyses are needed. One promising start in this direction is the effort by Dylan Riley and Robert Brenner to identify a new stage of accumulation that they label "political capitalism."[2] They argue that a growing share of profits come not from building better mousetraps but from forging a relationship with the state that guarantees earnings through direct subsidies, indirect subsidies such as funding research and development, protecting monopoly power, or providing generous government contracts.

One immediate objection to this analysis is that all stages of accumulation have been political. From the start, capitalism has been racial and patriarchal, and the state has always been integrally involved in the extraction of profits. Karl Polanyi was right when he said, "The road to the free market was opened and kept open by an enormous increase in continuous, centrally organized and controlled interventionism."[3] Riley and Brenner might simply respond that capital's dependence on the state has risen to levels more similar to the era of primitive accumulation than what was typical in the twentieth century.

A second issue, however, is more serious. Riley and Brenner insist that there is no room within this new political capitalism for anything like a return to the "class compromises" that characterized the three decades after World War II. They see this new political capitalism as fundamentally predatory, and they argue that "redistribution from capital to labour will be extremely difficult, if not impossible, because of the dependency of profits on

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2 Riley and Brenner launched this analysis in "Seven Theses on American Politics," *New Left Review* 138 (November/December 2022).

3 Karl Polanyi, *The Great Transformation* (Boston: Beacon Press, 2001 [1944]), 146.

politically engineered upward redistribution." They back this up by insisting that the welfare state had been dependent on high rates of investment in manufacturing and that those investments have remained weak in recent decades.

To be sure, domestic manufacturing employment has been declining for more than four decades, but US firms have been able to produce fabulous profits on iPhones, pharmaceuticals, advanced chemicals, electric cars, computer chips, and other recently developed products. Yes, even if one counts overseas employees, the number of production workers has declined. But value added per employee has been rising as firms take advantage of new technologies. Profit per worker can be rising even as manufacturing investment is stagnant since advances in technology often produce capital cheapening — more productive equipment at a lower price point.

In fact, the very large new public investments in computer chips, clean energy, and new research institutes that Congress approved in the first two years of the Biden administration can be seen as an effort to generate an even larger profit stream. Capitalists have become ever more dependent on the state because advances in technology no longer happen in corporate laboratories but rather in publicly financed labs and research institutes. However, these same public investments can, in fact, generate enough surplus that expanded income could finance higher wages and more generous social welfare programs. But corporations have successfully relied on politics and financial power to monopolize those profit streams to produce the huge increases in income and wealth inequality that have been analyzed by Thomas Piketty and his colleagues.[4]

4 Thomas Piketty, *Capital in the Twenty-First Century*, trans. Arthur Goldhammer (Cambridge: Harvard University Press, 2014).

The problem is that this high level of business dependence on the state presents capitalists with a nightmare scenario: that elected politicians could use it to discipline capital. Politicians could leverage that dependence to require firms to slash the pay gap between CEOs and workers, foster improved working conditions, return to actual competition in markets, accelerate the green transition, and even democratize corporate governance.

It is this fear that has driven much of the Republican donor class to its current embrace of authoritarian populism. In their minds, the only way to avoid the nightmare scenario is to curtail democratic governance. To be sure, the moderate authoritarians just want to curtail voting rights, lock in permanent austerity policies, and rely on a right-wing judiciary to block any progressive initiative. The full authoritarians want to emulate the "illiberal democracy" of Hungarian prime minister Viktor Orbán.

This article is meant to document the growing technological dependence of business on state investments by examining both historical trends and the details of some of the key legislation passed by the Biden administration. But we also intend to show that this new phase of accumulation provides opportunities for a left politics that demands the state discipline business across multiple dimensions.

The argument will be developed in four parts. The first will explain the reasons corporations have become dependent on government spending on science and technology. The second will give a brief history of the unique structures of the US developmental state. The third will look in detail at two of the major pieces of legislation passed in 2022. The final section will seek to describe how "technology-dependent political capitalism" provides a new terrain for political struggle for the Left in the United States.

THE EMERGENCE OF CORPORATE TECHNOLOGICAL DEPENDENCE

It is still widely assumed that most significant innovations come out of corporate laboratories. Economist Brad DeLong recently placed the corporate laboratory at the center of his account of US economic growth from the 1870s to today.[5] But the reality is that the largest corporate laboratories have been dismantled or very significantly downsized. The standard explanations for this decline emphasize the pressures of the market. Bell Labs had been the rock star of corporate laboratories, but after AT&T was broken up by an antitrust case, a smaller version of the lab was ultimately sold to Nokia. With the shift of corporate governance toward maximizing shareholder value in the 1980s, many CEOs cut back their budgets for research and development to focus instead on what would make the balance sheet look better in three months, six months, or a year.

But there is also an important technological side to the story. By the end of the twentieth century, few of these laboratories were as productive as those of the 1940s and 1950s. The main problem is growing technological complexity. Producing innovations today such as advanced batteries or driverless vehicles requires scientists and engineers with many different types of disciplinary expertise. Even the richest corporations find it difficult to afford hiring specialists in multiple fields, and they are also at a disadvantage in attracting the most talented technologists. Indeed, in a wide array of fields, it has been smaller start-up ventures — spin-offs from government, corporate, or university laboratories — and engaged, cross-organizational collaborations that have driven innovative breakthroughs.[6]

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5 J. Bradford DeLong, *Slouching Towards Utopia: An Economic History of the Twentieth Century* (New York: Basic Books, 2022).

6 See Fred Block and Matthew R. Keller, "Where Do Innovations Come From?

Accordingly, corporations have embraced the idea of "open innovation" that includes a variety of strategies that rely on people outside the firm.[7] One is simply to acquire smaller firms that have developed promising technologies. Another is to collaborate with one or more private firms to develop a new product or process. But the most common strategy is to work with government-funded scientists at universities, government laboratories, or the increasing number of large research institutes that the federal government has created to facilitate the innovation process. The third strategy incorporates the other two because working through these government-funded entities is often the best way to find business partners that one might work with or later acquire. This major shift in the locus of innovation from the corporate laboratory to publicly funded laboratories has been happening for decades, but recent legislation passed by the Biden administration is an attempt to consolidate and accelerate this transformation.

