MILKEN INSTITUTE

review

Enough Energy to Last a Billion Years

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The Milken Institute's mission is to improve lives around the world by advancing innovative economic and policy solutions that create jobs, widen access to capital and enhance health.

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What is prosperity, and how do we get more of it? In seven decades of thinking about those questions, and given that 2026 marks the 250th anniversary of America (and my 80th year), it's worth pausing to reflect on a few of the lessons that have endured.

Back in 1965, I developed a simple framework for thinking about prosperity. While I've revisited it many times, I have never felt the need to revise it: **P=ΣFti;*(ΣHCi;+ΣSCi;+ΣRAi;)** where prosperity (P) depends on financial capital and technology (Ft), which serve as multipliers of human capital (HC), social capital (SC) and real assets (RA).

Human capital refers to skills, education, experience and health. Social capital refers to the frameworks and values, including rule of law, free enterprise, universal education, property rights and transparent markets, that allow individuals to apply their capabilities productively. Real assets include savings, real estate, infrastructure, natural resources and factories. Financial capital and technology include various types of debt and equity instruments, derivatives, securitization, ETFs, investment vehicles and digital currencies – a list that continues to expand as our mastery of technology increases. By better connecting ideas to resources, financial technology is prosperity's accelerant.

Human capital is by far the largest asset class, representing 70-80 percent of value in developed nations, followed by social capital; other assets – equity, real estate and so forth – represent much less.

Prosperity, to return to our opening question, is first and foremost about people and the ways in which they organize their society and capture the benefits of human ingenuity. To build human capital, societies can expand access to high-quality education, extend both the length and quality of life, and attract individuals from around the world to join and contribute.

When we break down prosperity into its components and their relationships, we can view the American Dream as history's greatest operating system. It is not a promise of outcomes, but a system of conditions that allows individuals, regardless of background, to pursue a life of meaning and purpose. Financial and material wealth follow, but as the natural resource curse has shown, they are not the cause.

As the United States marks its 250th year, despite differences on many issues, one point of agreement among Americans remains striking. Surveys show that they share a common understanding of the American Dream: it is fundamentally about freedom and the ability to choose the life one wants to live.

Our challenge today is to protect and extend those conditions, in the United States and around the world.

Michael Milken, CEO

To borrow Thomas Paine's words from a quarter-millennium ago, these are truly times that try men's (and women's) souls. But I find comfort in the reality that thoughtful people are still busy advancing ideas that would make the world a better place. Consider the latest crop of articles in this, the 110th quarterly issue of the *Review*.

Gernot Wagner at the Columbia University Business School offers a primer on the least studied but arguably most promising source of renewable energy. "The Earth beneath our feet holds an almost comically simple solution to our energy problems," he writes. "Drill down a few kilometers anywhere on the planet and you'll find temperatures hot enough to boil water. Run that water through a turbine, generate electricity, reinject the cooled water, repeat. No fuel needed. No emissions. Just heat from the planet's molten core, which will remain hot for billions of years."

Sung Hee Choe and **Esther Krofah** at the Milken Institute explore what's needed to sustain America's place in biotechnology. "Leadership is no longer guaranteed," they warn. "The systems that supported past success are under growing strain. Governance of the biomedical system is fragmented across agencies and levels of government. Core infrastructure is unevenly developed and deployed. Funding is often short-term and disconnected from long-term needs. At the same time, peer nations are pursuing coordinated national life sciences strategies that integrate research, data, workforce and policy."

Rashad Ahmed, **James A. Clouse**, **Fabio Natalucci** and **Alessandro Rebucci** at the Anderson Institute for Finance and Economics

assay the impact of stablecoins in light of new regulation legitimizing their place in the economy. "Stablecoins," they write, "hold the promise of revolutionizing the domestic and international dollar payment system by lowering transaction costs, shortening settlement times, providing continuous 24/7 payment system access and broadening financial inclusion."

"At the same time, our survey-based analysis warns that stablecoins pose significant risks to systemic financial stability if the market grows as large as currently predicted – and especially if vast scale is achieved in a matter of a few years."

Simon Radford and **Aidan Irwin-Singer** at the Milken Institute ask what Europe must

LINCOLN AGNEW

do to reclaim a leadership role in the global economy. "Blueprints for raising productivity in Europe share priorities," they write. "Europe must invest in decarbonization, close the technology and innovation gap with the U.S. and China, and spend more on defense. More investment combined with structural policy changes could raise productivity and wages, making up ground on innovation while also seeing off the domestic challenge of populist insurgent parties."

"While the scale of the prescription might seem daunting, Europe is seen by many to have considerable comparative advantages to success. Moreover, the present geopolitical environment also provides the necessary pretext, to borrow Jean Monnet's phrase, of a crisis from which new solutions can be developed."

Simon Haeder at Ohio State's College of Public Health ponders the prospects, practical and political, of digging our way out of the health care mess in the United States. "So far," Haeder explains, "the Trump administration's focus has been on undoing Democrats' handiwork. Little focus has been on solving the problems of access, cost and distribution across the U.S. health care system."

"But in my view, there is a pragmatic solution that could be palatable for both parties. And the model has been around for decades in the form of the Medicare Advantage option that currently allows seniors to trade their Medicare fee-for-service benefits for a broad package of privately supplied managed health services."

Greg Leiserson at the NYU Law School laments the folly of depriving the Internal Revenue Service of adequate operating funds in an era of growing federal budget deficits and lagging revenues. "Fights about IRS funding mirror broader fights about the role of government in our lives," he opines, "and the ongoing failure of Congress to adequately fund the IRS reflects the lack of consensus on that issue. But the consequences of starving the IRS hardly fulfill anyone's idea of fairness or efficiency. A tax system that offers little in the way of assistance in meeting legal obligations and rewards clever evasion imposes unnecessary burdens on the public, undermines trust in government and forces Washington to borrow what it cannot collect."

David S. Mitchell a senior fellow at the Washington Center for Equitable Growth, makes the case for taxing wealth in the United States. "Despite the preponderance of rhetoric to the contrary," Mitchell asserts, "taxing wealth is consistent with the U.S. tradition of progressive taxation – and, in fact, is needed to patch an increasingly porous income tax system. Targeting taxes on the superrich's fast-growing accumulation of wealth, which today is largely in the form of unrealized capital gains, could go a long way toward improving the nation's fiscal position, combatting inequality, spurring more broad-based economic growth, and helping to offset the drift toward government by and for the rich."

In this excerpt from his new book, *How Progress Ends: Technology, Innovation, and the Fate of Nations*, **Carl Benedikt Frey** at Oxford explores a novel explanation for an old contradiction. "Arguments about economic development are an intellectual echo of a Cold War now more than 30 years behind us," he writes. "They either exalt decentralized systems, in which small firms experiment with little interference from the government, or they extol centralized bureaucratic systems in which strong states direct the economy through rational industrial policy. I argue these two ideal types each have their own ecological niche – that is, they are each well suited to different environments."

Happy perusing. — *Peter Passell*

BY SIMON F. HAEDER
ILLUSTRATIONS BY SAM WARD

In gaining the White House a second time, Donald Trump is plainly determined to leave no policy unchanged. The seemingly unending list of shocks to business as usual has included everything from sending paramilitary to cities to root out undocumented immigrants to tearing up trade treaties with allies. And while

the president's abandonment of health insurance subsidies for middle-income households competed only briefly for headline attention with assaults on Venezuela, criminal investigations of the Federal Reserve Board and hardball efforts to annex Greenland, there's little doubt that the president remained fixated on putting his stamp on health care policy.

Much of the early effort to this end focused on rolling back the expansion of access to insurance coverage built up during the Obama years. And though Republicans don't seem to have a coherent alternative vision for how they would deliver care or to whom, it makes sense to review the proposals on the table. For it's just possible there may be some constructive synthesis to emerge from the muddle.

THE ACA, TRUMP AND HEALTH CARE

After the landslide 2008 election, Democrats not only controlled the White House but also held a filibuster-proof majority in the Senate and outnumbered Republicans in the House by almost 80. Democrats also formed majorities in more than half the state legislatures. The party that first proposed universal health

insurance (under President Truman in 1945) finally saw its way clear to sweeping reform.

Well, sort of. Few initiatives have reflected so much disagreement within the Democratic Party or triggered partisan division as fierce as the Affordable Care Act (aka Obamacare), which squeaked through Congress in 2010. And while the ACA proved to be politically popular once the public got a taste of the benefits, it has never enjoyed the untouchable status of once-controversial programs like Social Security or Medicare.

Fast forward just a few years. Democrats lost 13 governorships and more than 800 seats in state legislatures. Republicans took control of both the Senate and the House, with Democrats losing a combined 69 seats in 2010 and another 22 in 2014. Yet, the ACA held on by the slimmest of margins in Congress through President Trump's first term, at least in part because Republicans couldn't agree on an alternative.

Then the pandemic happened. With Democrats back in the White House, efforts to repeal the ACA faded. Indeed, in the teeth of the emergency, even some deep red states like Oklahoma, Louisiana and Utah took advantage of the offer built into the ACA to expand Medicaid at no short-term cost to state budgets. Case closed.

Or maybe not. In the euphoria of the return to the White House, a more ideologically consistent conservative bureaucracy brought in by President Trump seemed determined to roll back the ACA. And they were able to hold together the Republican congressional majority to include major cuts to the ACA marketplaces in the One Big Beautiful Bill Act (OBBBA). The most dramatic impact was on Medicaid, the means-tested insurance system program for low-income households. Long opposed to the expansion of Medicaid to include financially pressed middle-income families, Republicans managed to cut more than a trillion dollars allocated to this purpose over the next decade.

Aware that Medicaid is popular with voters in purple districts, Republicans delayed most of the cuts past the 2026 congressional elections. They also gave the pruning some political cover: for the most part, instead of flat-out kicking people off Medicaid, they made it harder to qualify for the program and, once on board, to remain qualified. The added bureaucratic hoops haven't generated much anger among the public, yet will have as profound an impact on enrollment as a tighter means test.

And while the work requirements added to qualify for Medicaid are getting some media coverage, it's hard to catch voters' attention with tales of how frequently Medicaid enrollees have to certify their incomes, or how increases in co-pays deter doctor visits. Icing the cake, OBBBA makes it harder for states to come up with their share of Medicaid costs because they are no longer able to tax Medicaid providers to generate the needed revenue.

But what's likely to work politically with backdoor Medicaid cuts is more problematic for cuts in ACA subsidies to middle-income buyers of private insurance. Enrollment in the ACA marketplaces soared from 11 million to 24 million thanks to the "enhanced" means-tested subsidies added during the pandemic, and extended once afterward, that made insurance more affordable. Set to expire at the end of 2025, the OBBBA essentially deep-sixed those subsidies. But for reasons not entirely clear, Republicans decided to let the marketplace subsidies expire at the end of

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2025 rather than delaying their demise until after the 2026 election as they planned for Medicaid cuts.

One could argue that the Trump administration knew what it was doing. Without the subsidies, ACA market insurance is simply too expensive to lure younger, healthier people to buy insurance they don't think they'll need. That leaves sicker people to pay more to pick up the slack, creating a potential doom loop in which the least healthy people are priced out of insurance.

Ironically, the pain is likely to be felt most in red states. While the Urban Institute estimates that the average marketplace premium nationwide will rise by 22 percent thanks to the OBBBA, the figure is 39 percent for Tennessee and a whopping 69 percent for Arkansas.

To be sure, even prior to the major changes implemented via OBBBA, government health insurance was in the crosshairs of the Trump administration. For example, the FDA and the CDC were hit particularly hard by the DOGE rampage through federal agencies. Countless research grants were paused or canceled. And a slew of regulatory and administrative changes made it harder to qualify for benefits.

THE MESS WE'RE IN

So far, the Trump administration's focus has been on undoing Democrats' handiwork. Little focus has been on solving the problems of access, cost and distribution across the U.S. health care system.

Not only are costs higher than in any other country in the world, they are very much on the rise. Medicaid spending has nearly doubled from around $550 billion in 2015, while Medicare outlays grew from $650 billion to $1,100 billion over the same period. Today, the average premium for employer-sponsored

group insurance for families exceeds $26,000 annually, up from around $17,000 in 2015.

Moreover, all that money spent on health care is not buying superior health outcomes. Indeed, Americans are faring worse in terms of life expectancy, maternal mortality and management of chronic diseases than their counterparts in other affluent countries. But how could we expect anything different in a hopelessly fragmented system where the quality and availability of care depend heavily on geography, income and employment status?

Gilding this toxic lily, the bureaucracy (public and private) that has grown up to run countless insurance plans, to set fees for service and to manage prior authorization requirements is detested by almost everyone, save consultants and lawyers. Patients struggle to understand their coverage and navigate the system, while providers drown in paperwork. The best guesstimates suggest that at least one health care dollar in four – about $1 trillion per year – goes to administration.

REPUBLICAN ALTERNATIVES

Confronting these gargantuan challenges requires a grand strategy on how to make things better. Yet Republicans, lacking a practical alternative to the existing hybrid, piecemeal system, long ago grew accustomed to operating purely in opposition. To be sure, there is talk about the need for market-based reforms, deregulation, increased competition and devolution of administration to the states. But a coherent program has been strikingly absent since Nixon's Comprehensive Health Insurance Plan was derailed by Watergate.

Part of this failure to develop rational policy positions has been strategic. Throwing out buzzwords, asking tough questions of the opponent's proposal and fanning fears of a slippery slope to socialism is much easier than coming up with practical solutions that don't cost a ton of money or tread on ideological toes. And as the Clinton administration can attest, it works magic in blocking full-fledged health care reform.

But in part the failure has been policy-based. Personal responsibility and market-based solutions sound great until your opponent steals your plan and puts their name on it. Republicans have really found themselves in a bind ever since President Obama co-opted much of Massachusetts' Romneycare, named after Republican then-Governor Mitt Romney's state plan. The Affordable Care Act is many things, but it is definitely not the road to servitude predicted by hard-right opponents.

Republicans have done best politically when lambasting the ACA for the ACA's unquestionable shortcomings. As for the rare policy proposal, one stands out. Health Savings Accounts were established by the same legislation that created the Medicare Part D prescription drug benefit under President Bush in 2003.

The idea of HSAs is simple. Let people stash funds for health care expenses in tax-favored accounts: no taxes on the money put in, no taxes on money taken out to pay medical bills, and no taxes on investment earnings while the funds are waiting to be spent. Naturally, there are a few qualifiers. Most importantly, people have to be enrolled in insurance plans with high deductibles. With some of their own skin in the game, people will make better decisions about their health care – or so the theory goes.

This is where recent Republican proposals come in. Why not cut out the middlemen – the insurance companies? That is, shelf the expensive enhanced subsidies for the ACA marketplaces and send $1,000 directly to Americans to buy coverage or medical care.

More freedom, more choice – and one step closer to getting rid of that pesky Obamacare.

For the record, HSAs work, but at a scale that renders them afterthoughts. Two in three HSAs contain less than $1,000, presumably because it's hard to save money when the rent is due. In any event, $1,000 a year from the government would be peanuts in the American health care system.

Focusing on costs, some Republicans have also warmed up a perennial favorite: allowing insurance companies to sell policies across state lines. Insurers licensed in one state would be allowed to sell coverage to households anywhere in the country, creating a national marketplace of sorts. The hope and expectation is that carriers now operating only in low-regulation, low-premium states would bring down premiums by selling coverage in high-premium states.

There is less here than meets the eye, however. For one thing, most of the savings in low-premium policies come from stripping out benefits of less-than-universal attractiveness rather than from lower administrative costs or lower negotiated reimbursement to providers. In any event, many low-cost insurers don't seem all that interested in expanding across state lines, making it questionable how much would really change. It's also worth noting that the big carriers including UnitedHealth, Elevance Health and CVS Health already compete across the country and have tens of millions of policyholders.

Interestingly enough, the ACA actually offered states the opportunity to form so-called health compacts to unify their insurance markets. So far, no takers! Consumer protection post-expansion of the private market would also be problematic. If you bought a plan in Alaska regulated in Maine with a carrier headquartered in Texas, who will look out for you when things go awry? Consider, too, the problem of adverse selection. What would happen if healthier individuals drifted into cheaper plans with fewer benefits while sicker ones stuck to plans with more comprehensive coverage? Anyone see a doom loop in the making?

"Association health plans" are a related concept built on similar premises. Start with an affinity group of some sort – say, members of Costco or the Knights of Columbus. Then allow them to buy insurance as a group. In essence, the groups would mimic large employers purchasing coverage at a discount because of administrative efficiencies, purchasing power and risk spreading. What's not to love?

The legal environment surrounding association health plans is quite murky. The Trump administration found this out the hard way the first time around when it sought to dramatically expand the AHP market.

For one, the legal environment surrounding association health plans is quite murky. The Trump administration found this out the hard way the first time around when it sought to dramatically expand the AHP market. It is also not clear whether and how AHP plans would be covered by ACA minimum requirements – and whether those signing up would realize the limits of their coverage.

Legal questions aside, there are other reasons to be skeptical. There's no magic here: much of the potential savings would have to come from paring benefits – as in, your premium went down $200 month, but no longer covers maternity care, prescription drugs or mental health care.

Here, too, there's an issue of selection. AHPs sound workable for healthy people, but creating insurance ghettos for the healthy raises the cost of coverage for everyone else. It's worth noting, too, that fraud and insolvency have been a big challenge for AHPs in the past. It is not surprising that very few Americans have opted for AHP coverage when generous subsidies were available from the exchanges.

Republicans have been a little more timid about proposals to reshape Medicaid. The Big Beautiful Bill will kick millions from the program, but as quietly as possible by adding administrative hurdles for eligibility rather than formally narrowing access.

In the first Trump term, Republicans were much more aggressive in seeking to reshape the program. One proposal was to eliminate cost-sharing with the states and simply send a fixed sum to each state, giving them a lot of leeway to decide who's covered and how. But even analysts who are sanguine about how the states would allocate block grants worry the approach would burden states in ways they cannot manage.

How, for example, would Medicaid adapt to another pandemic? Or a recession? Or an expensive medical innovation that yielded undeniable benefits? (We're looking at you, Ozempic.)

A related proposal offers a bit more nuance and alleviates some of the concerns with block grants. Here, instead of delivering a lump sum linked to the state's population of low-income households, federal payments

would be tied to the numbers signed up for Medicaid. This approach would provide flexibility when Medicaid rolls swell – and also reduce the states' financial incentives to tighten eligibility.

Both approaches have proved a hard sell in a narrowly divided Congress. In the past, Republicans have deliberately set the proposed per capita payments low and paired the proposals with formulas meant to shrink the program over time. Estimates put coverage losses at 15 million beneficiaries back in 2017 during the height of the fight over Obamacare. It is hard to imagine a much different reception this time around. Moreover, with changes to health care finance without the political cover of OBBBA, bipartisan opposition would be easy to organize.

WHAT ELSE IS OUT THERE?