Before analyzing the structures of this new collaborative system, it is helpful to look more closely at a particular case. The pharmaceutical industry has long utilized a stepwise system of batch production in which chemicals are combined in multiple stages to produce a series of intermediate products before getting to a final product. This method is highly inefficient in both resource use and the production of large waste streams. The alternative would be to shift to continuous processing production that is used in making most chemicals, including petrochemicals. If organized correctly, such a system would in theory be faster, as well as use less energy, less water, less labor, and reduce the flow of waste products.[8]

Changes in the U.S. Economy, 1970–2006," *Socio-Economic Review* 7, no. 3 (2009).

7 Henry Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Cambridge: Harvard Business School Press, 2003).

8 The FDA has supported the transition to continuous production and "is taking proactive steps to facilitate the drug industry's implementation of emerging

However, processing pharmaceuticals is more complex, and the standards for end-product purity are much more demanding, than for industrial chemicals. The challenges are particularly acute in producing the large molecule pharmaceuticals such as insulin, monoclonal antibodies, and vaccines that are an increasing share of the industry's output. Figuring out how to make continuous process production work is both very expensive and very risky for firms, since the Food and Drug Administration (FDA) would quickly close down production lines that did not meet regulatory standards.

Under the Barack Obama administration, the government created fourteen advanced manufacturing institutes launched with a combination of federal dollars and money from industry as well as state and local governments (there are now sixteen). Each institute is intended to become a hub for a new type of manufacturing that would occur in the United States since high levels of automation would make offshoring both impractical and unnecessary. One of those institutes is the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), which was founded in 2016 and is located on the campus of the University of Delaware. NIIMBL has been focused on the task of helping industry transition to continuous process production of biopharmaceuticals.

All of this is stated explicitly in a 2021 article that has twenty-four coauthors representing all the major pharmaceutical firms.[9] The article outlines an "ambitious 10-year collaborative program" to "invent, design, demonstrate, and support commercialization

technologies" in this regard. Sau Lee, "Modernizing the Way Drugs Are Made: A Transition to Continuous Manufacturing," US Food and Drug Administration, 2017.

9 John Erickson et al., "End-to-end collaboration to transform biopharmaceutical development and manufacturing," *Biotechnology and Bioengineering* 118, no. 9 (2021).

of integrated biopharmaceutical manufacturing technology." The plan is to mobilize new technologies to monitor and automate the production process and to develop smaller and more flexible factories that can be used to produce a range of different biopharmaceuticals. NIIMBL is establishing a "test bed" where these new technologies will be mobilized, tested, and refined. The authors write:

> We have a significant opportunity to impactfully transform CMC [chemistry, manufacturing, and controls] development and manufacturing through end-to-end integration and technology advancement. We also concurred that collaboration in a consortium will significantly accelerate the transformation and develop shared principles of practice.

These firms will still compete with one another to develop new drugs and gain a larger share of the market, but they are collaborating to develop the technology required to produce them more efficiently.

The collaboration extends well beyond the pharmaceutical firms. Smaller and often highly specialized firms that make bioreactors, the instruments that monitor the processes, and the computer systems that provide the human interface are directly engaged in building this test bed. This makes it possible for multiple parties to coordinate both the development of needed equipment and the investments required to meet future demand for that equipment.[10]

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10 This need for coordination across the supply chain for new technologies is why the concept of network failure is so useful. Firms need network partners that are both competent and trustworthy. When government agencies are part of the network, they make it much easier for firms to find reliable partners. See Josh Whitford and Andrew Schrank, "The Paradox of the Weak State Revisited: Industrial Policy, Network Governance, and Political Decentralization," in Fred Block and Matthew R. Keller, eds., *State of Innovation: The U.S. Government's Role in Technology Development* (New York: Routledge, 2011), 261–81; Andrew Schrank and Josh

This ambitious ten-year project may seem more aligned with Soviet plans than with the conventional view of fierce competition among rival firms. But it is obvious why this project is appealing to the firms. The second paragraph ends by saying, "The ability to work within a consortium helps de-risk these activities." The government, in short, is facilitating much of the expensive and risky process of figuring out how to transition to continuous process production. Moreover, if the United States overcomes these technological barriers faster than other nations, there will be huge profit windfalls when US firms are able to win a larger share of the global market for biopharmaceuticals. Of course, the same pharmaceutical firms are fiercely resisting limits on the prices they charge for medicines, and there is nothing in NIIMBL's bold initiative to assure that the future profits from continuous process production of biopharmaceuticals will be shared with taxpayers, employees, and consumers.[11]

THE "NEW" DEVELOPMENTAL STATE: DECENTRALIZED, DIVERSE, HIDDEN IN PLAIN SIGHT

NIIMBL was one of a series of advanced manufacturing institutes created by legislation passed under the Obama administration that embraced the notion of "innovation policy" more openly than its recent predecessors. But understanding where the NIIMBL model came from and how it relates to the federal government's broader

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Whitford, "The Anatomy of Network Failure," *Sociological Theory* 29, no. 3 (2011).

11 Moderna, one of the biotechnology firms that developed the first mRNA vaccine against COVID-19, was funded by the Defense Advanced Research Projects Agency beginning in 2013 to work on mRNA vaccines. US law requires firms whose research is supported by the government to include that information in patent applications. However, researchers at a small watchdog group discovered that Moderna successfully filed 126 patents through August 2020, and none of them mentioned government funding. Since then, Moderna has, ironically, sued Pfizer and BioNTech for infringing its patents.

role in the economy requires us to go further back in time to the development and expansion of a series of programs that crosscut Democratic and Republican administrations. In briefly tracing that history, we argue that two key features characterize the growth of the United States' strongly developmental state. First, its rise was gradual, with new layers of programs and policies emerging over an extended period and across different agencies. In part because of this layering, the programmatic structure is diverse and radically decentralized — unlike the commonly cited, more highly centralized developmental programs often associated with the rise of the "Asian Tigers" or parts of the European continent. Second, the United States' strongly market-centered orientation has served to obscure many of these programs from public view. That is, because neoliberal politics and policies dominated US political discourses and international engagement tactics in the later twentieth and early twenty-first centuries, politicians often avoided embracing platforms or programs that would be seen as increasing the state's role in the economy, outside of a few areas of bipartisan support, like the military. Nevertheless, neoliberal political rhetoric did not prevent politicians from adopting an array of state-centered mechanisms for advancing innovation and industrial development, typically under the guise of enhancing "competitiveness." Most programs were rarely discussed in national political debates and rarely covered in the press unless they generated high-profile failures. What has resulted is a hidden (in plain sight), highly decentralized developmental architecture that, we suggest, has undergirded US economic growth and its innovative capacities in profound ways.