Republicans are in a bind. Just saying no to socialism was a viable opposition strategy as long as most middle-income households had adequate insurance from their employers at little cost. But Americans' experience with subsidized private insurance through the exchanges and easier access to Medicaid have made it far more difficult to convince them that the sky would fall without changes that threaten their existing coverage.

In January 2026, the White House unveiled The Great Healthcare Plan, which it labeled "a comprehensive plan to lower drug prices, lower insurance premiums, hold big insurance companies accountable and maximize price transparency." The plan is short on specifics, however, and it doesn't begin to tackle the fundamental difficulties of deciding who gets what care at what price.

Even if one could set aside the politics and the financial interests at play, a big dose of free-market ideology isn't likely to provide much help. Market-based solutions work best when buyers understand what they are buying, when no one but the buyer and seller are affected by the market outcome and when price competition is not blocked by market concentration or monopolistic control of technology. None of these conditions describes the market for health care.

That doesn't necessarily mean that government intervention with regulation, subsidies or Trump-style pressure on pharma to lower prices will always make things better. But it definitely means that simply unleashing the market as a fix is a nonstarter.

Democrats, for their part, aren't burdened with the fantasy that Milton Friedman had all the answers. But neither are they free of ideology or interest-group politics in figuring out what ought to happen to health care – or to the point, what's possible.

For the most progressive parts of the party, Obamacare is but a stepping stone. Universal, state-financed (and perhaps state-delivered) care is the goal. In a socialized system like the National Health Service in the UK, nearly all medical providers are directly employed by the government. Socialized medicine, by the way, is hardly an alien concept in the U.S.: the Veterans Health Administration provides free care to some 9 million veterans in 1,380 facilities that employ 370,000 professionals.

Canada, for its part, uses a hybrid system leaning toward the socialist model. Coverage is universal and the government is the sole payer/insurer. There are some nuances here. But generally, tax dollars – and not private premiums – fund the system, while government establishes the rules of the game and the fees for service paid to private providers.

There are lots of things to like about single-payer systems or full-blown government delivery of care. For one, everybody is covered. For another, the costs of administration aren't burdened by gaming about the

conditions of coverage and the compensation provided. But socialized medicine has its own major drawbacks.

In most cases, single payers use their monopoly powers to rein in costs. The only buyer of pharmaceuticals in the UK that really counts is the National Health Service, and the only price is the one set by the government. The catch here is that, to contain costs, access to expensive drugs (as well as services) must be rationed or in some cases denied to everyone.

One way or another – actually, in many ways simultaneously – costs will eventually have to be contained by some combination of rationing services and limiting the compensation of providers.

The subtler problem is political. Single-payer systems centralize purchase decisions, maximizing the prospects that choices will be driven by political considerations rather than a comparison between costs and benefits. Even the U.S. system, which depends on multiple payers, has been affected by this sort of political calculus. For example, in 1972 Congress decided to provide kidney dialysis to virtually all (today, roughly 555,000) Americans who can't survive without it. That isn't necessarily a bad thing, but it does leave one to wonder why kidney disease, and not other serious illnesses, is treated this generously.

OK, if not a single-payer system, how about a hybrid in which something like the government insurance now provided to federal employees is offered as an alternative to private insurance on the ACA exchanges? The idea of a "public option" gained prominence during the debate over the ACA in 2008 and 2009. But it died in 11th-hour negotiations among Democrats thanks primarily to the opposition of Senator Joseph Lieberman, who made no secret of his wish to defend the private insurance industry from public competition.

The failure to include the public option has since been blamed by some liberals for all that ails Obamacare. But that is debatable. Managing a public option would be almost as problematic as running a single-payer system. What services would it include? How aggressively would it be allowed to compete? What if it went insolvent?

It's easy to ignore the proverbial forest when assaying what has been done and what should be done about the humongous American health care system. Two things, it seems to me, stand out.

First, we should not forget that Obamacare created a new reality for what health care in the United States could look like. Some 40 to 45 million Americans got health insurance, moving the country a long way toward universal coverage. They won't give it up easily. Indeed, the ACA has never been more popular since President Trump put a target on its back – roughly two in three Americans approve. And it is hard to imagine a stable political equilibrium in which Republicans manage to roll back much of the gain[illegible]ccess.

Second, neither political party seems to have a clue on how to defuse the supply-side time bomb threatening the long-term stability of the American health care system. Thanks to rapid population aging and the clampdown on immigration, the demand for care is rising faster than the economy is growing. Meanwhile the cost of medical services is rising faster than overall inflation because

labor productivity growth in the industry is slow, the supply of highly trained personnel is constricted by regulation and medical innovation seems to add more to costs than it saves.

To date the system has lived with cost pressures in part by making them less visible to the public. The rising cost of premiums paid by employers only indirectly reduces living standards by slowing the growth of wages; Medicare and Medicaid costs are shoveled into federal deficits. But one way or another – actually, in many ways simultaneously – costs will eventually have to be contained by some combination of rationing services and limiting the compensation of providers. We just don't know when the proverbial straw will break the camel's back.

ROOM FOR THE DEAL?

Both Democrats and Republicans, then, face daunting challenges in delivering sustainable health care that Americans are willing to pay for. But in my view, there is a pragmatic solution that could be palatable for both parties. And the model has been around for decades in the form of the Medicare Advantage option that currently allows seniors to trade their Medicare fee-for-service benefits for a broad package of privately supplied managed health services.

The idea would be to combine Medicare Advantage with all other publicly funded programs like Medicaid and the Children's Health Insurance Program and let beneficiaries pick their own coverage from privately run managed care organizations. Then, add everyone who is getting their insurance from their employer for good measure. To be sure, managed care sold under the Medicare Advantage rubric hasn't saved Medicare any money, which was how it was initially sold to Congress. But Medicare Advantage seems to be a big hit with seniors, and there are a bunch of upsides here that could make it technically feasible and politically palatable to use the Medicare Advantage model in public-private hybrid managed care.

For one, the insurance pools would become much bigger, offering the prospect of economies of scale in both administration and service, as well as increased market power in bargaining with hospitals and other providers. Second, integrating the patchwork of programs and policies that barely hold things together now offers the potential for massive administrative savings. This approach would also rid the health care market of the anachronism that state lines should serve as boundaries for insurance markets.

Equally important, the system wouldn't look or feel very different from what Americans are currently used to. Households would be served by private entities, many of the same insurers who currently manage group policies. One major difference – which would presumably be popular – would be the ability to switch from one insurer to another in search of lower prices or better service.

A Medicare Advantage-like system would be no panacea. While the managed care providers would have incentives to increase the productivity of care delivery, one way or another we'd have to find ways to resolve the issues of who is subsidized and how much, and who gets access to expensive new technology. Moreover, some problems plaguing the current system, like the maldistribution of doctors that undermines the quality of care in low-income rural areas, may not be solvable at all. But getting everyone into the same insurance market, generating some financial savings, expanding the numbers covered and preserving the private-public nature of the system seem like a good start to me – one that both Democrats and Republicans could get on board with.

STABLECOINS

What we know – with a little help from the podcast crowd

BY RASHAD AHMED, JAMES A. CLOUSE, FABIO NATALUCCI AND ALESSANDRO REBUCCI

ILLUSTRATIONS BY JAMES STEINBERG

With more than a quarter-trillion dollars' worth of stablecoins in use and the much-anticipated GENIUS Act establishing a dual federal and state regulatory framework for regulating this tech-driven digital asset, it's pretty clear that stablecoins are going mainstream. Here, we offer a primer on what stablecoins are, what they could become and how financial markets are responding. ¶ Then we try something novel: an assessment of the public policy implications supported by a new Andersen Institute survey of expert opinion filtered through large language model AI analysis of podcast episodes devoted to stablecoins. The survey data suggest that stablecoins hold the promise of revolutionizing the domestic and international dollar payment system by lowering transaction costs, shortening settlement times, providing continuous 24/7 payment system access and broadening financial inclusion. ¶ At the same time, the survey-based analysis warns that stablecoins pose significant risks to systemic financial stability if the market grows as large as currently predicted – and especially if vast scale is achieved in a matter of a few years. The new regulatory framework introduced by the GENIUS Act, with specific design features aimed at addressing some inherent vulnerabilities, does have the potential to ameliorate some risks, but will not eliminate them.


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THE NITTY GRITTY

A stablecoin is a form of cryptocurrency, a virtual currency living encrypted on decentralized networks that promises to maintain a constant value against a reference asset – typically the U.S. dollar. Dollar-denominated stablecoins gained early traction from the demand for a stable medium of exchange within the volatile crypto ecosystem. The total market capitalization of USD stablecoins grew by nearly half in 2025 to just under $300 billion.

For GENIUS-noncompliant stablecoins, holding risky assets such as cryptocurrencies and commodities exposes the issuer to additional risks, notably market risk.

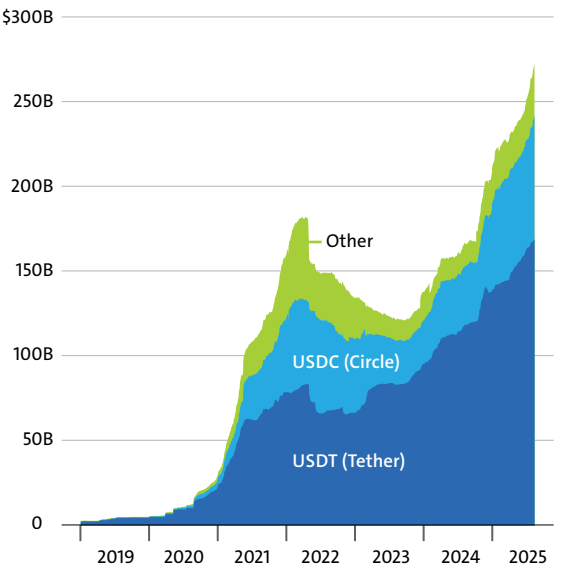
The dollar-anchored stablecoin supply currently in circulation is highly concentrated, with just two providers, Circle, which issues USDC, and Tether, which issues USDT, responsible for over 85 percent of the total.

But this is apparently just the beginning of the build-out. The stablecoin market is expected to expand rapidly, with bullish estimates of capitalization as high as $4 trillion by 2030.

The attention of Wall Street and the media paralleled the growth of supply of USD stablecoins in 2025. This tsunami of tokenized money and its technological novelty, combined with strong interest in providing a legal framework on the part of both investors and the crypto industry, culminated with the passage of the GENIUS Act with bipartisan support. The GENIUS Act (formally, the Guiding and Establishing National Innovation for U.S. Stablecoins Act) requires any USD stablecoin issued in the United States to be fully backed by safe U.S. dollar assets. Some $20 billion to $30 billion in foreign-issued stablecoins like Tether's USDT – which pegs to the U.S. dollar but is partly backed by cryptocurrencies, commodities and non-dollar assets as reserves – are not GENIUS-compliant. However, USDT can continue to circulate, and Tether can operate legally as offshore stablecoins.

In accordance with the act, GENIUS-compliant stablecoin issuers must invest the U.S. dollars they receive in short-term, high-quality, liquid assets (HQLA) such as U.S. Treasury bills, reverse repos and bank deposits – but with no standardized allocation requirements. The GENIUS Act does prohibit compliant stablecoins from paying interest directly to holders, although market participants have already found workarounds by

U.S. STABLECOIN MARKET CAPITALIZATION



SOURCE: The authors

The authors are economists affiliated with the Anderson Institute for Finance and Economics in Washington, DC. A detailed description of the development and interpretation of the AI survey of podcasts used in the article can be found in their white paper.

indirectly offering interest by other names.

GENIUS-compliant issuers' business model is simple and profitable: they earn interest on their reserve portfolios of high-quality short-term liquid assets without paying interest on their liabilities/deposits. Other stablecoin issuers' business model (and that of GENIUS-compliant ones that find ways to indirectly reward holders) will earn a spread between the return on their reserves and their cost of funds.

Stablecoin Reserves

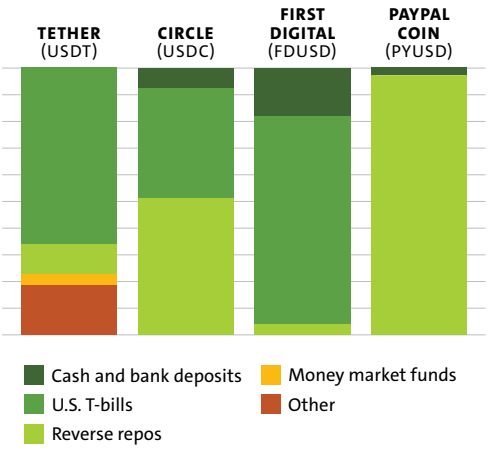
The figure to the right compares the reserves composition of four USD stablecoins: Tether (USDT), Circle (USDC), First Digital (FDUSD) and PayPal Coin (PYUSD). Circle is a U.S.-issuer with reserves consisting exclusively of GENIUS-compliant assets. Meanwhile, Tether, the largest issuer globally, is not U.S.-domiciled and holds a significant share of reserves in non-HQLA. All four issuers hold small amounts of cash and bank deposits to meet demand for immediate redemptions.

The largest reserve assets backing Tether and First Digital are T-bills, while Circle is backed by a larger portion of reverse repos. To date, PayPal Coin holds no T-bills and is almost fully backed by reverse repos. Tether, for its part, also holds $6.6 billion of precious metals, $7.6 billion of bitcoin, and some corporate bonds and non-U.S. sovereign debt.

Each reserve asset class poses some risks. Bank deposits and money market funds expose issuers to liquidity risk. Moreover, deposits held by issuers are likely too large (more than $250,000) to be covered by FDIC insurance, exposing issuers to credit risk. Reverse repo lending is subject to some, albeit small, counterparty credit risk. Even T-bills, arguably the world's safest asset, carry some interest-rate risk and liquidity risk especially during periods of market dislocation.

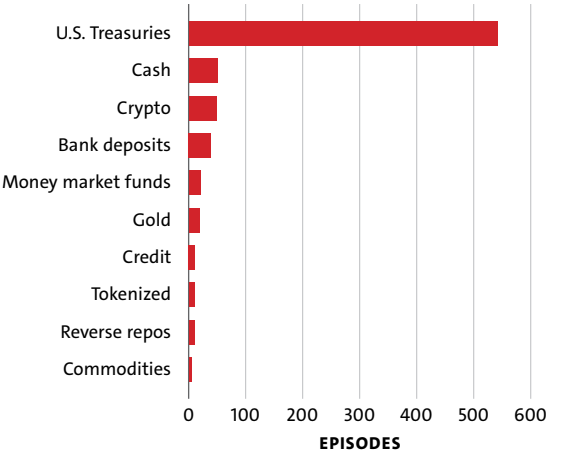
For GENIUS-noncompliant stablecoins, holding risky assets such as cryptocurrencies and commodities exposes the issuer to additional risks, notably market risk. Other assets can expose the issuer to foreign exchange risk if the securities are not denominated in dollars.

COMPOSITION OF STABLECOIN ISSUER RESERVES



SOURCE: Stablecoin issuer reserve reports for Tether (March 2025), Circle (April 2025), First Digital (May 2025), PayPal Coin (April 2025)

TOP STABLECOIN RESERVE ASSETS BY PODCAST MENTIONS



NOTE: The prompt asked the LLM model: "Which assets does the speaker mention the most in the episode as stablecoin reserves or to back stablecoins?"

SOURCE: R. Ahmed, J. Clouse, F. Natalucci, A. Rebucci and G. Sun. "Stablecoins: A Revolutionary Payment Technology With Financial Risks." Andersen Institute for Finance and Economics, October 2025

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Stablecoins, Bank Deposits and Money Market Funds

Setting aside their purely digital nature, USD stablecoins are often compared to bank deposits and money market funds because they are also used as means of payment and liquid stores of value. Under the GENIUS Act, stablecoin holders (like bank deposit holders) are legally viewed as creditors with a priority claim on the reserve assets of the issuer, which must be held in segregated accounts. However, in the event of a default, it is unclear whether stablecoin holders have recourse to assets held outside the segregated account that reflect reinvested earnings of stablecoin issuers.

This contrasts with the treatment of the owners of bank deposits, who have claims on all assets of the bank, including those reflecting the reinvestment of retained earnings. By contrast, shareholders in money market funds are considered equity holders in the funds. Moreover, neither stablecoins nor bank deposits are considered securities, while money market funds must be registered with the SEC.

Lastly, but crucially, stablecoin issuers do not pass through the interest earned on reserve assets to their holders, while money market funds do (net of fees). Banks sit in the middle, typically paying depositors interest rates below market-based money market rates.

The degree to which an asset is interest-bearing will determine the potential sources of the demand for GENIUS-compliant stablecoins over economic and interest rate cycles. As discussed below, the quantity of stablecoins outstanding declines when interest rates rise, and vice versa, as the opportunity cost of holding non-interest-bearing instruments rises and falls with interest rates.

Experts' Perception of Regulation

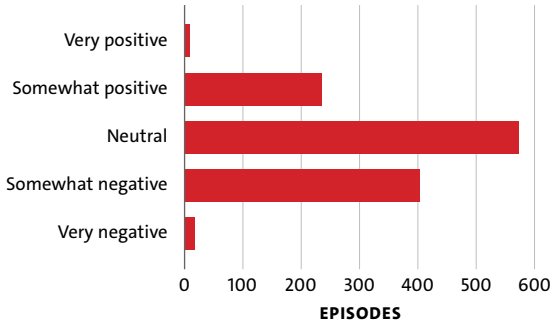
Over the podcast survey sample period, the dominant expert view of regulation has shifted from restrictive to neutral (Figure below, right panel). Much of the shift occurred once the GENIUS Act legislative process picked up in May 2025 and improved further after the Senate vote.

USE CASES AND POTENTIAL BENEFITS

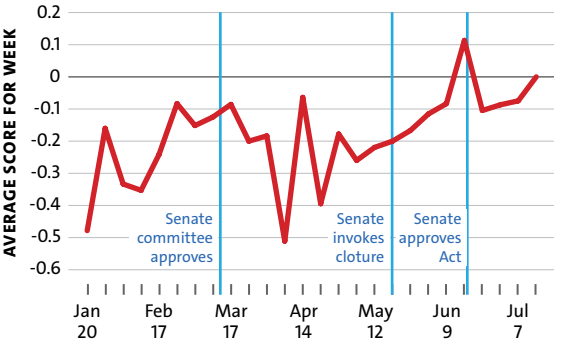
Stablecoins are seen in our survey as financial infrastructure or a settlement technology, a medium of exchange for crypto trading, a

VIEWS OF REGULATION

ATTITUDES TOWARD STABLECOIN REGULATION BY PODCAST MENTION



REGULATION ATTITUDE SCORE DURING 2025 GENIUS ACT LEGISLATIVE PROCESS



SOURCE: R. Ahmed, J. Clouse, F. Natalucci, A. Rebucci and G. Sun. "Stablecoins: A Revolutionary Payment Technology With Financial Risks." Andersen Institute for Finance and Economics, October 2025

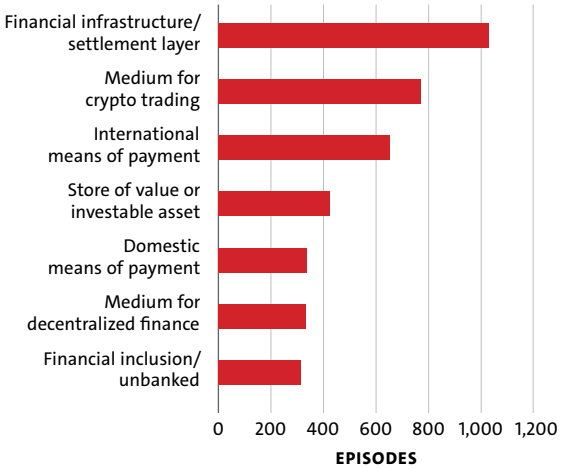
domestic or international means of payment, a store of value, a medium for DeFi and tools to address financial inclusion.

Payments and Financial Infrastructure

The use of stablecoins as a settlement layer or means of payment could enable faster and cheaper transactions utilizing blockchain and smart-contract technology. In contrast to the existing two-tiered payment system, stablecoin payments can settle on-chain directly between digital wallets without relying on central bank or interbank settlement. For businesses, accepting stablecoin payments in lieu of credit cards could lower costs by significantly reducing interchange fees. Increased settlement speeds mean businesses could also reduce the lag between time of sale and the money received from the sale. (Note one downside, though: while refunds are commonplace in online commerce, blockchain transactions are inherently irreversible.)

Stablecoins may also bring efficiency gains to international payments and remittances. The cross-border retail payments market is large and expected to grow further in coming years. Stablecoins have the potential to reduce cross-border intermediation fees and provide 24/7 payment system access. This alluring cross-border role explains why our surveyed experts mention non-U.S. holders of USD stablecoins more frequently than U.S. holders.

TOP FUNCTIONS OF STABLECOINS BY PODCAST MENTIONS



SOURCE: R. Ahmed, J. Clouse, F. Natalucci, A. Rebucci and G. Sun. "Stablecoins: A Revolutionary Payment Technology With Financial Risks." Andersen Institute for Finance and Economics, October 2025

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Facilitating Cryptocurrency Activity

To date, stablecoins are most often used as a medium of exchange for trading cryptocurrencies. Indeed, many crypto exchanges quote cryptocurrency prices in stablecoins instead of dollars. Stablecoins also bring some degree of stability to volatile cryptocurrency markets, facilitating trades without requiring traders to convert capital back and forth from legal tender.

A Tool for Financial Inclusion

Advocates claim that stablecoins may increase financial inclusion because barriers to holding stablecoins may be lower than barriers to holding U.S. dollars in bank deposits. Some perspective is useful here: stablecoins do not provide other clear advantages over other electronic mobile payment methods, yet potentially expose the unbanked to greater fraud and cybersecurity risks. Nonetheless, USD stablecoins have already seen some success in non-U.S. jurisdictions – for example, with large underbanked populations in Nigeria.

Store of Value and Investable Asset

If stablecoins eventually become popular vehicles to hold liquid assets that earn interest – effectively functioning as tokenized money market funds – they could grow into an asset class with a major role in dollar-based payment and financial systems. USD stablecoins promise a less costly and more portable store of value than physical cash, as storing and transporting large quantities of currency is expensive and risky. This function, like cash holdings of large-denomination notes, has proven particularly appealing outside the United States.

International Role of the U.S. Dollar

Our survey paradoxically suggests that stablecoins are seen as either potentially strengthening or weakening the international role of the U.S. dollar. While dollar hegemony is the fifth most mentioned benefit of stable coins in our survey of experts, weakening of USD hegemony is ranked as the seventh most mentioned risk.

There's no contradiction here. On one hand, stablecoins could strengthen the role of the U.S. dollar by increasing foreign dependence on the rails of the U.S. payment system

and by channeling foreign demand into liquid U.S. assets such as U.S. Treasuries. However, stablecoins could also weaken dollar hegemony by contributing to the fragmentation of the traditional dollar system.

YES, BUT...

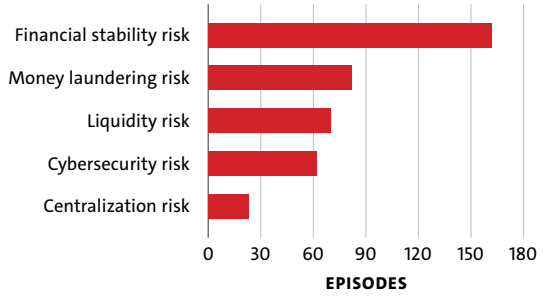
Our podcast survey clearly identifies systemic financial stability as the main perceived risk, followed by money laundering and other illicit finance. The risks of illiquidity and cybersecurity risks came in as third and fourth. Centralization risk generally refers to the risks arising from USD stablecoins being issued and backed by a centralized entity. These include, for example, operational, credit and counterparty risk.

Financial Stability Risks and Vulnerabilities

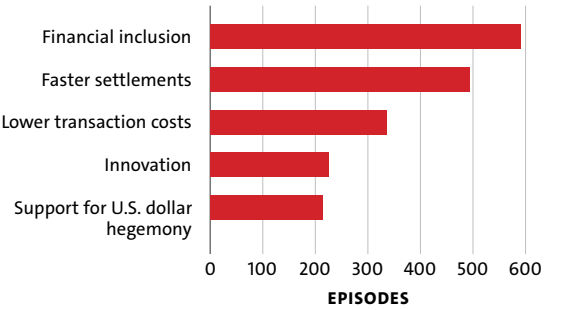
Financial stability risks and vulnerabilities inherent to stablecoins are similar to those associated with other money-like instruments and means of payment. These vulnerabilities include liquidity and risks of runs on the issuing institution due to maturity mismatches, counterparty and credit risks, and interconnectedness with other parts of the domestic and international financial system. Note, moreover, that they carry the same foreign exchange risk as plain-vanilla U.S. dollar holdings – and that the stablecoins not meeting GENIUS standards may be backed by assets that also carry maturity and credit risks for the issuer.

Consider, too, that GENIUS-compliant stablecoin issuers have limited scope to lever their asset portfolios, although on the other side of the market, stablecoins (GENIUS-compliant or not) tend to be used by investors to deploy leverage in cryptocurrency markets. These risks are much less pronounced for GENIUS-compliant stablecoins than for noncompliant stablecoins.

TOP STABLECOIN RISKS BY PODCAST MENTIONS



TOP STABLECOIN BENEFITS BY PODCAST MENTIONS



SOURCE: R. Ahmed, J. Clouse, F. Natalucci, A. Rebucci and G. Sun. "Stablecoins: A Revolutionary Payment Technology With Financial Risks." Andersen Institute for Finance and Economics, October 2025

Liquidity and Run Risk

Both GENIUS-compliant and noncompliant stablecoins are potentially vulnerable to the equivalent of old-fashioned bank runs. This is because the issuer promises on-demand redemption of its liabilities at par, while its assets may not always be sufficiently liquid or capitalized to satisfy snowballing redemptions. However, the GENIUS Act gives issuers the option to borrow in repo markets to meet redemption demands, alleviating some of this vulnerability compared to noncompliant stablecoins.

As noted earlier, liquidity risks are heightened in a volatile interest rate environment because the opportunity cost of holding non-interest-bearing stablecoins changes with interest rates. While the GENIUS Act should go

GRAPH BY MATTHEW DUBEAU

a long way toward instilling trust in this new market and ameliorating some of these vulnerabilities, it does not eliminate liquidity risk – especially because even GENIUS-compliant stablecoins (unlike bank deposits) are not federally insured and do not have a public liquidity backstop.

Credit and Counterparty Risk

Stablecoin holders are also exposed to credit risk. Because stablecoin issuers can default and stablecoins are not government-insured, stablecoin holders will be exposed to the default of the issuer. Additionally, stablecoin issuers may also be directly exposed to credit risk because some of their reserve assets carry credit risk. Bank deposits held as reserves by stablecoin issuers carry credit risk because they would likely exceed the FDIC insured limit of $250,000 per deposit institution.

LESS PRONOUNCED RISKS FOR GENIUS-COMPLIANT STABLECOINS

	GENIUS-COMPLIANT	NON-COMPLIANT
Liquidity and run risk	○	●
Credit risk	○	○
Counterparty risk	○	○
Market risk	○	○
FX risk	○	○
Operational and cyber risk	○	●
Illicit finance risk	○	●
Leverage buildup	○	○
Interconnectedness (U.S.)	●	○
Interconnectedness (global)	●	●
Public backstop	No	No

● High
○ Medium
○ Low

SOURCE: The authors

In fact, during the run on Silicon Valley Bank in March 2023, Circle Bank publicly disclosed that it held $3.3 billion (8 percent of its reserves) in deposits with SVB, virtually all of which were uninsured. Following the disclosure, the secondary market price of USDC, the stablecoin issued by Circle, fell substantially below $1 until federal regulators stepped in to guarantee all SVB deposits. The outstanding supply of Circle's USDC shrank 44 percent in the weeks following the event.

Market Risk

Most stablecoin holders are exposed to market risk, as the secondary market price for stablecoins can deviate from $1 for a variety of reasons. Only select authorized participants can access the primary market and redeem at par directly with the issuer. Market risk is much larger for noncompliant stablecoins backed by assets carrying material market risks themselves.

Similarly, stablecoin issuers are also exposed to market risk in the form of interest rate risk. Since GENIUS-compliant stablecoin issuers back their liabilities with T-bills, account holders are exposed to the possibility that interest rate increases could depress the value of the liquid assets that back the coins.

Leverage and FX Risk

The GENIUS Act provides for the possibility that compliant issuers borrow in repo markets – but only to meet liquidity needs as opposed to increasing leverage. Moreover, GENIUS-compliant stablecoins must be backed by U.S. HQLA, leaving no room for foreign exchange risk on the balance sheet of the issuer.

By contrast, issuers of noncompliant stablecoins may in principle use leverage to enhance their own returns. Tether, for example, has at times extended loans to third parties by borrowing against the reserves backing its stable-

coins. GENIUS-compliant stablecoin issuers are only allowed to borrow against assets held as reserves to meet specified liquidity needs.

In principle, noncompliant USD stablecoins may also invest in non-dollar denominated assets that carry foreign exchange risk. Tether has a small allocation of reserves in non-U.S. sovereign debt, although their currency denomination is not disclosed.

Operational and Cyber Risks

Like holders of other forms of cryptocurrency, holders of stablecoins are exposed to operational and cybersecurity risks. While GENIUS-compliant issuers will be subject to ex ante regulatory requirements and ex post monitoring that mitigate the vulnerability of their coins compared to noncompliant coins, they will also become more attractive targets of cyberattacks and potentially stronger conveyors of operational risk because they likely will be more widely adopted within the U.S. financial system.

Illicit Finance Risk

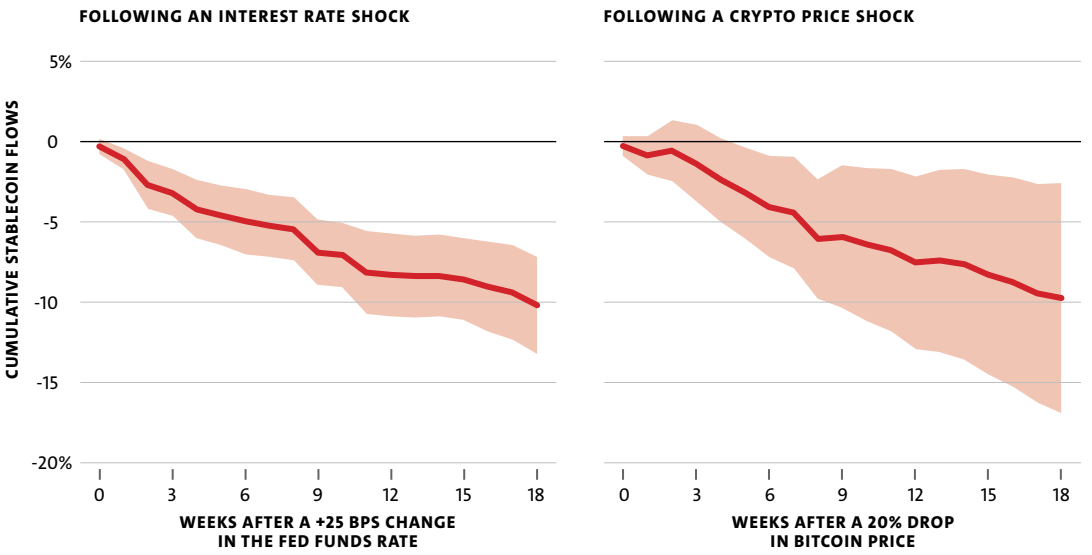
The pseudonymity of stablecoins enhances privacy, of course, but also raises the risk of their use for illicit financing activities. Crypto analytics firms such as Chainalysis and TRM Labs estimate that stablecoins account for over 60 percent of illicit cryptocurrency transaction volume, overtaking bitcoin as the cryptocurrency of choice for illicit finance. These firms also estimate that cryptocurrencies accounted for about $50 billion in illicit finance activity in 2024.

Most crypto-financed illicit activity is used to cover the tracks of scammers and ransomware extortionists, but stablecoins have also been increasingly used for sanctions evasion. There is also some evidence of increased use in money laundering activities by terrorist organizations.

Interconnectedness

A growing stablecoin market significantly strengthens interconnectedness between the

STABLECOIN RESPONSES TO MARKET SHOCKS



GRAPHS BY MATTHEW DUBEAU

SOURCE: R. Ahmed, J. Clouse, F. Natalucci, A. Rebucci and G. Sun. "Stablecoins: A Revolutionary Payment Technology With Financial Risks." Andersen Institute for Finance and Economics, October 2025

crypto ecosystem and the traditional financial system. Stablecoin redemption risks tend to grow when cryptocurrency prices decline because stablecoins facilitate cryptocurrency trading and use of leverage in that market. Consequently, stress in crypto markets has the potential to propagate to (and beyond) traditional financial markets such as the Treasury, repo and deposit markets in which stablecoin reserves are invested. When cryptocurrency prices fell dramatically in 2022, the stablecoin Terra failed and crypto market stress spread to Tether, which faced redemptions and significant downward price pressure in secondary markets.

Another source of interconnectedness comes from issuers' creation of stablecoins in multiple markets. With stablecoins circulating across multiple jurisdictions under differing regulatory regimes, it is also possible that redemption stress will originate in a more loosely regulated jurisdiction, perhaps due to a deterioration in the value of assets that are eligible reserves under that jurisdiction's regulatory regime. The issuer may then also face strains and redemptions in the more tightly regulated jurisdictions.

Consequently, entities in more tightly regulated jurisdictions may end up with runs simply because of the misperception that the two versions of the stablecoin are equally at risk. Alternatively, the balance sheets of more tightly regulated entities could be used to bail out more loosely regulated entities, spreading the risk.

REGULATORY GAPS

While the GENIUS Act lays the foundation for a comprehensive regulatory framework for stablecoins, it leaves several issues unaddressed. For one thing, the act does not grant stablecoin issuers access to public liquidity backstops or guarantees in times of financial stress. Unlike U.S. dollars, USD stablecoins are not backed by the full faith and credit of the U.S. government. Nor does any regulatory agency insure stablecoin holders the way the FDIC insures bank depositors.

In the event of a liquidity shock, banks have access to the Federal Reserve discount window and to the Fed's standing repo facility. Stablecoin issuers that are subsidiaries of insured depository institutions may also have indirect access to Fed liquidity facilities to the extent that their parent banks are prepared to borrow against their own collateral and can pass funding on to stablecoin subsidiaries. However, non-bank stablecoin issuers would not have such indirect access.

Second, the act prohibits stablecoin issuers from paying interest to holders, but (as noted earlier) does not appear to prohibit indirect financial incentives on stablecoins via exchanges, decentralized protocols or partnerships with third parties – a common stablecoin practice that has recently become a point of tension with the banking industry.

* * *

Stablecoins are likely here to stay, bringing both new technological opportunities and financial risks. The GENIUS Act and companion legislative proposals, along with executive orders blocking the development of a public alternative in the form of a central bank digital currency in the United States, suggest that this is the direction in which USD digital money will evolve in the future.

This is hardly the end of the story, though. While the GENIUS Act does add a layer of regulatory certainty, the market is too new and insufficiently tested by stress to offer much perspective on the balance of costs and benefits in this next step in digital finance. Stay tuned.

Sustaining U.S. Biomedical Leadership

BY SUNG HEE CHOE AND ESTHER KROFAH

ILLUSTRATIONS BY LINCOLN AGNEW

The United States is indisputably the world's leader in biomedical research and innovation – and for good reason. Public investment through agencies such as the National Institutes of Health, combined with private-sector entrepreneurship and philanthropic support, has driven discoveries that have fundamentally changed how diseases are prevented, diagnosed and treated. Vaccines, antibiotics, cancer therapies, imaging technologies and advances in genomics all emerged from an ecosystem in which government funding, academic research and private capital reinforced one another.

These scientific achievements have translated into immense gains for society. To be sure, health care outcomes vary widely by region and socioeconomic group. But that doesn't diminish the reality that once-fatal diseases have become manageable or curable. All told, life expectancy has increased by eight years since the 1960s.

Meanwhile, the economics of health advance have complemented the social gains. Millions of jobs have been created across research institutions, biotechnology and pharmaceutical companies – and, of course, health care institutions. Regional economies, from Boston and the San Francisco Bay area to North Carolina's Research Triangle, have been built around life sciences innovation. Biomedical research has also strengthened America's global standing, serving as a source of soft power in bolstering diplomacy and goodwill.

Yet this leadership is no longer guaranteed. The systems that supported past success are under growing strain. Governance of the biomedical system is fragmented across agencies and levels of government. Core infrastructure (e.g., data systems, clinical research capacity and workforce) is unevenly developed and deployed. Funding is often short-term and disconnected from long-term needs. At the same time, peer nations are pursuing coordinated national life sciences strategies that integrate research, data, workforce and policy.