A Brief History of the US Innovation State

Government involvement in "industrial policy" goes back to the nation's founding; it has frequently been traced to Alexander

Hamilton and a series of his writings, most famously the "Report on Manufactures," which advocated government involvement in building, protecting, and nurturing the new nation's nascent industries. Although the level of early government involvement was uneven, throughout the nineteenth century the federal government invested in an array of public works that supported a growing industrial and scientific base — perhaps most prominently in the application of science to agriculture, but also in areas ranging from the construction of canals, railroads, and bridges to the creation of land grant universities to wartime initiatives that fostered breakthroughs in a variety of technologies and technological fields.

Nevertheless, World War II was an important turning point, as the federal government's involvement in science and technology dramatically deepened. It organized the Manhattan Project to develop the first atomic bomb, the Rad Lab that worked on radar, and a series of additional wartime efforts that involved coordination and financial support for both scientific advances and manufacturing and production innovations. After the war, the federal government established and maintained strong funding for science. But while some advocates pushed for a more centralized agency to coordinate science-and-technology-related programs, no such coordinator emerged from the political struggles of that era. The National Science Foundation (NSF) was established in 1950, but with a modest budget and no overall coordinating capacity. Military research and development spending continued to be organized independently of the NSF.

A national laboratory system was established to oversee the country's nuclear facilities, which expanded their focus into other areas of research. In the 1970s, these labs were placed under the authority of a new Department of Energy. The nascent National Institutes of Health, which built upon prior federal health-related research programs, was established and expanded through increased funding for both intramural and extramural research. In the late 1950s and 1960s, massive resources were funneled through the National Aeronautics and Space Administration (NASA). Neither the NSF nor any other central agency was given responsibility for the overall coordination of these increasingly diverse federal research activities. In short, in the postwar era, a layered series of programmatic initiatives generated an elaborate, if highly decentralized, innovation architecture.

A second turning point occurred in the late 1950s, when the Defense Advanced Research Projects Agency (DARPA) was established in the wake of the Soviet launch of Sputnik. From the beginning, DARPA was envisioned as blending “basic” and “applied” insights in the service of facilitating long-term, disruptive research that might have significant military and technological impacts. To pursue these “blue-sky” activities, DARPA was provided autonomy from established defense programs in an effort to avoid the kind of slowdowns and highly bureaucratized structures characteristic of military procurement. But it was DARPA’s operational model that was pivotal: the agency learned that working with and linking together dispersed scientists across organizational boundaries was critical to pushing forward novel ideas. In particular, it began working with the smaller, often fragile start-up firms that were just beginning to emerge in places like Silicon Valley. While DARPA did contract with large firms, smaller firms were often nimbler and more responsive, since they were not worried about disrupting extant profit lines and their survival depended on developing new technologies rapidly. In turn, smaller ventures’ dynamism could be leveraged to catalyze the efforts of larger, slower-moving firms that feared being left behind by new technological developments.

DARPA served as a model for other agencies tasked with fostering innovative breakthroughs.[12] Elements of the model began to diffuse to a variety of federal programs in the late 1970s and 1980s, despite the Ronald Reagan administration's loud commitment to free-market principles. In fact, during this time, bipartisan concerns over rising international competition fueled a burst of political action seeking to expand the transition of scientific research from lab to market. This included the initiation of programs like Industry-University Cooperative Research Centers and Engineering Research Centers at the NSF; the Bayh-Dole and Stevenson-Wydler acts, designed to foster technology transfer from universities and government research laboratories, respectively; the Manufacturing Extension Partnership, which was designed to assist small and medium-size manufacturers; and a series of additional, typically decentralized initiatives aimed at fostering innovative technology developments.[13]

Among the most important of these initiatives was the creation of the Small Business Innovation Research (SBIR) program, which provides funding to firms with fewer than five hundred employees that have an idea for a new product that is both commercially and technologically promising. The program is administered in a decentralized fashion by eleven different government agencies, and it has become the first stop for start-ups since it supports more early-stage businesses each year than venture capital firms.[14]

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12 See Matthew R. Keller, Fred Block, and Marian Negoita, "What makes a developmental network state durable?," *Sociology Compass* 16, no. 1 (2022).

13 For extended discussions, see Fred Block, "Swimming Against the Current: The Rise of a Hidden Developmental State in the United States," *Politics & Society* 36, no. 2 (2008); Elizabeth Popp Berman, "Not Just Neoliberalism: Economization in US Science and Technology Policy," *Science, Technology, & Human Values* 39, no. 3 (2014).

14 Block and Keller found that SBIR-funded firms won nearly a quarter of the R&D 100 Awards, a prestigious innovation competition, in the 2000s ("Where Do Innovations Come From?"). A recent analysis has shown that a series of repeat SBIR award winners have played important ongoing roles as targeted service

For the purposes of simplification, we can divide the core contemporary activities that have arisen from this repeated layering of policy into four domains. To be sure, the divisions are somewhat artificial; there are overlaps and loosely coordinated or informal linkages between programs. For instance, an award provided by the SBIR program might be used by a small firm recipient to fund access to equipment or personnel at a federal laboratory, a pattern we found with some frequency in previous analyses.[15] Or an NIH grant to a university scientist might eventually result in a spin-off company that is funded by SBIR, participates in a collaborative research center, or is further developed by a military research program. But we can use these categories to get a handle on the kinds of activities supported by diverse programs spread across an array of federal agencies. We also provide budget and personnel figures for many programs, to give a sense of their scale.

The first core layer consists of government laboratories, which include the seventeen Department of Energy (DOE) national laboratories, such as Lawrence Berkeley, Oak Ridge, and Sandia. Although initially established to manage the United States' nuclear weapons arsenal, the labs evolved to support research in a wide range of technology fields. This layer also includes the twenty-seven separate institutes that comprise the NIH. Altogether, there are more than three hundred different federal laboratories. Some of these laboratories, including the DOE labs, are managed by nongovernmental contractors, so their employees are not counted as part of the federal workforce. The DOE's 2021

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providers for a wide array of innovative ventures. See Maryann Feldman et al., "Evaluating the tail of the distribution: the economic contributions of frequently awarded government R&D recipients," *Research Policy* 51, no. 7 (2022).