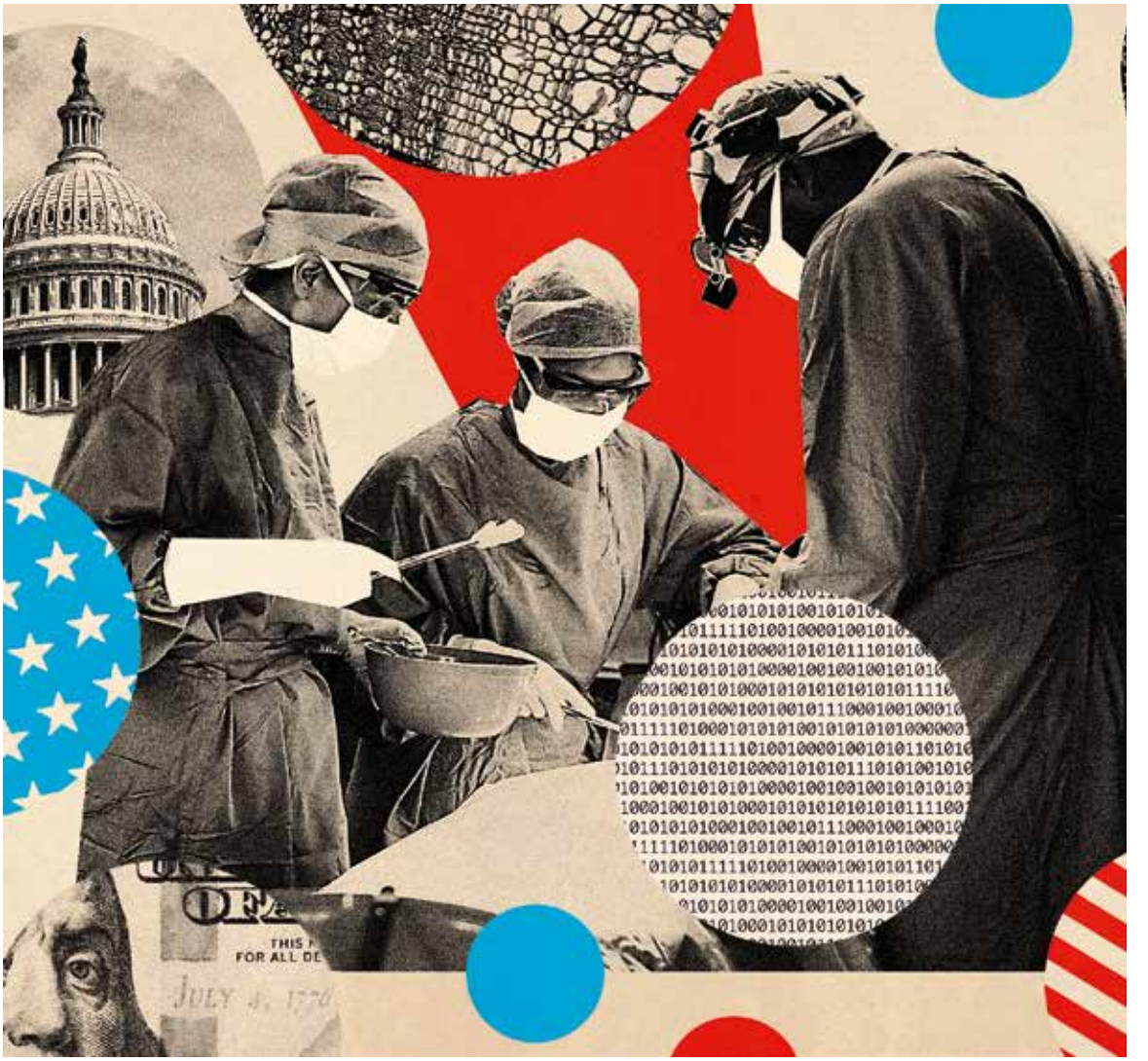
Without modernization and alignment, the United States risks falling behind – not because of a lack of scientific talent or ingenuity but because the underlying systems that translate discovery into real-world impact are not adapting to the evolving needs of modern science.

This article makes the case for the U.S. Congress to commission a National Life Sciences Strategy and Implementation Plan to set priorities, guide investment and sustain American leadership in biomedical research and innovation. The goal is not to centralize science or dictate research agendas but to strengthen the biomedical enterprise to deliver better health, stronger economic growth and greater national security.

THE CHALLENGE

The U.S. biomedical ecosystem is vast but highly fragmented. Federal agencies operate under disparate statutory missions, authorities and budget processes. States invest independently based on local priorities and economic strategies. Universities compete for grants, talent and prestige. Philanthropic organizations focus on specific diseases or populations. Companies allocate capital according to market incentives and shareholder expectations.

SUNG HEE CHOE is managing director on the FasterCures team at the Milken Institute. **ESTHER KROFAH** is executive vice president of Milken Institute Health at the Institute.



These dynamics have fueled creativity, competition and innovation. But they also create systemic inefficiencies that become more pronounced as science grows more complex. As a result:

Research priorities shift frequently, reflecting changes in leadership rather than long-term scientific opportunity or population health needs.

Data are generated at enormous scale, but remain siloed across institutions and agencies, limiting their usefulness to improve health.

Clinical research infrastructure is concentrated in a relatively small number of academic medical centers and geographies, leaving many communities without access to the cutting-edge therapies that clinical trials can offer.

Regulatory and payment systems lag scientific opportunities, creating uncertainty for innovators and delaying patient access to effective treatments.

Workforce pipelines struggle to keep pace with emerging needs in science, data and technology.

VISION FOR A NATIONAL LIFE SCIENCES STRATEGY

The adoption of a National Life Sciences Strategy is not intended to replace investigator-initiated research or to dictate the nation's

scientific agenda. Scientific creativity and discovery remain the foundation of progress. Instead, a national strategy would shape the conditions under which science thrives, providing clarity, stability and coordination to strengthen the connective tissue of the biomedical enterprise.

Fundamentally, a national strategy would:

Set clear, long-term priorities grounded in scientific opportunity, population health needs and national interests.

Align investment across agencies and sectors, reducing duplication and signaling where sustained effort is required.

Identify gaps in infrastructure, including data platforms, clinical research capacity and workforce pipelines.

Provide continuity and accountability across political cycles, enabling ambitious, long-term goals to be pursued.

The National Aeronautics and Space Administration's decadal survey offers a model for long-term scientific priority-setting that balances ambition with accountability. Conducted every 10 years by the National Academies of Sciences, Engineering, and Medicine at the request of Congress and NASA, the survey brings together independent experts to assess scientific opportunity, technical readiness and budget realities across an entire field of NASA-related technology.

The resulting consensus-driven roadmap guides mission selection, investment decisions and cross-agency coordination over a

sustained period, while incorporating mid-cycle updates to respond to breakthroughs or changing conditions. Critically, the process provides stability across political cycles, aligns public and private stakeholders around shared priorities and creates transparency for Congress and the public about how resources are allocated. A comparable approach applied to the life sciences could help the U.S. move beyond fragmented initiatives toward a long-term strategic framework for biomedical research and innovation, one that is capable of anticipating future challenges and sustaining global leadership.

WHY ACTION IS NEEDED NOW

Three forces make a National Life Sciences Strategy especially urgent.

Global Competition Is Intensifying

Other nations increasingly view leadership in the life sciences as a strategic asset tied to economic growth, national security and global influence. Countries including the UK, Australia, UAE and Singapore are pursuing coordinated strategies that integrate research funding, data infrastructure, workforce development, regulatory modernization and industrial policy.

The United States remains the global leader in biomedical innovation, but that position cannot be taken for granted. In an era of strategic competition, a National Life Sciences Strategy is a tool to sustain competitiveness and ensure that American leadership continues to deliver benefits at home and abroad.

The Future of Biomedical Research Is Shared

Modern medical breakthroughs increasingly rely on large, shared resources. These include health data from millions of people, genetic information, powerful computing systems and artificial intelligence tools. These shared platforms make it possible to understand the biological basis of disease, design better clinical trials and develop treatments faster and more efficiently.

Building and maintaining these resources require sustained, long-term investment. When funding is short-term and fragmented, institutions may build duplicative systems that cannot communicate, wasting resources and limiting impact. Without coordination, the United States risks underinvesting in the foundational infrastructure that modern science depends on or duplicating efforts across institutions and agencies.

Translation Requires Alignment Beyond Discovery

The primary bottleneck in delivering new treatments to patients is no longer scientific discovery but rather translating scientific knowledge into real-world capacity. When parts of the biomedical system are misaligned, promising innovations can stall. Clinical trials may be designed without considering what evidence regulators or payers will really need to clear new technologies for widespread use. Data collected in research settings may not reflect true patient pathologies or demographics. Payment policies are not flexible enough to accommodate new innovations.

A national strategy could help ensure that research priorities anticipate downstream needs, aligning discovery with regulatory review, coverage decisions and implementation in health systems. This alignment can shorten timelines, reduce uncertainty and accelerate access to effective interventions.

ELEMENTS OF A NATIONAL STRATEGY

Several components are essential to a National Life Sciences Strategy.

Independent, Expert-Led Priority Setting

An independent expert body should be commissioned by the U.S. Congress to develop a National Strategy on a fixed cycle, such as every five years. Independence and transparency are critical to building trust and ensuring that priorities reflect evidence, not short-term pressures. Modeled on successful approaches in other domains, this body would:

- Assess scientific opportunity across disciplines.
- Consider population health needs and disease burden.
- Identify gaps in infrastructure, data and workforce capacity.
- Engage public, private, philanthropic and patient stakeholders.

An Implementation Plan With Accountability

The national strategy must be paired with a clear plan that:

- Identifies priority areas for coordinated investment.
- Clarifies roles and responsibilities across federal agencies and entities.
- Signals opportunities for public-private partnership.
- Includes mechanisms for transparency, measurement and mid-cycle reassessment.

Core Strategy Components

To be effective, a National Life Sciences Strategy must also consider the structural enablers of biomedical progress. At a minimum, the strategy should:

- Identify "grand challenges" where coordinated investment can bring forth transformative advances (preventing neurodegenerative disease or building foundational biological resources). These challenges should be treated as generational undertakings supported by sustained funding, shared infrastructure and innovative financing mechanisms.
- Include workforce projections to identify emerging skill needs and potential talent gaps across the biomedical enterprise and to inform alignment of education, training and federal workforce policies.
- Assess critical technological or data gaps that constrain research, development and translation, to guide targeted investments in infrastructure.

Robust Input Processes

The credibility of a National Life Sciences Strategy will depend on the quality and breadth of its input processes. Strategy development should:

- Include systematic horizon scanning to identify emerging technologies, evolving health threats and shifts in global scientific and competitive dynamics.
- Engage the public, capturing patient, caregiver and community perspectives on unmet needs and research priorities.
- Rely on expert advisory panels that bring together diverse disciplines across science, medicine, industry, ethics and policy to ensure balanced, evidence-based recommendations.
- Incorporate international benchmarking to assess where U.S. leadership is strongest and where it is most vulnerable.

Impact for Key Stakeholders

A National Life Sciences Strategy would deliver tangible value across the ecosystem:

- **For patients and communities,** it promises broader access to clinical research and faster translation of discoveries into treatments and cures.
- **For researchers and institutions,** it provides clarity on long-term priorities and sustained investment in shared infrastructure.
- **For industry and investors,** it offers pre-

dictability and stability and supports long-term planning and partnership.

• **For philanthropies,** it offers a framework to align resources with national priorities and maximize impact.

• **For policymakers,** it provides a practical mechanism to steward public investment in responsible ways even while we strengthen our health, economic competitiveness and national security.

THE CHALLENGE

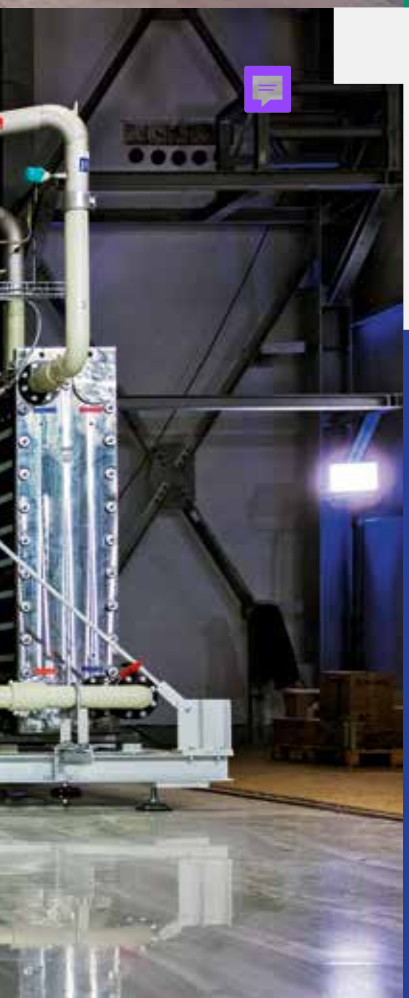
The convergence of advances, availability of data and heightened awareness of risk creates an opportunity to strengthen America's biomedical enterprise. But opportunity alone hardly guarantees leadership, which requires intentional coordination, sustained investment and accountability. A National Strategy, commissioned and sustained by the U.S. Congress, would be a major step in this direction.


H2U

Europe and the Global Technology Race

Recapturing the Initiative

BY SIMON RADFORD
AND AIDAN IRWIN-SINGER



THERE IS PERHAPS no more striking point made in Mario Draghi's report on Europe's competitiveness than the fact that "there is no EU company with a market capitalization over €100 billion that has been set up from scratch in the last 50 years." This report, in vividly exposing Europe's multiplicity of macroeconomic challenges, has galvanized the European Commission to make competitiveness its policy lodestar for the near term. Yet, by September 2025, a year after the former European Central Bank governor's landmark diagnosis of Europe's waning international competitiveness, only 11 percent of his 383 recommendations had been implemented. The pace has not noticeably quickened since.

Similarly, the UK's general election in 2024, which ushered in a Labour government under Keir Starmer in a landslide vote, also promised to put competitiveness and greater investment at the top of its agenda. Yet, despite positive reforms to pension investment regulation as well as changes in planning law designed to unlock crucial infrastructure projects, whole-economy investment in the UK in Q3 2025 was just 18.6 percent of GDP, the lowest among G7 nations.

Whether it is the Draghi report, Starmer's missions or, for that matter, the embattled policy agenda of the Merz government in Germany, blueprints for raising productivity in Europe share a remarkable consensus on priorities: Europe, it's widely acknowledged, must invest in decarbonization, close the technology and innovation gap with the U.S. and China, and spend more on defense. More investment combined with structural policy changes could raise productivity and wages, making up ground on innovation while also seeing off the domestic challenge of populist insurgent parties.

One of the structural impediments to Europe's ability to raise investment in these crucial areas, however, is a lack of fiscal room to maneuver. Growing public debt, accumulated partly during the 2008-9 financial crisis and the Covid-19 pandemic but also stemming from long-run challenges such as an aging population, constrains the ability of governments to cure what ails by throwing public money at the problem.

For one thing, it would take a lot of throwing: closing the competitiveness gap would cost upward of $4 trillion by 2030. Indeed, one worry we have heard from those in one of the few major European economies *with* fiscal space – Germany – is that the ability to spend money on its priorities might blunt incentives to make hard policy choices on structural reforms.

SIMON RADFORD and AIDAN IRWIN-SINGER are, respectively, director and associate director of policy and programming at the Milken Institute in Europe.

FROM DIAGNOSIS TO ACTION

To boost investment in Europe to the levels needed to regain competitiveness, leaders must find ways to make its priority areas attractive to private investors who have the option of allocating assets anywhere in the world. To do so, they need to offer both innovative financing mechanisms and reforms that have enough of an effect on investors' risk/return perception to "crowd-in" additional funds. If the Draghi report sets out what Europe needs to do in terms of increasing investment in key areas, exactly how this should be done remains to be determined.

That is where we have stepped in, launching the Milken Institute's Investing in Europe's Competitiveness Initiative. By breaking down three major areas designated by Draghi (and the avowedly related objectives of Europe's political leadership) into ongoing workstreams, we are bringing together investors, policymakers and others to identify routes forward in three priority sectors: infrastructure, tech and defense.

While we have busied ourselves with policy projects relating to each of these three verticals, one vital "horizontal" has repeatedly emerged in discussions with thought leaders across sectoral boundaries: the need for Europe to capitalize on its world-leading research base to commercialize more R&D. Getting there would require policy changes at both national and EU levels – but also a mindset shift into how governments can best partner with the private sector.

To understand the scale of the change that

PREVIOUS PAGES: PAUL GLASER/PICTURE ALLIANCE VIA GETTY IMAGES; ROLF VENNENBERND/PICTURE ALLIANCE VIA GETTY IMAGES

tech could make in Europe's priority sectors, consider what we learned in discussions with investors and thought leaders on questions of infrastructure and decarbonization. They have repeatedly made clear that Europe has the potential to lead in clean technologies such as green hydrogen and fusion energy, and to transform infrastructure to support ambitious net-zero goals. Their views are backed by the International Energy Agency, which estimates that new technology has the potential to provide over 70 percent of the emissions reductions needed in the energy sector to reach global net zero by 2050, while digital technologies alone could reduce global emissions by up to 20 percent by 2050.

Many of the innovations driving the current wave of decarbonization – notably, solar and wind power – were developed in Europe. But competition from China has led to the evisceration of Europe's solar industry.

THE URGENCY OF NOW

The potential impact of breakthrough technologies on Europe's competitiveness has been sharpened by recent events. The geopolitical and economic realities of the war in Ukraine – where Europe's spending on Russian energy still outstrips its own aid to Ukraine – have helped to highlight both its own energy dependence and the higher prices borne by companies in the EU compared to their Chinese or U.S. equivalents.

EU industrial electricity prices were €0.199 per kilowatt-hour in 2024, far higher than in China (€0.082) and the U.S. (€0.075). British energy prices are even higher thanks to its reliance on natural gas in grid balancing and in setting wholesale electricity prices, as well as additional levies to fund renewables. Indeed, Britain's families face average bills more than £50 a month higher than they were five years ago, abetting a populist backlash against ongoing efforts to reach net zero.

New fuel sources, advances in long-term battery storage and new technologies to decarbonize industry must be at the heart of any responsible climate policy portfolio. But change is also necessary to level the playing field for Europe's manufacturers and exporters who need lower energy costs to thrive.

One stakeholder pointed out to us that Europe has a unique opportunity to assert global leadership in climate innovation thanks to the Trump administration's reversal of President Biden's Inflation Reduction Act subsidies for emerging clean technologies. Nonetheless, while Europe has outpaced the U.S. in decarbonizing both its energy system and broader economy, it has been far less successful at attracting startup capital to emerging climate technologies. EU cleantech venture investment totaled €8.8 billion in 2024, down from €11.6 billion in 2023, giving it a modest 22 percent global share in cleantech VC investment. Even adding in the £5 billion from companies that raised money in the United Kingdom in 2024, the figure was far below the United States' 42 percent global share in cleantech fundraising.

Europe must also act urgently to ensure that it does not lose its technological lead to other geostrategic rivals, in particular China. Many of the innovations driving the current wave of decarbonization – notably, solar and wind power – were developed in Europe. But competition from China, which has not only

achieved enormous scale and reduced the cost curve in solar-panel production but has out-innovated Europe, has led to the evisceration of Europe's solar industry. To avoid repetition of this predicament in other cleantech industries, Europe must focus investment on R&D and avoid complacency in the face of anti-competitive practices by other economic blocs.