15 Matthew R. Keller, Fred Block, and Marian Negoita, "How does innovation work within the developmental network state? New data on public-private agreements in a U.S. Department of Energy laboratory," *Sociologias* 19, no. 46 (2017).

financial statements suggest that the agency supported approximately 130,000 workers, of which roughly 115,000 were employed by contractors. In addition, the DOE reported spending some $14.1 billion on research and development (R&D) activities.[16] For its part, the NIH has the second-largest budget of any agency in the federal government, behind the Department of Defense. In FY 2022, that budget was just over $45 billion. Although the lion's share is allocated to extramural research, approximately 10 percent of the NIH budget supports research conducted by around six thousand scientists in its own laboratories.[17]

A second layer of developmental activities consists of collaborative research institutes that receive federal funding but are managed by universities or organized as nonprofits. There are now hundreds of these institutes of varying sizes, but there is apparently no comprehensive, updated inventory. The growth of these institutes began with the NSF's Industry-University Cooperative Research Centers (IUCRCs) that were piloted in 1973. A university scientist whose research has industrial applications is given an award to establish a center, with the requirement that firms be recruited as dues-paying members. The goal is that even after federal support ends, industry members would contribute enough to keep the center going. In 2020 alone, there were seventy-three such active centers funded by the NSF, which brought together 1,385 researchers.

Both the NSF and other government agencies have emulated this model, although requirements for industry funding vary widely. In its 2020 budget request, the NSF reported sixty-five centers beyond the IUCRC program. These included Engineering Research

16 US Department of Energy, "FY 2021 DOE Agency Financial Report" (2021), 14, 38, chart 9.

17 National Institutes of Health, "Budget," nih.gov.

Centers, Materials Research Science and Engineering Centers, and Centers for Chemical Innovation. In addition, using funds from the "stimulus" that followed the financial crisis of 2007, the DOE has created some forty-one similarly collaborative Energy Frontier Research Centers (EFRCs) and five larger and more generously funded Energy Innovation Hubs, which are designed to foster coordinated research into medium- and short-term hurdles in particular technology fields, respectively.[18] Other government departments, including Homeland Security and Transportation, also fund networks of collaborative centers.

Although other presidential administrations added to the catalogue of collaborative centers, the Obama administration was the most deliberate of recent ones to build on this legacy. In addition to the stimulus-funded EFRCs and Energy Innovation Hubs, it also created the network of advanced manufacturing institutes that are funded through a combination of federal, state, local, and industry resources.[19] The aforementioned NIIMBL is one of these centers; as of this writing, it listed 186 members, including fourteen large pharmaceutical firms, seventy small and medium-size firms, and many academic and nonprofit institutions.

These centers are often fulcrums for creating "collaborative public spaces" where the trustful exchanges of information critical to innovation are more likely to occur.[20] Because government entities are not directly competing with private firms in the market,

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18 The EFRCs and Energy Innovation Hubs were initially launched with the use of stimulus funds after the financial crisis of 2007–9. Also included in that stimulus funding was the establishment of the Advanced Research Projects Agency–Energy, which was modeled on DARPA.

19 See William B. Bonvillian and Peter L. Singer, *Advanced Manufacturing: The New American Innovation Policies* (Cambridge: MIT Press, 2018).

20 Richard K. Lester and Michael J. Piore, *Innovation: The Missing Dimension* (Cambridge, Harvard University Press, 2006).

they can serve as effective facilitators in complex collaboration networks. Moreover, the great advantage for the government in creating these collaborative centers is their flexibility. While it can be bureaucratically challenging to close one of the three hundred government laboratories, these institutes can more easily be phased out if they are not productive. The highly specialized focus of the research centers facilitates bringing together technologists from big and small firms and from universities and government laboratories. The idea is to accelerate technological breakthroughs by creating dense networks of technologists working to overcome recognized technical obstacles.

A third layer involves a set of programs that provide targeted funding and, typically, brokerage functions that enable a decentralized set of collaborations between technology firms, federal agencies or contractors, and other external funders or supportive parties. Two important examples of this type of program are the SBIR program and the Manufacturing Extension Partnership (MEP). SBIR is a paradigmatic example of decentralization — each participating agency develops its own priorities and manages its own awards, meaning that any given small firm may be able to pitch an idea to multiple federal agencies operating in its field. Although SBIR began as a targeted funding program, it gradually developed a series of mechanisms to link its small firm awardees to networks of supportive constituents (including defense contractors, venture capitalists, and other private investors) and federal agency procurement opportunities.

The MEP provides a different variation on a similar, decentralized theme. Fifty-one regional centers provide services to support small and medium-size manufacturers as they grapple with complex supply chains, new technologies, workforce development, export requirements, and other manufacturing-related issues. MEP reports that it "interacted" with more than thirty-four thousand manufacturers in 2021, but it does so through different mechanisms. Some field offices provide direct services; others essentially serve as network brokers, connecting local manufacturers to third parties that provide consultation or services to supported companies.[21]

There are other programs that operate along these lines: providing targeted funding but also facilitating collaborative linkages between small and large firms, private funders, federal programs and contractors, and university scientists. During the late Obama and Donald Trump years, for instance, the Department of Defense initiated a number of programs precisely focused on developing linkages with the smaller firms that have been sources of new ideas and technologies in the US innovation system.[22] The central point about these programs is that they both provide funding to critical actors in the innovation system and serve to certify and directly connect those firms to other supportive actors in a "fragmented" US innovation environment in which crosscutting collaborations are vital for pushing forward new ideas.

A fourth layer of the innovation state includes direct financial support via grants or contracts to researchers at universities, federal laboratories, nonprofit research centers, and private firms that advance research on particular problems. Award decisions in most programs are organized through systems of peer review, in which funding decisions rest on evaluations by other scientists and engineers. The total amount of such support to colleges and universities in FY 2019 was $38 billion, which also includes support for university-based research centers and institutes.

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21 Philipp Brandt, Andrew Schrank, and Josh Whitford, "Brokerage and Boots on the Ground: Complements or Substitutes in the Manufacturing Extension Partnerships?," *Economic Development Quarterly* 32, no. 4 (2018).

22 These programs include the Defense Innovation Unit in the Department of Defense as well as branch-specific agencies like SOFWERX, AFWERX, and NavalX.