The most urgent demand – a direct lesson of the war in Ukraine – is the need to boost Europe's defenses. Up to €800 billion in additional spending by 2030 will be mobilized through the ReArm Europe Plan, with the European Commission proposing funds for joint procurement and research alongside member states committing to targeting higher GDP percentages (like Germany's push toward 3.5 percent). The UK for its part spent around 2.3 percent of GDP on defense in 2024, with plans to increase this to 2.5 percent by 2027 and 3.5 percent by 2035.

The lesson from the battlefields of Eastern Ukraine that Europe must rapidly invest in its sovereign capabilities has a crucial qualifier. Defense ministries cannot merely invest in "heavy metal" platforms procured over long timescales from established sources. They must also invest across a range of technologies and capabilities to meet readiness needs evident both now and in the future, when they are likely to profoundly change.

Along with demonstrating the roles of warships, fighter jets and missile systems to project force at range and scale, Ukraine taught us that cheap drones can destroy expensive weapons systems. The side that wins isn't necessarily the side with the latest high-tech hardware, but rather the side that diagnoses, builds, replaces and adapts faster than its adversaries. If the UK and EU are to add new, tech-driven sources into a future sovereign procurement mix – and not be forced to choose between foreign market-leading providers and inferior domestic solutions – then defense ministries will need to move from largely passive shoppers to shaping an innovative but sustainable domestic technology market.

This will require an urgent effort to identify both pain points and opportunities to close readiness gaps in constant conversation with technologists and European allies, moving faster on contracts to sustain venture-backed businesses and actively fostering competition to encourage suppliers to improve on initial solutions. It also requires adaptions in work practices so companies can partner to leverage data, rapidly develop new software, and build the necessary hardware to take advantage of the new capabilities it unleashes.

While Helsing, a software company specializing in defense missions, is one promising example of an emerging European defense challenger, Europe conspicuously lacks the Palantirs and Andurils – offshoots of Silicon Valley bringing the promise of AI to develop breakthrough defense capabilities. Ukraine's drone companies have emerged as world leaders (along with the Russians opposing them). But it remains to be seen how adeptly they might be made part of a permanent European defense ecosystem when fighting relents in their own country.

Beyond adjacent technology-led capabilities like drones and autonomous underwater vehicles, European defense ministries must also monitor and leverage breakthroughs in critical and emerging technologies such as quantum computing. Paulo Surico of London Business School argues that rather than spur future "guns vs. butter" debates that risk curtailing defense investment, military spending will actually boost economic growth and competitiveness as long as it is skewed toward R&D. His research finds that an increase

JENS SCHLUETER/GETTY IMAGES

Scientists at the new ThyssenKrupp Nucera SOEC green hydrogen components pilot plant in Germany.

in R&D-related military spending worth 1 percent of GDP could lift aggregate output by as much as 2 percent over time.

PUBLIC SQUALOR DOES NOT LEAD TO PRIVATE ABUNDANCE

Publicly funded research with defense applications, from the development of GPS to the creation of the internet, has long benefitted the private sector economy. Mariana Mazzucato (University College London) has demonstrated how that icon of private sector consumption, the iPhone, depended hugely on public sector innovation for many of its most compelling features. The Trump administration's abandonment of global leadership on climate issues and cuts in public research spending give Europe an opening to catch up by boosting R&D, targeting the recruitment of leading research teams to relocate across the Atlantic.

Our workshops and roundtables have identified two key gaps that the continent must close to achieve global tech leadership. First, Europe needs to convert its leading research into commercial products. Second, it needs to channel its surplus savings into domestic production, a process facilitated by the development of a deeper, more unified capital market.

The first step in bridging the gap from basic research to commercialization remains daunting despite the reality that Europe is well endowed with research capacity. The UK's globally renowned universities including Cambridge, Oxford, Imperial and University College London compete with their top U.S. counterparts, while the likes of the Sorbonne, ETH Zurich and LMU Munich regularly make lists of world-leading research institutions. However, U.S. institutions have long lured Europe's leading PhD students and researchers to American shores, where universities offer better funding, higher pay and more varied job prospects.

The EU's Choose Europe initiative, as well as the UK's Global Talent Fund and the British Academy's International Fellowships, aims to make the continent more attractive for researchers and recruit teams to locate in European labs.

Equally important, the U.S. continues to lead Europe in spinning off companies from universities and capitalizing on academic research. There are multiple causes for this, but a key explanation lies in the maturity of the investment ecosystem. There is a lack of venture capital in Europe compared to the U.S., with only London and Munich making it onto lists of global VC hubs.

How best can Europe catch up with its global competitors in commercializing government-funded innovation? Participants in our workshops point to the need to keep the best researchers from defecting to U.S. universities, coaxing back those who have left and copying some of the best aspects of the U.S.'s Bayh-Dole Act to make it easier for researchers to establish companies. The EU's Choose Europe initiative, as well as the UK's Global Talent Fund and the British Academy's International Fellowships, aims to make the continent more attractive for researchers and recruit teams to locate in European labs.

SCALING TO COMPETE

We focused above on ways to bring more

Gundbert Scherf, co-founder and co-CEO of Helsing, with a model of an HX-2 drone.

JENS KALAENE/PICTURE ALLIANCE VIA GETTY IMAGES

human capital to the table. But strategic deployment of financial capital into world-leading infrastructure needed to accomplish breakthroughs could also help Europe catch up. For example, the UK is now investing over £350 million (part of a £1 billion funding boost to expand capacity 20-fold by 2030) to create a network of advanced supercomputers specifically for AI research, with new sites in Edinburgh, Bristol and Cambridge. The UK is also looking to infrastructure investment to support its lead in quantum computing. Such investments reflect on disappointing past experience where promising domestic European tech startups such as DeepMind had to turn to the capital and infrastructure of Silicon Valley giants to help them grow and scale.

But new companies spilling out of European universities are only useful if they are neither strangled in the crib due to lack of funding nor forced to leave home for the U.S. due to a fragmented European market. Our roundtable at the Berlin Global Dialogue in late 2025 and meetings with both private- and public-sector leaders in Germany made clear that while Europe's single market in goods remains a source of strength, the diversity of both data sources and tech regulation made scaling less attractive than in the U.S. with its unified market and less risk-averse corporate technology adopters. Proposals such as EU Inc to create a single standardized EU legal entity were greeted with enthusiasm, but their potential will only be fully felt if there is greater harmonization of national-level regulation.

With a bigger volume of breakthrough companies and a smoother path to growth within Europe, the final piece of the jigsaw for creating a global leadership is greater accessibility to

funding for scaling up. A Milken Institute-hosted meeting between European Commissioner Valdis Dombrovskis (the commissioner in charge of cutting EU red tape) and leading investors at recent IMF meetings made clear that reforms embodied in Europe's Savings and Investments Union are proceeding too slowly. Marching orders are clear, if a bit daunting:

- Europe must continue to reform its pension systems so they can invest at the scale of leading global pension funds.
- The region must complement SME bank lending with deeper and more sophisticated capital market funding, and in the process mitigate the effects of the tough Basel rules inhibiting bank lending to SMEs – as the UK has done with its Edinburgh Reforms.
- Bankruptcy regimes need to be harmonized across the EU.
- Europe needs to unify its securities listings environment to give investors the depth and liquidity enjoyed in the United States.

One of the least remarked upon effects of Brexit has been that the chances of London remaining the financial heart of a Europe-wide capital markets union in the medium-term are no longer realistic. That is certainly a blow to former Italian Prime Minister Enrico Letta's vision for financial integration. However, growing recognition that Europe's underpowered capital markets are now a serious threat to not only the continent's competitiveness but also its security should provide the political impetus to reforms that have hitherto been lacking.

While London may no longer enjoy the status of Europe's financial epicenter, the UK's Mansion House reforms have made welcome progress in pooling domestic pension assets and encouraging investment into earlier-stage growth companies and crucial infrastructure assets. This remains part of a longer journey, though, as many public pension funds generate their own internal management capabilities.

JAN WOITAS/PICTURE ALLIANCE VIA GETTY IMAGES

GOVERNMENTS MUST THINK LIKE CO-INVESTORS

While our roundtables and our deep-dive projects in three workstreams identified the need for a step change in attention to emerging and critical technologies, it also became clear that doing this in a sustained way would require governments to go from simply instituting one-off, high-potential reforms to becoming flexible ongoing partners in directing Europe's technological potential.

In interviews with high-ranking Biden administration officials, leading U.S. investors

Medical students, Leipzig, Germany.

and corporate heads – including both those supportive and critical of the Biden administration's industrial policies – we uncovered lessons for how European governments could be fast followers. The idea is to take what worked with the Inflation Reduction Act, the Bipartisan Infrastructure Law and the CHIPS and Science Act while taking to heart the obstacles that stymied efforts to spur infrastructure deployment.

In the 1960s, industrial policy meant picking winners and losers. In the 1980s, industrial development was left to the "free market." But at the same time there was an emerging consensus that governments needed to think of themselves as investors in innovation. A revised vision offered today by Harvard's Dani Rodrik: rather than singling out national champions, governments should invest in, cultivate and unencumber a portfolio of diverse bets on critical technologies.

GOVERNMENTS MUST REFORM TO WIN INDUSTRIES OF THE FUTURE

To give that portfolio of bets the best chance of success, our research suggests that governments need to concentrate on four main areas:

- Providing the incentives to encourage private "crowd-in" investment in critical priority areas.
- Recognizing the complexity of modern industrial policymaking by bringing expertise into all levels of government.
- Overcoming barriers to delivery, particularly in the spheres of planning and regulation.
- Creating markets for new technologies

that facilitate effort to scale.

In short, governments need to do more than allocate funds for joint efforts with private investors. They must be true venture partners, engaging energetically with a large portfolio of investments.

Lessons from the U.S. show the vital importance of government capacity as well as failures of government coordination. Some agencies like the CHIPS Program Office benefitted greatly from recruiting external expertise, showing the potential gains when government can sit across from investors and technologists as equals. Others were hamstrung by insufficient sector knowledge, staffing and a failure to manage conflicts between national priorities and local realities on the ground.

Greater partnerships between and across European countries can help create bigger markets for entrepreneurs and investors sensitive that the size of the prize is correlated with the amount worth investing to achieve it.

To learn from these lessons, European governments must move beyond traditional squeamishness in recruiting those with atypical backgrounds, create more opportunities for civil servants to move into the private sector with the confidence that they can be recruited back and understand that cuts to subnational tiers of government – where policy is typically delivered – risk derailing the rollout of national government priorities.

It is not enough to simply will the ends without providing the means: delivery barriers constrain the deployment of much-needed infrastructure, which can have major knock-on effects on the wider ecosystem. Building infrastructure or industrial facilities is fraught with risks that contractors, clients and project sponsors must navigate, and the U.S. has repeatedly struggled to build major projects, as detailed in Ezra Klein and Derek Thompson's book *Abundance* and in our own interviews. The UK and EU recognize echoes in the U.S. discussion of their own often-sclerotic approaches to rolling out large projects, impacted by similarly complex regulation and frameworks that give too much power to stakeholders who object outright to projects.

While both *Abundance* and Dan Wang's book *Breakneck*, contrasting Chinese engineering culture with the U.S.'s lawyerly one, have raised the salience of supply-side constraints on building national infrastructure, the perils of an overly legalistic approach have been recognized for decades. A 1990 study found a strong positive correlation between a higher proportion of engineering college graduates in a country and a faster rate of economic growth. Conversely, countries with a higher proportion of lawyers tended to grow more slowly. Lawyers, the researchers argued, serve an important function in establishing the rule of law. But too many of them can lead to unproductive, rent-seeking activities like inordinate litigation and wealth redistribution rather than wealth creation, undermining overall productivity and investment.

European governments on both the left and right have shown some appetite to unblock barriers to infrastructure deployment and constraints on growth planning for specific sectors. But these policies must continue on both a supranational, national and project basis for growth to meaningfully change.

While the EU has embraced simplification in many areas, some participants in our roundtables called for more deregulation as well as simplification. Mario Draghi himself has expressed frustration at the pace of deregulation and decreasing the burdens on European businesses while growth remains sluggish.

Finally, new technologies cannot become reliable competitors of incumbent solutions without government help to reach the scale needed to lower costs. The Biden administration's Inflation Reduction Act aimed to lower the cost of renewables primarily through a comprehensive system of long-term tax credits designed to incentivize domestic manufacturing and project development.

The ability of U.S. renewable energy projects to reach cost parity with fossil fuels was curtailed by President Trump's reversal of many of the IRA's provisions. But the principle remains to be learned by European governments. Just as venture capitalists monitor the potential upside value as a technology comes to market and customers react to its potential, so, too, do investors seek to monitor their portfolio companies' fixed and marginal cost base as operations expand.

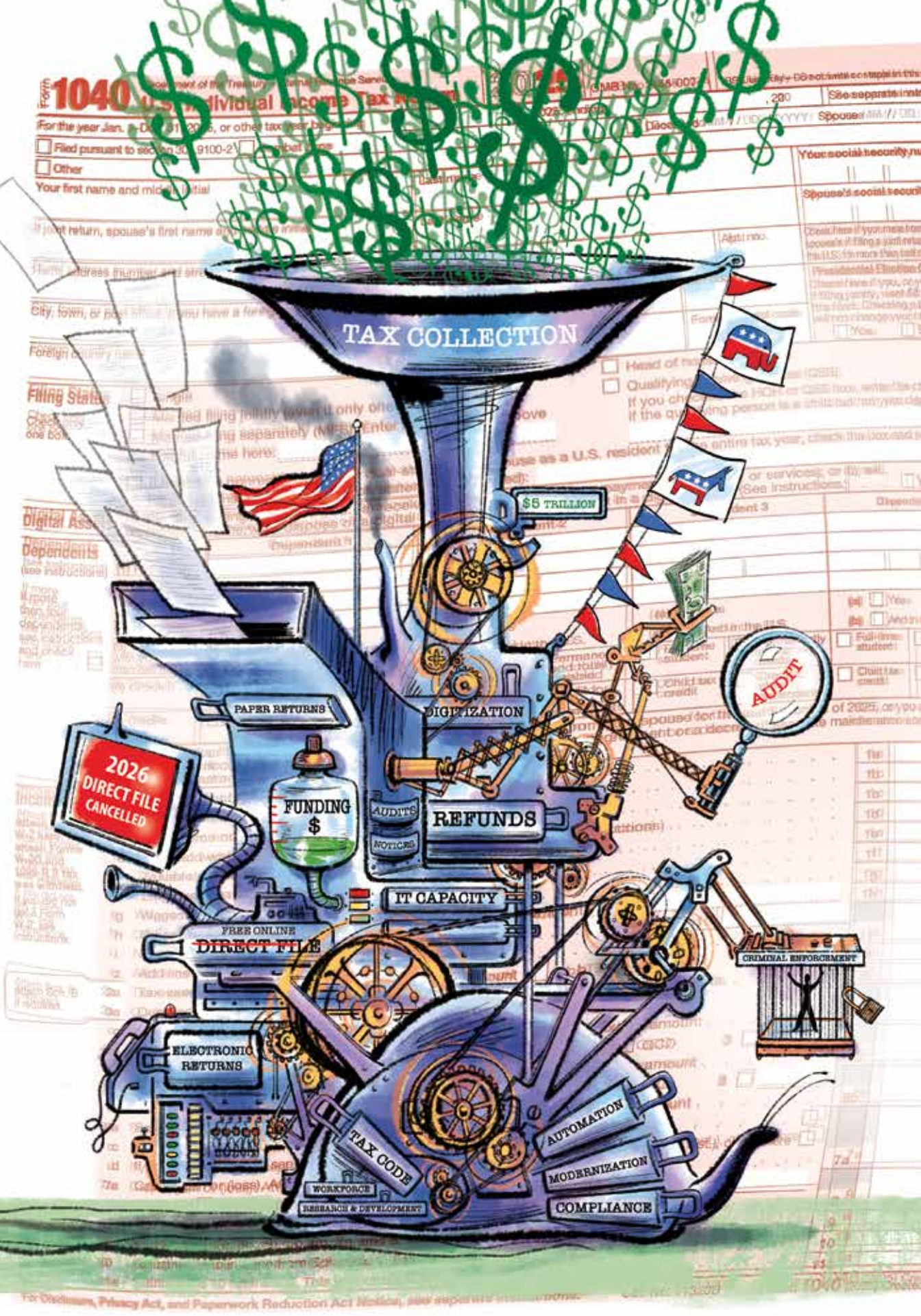
European governments lack the "exorbitant privilege" of possessing the globe's primary reserve currency (the U.S. dollar) and thus cannot emulate the fiscal largesse of the Biden administration in spending profligately to scale new technologies on their own. There is still much that they could do, though, to encourage the take up of new technology.

"Challenger" defense companies in the United States have decried cost-plus procurement contracts given to incumbents rather than specifying needed effects and price points and letting competitors find innovative ways to deliver – ways in which European defense procurement might also evolve. Advance market commitments (an idea developed by Nobel economist Michael Kremer to facilitate innovation in vaccines) can help lock in demand from government if milestones are reached, thereby reducing risk borne by private investors. Lastly, greater partnerships between and across European countries can help create bigger markets for entrepreneurs and investors sensitive that the size of the prize is correlated with the amount worth investing to achieve it. That can take the form of joint cooperation and procurement on defense with European allies, or with greater coordination to foster a more unified European energy market.

FROM POTENTIAL TO GLOBAL LEADERSHIP

While the scale of the prescription outlined above might seem daunting, we have discovered more optimism among key players than might be expected. Europe is seen by many to have an opportunity before it and considerable comparative advantages to success. Moreover, the present geopolitical environment also provides the necessary pretext, to borrow Jean Monnet's phrase, of a crisis from which new solutions can be developed. While the U.S. has attracted more financial assets from abroad than all other global regions combined since 2010, Europe ended 2025 with stock markets up from where they started, with hopes that an end to the war in Ukraine is in sight, and with governments focused on competitiveness and growth like never before.

But hope is not a strategy. Only by continuing the hard work of policymakers, investors, corporate leaders, entrepreneurs and others coming together to unleash the region's potential can we hope to make good on the call to action issued by Draghi and others. Europe should not be seen as the continent of yesterday, but as the author of tomorrow.


TAX COLLECTION
$5 TRILLION
AUDIT
PAPER RETURNS
DIGITIZATION
2026
DIRECT FILE
CANCELLED
FUNDING
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AUDITS
NOTICES
REFUNDS
IT CAPACITY
FREE ONLINE
DIRECT FILE
CRIMINAL ENFORCEMENT
ELECTRONIC
RETURNS
TAX CODE
WORKFORCE
RESEARCH & DEVELOPMENT
AUTOMATION
MODERNIZATION
COMPLIANCE

INVESTING IN THE IRS

A No-Brainer

BY GREG LEISERSON

ILLUSTRATIONS BY STEVEN SALERNO

IN OCTOBER 2025, the Treasury Department announced that it would shut down Direct File, the IRS's free, two-year-old online tax preparation tool. It cost too much to maintain and was used by too few people, the Treasury claimed, and would be discontinued in favor of increased reliance on volunteer tax preparation and a combination of free and paid services provided by the private sector. ¶ The end of Direct File is a fitting symbolic conclusion to the Biden administration's efforts to modernize the IRS. The Inflation Reduction Act of 2022 provided a historic $80-billion infusion of funds to strengthen enforcement and modernize IRS operations. This investment came after a decade of underfunding and operational challenges arising from the pandemic had pushed the agency to the brink. In 2022, only 21 percent of callers reached a live agent or received automated assistance, and the inventory of unprocessed paper returns peaked at over 20 million. ¶ While modest in terms of the human and financial resources involved, Direct File captured the ambitions of the reform effort. It was a slick online tool that made the taxpayer experience simpler and easier, offering hopes of helping to incubate a new IT culture in the agency along the way. At the same time that a small team was working on Direct File, many more employees were pursuing a host of other critical modernization efforts, most of which were decidedly less visible.