If one were to sum the expenditures from these four layers of programs, the totals would be substantial, representing a huge government input into the science-and-technology-based economy vis-à-vis both financing and employment of scientists and engineers. And these are not the only expenditures made by the state that bear on the US innovation system. State and local governments have their own (often quite extensive) business and innovation support infrastructures that complement federal programs. Those programs, including the initiation or support of incubators and accelerators that help smaller local firms find federal and other supportive resources, have grown substantially over the last decade. They now comprise a fifth important pillar of government support to the innovation economy.[23]

In short, the state massively supports the innovation system in the United States and has done so for decades. Crucially, these layers all survived the Trump administration, despite the former president's anti-science stance. But it is not just financial outlays that matter. The diverse and decentralized approach aids the emergence of novel ideas from multiple parties operating from the ground up rather than planning them from the top down. And it helps to connect the dots between dispersed parties by creating collaborative public spaces that facilitate exchanges of information and by brokering relations between diffuse actors in a fragmented innovation and production environment.

RECENT LEGISLATION: NEW LAYERS OF A SCIENCE AND TECHNOLOGY STATE

When Joe Biden took office, many of these ongoing programs were simply continued or, in some cases, deepened or reworked to

23 For additional discussion of the "thickening" of state and local contributions to innovation networks, see Fred Block, Matthew R. Keller and Marian Negoita, "Revisiting the Hidden Developmental State," *Politics & Society* (2023).

address new priorities. In addition, a series of new programs picked up where the Obama administration had left off four years earlier. In the NSF, for instance, a new Regional Innovation Engines program was initiated in 2021 in an effort to "catalyze and accelerate regional-scale, R&D-based innovation ecosystems" that involve collaborations between industry, universities, governments, and community stakeholders.[24] The program funds different regional centers with up to $160 million over ten years, highlighting an emphasis on decentralized federal programs concerned with network building as a means to foster economic development.

But the ambitions of the new administration were also manifested in four new laws that passed a narrowly Democratic Congress. While a thorough analysis of all four is beyond the scope of this article, we focus on two that were most explicitly concerned with promoting innovation as a route to generating economic growth and addressing acute problems like climate change. The CHIPS and Science Act and the Inflation Reduction Act, both passed in 2022, contain the hallmarks of federal science and innovation strategies for the last generation: rooted in decentralized governance approaches that implicitly seek to bolster network construction, on the one hand, and designed in ways that tend to obscure the federal role in the program implementation process, on the other.

This construction is important, we will argue, for two main reasons. One, though they have received at best modest coverage in the press, the scale of these programs is massive — they represent the largest investment in innovation and productive capacity since World War II, which complements the elaborate existing innovation infrastructure outlined above. How these programs are structured and how effective they are (and are perceived to be) have real consequences not just for science-and-innovation-centered

24 National Science Foundation, "NSF's Regional Innovation Engines Program," nsf-gov-resources.nsf.gov/2022-06/nsf_engines_and_tip_slides_updated508.pdf.

outcomes but also on critical issues like emissions reductions and the transition to a greener economy, lowering health care costs, addressing inequalities in regional development, and job creation in the manufacturing and technology sectors. These investments could have substantial ripple effects on politics if they are successful in achieving some of the aims we outline below.

While these laws involved complicated political compromises, powerful leftist legislators, including Bernie Sanders and Pramila Jayapal, were able to insert some provisions that could be utilized both to begin disciplining capital and to share the gains of innovation more broadly than the current system does. This inclusionary potential runs in two main directions: incorporation of new regions or geographies outside core innovation centers or clusters in the United States, and inclusion of populations currently marginalized or underrepresented in the US innovation system.

To be sure, some parts of these legislative packages look like standard "political capitalism" that subsidizes the profits of established large firms. However, other parts fit with the Biden administration's more aggressive antitrust policies, which are intended to restore competition in markets that have become increasingly monopolized over the last four decades.[25]

Furthermore, technology-based industries have often been characterized by winner-take-all dynamics in which leading players are able to sustain and reinforce monopolistic or oligopolistic positions even when powerful firms are not particularly innovative. In the pharmaceutical industry, for instance, major companies have been described as being in an innovation deficit for many years; they typically rely on dedicated biotechnology firms or collaborations with external actors — like university and government

25 Thomas Philippon, *The Great Reversal: How America Gave Up on Free Markets* (Cambridge: Belknap Press, 2019).

researchers and laboratories — to generate new products. Firms like Google, Facebook, Uber, and Airbnb, meanwhile, have used their substantial resources to buy up or suppress competitors and lobby for legal rules that insulate their market positions.

DARPA is the classic example of a policy approach that generated technological development by bypassing established firms. The agency was able to leverage its limited resources by investing in start-ups and linking actors in novel ways amid efforts to generate cutting-edge technologies. When those efforts are successful, established firms have a more difficult time suppressing or limiting their own innovation efforts; they risk becoming obsolete. Under the Obama-era "stimulus" package, the DOE took a similar approach when it provided loans not just to the large, established automakers in efforts to advance electric vehicle (EV) technologies and production but also to upstart rivals that included companies like Fisker and Tesla. While Fisker eventually failed, Tesla survived and thrived after its early financial struggles; it has arguably provided a strong impetus for the big US automakers to jump more rapidly and deeply into mass production of EVs.

Both the CHIPS and Science Act and the Inflation Reduction Act build on the history of highly decentralized innovation policies to encourage a more bottom-up strategy of economic and technology development that is oriented toward increasing competition and expanding the role of small and medium-size enterprises.

CHIPS and Science: Decentralization and Collaborative Networks

The CHIPS and Science Act's headline goal is to bolster the US semiconductor industry, and the legislation authorized approximately $50 billion for that purpose. The lion's share ($39 billion) of those funds is dedicated to incentives for semiconductor R&D and domestic production capacities. Most of this will go to established large firms that already have the resources needed to build hugely expensive semiconductor fabrication plants. Additional expenditures ($11 billion) support the establishment of collaborative research and development centers or programs, including a National Semiconductor Technology Center, a National Advanced Packaging Manufacturing Program, and "up to three new Manufacturing USA Institutes."[26] Though coordination authority is largely given to the Department of Commerce, the initial implementation strategy released by that department contains a whirlwind of cross-agency and public-private collaboration imperatives, with contributions from the departments of Defense, Energy, Treasury, State, Homeland Security, and the NSF, among others. That same initial implementation strategy repeatedly stresses coordination with multiple stakeholders; its fourteen pages of text use the words "cluster," "network," "coordination," and variants of "collaboration" some thirty-eight times, reinforcing the emphasis on creating crosscutting networks of specialists to bolster industry capacities.

But the "science" part of the CHIPS and Science Act is significantly larger, in sheer dollar terms, than the investment in microchips. Allocations there are intended to bolster scientific capacity across multiple federal agencies. Up to $81 billion over five years is authorized for the NSF to increase basic and applied research and research capacity, to spread those capacities over a wider number of regions and more diverse population groups, and to build STEM education and outreach programs.[27] The National Institute of Standards and Technology (NIST) in the Department of Commerce is authorized $9.68 billion over five years to expand a range of programs, perhaps most notably

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26 US Department of Commerce, "Biden Administration Releases Implementation Strategy for $50 billion CHIPS for America Program," September 6, 2022.

27 Title 3 of the legislation, the "National Science Foundation for the Future Act," contains the key provisions for the NSF.

including the Manufacturing Extension Partnership. The legislation also establishes or expands a series of research, measurement, standards-setting, and outreach activities related to fields including greenhouse gas measurements, biomanufacturing, cybersecurity, biometrics, and artificial intelligence, among others.[28] The same legislation authorizes an additional $829 million to support the advanced manufacturing institutes.

The Department of Energy is authorized to initiate or expand an array of programs in a long list of areas, from nuclear energy to carbon capture to energy storage to scientific computing. The legislation follows the trend in authorizing a series of collaborative research centers — for bioenergy, carbon storage and geological computational science, and "high-performance computing for fusion," while also upgrading facilities and major equipment that has often played a central role in a long-standing federal mechanism for collaboration: Cooperative Research and Development Agreements that federal facilities can use to engage with private firms on an array of technology-oriented projects.[29] Elsewhere, among its other components, the legislation tasks the Department of Commerce with establishing twenty "geographically distributed regional technology and innovation hubs" that bolster innovation capacity in areas outside extant regional innovation cores.

In short, the contours of the legislation follow a consistent pattern. Investments in science and technology are deeply decentralized and spread among multiple agencies, institutions, and regions. The law also continues the pattern of establishing or

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28 Title 2 of the legislation contains these details.

29 The opening of the DOE section on "Basic Energy Sciences" authorizes upgrades to the Advanced Light Source, the Advanced Photon Source, the Spallatron Neutron Source, the Linac Coherent Light Source II, the Cryomodule Repair and Maintenance Facility, the Nanoscale Science Research Center, and the National Synchrotron Light Source II, among other facilities and equipment upgrades or investments.

supporting a series of collaborative research centers or projects oriented to clustered or networked developmental strategies that engage multiple stakeholders including universities, private firms, and state and local authorities. It expands the government's role as a core coordinator and supporter of collaborative research networks.

To be sure, the text of legislation is one thing; implementing programs can be quite another, and many of the specific implementation strategies for the act are, as of this writing, still in development. Nevertheless, one can see in the legislation the grounds for a more inclusive governance regime that could serve to temper the dramatic inequalities typically associated with the US tech-based economy. Key provisions of the CHIPS and Science Act promote competition that will challenge existing monopolies. Indeed, the preliminary implementation strategy released was explicit on this point, noting that the "department expects to give preference to projects that include state and local incentive packages that maximize regional and local competitiveness, invest in the surrounding community, and prioritize broad economic gains, rather than outsized financial contributions to a single company."[30] There are at least two key mechanisms through which that orientation is manifested.

First, many of the act's provisions focus attention on smaller, start-up-style entities. That is, rather than invest in very large, centralized projects that could be dominated by larger firms, significant attention was given to fostering "bottom-up" collaborations from multiple institutional loci. This includes, on the one hand, investment in government laboratories whose personnel and resources are, as noted, accessible to a wide range of private firms and public actors through various cooperative mechanisms. Those investments are complemented by items like a small business voucher program that is intended to facilitate greater access to those resources by small

30 "A Strategy for the CHIPS for America Fund," 2022, nist.gov.

firms (section 10718). It also includes provisions that enable a freer flow of scientists from government labs to the private sector and vice versa — e.g., by establishing an entrepreneurial leave program (section 10719) to encourage lab scientists to pursue commercial ventures, and by establishing a program to embed external technologists in the DOE to work collaboratively on novel ideas. Funds are, in addition, allocated to support clean-energy-focused business incubators and accelerators targeting smaller, start-up ventures, and a smaller pool of funds is allocated to items such as prize competitions for university students to develop clean energy business models. In the NIST, such programs include a substantial expansion of the MEP, which supports small and medium-size manufacturers. And the legislation spreads science funding over a wide array of research areas, ranging from nuclear energy to climate systems, microelectronics research for energy applications, high energy physics, artificial intelligence, and advanced computing. Moreover, key programs have structured potentially larger allocations via grants, loans, and loan guarantees in ways that emphasize co-investment, not reliance on government funds alone. That is, there is no singular focus or pool of funds that could more easily be co-opted by large firms already established as market leaders. The fields for investment are diverse, the relevant actors typically dispersed across public and private sectors, and requirements for collaborative inputs to projects are emphasized.

A second, related mechanism is a focus in key parts of the legislation on the construction of "innovation environments," including the privileging of collaborative research centers, the inclusion of multiple stakeholders and complementary resources, and the creation of collaborative public spaces. Here the legislation is also clear and explicit. On the one hand, CHIPS and Science authorizes $10 billion for the Department of Commerce to establish up to twenty "regional technology and innovation hubs" that are not already leading technology centers; it requires communities to demonstrate the development of crosscutting local collaborations and the buy-in of multiple stakeholders (section 10621). The DOE, meanwhile, is authorized to establish regional partnerships to promote clean energy innovation through a "Regional Clean Energy Innovation Program" (section 10622).

In short, the legislation tends to lean in to decentralization and regional or field-based collaborative investments rather than direct subsidies to large corporate actors. To be sure, this is a blueprint based in legislative compromise. One can contest which technology areas are included and how much they receive. There is, after all, no allowance for federal entities to take shares or direct returns from companies that develop new technologies with the support of federal resources, facilities, or expertise — a long-standing pattern in federal technology programs. Nevertheless, we are suggesting that what the legislation does contain is an emphasis on fostering collaboration and emerging venues for competition, rather than directing resources to national champions, or centralized or large-scale-oriented allocation processes that are more likely to be accessible primarily to large, field-leading corporate entities.