By October 2025, however, Congress had rescinded essentially all of the money for enforcement, the IRS had spent most of the funds specified for taxpayer service and the Trump administration had pushed out or fired roughly 25 percent of the IRS workforce. All that remained was a portion of the funds the IRA had made available for IT, which Congress cut further in February 2026. One more cycle of budgetary feast and famine at the IRS had concluded.

WHY THE IRS MATTERS

Revenue collection, it hardly needs saying, is a fundamental governmental responsibility. The IRS collects taxes that fund everything from national defense to Social Security, consumer protection and environmental regulation. The agency gathers nearly $5 trillion in taxes each year, 16 percent of the GDP. The IRS also has a uniquely sensitive role in government as it possesses (and is legally obliged to protect) personal and financial information for nearly every American business and household.

In a country as large as the United States, tax administration operates at a vast scale. More than 160 million families file individual income tax returns each year. The IRS estimates that on average these households spend 12 hours record-keeping, planning and filling out forms, and pay $290 out of pocket for assistance in preparation. And those numbers do not include anything that comes after the return is filed, such as responding to IRS notices if something is wrong with the return or payment.

But the tax system extends far beyond individual income taxes – think business income taxes, employment taxes and estate and gift taxes, among others. The IRS processes 2 million corporate tax returns, 6 million S corporation returns, 5 million partnership returns and 34 million employment tax returns each year. And to make this system work, the IRS handles 4.6 *billion* information returns. Information returns, such as W-2s, which report wages paid and taxes withheld, make it easier for individuals to file taxes accurately and for the IRS to determine whether the correct tax is paid. In total, the federal tax system imposes an estimated paperwork burden of 7 billion hours and $148 billion in out-of-pocket costs annually.

The voluntary compliance rate is 85 percent, but that means that more than $700 billion owed each year is not paid in a timely fashion (or ever). To discourage noncompliance and collect unpaid tax, the IRS has an escalating series of enforcement actions ranging from computer-generated notices to audits and criminal enforcement in partnership with the Department of Justice. But the current reach of enforcement is light, to say the least: in recent years, the individual audit rate has been just three in 1,000 returns filed.

We all have an interest in efficient collection. People who do not pay their taxes impose costs on everybody else, because one way or another someone bears the shortfall. Congress must either increase other people's taxes, reduce the provision of public services or run higher budget deficits that cut into the pace of investment and economic growth. Not collecting also undermines trust in the rule of law. And honest businesses shouldn't have to compete against those who cheat on their taxes to gain an advantage.

More effective tax administration would deliver tangible benefits to the public in the form of less time and money filing returns as

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well as lower rates of tax evasion. Today, roughly 13 percent of taxes owed are never collected – in the range of what the federal government spends on the means-tested Medicaid and Children's Health Insurance Programs, or more than enough to deliver a $2,000 payment annually to every person with income below $100,000.

What could taxpayers look forward to if the IRS were fully modernized? You would be able to complete your return online easily and for free. The IRS would use data it already collects on your income to help you complete your return. You would have confidence that your taxes were done correctly because there would be clear answers to your questions, and follow-up from the IRS would therefore rarely be necessary. When there was a need for follow-up, the system would be tuned so that all correspondence is clear and provides concrete steps to resolve the issue. Meanwhile, better service from the IRS would drive shady (and often inaccurate) tax preparers out of business, as well as companies preying on people with tax debt.

BUSINESS AS USUAL

For the overwhelming majority of taxpayers who file electronically, the system operates smoothly. They have tax withheld from paychecks, make any required estimated payments online and receive refunds directly to their bank accounts. Preparing and filing taxes takes more time and is more expensive than it needs to be, but the system works.

Moreover, the agency is capable of quickly delivering specialized services at scale in a crisis. During the pandemic, for example, the IRS processed three rounds of relief payments, known as Economic Impact Payments, and implemented the Employee Retention Tax Credit and the advance Child Tax Credit, among other emergency policies adopted by Congress. It issued the first Economic Impact Payments in 2020 within two weeks of the enactment of the authorizing legislation and delivered 160 million payments to all individuals believed to be eligible within nine weeks.

Problems are not limited to the paper chase, however. Identity theft affidavits are more than a year behind in processing even though they can be filed online.

However, while the IRS routinely moves mountains, the mechanisms by which it works are often far from efficient – especially when paper submissions are involved or there are problems with returns. Delays in processing paper documents consistently run several months or more. As of January 2026, the IRS was processing paper-amended individual tax returns and letters from individual taxpayers received in September 2025. (Paper original returns are processed more quickly because the IRS prioritizes them.)

Problems are not limited to the paper chase, however. Identity theft affidavits – filed when taxpayers believe they have been victims of identity theft – are more than a year behind in processing even though they can be filed online. And access to knowledgeable advice and action by phone is hit and miss.

Moreover, it is often difficult to determine whether your taxes have been calculated correctly, even if you pay a preparer. Congress has written a complex tax code, and that code must be applied to the widely varying and ever-evolving realities of millions of families and businesses. In cases where the IRS has yet to issue regulations translating Congressional

intent into concrete guidelines, it may not be willing or able to provide detailed responses to questions.

Unless Congress acts, the quality of taxpayer services will likely deteriorate further in the coming years as the last of the funding from the IRA runs out. The outlook for compliance is, if anything, even more bleak. Audit rates for individuals with incomes above $5 million and for corporations with assets above $1 billion both fell 71 percent from 2010 to 2020. The audit rate for partnerships was never high – only five in a thousand returns were audited in 2010. But that paltry rate has been cut by more than 80 percent, meaning that even partnerships engaged in very aggressive tax evasion face a low risk of audit.

Using IRA funds, the IRS hired about 8,000 compliance personnel in 2024 to bring the compliance workforce to nearly 39,000 – a level last reached in 2013. However, with many of these employees still in their probationary period in early 2025, they were particularly exposed to the Trump administration's indiscriminate layoffs of probationary employees.

When staff were laid off, reports quickly surfaced about audits dropped or adrift. It's still not clear what ultimately happened to prominent cases such as the audits of 76 of the largest partnerships with average assets over $10 billion that the IRS announced in 2024. However, available reporting suggests many cases have been closed. It is also unclear what will happen with some of the signature enforcement initiatives undertaken with IRA funding, such as those targeting high-income non-filers.

Turning to information technology, Direct File was not the only casualty of the DOGE chainsaw. Many IT modernization projects were cancelled in early 2025, and while the Trump administration's rhetoric emphasizes the priority of information technology in government, most of its current work is simply the continuation of Biden-era efforts that were haphazardly paused and restarted.

Moreover, the current administration is

making the IT challenges more severe. With federal government salaries uncompetitive with the private sector in IT, it has always been a stretch for agencies to build in-house expertise. And one of the few advantages the federal government could offer has been stable employment – until now, anyway. Adding to the burden, the Trump administration is reportedly favoring IT contractors owned by political allies, which may lead to inferior products.

On another front, the Trump administration has undermined trust in the IRS, which is critical to obtaining voluntary compliance. For one thing, the administration is requiring the agency to share information with ICE – sharing found to be illegal in one court case. For another, the administration continues to push the agency to politicize audits. Not to mention to nullify the impact of audits when evasion is found: President Trump has issued several pardons to people convicted of tax crimes, including reality TV stars Julie and Todd Chrisley, whose family members endorsed Trump at the 2024 Republican convention, and Paul Walczak, a health care executive who pled guilty to tax crimes and whose pardon application recounted what his family had done to support the Trump campaign.

As this article is being written, it is still too early in the 2026 filing season to see what impact the administration's mismanagement of the IRS will have. However, many of the harms will come not in this filing season but in the years that follow, whether it is encouraging noncompliance or failing to deliver improvements in the tax filing experience that would make it easier and cheaper to file.

WHY IRS REFORMS FAIL

Modernizing the IRS is inherently difficult because of the complexity of the tax code and the size and diversity of the United States economy. Some barriers to efficiency are unavoidable – tax administration will never be simple and will always face sabotage from politically potent interests – while others can and should be taken on as part of reform efforts. We walk through some of the more specific challenges below.

Hollowed out IT. Like other federal agencies, the IRS struggles with limited IT capacity. The agency relies on contractors to complete IT projects and lacks adequate technical talent internally to assess the quality of these contracts, let alone execute the work itself. This delays modernization and creates misaligned incentives. Notwithstanding these difficulties, IRS reform plans always put technology at their very center because automation is what enables the agency to do more with fewer resources, to make its workers more productive, and to offer easy ways for the public to interact with the agency.

Reliance on external contractors. The IRS depends on external contractors for far more than IT. Using contractors enables the agency to scale up or scale down quickly in response to changes in funding and to avoid hiring and firing – but at a significant cost to the quality of the work. In addition, dependence on contractors makes ongoing maintenance more difficult and makes it more complicated to adapt specific projects to evolving contexts.

Inadequate and inconsistent funding. Despite the well-established reality that the return on investment in enforcement can be spectacularly high and there is a critical need for tech upgrades, Congress has cut the IRS's base budget by 40 percent since 2010, and many members are seeking even deeper cuts. Inadequate funding guarantees inadequate service and more noncompliance. Almost as bad, inconsistent funding makes long-term planning difficult and encourages the IRS to

spend money as fast as possible when it is available, reducing the effectiveness of the spending it does do.

Contested visions for enforcement. IRS reforms often involve calls for improved enforcement, but there is no shared vision of what that would look like. Proponents of the IRA cash infusion advocated stronger enforcement with respect to high-income and high-wealth individuals, large corporations and complex partnerships. But many critics of the IRA view recent enforcement declines as a good thing – a counterblow to The Deep State. In contrast, after years of claiming that the Biden administration was planning to audit families with incomes under $400,000, and sharply criticizing the administration for it, House Ways and Means Committee Chair Jason Smith released a draft tax bill that would effectively audit millions of low-income families.

Political weaponization. During the Obama years, Republicans accused the administration of politicizing the review of applications for nonprofit status by conservative organizations. In fact, while there was serious mismanagement of the review process, there's no evidence of involvement by the White House. Under the Trump administration, by contrast, IRS Criminal Investigation agents have been pulled from investigating serious tax and financial crimes to do immigration enforcement. Even more sobering, the administration is pressuring the IRS to audit its perceived political enemies.

Management obstacles. One consequence of underfunding is to encourage power centers within the IRS to compete for scarce resources in pursuit of separate needs, undermining cooperation and modernization efforts. Interminable delays in hiring staff and contracting services from vendors stretch reform initiatives by years. Career officials at the IRS often view reform efforts as political contrivances that will be swept away by the next election. Unfortunately, that perspective proved to be correct in 2025.

TURNING THE PAGE

Congress bears substantial responsibility for the failures of IRS reforms, first and foremost by failing to provide adequate, sustained funding. But beyond starving the IRS of money, Congress has failed to give the agency the flexibility to recruit top talent or even to communicate clear goals. To ensure taxpayers pay what they owe and provide taxpayers the service they deserve, Congress should:

Fund the IRS. Base-operation funding is now smaller than any year since the 1980s, adjusted for inflation. The inadequacy of the IRS's budget drove deterioration in IRS service, and necessitated the substantial infusion of one-time, long-term funding from the IRA when the agency's mission was plainly in jeopardy. But Congress has now pulled back most of that money. Congress has done this even though funding the IRS is the rare form of spending that pays for itself. The task now is to generate a legislative consensus behind a sustainable commitment to long-term funding.

Provide direct-hire and critical-pay authorities. The IRS must compete for talent with accounting and law firms that pay far more. Many of the lawyers and accountants at those firms spent time at the IRS, where they gained valuable experience, and then left to play for the other team. Short-circuiting traditional government hiring processes would help, and allowing the agency to pay competitively for specialized talent would help even more. This flexibility should be provided across key functions, but in practice the IRS would likely use it where it is most handi-

capped, in information technology and legal expertise.

Strengthen enforcement. Maximizing voluntary compliance is the goal, but credible enforcement is critical to get from here to there. Congress could improve compliance by toughening penalties – for example, by making repeated failure to file tax forms a felony for people with substantial tax liability. It could also consider providing the IRS with more flexible authorities for collecting information on emerging tax avoidance issues, which recent court decisions have made more costly.

GOING IT ALONE

The IRS's challenges are more severe than ever, with the agency facing both longstanding problems and the added challenges of the Trump administration's inclination to sabotage government institutions. Success is not possible without sustained adequate funding. But even if Congress does not provide the cash, the IRS will still need to push forward with what it's got. While many of the changes suggested below are consistent with the Trump administration's stated goals for the IRS, others, especially those related to compliance and restoring public trust, are not consistent with this administration's statements or actions. It appears taxpayers will need to wait for a future administration for the IRS to take on those projects.

Update the mission. The IRS has historically been a reactive agency. It processes returns that taxpayers submit. It sends notices where there is a problem with those tax returns. It examines returns for errors and inconsistencies. It responds to installment agreement requests and other collection issues. It considers appeals. And it defends agency decisions in court.

Those are all important aspects of the work, but they are insufficient. A modern IRS should be proactive, endeavoring to minimize the burden of filing, preventing mistakes on returns before they occur and deterring evasion before it happens. The IRS will continue to process the returns it receives and examine the returns it processes. But these responsibilities ought to be subsumed by the broader mission to reduce the tax gap and make it easier for taxpayers to meet their obligations and claim credits they are eligible for.

The agency needs to rethink how it funds, governs and oversees large-scale digital product delivery, especially for work that cuts across offices of the organization.

Clarify funding constraints. The IRS has numerous can't-fail responsibilities, notably processing returns and payments. But it also has numerous shouldn't-fail responsibilities that will nonetheless fail if Congress does not increase funding. For example, the agency will not be able to provide adequate levels of phone service, respond adequately to mail inquiries or conduct adequate examinations without more money. Where Congress provides insufficient funding, the IRS must communicate that reality, explaining the size and consequences of the deficit, accepting there will be political blowback, and attempting to communicate that the responsibility ultimately lies with Congress.

Address internal management and capacity shortfalls. The IRS must develop and implement a plan to build internal capacity. As part of this, the agency needs to rethink how it funds, governs and oversees large-scale digital product delivery, especially for work that cuts across offices of the organization. There

are multiple options for delivery, but they all require attracting digital talent that works directly for the organization and collaborative executive support from across the agency. The IRS must also expand legal capacity to ensure the agency is able to adequately enforce the law at the top, where highly complex fact patterns and access to top advisors can make it hard to determine the line between lawful tax avoidance and noncompliance or evasion.

Improve internal data collection. Available data on IRS activities often lacks the granularity necessary to guide modernization efforts. The IRS needs a specific focus on data supporting strategic decision-making. Among other innovations, the agency should collect detailed information on why people call or write the IRS and on whether their problems are resolved when they do contact the agency, along with more granular information on enforcement and collections activities.

A ROAD MAP TO REFORM

The IRS must modernize regardless of the level of funding Congress provides – the level of funding should only affect the pace. The IRS should prioritize initiatives that will make employees more productive, reduce the need for services that are expensive to provide (e.g., reduce the number of incoming phone calls) or directly follow through on commitments in the mission. Immediate priorities should include:

Restore free online filing. Making it possible to file directly online at no cost should be the bare minimum goal now. It is no different than providing paper tax forms in 1913. The IRS should also use information it already receives to make filing as quick and easy as possible. Moreover, resuscitating Direct File would provide the IRS with important data about what guidance is needed by taxpayers filing their returns, not to mention giving taxpayers greater peace of mind when filing.

Provide self-service options that allow taxpayers to avoid phone calls and letters. There are many routine tasks today that cannot be completed without phoning or writing the IRS. The resulting contacts are expensive and slow to process.

Digitize incoming information. Paper returns and correspondence require expensive manual entry. Moreover, only some of the information on those documents is extracted into electronic systems; the information that is not extracted remains invisible to service and compliance systems.

Automate processes to the maximum extent possible. Processes that are entirely automated, including individual tax filing for most families, are quick and efficient. Processes that require manual intervention are not. The IRS should publicize a list of priority functions to automate and work through it.

Provide additional guidance to improve voluntary compliance. Guidance can dramatically increase the productivity of enforcement personnel by taking issues that would be resolved in a time- and resource-intensive audit and instead relying on voluntary compliance with published guidance to achieve similar results.

Better align business audit rates with risk across segments. At present, audit rates for different types of businesses are largely driven by IRS capacity rather than by calculations of potential gains in revenue. Partnerships are rarely audited because it is difficult for the IRS, while C corporations are audited at much higher rates because it is easier. In practice, aligning audits with the risk of noncompliance almost certainly means increasing audit rates for partnerships, especially those embedded in complex business structures. At the same time, the IRS should endeavor to

improve the models that it uses for case selection with increased attention to the likely tax harvest.

Explain how cases are selected for audit. It would be counterproductive to provide public information about the specific risk assessment algorithms the IRS uses to select audit cases because that would simply be a roadmap for tax evaders to escape detection. But it would make sense to provide greater detail about the broad strokes of why audits are initiated and the number of audits selected as a way of building trust in the fairness of the selection process.

WHAT IS TO BE DONE

Fights about IRS funding mirror broader fights about the role of government in our lives, and the ongoing failure of Congress to adequately fund the IRS reflects the lack of consensus on that issue. But the consequences of starving the IRS hardly fulfill anyone's idea of fairness or efficiency. A tax system that offers little in the way of assistance in meeting legal obligations and rewards clever evasion imposes unnecessary burdens on the public, undermines trust in government and forces Washington to borrow what it cannot collect.

Even if Congress fails to provide adequate, sustained funding, the IRS needs to plow forward, recognizing the priority of making the taxpayer experience as easy and seamless as possible and improving compliance among those taxpayers with the most complex filings.

Unfortunately, the Trump administration is making the challenges of IRS modernization more daunting rather than less. Senior leaders and experienced staff across the organization have been pushed out, and IT projects shut down. Moreover, sharing confidential tax information with the Department of Homeland Security in violation of taxpayer privacy laws and reportedly pressuring the IRS to target enforcement against the administration's perceived political enemies risk undermining the rule of law and trust in the IRS.

In the long run we will all pay the price. ●

The Geothermal Opportunity

BY GERNOT WAGNER

The Earth beneath our feet holds an almost comically simple solution to our energy problems. Drill down a few kilometers anywhere on the planet and you'll find temperatures hot enough to boil water. Run that water through a turbine, generate electricity, reinject the cooled water into the ground, repeat. No fuel needed. No emissions. Just heat from the planet's molten core, which will remain hot for billions of years – long after anyone stops caring about quarterly earnings reports. ¶ This isn't some exotic technology. Humans have been harnessing geothermal energy for millennia. The ancient Romans built elaborate bath complexes over hot springs. In the 14th century, residents of Chaudes-Aigues in France piped geothermal water through the world's first district heating system. The Maori of New Zealand cooked food in geothermal steam pits for centuries before European contact.

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In 1904, an Italian prince named Piero Ginori Conti successfully powered five light bulbs with geothermal power in Larderello, Italy – the first time geothermal energy had been converted to electrical power anywhere on Earth.

That should have been the beginning of a revolution. Instead, geothermal power has spent the past century as energy's perennial also-ran. Modern deployment creeps forward slowly, highly concentrated in a handful of countries blessed with obvious volcanic geology. Kenya and Iceland lead the list of countries where geothermal plays an outsized role, by virtue of being located on tectonic plate boundaries where the Earth's heat rises closest to the surface. The list traditionally also includes El Salvador, New Zealand and Nicaragua, all in locales with similar geological features.

Meanwhile, 80 percent of geothermal energy consumed globally goes to heating and cooling, 20 percent to electricity generation. While the two technologies have fundamental differences, there's a clear link – even if just in people's imagination. The pools of Iceland's Blue Lagoon are perhaps the most famous example of the broader benefits of geothermal power. Indeed, the pools of the outdoor spa operational throughout Iceland's dark, cold winters are filled with the pristine-clean waste water of one of HS Orka's power plants. These brine pools now attract so many paying tourists that they account for a sizable portion of the energy company's revenues.

By now we know that geothermal's potential extends well beyond happenstance based on winning the geological lottery – spectacular where you can find it, useless everywhere else. Recent drilling innovations, particularly those borrowed and adapted from the oil and gas industry, are making it increasingly viable to tap geothermal resources in ordinary geology beneath ordinary places. Not just in volcanic hotspots, but places where people live and work. Under Iowa. Under Germany. Perhaps under most of the planet's surface.

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THE QUIET REVOLUTION

While solar panels have been leading the renewables revolution, geothermal heating and cooling have been scaling up with minimal fanfare. Global geothermal heating and cooling capacity now exceeds 170,000 thermal megawatts and is on path to almost double by mid-century. More than half of that installed capacity, and around half of the expected growth, is in China alone – though Iceland still holds the crown for the highest capacity per capita by far. This isn't speculative future capacity. These are systems operating today, keeping buildings comfortably warm with direct heat produced without burning fossil fuels.

The economics are compelling, and it begins with the physics. Ground-source heat pumps exploit the fact that underground temperatures remain relatively constant year-round – cool in summer, warm in winter compared to surface air. Moving heat is thermodynamically cheaper than creating it through combustion. For heating applications, geothermal systems can easily achieve efficiencies of 300-400 percent, with some advanced technologies reaching 600 percent or more. The theoretical maximum for a gas furnace is 100 percent, the practical around 95 percent – meaning that heat pumps deliver three to four or more units of heat for every unit of electricity consumed. Physics, not wishful thinking.

Heating demand from geothermal sources

The U.S. gets into the act, here, drilling a hole for a geothermal heat pump installation in Hamilton, Colorado.

AP PHOTO/BRITTANY PETERSON

is projected to nearly double by 2050, driven primarily by three factors. First, district heating systems in cold climates, where geothermal can displace fossil fuel boilers that currently spew carbon into urban airsheds. Second, residential and commercial buildings adopting ground-source heat pumps as costs fall and carbon-sparing policies tighten. Third, and most significantly, China's aggressive coal-to-heat replacement policies, which aim to eliminate the small-scale coal boilers that have choked Chinese cities in toxic smog for decades along with delivering their portion of greenhouse gas.

The Xiong'an district heating project illustrates what's possible when policy, state-owned enterprises and finance align. Located in Hebei Province near Beijing, Xiong'an has replaced nearly all its coal-fired heating with geothermal energy, serving almost a million residents. The project didn't succeed through market forces alone – it required government mandates, subsidized drilling, and the muscle of China's state-owned oil companies repurposing their expertise toward heat extraction. The result is a replicable model that China is now deploying across dozens of cities.

In the United States, similar projects are emerging through thermal energy networks: shared, ambient-temperature geothermal loops that connect multiple buildings with clean thermal infrastructure. Pilot projects, such as Colorado Mesa University's campus-scale system and utility-owned networks in Massachusetts, demonstrate how pairing diverse building loads on a centralized loop can cut emissions and stabilize energy costs when supported by policy and financing.

This matters because heating rep[illegible]nts a massive slice of global energy consumption and carbon emissions. In cold climates, heating can account for 50 percent or more of building energy use. Electrifying heating with renewables is part of the answer. However, heating demand peaks on cold winter evenings when direct solar output falls to zero

Gunnuhver hot spring geyser in Iceland with its geothermal power plant.

and wind may or may not cooperate. Batteries help, but geothermal neatly sidesteps this problem – or perhaps better, nicely complements more standard approaches. Geothermal heat is both clean and firm – always on, weather-independent, season-independent, ready when needed. And what goes for geothermal heating and cooling applications goes equally for geothermal electric power.

BASELOAD POWER WITHOUT COMPROMISE

If geothermal heating is the quiet success story, geothermal electricity generation is the promising underachiever. Current global capacity sits at around 17 gigawatts – a rounding error compared to solar or wind. Conventional geothermal power plants are geographically constrained to rare hydrothermal reservoirs, typically found along the Pacific Ring of Fire and rift zones where tectonic activity brings hot water or steam close enough to the surface to tap economically.

This geographic lottery has relegated geothermal to niche status in most energy planning. If you're not sitting on a hydrothermal reservoir, conventional wisdom says geothermal power isn't an option. Better to build solar and wind instead, add batteries to handle intermittency. But this approach ignores geothermal's rare combination of attributes that no other renewable energy source can match.

Geothermal power is firm, meaning it de-

GETTY IMAGES

livers consistent output on demand. It operates 24/7, unaffected by clouds, darkness, calm air or seasons. There is no need for a nuclear non-proliferation treaty to try to rein in military uses of the technology. It's zero-carbon once built. It has extraordinarily low land-use intensity – a geothermal plant occupies a fraction of the land required for equivalent solar or wind capacity. Thanks to low downtime, capacity factors typically exceed 90 percent, compared to 25 to 30 percent for solar and 35 percent for wind. This turns geothermal into a backup power source for renewables, or simply baseload power to begin with.

The system-level implications are profound. Clean grids of the future with substantial geothermal capacity will need far less renewables overbuild or battery storage than ones without any clean, firm power. Right now, geothermal means less backup gas or – god forbid – coal. A simple levelized-cost comparison that treats all kilowatt-hours as equivalent regardless of when they're delivered, is thus unlikely to show the full system-level benefits of power that requires no storage or backup and little land to boot.

The real excitement lies in next-generation geothermal technologies that could break free from geographic constraints entirely. Enhanced geothermal systems, closed-loop systems, and superhot rock drilling could expand geothermal power to most regions globally and unlock hundreds of gigawatts of potential capacity. The heat content in the upper 10 kilometers of Earth's crust contains roughly 50,000 times more energy than all the world's oil and gas resources combined. We're not talking about eking out a few percentage points of our energy mix. We're talking about a resource base that could, in principle, power human civilization for millennia.

Enhanced geothermal systems work by creating reservoirs in hot rock that lacks natural permeability. Drill down to the rock, fracture it hydraulically, inject water into one well, collect steam or hot water from another. The technology mirrors hydraulic fracturing techniques developed for shale gas – controversial in that context for good reason, but applied here to create a zero-carbon energy source. Closed-loop systems go further, circulating fluid through a sealed wellbore that extracts heat through conduction alone, eliminating any interaction with groundwater or need for permeable geology. Superhot rock drilling targets temperatures above 374°C where water becomes supercritical, dramatically increasing energy output per well.

These aren't fantasies. Multiple companies are drilling, testing and demonstrating these technologies right now. Fervo Energy has operated enhanced geothermal systems in Nevada. Eavor has built closed-loop systems in Canada and Germany. The learning curves that drove down costs in solar and wind can and should apply to geothermal. Early projects are expensive; later ones cost a fraction. The big question is whether – when – we'll fund enough early projects to move far enough down that cost curve for geothermal to take off.

THE BARRIERS THAT BIND

The barriers to scaling geothermal are real, interconnected, but solvable with sufficient policy attention and capital.

Exploration risk dominates. Tens of millions of dollars need to get spent upfront before confirming a viable resource. Failed wells can exceed $10 million per site, and early-stage projects might drill multiple failed wells before finding success or giving up. This adds up to an unattractive risk profile for investors – huge upfront capital requirements with binary outcomes and years before any revenue.

Oil and gas exploration faces similar risks, but those industries have mature financing mechanisms, government support and decades of risk pooling to spread exposure. Geothermal has none of this institutional infrastructure.

Drilling costs make up 35-40 percent of total project capital expenditure and represent the largest source of levelized cost variability. A well projected to cost $5 million instead of $8 million can mean the difference between a project that attracts financing and one that dies in the planning stage. Incremental improvements in drilling speed, reliability and cost effectiveness compound rapidly over the life of an industry. Yet geothermal drilling gets a tiny fraction of the innovation funding that upstream oil and gas commands, despite the technologies being largely transferable.

Players on the frontier of drilling technology are showing what's possible. Quaise's millimeter-wave technology vaporizes rock without mechanical contact, potentially reaching superhot depths much faster than conventional methods. GA Drilling's plasma-based drilling system cuts through hard rock faster than conventional rotary drilling. HyperSciences uses projectiles accelerated to hypersonic speeds to pulverize rock. These approaches sound exotic, but they're reaching pilot and field-testing stages, demonstrating real potential to slash drilling costs and enable geothermal access in more problematic geology.

Geographic dependence remains a con-

Iceland's Blue Lagoon geothermal spa with the Svartsengi geothermal power plant seen behind it.

GREG BALFOUR EVANS/ALAMY

straint for conventional hydrothermal resources, though next-generation technologies are loosening this straitjacket. Still, the best near-term opportunities cluster in regions with favorable geology, and those regions aren't always close to demand centers. Long-distance electricity transmission adds cost and complexity, though geothermal's firm output makes it more valuable for transmission investment than intermittent sources that might not deliver during peak demand.

Financing challenges extend beyond exploration risk. Geothermal projects have long lead times – five to 10 years from initial exploration to commercial operation. Developers need patient capital willing to wait years for returns. Traditional project finance requires proven resources and stable revenues before committing, creating a classic chicken-and-egg problem. Government-backed insurance schemes, modeled on those used for nuclear power and large infrastructure projects, could mitigate exploration risk and unlock private capital. Blended finance structures mixing concessional public funding with commercial investment could bridge the gap until track records accumulate. These mechanisms exist in other sectors; geothermal needs them, too.

Workforce bottlenecks slow deployment even where resources exist and financing is available. The skilled workforce for geothermal drilling overlaps with oil and gas: drilling engineers, geologists, rig operators, completion specialists. As the energy transition accelerates, these workers face an uncertain future in fossil fuel extraction. Geothermal offers a natural landing spot, but workforce

High-pressure steam being moved from boreholes to Krafla geothermal power plant in Iceland.

development requires coordination between industry, government and educational institutions. Drilling schools need to train for geothermal applications. Certification programs must recognize geothermal-specific skills. Veterans of oil and gas need pathways to transition their expertise toward heat extraction.

Permitting, for its part, represents a Kafkaesque maze that varies wildly by jurisdiction. In the United States, a geothermal project might require permits from federal, state and local agencies covering environmental review, water rights, land use, drilling operations and more. Timeline uncertainty kills projects – developers can't commit capital without knowing when they might begin drilling. Streamlined permitting that reflects geothermal's low environmental footprint would accelerate deployment, but reform requires political will and bureaucratic cooperation that's often absent.

THE OIL AND GAS INDUSTRY TO THE RESCUE?

Here's where things get interesting and a bit uncomfortable. The industry with the deepest expertise in subsurface drilling, reservoir engineering and resource extraction as well as a decades-long record of effectively lobbying for what it needs is precisely the one that clean-energy fiends are trying to phase out – and for good reasons. Oil and gas companies possess the technical capability, workforce, equipment and financial resources to scale geothermal rapidly. They also face a future in which their core business becomes increasingly untenable as carbon constraints tighten.

This ought to be a win-win. The BPs, Chevrons, ExxonMobils, Shells and Totals of the world have geothermal capacity that dwarfs most pure-play geothermal developers. They understand drilling in ways that startups

PHIL DEGGINGER/ALAMY

don't, and won't for decades. Their supply chains, logistics networks and operational expertise transfer directly to geothermal applications. Their workforces need jobs in a decarbonizing economy.

The potential synergies are enormous. Oil and gas companies could repurpose offshore platforms for geothermal development, use depleted oil fields as geothermal reservoirs, co-produce geothermal electricity from active oil fields, and redeploy drilling rigs toward heat extraction. Italy and Indonesia are already seeing this happening, with oil and gas companies diversifying into geothermal using their existing capabilities. China's state-owned oil giants lead the country's geothermal heating and power expansion, applying their drilling expertise and capital access to a new application.

This isn't about giving oil and gas companies a pass on climate damage or pretending they're climate heroes. It's about recognizing that a just transition requires creating pathways for workers and capital currently tied up in fossil fuels. Geothermal offers precisely such a pathway – similar technical requirements, comparable risk profiles, directly transferable skills. The alternative is layoffs, stranded assets and fierce political resistance to climate action from workers and communities facing economic stagnation or worse.

Policy should embrace this transition explicitly with tax credits for oil and gas companies investing in geothermal, support for retraining, regulatory changes that ease the transition of drilling permits from oil to heat, and labor agreements that protect union jobs in the shift from extraction to clean energy. This isn't complicated. It requires acknowledging that the same people who drilled for oil can drill for heat, and it's in everyone's interest to help them do so.

BEYOND THE BINARY: GEOTHERMAL AS THERMAL INFRASTRUCTURE

The conventional framing treats heating and cooling on the one hand and electric power on the other as separate energy silos requiring separate solutions. This binary is correct at one level, but limiting. They're all thermal services, and they're more interconnected than most energy planning acknowledges. A geothermal resource can provide direct heating, drive heat pumps for cooling, generate electricity or do all three simultaneously depending on temperature, depth and end-use requirements.

This integrated view clarifies geothermal's potential as foundational thermal infrastructure rather than niche power generation. Consider a geothermal system serving a city district. The hottest fluid drives a power plant generating electricity. Waste heat from power generation feeds a district-heating network. In summer, the same wells provide cooling via absorption chillers. A single resource serves multiple end uses, maximizing efficiency and economics.

Industrial applications extend this logic further. Many industrial processes require direct heat rather than electricity – think food processing, chemical manufacturing, mineral processing, desalination. Geothermal can provide this heat more efficiently than generating electricity and converting it back to heat. Co-location of geothermal resources with industrial facilities reduces transmission losses and creates resilient local energy systems. Co-production of heat and power creates other synergies and lowers costs.

The rise of AI and data centers creates its own unique opportunities. Geothermal systems can provide both the electricity to run servers continuously and the cooling to remove heat, creating a closed-loop thermal management system. Several hyperscale data

center operators are already exploring geothermal partnerships.

Then there are some unexpected complementarities. Geothermal and nuclear are typically seen as competing for attention by those in search of clean, firm, baseload power. Both face high upfront costs and long development timelines. But there may be roles for both together. A clean energy system could integrate large nuclear plants for major load centers with distributed geothermal serving smaller cities, industrial facilities and district heating networks.

Critical minerals represent another unexpected opportunity. Geothermal brines often contain lithium, zinc, manganese and other minerals that can be extracted during power generation. This co-production can improve project economics and provides domestic sources of materials essential for batteries, electronics and clean energy technologies. The Salton Sea in California contains one of the world's largest lithium deposits, accessible through geothermal operations. Extracting lithium from brine generates far less environmental disruption than hard rock mining, offering a pathway to secure mineral supply chains while producing zero-carbon power.

THE POLICY VACUUM

None of this will happen automatically. Carbon pricing that made fossil fuels pay their full social cost would help geothermal compete on operating cost, though they would do nothing to address the exploration risk and upfront capital barriers. Direct subsidies, production tax credits and investment tax credits could work if scaled appropriately – the United States now offers tax credits for geothermal that are too small to move the needle for most projects. And there is a long list of other, more direct policy interventions.

Exploration risk insurance deserves particular attention. A government-backed insurance program that covers some portion of dry hole costs would unlock private capital almost immediately. Iceland's model is instructive: the government assumes exploration risk, developers repay from successful projects and the program becomes self-sustaining as success rates improve and knowledge accumulates. The European Union has since set out to duplicate the model elsewhere across the continent. The United States should look to Europe to implement something similar at national scale.

Streamlined permitting is unglamorous but essential. Geothermal projects shouldn't face more regulatory burden than fossil fuel extraction when their environmental footprint is dramatically lower. Time limits on permit decisions, consolidated permitting authority and clear standards would provide the certainty that developers need to commit capital.

Research funding remains wildly disproportionate to potential impact. The Department of Energy's geothermal budget is roughly $100 million annually – less than 2 percent of its renewable energy spending despite geothermal's potential to provide firm capacity at scale. Targeted research into drilling technology, enhanced geothermal systems and supercritical fluids could accelerate commercialization and drive down costs. The returns on such research compound over decades as the technology improves and deploys globally.

Renewable portfolio standards could explicitly include geothermal and reward firm capacity more highly than intermittent generation sources. A kilowatt-hour delivered during the evening demand peak in January is more valuable than one delivered at noon in

Geothermal energy used to heat a greenhouse.

RAUL MORENO/SOPA IMAGES/SIPA USA VIA AP

August, but most renewable energy mandates treat them identically. Capacity markets, firm power requirements or other mechanisms that value reliability would shift investment toward geothermal and other dispatchable resources.

Workforce development requires coordination that market forces alone won't provide. Community colleges near oil and gas regions could offer geothermal drilling programs. Labor unions could negotiate transition agreements that protect workers moving from fossil fuel extraction to geothermal. Federal job training programs could target displaced oil and gas workers for retraining. The skills are largely transferable; the barrier is organizational, not technical.