CHIPS and Science also makes some deliberate efforts to spread federal resources to underrepresented communities and regions outside the core of existing innovation clusters. The aforementioned regional innovation hubs are designed to support regions other than those already established as technology clusters or cores, for instance.[31] Elsewhere in the legislation, there are provisions within new funding allocations to the NSF, for instance, to deliberately include funding for minority-serving institutions, including

31 Section 10621 (d)(1) specifies there will be a "competitive, merit-review process to designate eligible consortia." The next section, (d)(2), is titled "Distribution"; it describes a range of conditions surrounding "geographic and demographic diversity in the designation of regional technology hubs."

historically black colleges and universities (HBCUs). The act also increases resources to the EPSCoR program (the "Established Program to Stimulate Competitive Research"), which provides funding to geographic regions that receive disproportionately small percentages of R&D funding from NSF programs.[32] And it formalizes an extant NSF INCLUDES initiative ("Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science") designed to mobilize a "collaborative infrastructure to accelerate and enhance the preparation, participation, and contributions of historically excluded populations in STEM."[33] Finally, the legislation includes funds for STEM education in rural areas, complementing an emphasis on the extension of rural broadband services found within the major infrastructure bill that passed Congress the prior year. While these programs are relatively modest in terms of overall funding, they represent efforts to expand both the geography of inclusion and the institutions and groups with access to opportunities in the innovation economy. Additional clauses of the legislation target some $200 million of funding on job training activities in the semiconductor field. One could certainly imagine increasing the scope and scale of such programs over time and across agencies in future legislative rounds. But they contain the seeds of an expanded, more inclusionary approach to facilitating innovation and diversifying its geography.

Development Under the Radar: The Inflation Reduction Act

Although there are overlapping or complementary approaches in the two 2022 pieces of legislation, there is a slightly different

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32 For an overview of EPSCoR, see new.nsf.gov/science-matters/nsf-101-geographic-diversity-through-epscor.

33 NSF INCLUDES National Network, includesnetwork.org/about-us/who-we-are.

center of gravity in the Inflation Reduction Act of 2022 (IRA). Widely lauded as a significant step in addressing climate change, the IRA relies far more heavily on "demand side" measures like tax credits and other financial incentives.[34] As one analysis put it, the legislation "will rely heavily on the tax code to advance the deployment of clean energy technologies and to combat climate change."[35]

Among its various provisions, the legislation provides tax credits for manufacturing clean energy technologies, for carbon sequestration facilities, and for the production of clean hydrogen, biofuels, and cleaner airline fuels. It provides tax credits for the construction of EV charging stations and for purchases of EVs. It provides credits for the purchase of efficient energy products in residential properties — like heat pumps, water heaters, boilers, and stoves — and for commercial buildings to improve energy efficiency. And it provides tax credits for investments in renewable energy properties like solar and wind farms, production tax credits for certain green energy fields (solar, wind, geothermal, biomass, and hydropower, centrally), and manufacturing production credits for certain renewable energy technologies and components.

The legislation also contains direct allocations to or "investments" in a number of federal agencies, including the departments of Energy, Defense, and Agriculture and the Environmental Protection Agency (EPA). Some of these appropriations are also in the form of pass-through credits; the EPA, for instance, is allocated

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34 The official estimate is that the IRA will spend $392 billion over ten years on climate-related initiatives. However, since there are very large sums allocated for loan guarantees and tax credits that are not capped, the actual economic impact could be closer to $1 trillion. John Bistline, Neil R. Mehrotra, and Catherine Wolfram, "Economic Implications of the Climate Provisions of the Inflation Reduction Act," March 29, 2023.

35 Nicole M. Elliott et al., "The Inflation Reduction Act: Summary of Budget Reconciliation Legislation," Holland & Knight, August 8, 2022.

a large pool of funds to provide incentives for methane reduction and for investments in cleaner energy technologies. The latter has been described as a green bank that will provide $27 billion to support green lending at the state level. The US Department of Agriculture is provided resources to support conservation and forestry programs. Some of its resource allocations are in the form of credits for various types of environmentally conscious practices; others involve the extension of technical assistance, loan subsidies, or competitive grants for a variety of clean energy technologies. In some cases, the federal agency is the implementing agency, but in many instances, the programs set and manage incentives for external entities to adopt particular practices. In providing these kinds of credits or incentives to external parties, this program resembles the more hidden or stealth-oriented approaches consistent with an extended history of US innovation policies.

In both the CHIPS and Science Act and the IRA, there are specific conditions attached to government assistance to firms. In the CHIPS bill, for example, firms that receive federal dollars to build new semiconductor fabrication plants are required to pay prevailing wages to construction workers. However, such conditions are more common in the IRA legislation. Firms or other actors partaking in the program must meet a core set of conditions to fully access federal support. Many of those conditions are modest and could be substantially strengthened, but they represent some initial steps toward a strategy of disciplining business.

Most prominent among the various conditionalities in the legislation, and the assorted guidance documents that have since been issued, are clauses concerning what does and does not qualify as a project under any given area.[36] But there are also requirements

36 For instance, the IRS has begun to issue guidance to individuals or entities wishing to claim tax credits. See irs.gov/credits-and-deductions-under-the-inflation-reduction-act-of-2022.

that firms pay "prevailing wages" for government-supported construction projects, and that such projects also employ workers with "apprentice" certification for a minimum percentage of labor hours. The Department of Labor provides detailed instructions on how to calculate prevailing wages in specific localities.[37] In at least some instances, the act provides additional incentives for clean energy technologies to be deployed in lower-income communities, in "energy communities" (defined, inter alia, as "brownfield" sites, localities that meet a threshold rate of tax revenues from extraction-based industries and have higher unemployment rates, or areas adjacent to shuttered coal mines or coal-fired energy facilities). Some additional incentives are provided for projects in which construction components, like steel, are produced in the United States.

To be sure, these conditions are modest, and they are in some cases conditional.[38] But they also hint at the potential to encourage or mandate that recipients of federal funds or participants in federally organized research programs implement high-road employment policies that might include better wages and benefits, childcare and family leave policies, training and certification opportunities or requirements, or other policies designed to facilitate improved workplace conditions. Given that these federal programs have become critical to the innovation system, there are at least potential grounds for renegotiating relations between labor and capital.

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37 The Department of Labor's instructions for accessing wage determinations can be found at dol.gov/sites/dolgov/files/WHD/Obtaining-WDs.pdf. The IRS's guidance can be found at federalregister.gov/documents/2022/11/30/2022-26108/prevailing-wage-and-apprenticeship-initial-guidance-under-section-45b6bii-and-other-substantially.

38 In some instances, the act establishes a "base" tax credit rate that does not require participants to meet the wage and apprentice requirements and a "bonus" rate that is substantially higher for projects that do meet these requirements.

DISCUSSION AND CONCLUSION

It remains to be seen how effective the Biden administration will be in implementing these pieces of legislation. A host of political and economic contingencies could undermine their effectiveness or even defund some of the key programs. It is also true that, as in other cases of developmental states, firms nurtured by federal programs can "kick away the ladder" they themselves used to facilitate growth or otherwise attempt to reroute the state's resources into their own pockets. As the billionaire Elon Musk — whose businesses have been well documented as major recipients of federal loans, contracts, and other government subsidies — put it in comments arguing against one of these recent legislative actions: "It does not make sense to take the job of capital allocation away from people who have demonstrated great skill in capital allocation, and give it to an entity that has demonstrated very poor skill in capital allocation, which is the government."[39] Yet those allocation abilities have become increasingly central to innovative dynamism, and they supported Musk's company Tesla when it was struggling through financial losses.

However, the fact that these bills were approved by Congress suggests that they had the backing of significant corporate interests. Moreover, the number of applications for loan guarantees and multiple announcements of plans for new factories for batteries, electric cars, and semiconductors suggest that businesses are responding with enthusiasm. In fact, PhRMA, the main pharmaceutical industry lobbying group, has petitioned the Biden administration to be included in some of the benefits offered in the CHIPS and Science Act.[40] They explicitly ask for federal loans and tax credits to support the domestic manufacturing of drugs.

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39 Ben Zeisloft, "Elon Musk: 'Government Is Simply the Biggest Corporation, With the Monopoly on Violence,"' *Daily Wire*, December 7, 2021.

40 Jamie Smyth, "Big Pharma lobbies for 'Chips Act' style tax breaks," *Financial Times*, March 20, 2023.

In short, significant sectors of capital in the United States recognize their dependence on the government to fund the development of new technologies, including both financial and logistical support for building new production facilities. And yet there is little indication that many of these firms have abandoned their support for the Republican Party, even when its main spokespeople campaign against "woke capitalism." This political schizophrenia is rational because these corporations need the public to believe that their profits result from entrepreneurial creativity and risk-taking and have nothing to do with initiatives taken by bumbling governmental bureaucrats. Furthermore, they can rely on Republicans to protect them from tax increases.

Nevertheless, this heightened corporate dependence on the state creates strategic opportunities for the Left. Even if tentative and partial, those possibilities are revealed when government support to corporations is contingent on behavior such as paying prevailing construction wages or providing quality childcare. While these are admittedly modest steps, they hint at the possibility of the government using corporate dependence to impose far more substantial conditions on companies.

To be sure, this will only happen with substantial and ongoing social movement pressure on political leaders. Several paths for such mobilization are immediately obvious. One approach would be to emulate some of the campaigns of the past that focused public attention on the bad behavior of a particular corporation or industry. The campaign would highlight both the dependence on government largesse and some of the firm's or industry's more egregious practices. Then pressure would focus on legislators to demand that government assistance be made conditional on the firm or firms agreeing to neutrality when employees attempt to unionize, or to abandon a destructive environmental practice, or even to establish a bicameral governance structure that would give employees a veto over key decisions.[41]

A second strategy would focus on the local or state level, where innovation ecosystems are being created or managed. Labor unions and community groups would demand seats at the table at the organizations that receive federal innovation dollars and work to coordinate innovation initiatives. Once at the table, they would be in a position to question priorities, demand more benefits flow back to the community, and impose greater accountability. These bottom-up campaigns in multiple places could then coordinate to put pressure on Congress to mandate higher levels of citizen involvement and new mechanisms to assure that profits are shared more widely.

This latter strategy would capitalize on the progressive potential in the highly decentralized US developmental apparatus. That decentralized approach has enabled government programs to pursue multiple pathways toward overcoming technical obstacles — a strategy critical to innovation in a highly complex technical environment where the best route forward is uncertain. That decentralization can also hinder the ability of powerful interests to capture large shares of government programs designed to support innovative developments. But decentralization combined with political organizing and mobilizing could begin to open the innovation system to demands for democratic accountability.

The key point is that, with the higher level of dependence on the state in this new phase of accumulation, firms targeted for governmental discipline have reduced opportunities to draw on the standard repertoire of capital's resistance tactics. Firms that deliberately cut back their investment outlays in the United States

41 Isabelle Ferreras, "Democratizing the Corporation: The Proposal of the Bicameral Firm," *Politics & Society*, forthcoming.

are vulnerable to losing their other government-guaranteed benefits. Threatening to move operations overseas could mean giving up access to US science and technology resources that are often the most sophisticated in the world. Likewise, creating a unified capitalist response becomes substantially more difficult, as firms and industries have varying mixes of dependency, benefits, and grievances.

It remains an open question as to the scale and scope of concessions that this kind of strategy might be able to extract from capital. Even so, the effort would raise awareness that, at this technological stage, our ability to produce and innovate has little to do with the genius of Elon Musk, Jeff Bezos, or other billionaires. It has everything to do with the government's role in nurturing, coordinating, and financing the development of new technologies as well as the labors of many thousands of people who do the work of science, design, and production. As Karl Marx foresaw in the *Grundrisse* when he anticipated the current technological reality,

> what appears as the mainstay of production and wealth is neither the immediate labor performed by the worker, nor the time that he works — but the appropriation by man of his own general productive force, his understanding of nature and the mastery of it; in a word, the development of the social individual. The theft of others' labor time upon which wealth depends today seems to be a miserable basis compared with this newly developed foundation that has been created by heavy industry itself.[42]

42 Karl Marx, *Grundrisse*, ed. and trans. David McLellan (New York: Harper & Row, 1971), 142.