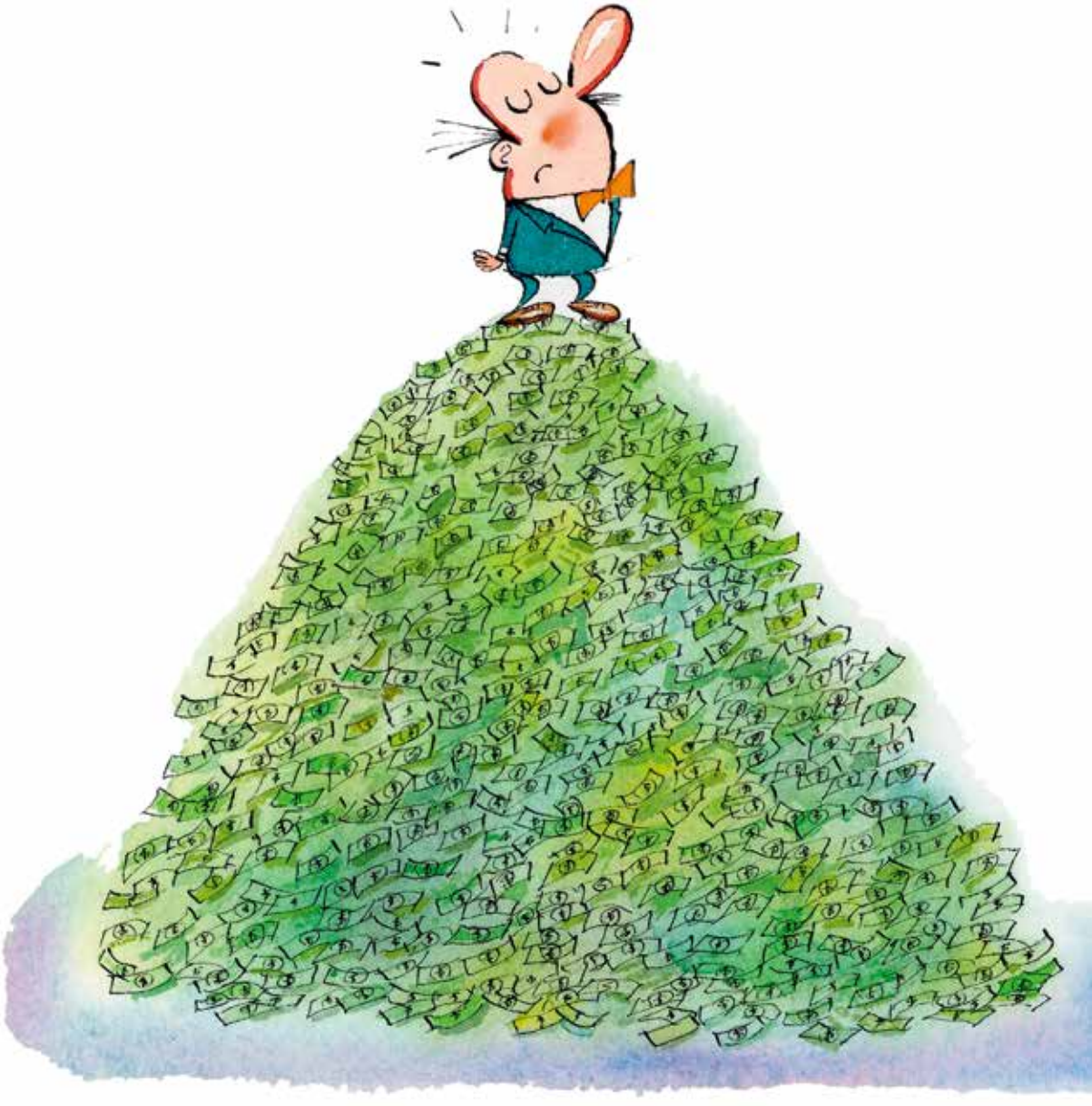
A FRAMING SHIFT

The real opportunity isn't just adding geothermal capacity to our energy mix. It's recognizing geothermal as foundational infrastructure that complements rather than competes with other clean energy sources. Solar power is still king; solar and wind plus batteries may do the lion's share of decarbonization, while geothermal provides the firm foundation – the baseload power, the district heating and the industrial heat.

There is no one-size-fits-all energy source that does it all everywhere. But geothermal can move well beyond its current Icelandic and Kenyan bases and shift from geological lottery to universal resource, from marginal player to foundational component.

The geothermal opportunity is simple: use the heat beneath our feet instead of burning things dug up from ancient rocks. The barrier isn't technical or economic in any fundamental sense. It's institutional, political and cognitive. We lack the financing mechanisms, policy frameworks and mental models to deploy geothermal at scale. These are all fixable problems, and they are definitely worth wanting to fix to get nearly unlimited, 24/7 power and heat regardless of weather, season or geopolitics. The question is whether we're clever enough to use it.

Is Taxing Wealth Possible?



Practical? Desirable?

Yes, if we're smart about it

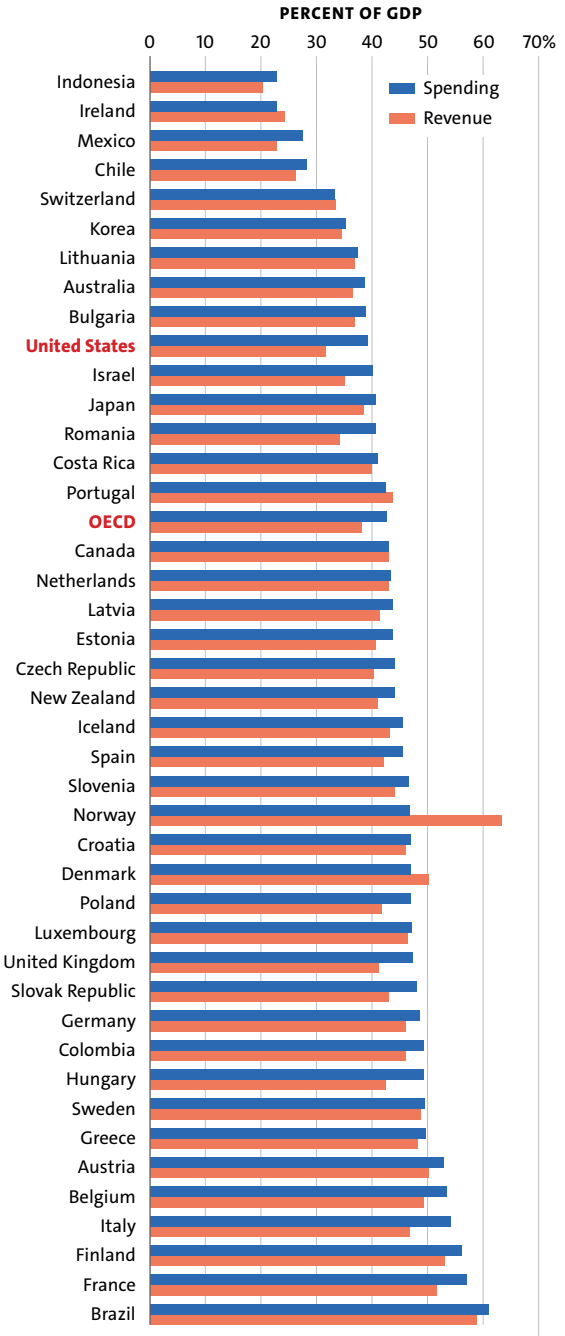
BY DAVID S. MITCHELL

ILLUSTRATIONS BY HAL MAYBORTH

While the American economy has outperformed much of the industrialized world in recent years, there are good reasons to be deeply concerned about its long-term prospects. It is dogged by high debt, high inequality and (by historical standards) slow growth – related problems that vex policymakers and economists alike. One fix, which promises to address all three simultaneously, is gaining political traction: a wealth tax on the super-rich. ¶ Is this merely a Hail Mary pass, a reflection of frustrations that have been building across the new millennium that is no more than a diversion in our bitterly divided political arena? Or is it our last, best chance to ensure the U.S. tax system is effective, efficient and fair? As debates about wealth taxes heat up – notably in bellwether California, where such a tax measure may be placed before voters in November – how can citizens separate fact from fiction? ¶ I argue that, despite the preponderance of rhetoric to the contrary, taxing wealth is consistent with

THE U.S. IS A RELATIVELY LOW-TAX AND LOW-SPEND COUNTRY

REVENUE AND SPENDING IN DEVELOPED COUNTRIES



SOURCE: OECD (2025), Government at a Glance 2025, OECD Publishing, Paris, https://doi.org/10.1787/0efd0bcd-en

the U.S. tradition of progressive taxation – and, in fact, is needed to patch an increasingly porous income tax system. Targeting taxes on the super-rich's fast-growing accumulation of wealth, which today is largely in the form of unrealized capital gains, could go a long way toward improving the nation's fiscal position, tempering inequality, spurring more broad-based economic growth and helping to offset the drift toward government by and for the rich.

DEBT AS FAR AS THE EYE CAN SEE

The federal government's annual deficit is roughly 6 percent of gross domestic product, and the national debt is nearly 100 percent of GDP – both near historic highs even though we currently face no major war, recession or pandemic. With interest rates climbing in recent years, interest payments on the debt are now cannibalizing a record one-sixth of the federal budget.

Though a fiscal crisis does not seem imminent – the dollar's unique role in the global economy provides a lot of insulation – the risk of such a crisis is nevertheless increasing as there is no sign of the deficit trend reversing. Indeed, even if the Trump tariffs are allowed to stand by the courts, that roughly $175-billion tax increase on consumers would barely dent the $1.8-trillion budget deficit.

Conservatives argue that huge deficits even when the economy is operating near full throttle constitute a spending problem, not a revenue shortfall. While every analyst, conservative or liberal, has favorite targets for stricter spending discipline, the "spending problem" rhetoric belies hard, cold facts.

Government accounts for relatively little spending as a percentage of GDP by compar-

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ison to other affluent nations – and notably less than should be spent in scientific research, education and infrastructure if the U.S. is to remain a global leader and sustain productivity growth along with the economic capacity to deliver quality-of-life improvements.

This is why attempts at severely curtailing federal services – such as Elon Musk's predictably disastrous Department of Government Efficiency – inevitably bump against the reality that the U.S. government is already relatively lean. In fact, an underreported fiscal fact is that the reforms in the Affordable Care Act did help to "bend" the health care cost "curve" down (remember that crisis of the early 2000s?), saving the government trillions of dollars.

SLOW AND UNEQUAL GROWTH

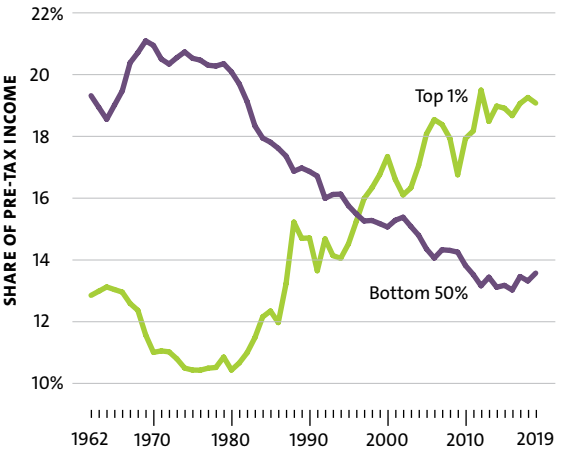
Optimists hold out hope that the U.S. can grow out of chronic budget deficits. While it's true that faster economic growth could improve the fiscal outlook by shrinking the debt-to-GDP ratio, both generating more tax revenue without higher tax rates and reducing the demand for safety-net services like unemployment insurance and food stamps, there is little reason to believe that – even with an AI-fueled productivity boom – the U.S. is poised to consistently grow at the 3-plus-percent rate required to begin to close the budget gap, especially if immigration continues to fall.

The societal picture gets gloomier when one also considers the unequal nature of recent economic growth. While the most recent data suggest a possible plateauing of inequality, the general trend toward winner-take-all in recent decades has been unmistakable.

Inequality is not just a moral stain on the country that threatens political stability, it contributes to our precarious economic position. Some research suggests that economies with high levels of inequality can't grow rapidly. As Heather Boushey, a member of the Biden Council of Economic Advisors, has argued, this is likely a result of the way inequality obstructs opportunity by lowering investment in human capital and beefing up unproductive rent-seeking as the rich seek to cement their privileges.

Similarly, Thomas Piketty has noted that with returns to capital growing faster than those to labor, value extraction is rewarded over value creation, undermining incentives for work and innovation. It's no coincidence that the S&P 500 has grown 400 percent in real terms over the past 20 years, while real wages grew by 12 percent. It seems likely that the continued development of artificial intelligence, which may well increase economy-wide productivity, will only exacerbate this capital-labor divide.

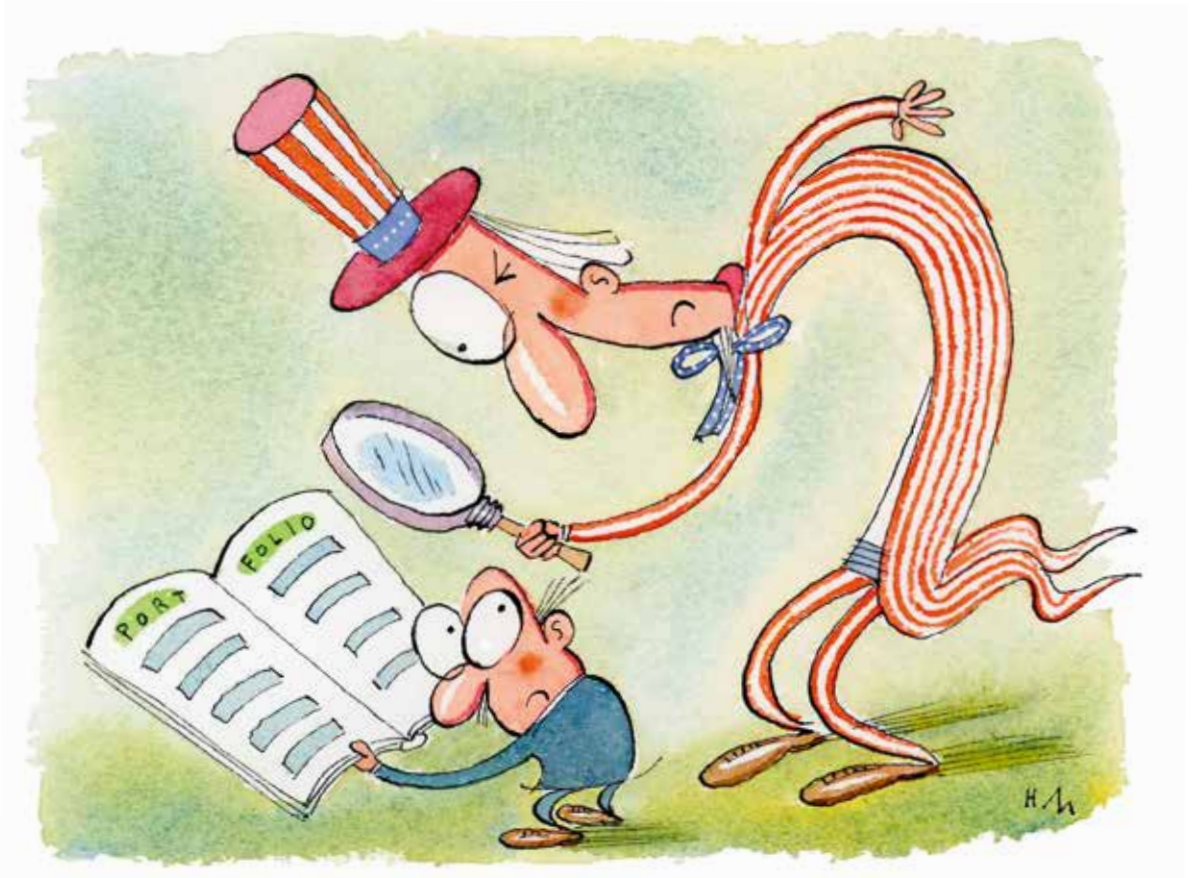
INCOME SHARE TREND FOR TOP 1% DIVERGES FROM MOST AMERICANS AFTER 1980



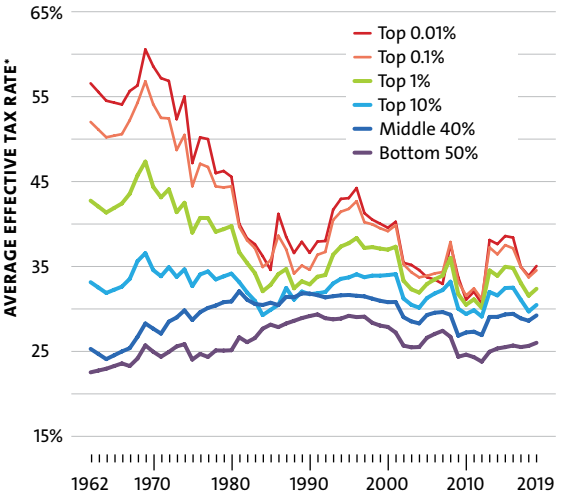
SOURCE: Thomas Piketty, Emmanuel Saez and Gabriel Zucman, "Distributional National Accounts: Methods and Estimates for the United States." Distributional series, Table B1 (February 2022)

TAXES AS BOTH CAUSE AND EFFECT

The rise of inequality over the past few decades also helps explain some of the hollowing out



TAXES HAVE BECOME LESS PROGRESSIVE OVER TIME IN THE UNITED STATES



*Average effective tax rate as percentage of all pre-tax income, including taxes from all levels of government

SOURCE: Thomas Piketty, Emmanuel Saez and Gabriel Zucman, "Distributional National Accounts Methods and Estimates for the United States." Distributional series, Table G1 (February 2022)

of the tax system. As more income is earned by those at the top – often capital income earned through highly complex business structures – taxes became more easily gamed and less progressive.

Some of this is the consequence of the tax code not keeping up with the times. For example, the cap on Social Security payroll taxes excluded just 10 percent of top wages in 1977. But because of faster salary growth at the top in recent decades, the cap now misses 17 percent of the highest salaries, costing the Social Security Trust Fund trillions of dollars.

Or consider capital gains, which are taxed at a favored rate. Because of the explosive growth in the stock market (and the corporate trend toward retaining earnings rather than paying dividends), these capital gains have become a much more important stream of income for the richest Americans. Realized capital gains – that is income realized when as-

sets are sold – are notoriously volatile since they depend in large part on stock market performance. But they have nonetheless been inexorably climbing as a portion of income from an average of 2.58 percent of GDP between 1963 and 1983 to 4.35 percent over the past 20 years.

Some of the changing nature of the tax system was the result of proactive policy choices by a political class that was captured by claims from investors that, in spite of mountains of evidence to the contrary, lower taxes increase broad-based growth.

The apotheosis of this approach came last year, when Republicans in Congress passed a deeply regressive measure that will cut revenues by $5 trillion and add $3.4 trillion to the national debt over the next decade. One trillion dollars of that will go just to the top 1 percent of earners (who in 2027 will make more than $526,000). But this was certainly not the first time in recent memory that tax cuts favored the rich.

Regressive tax cuts also passed in 2001, 2003 and 2017, which retrospective analysis shows are the main cause of the current debt trajectory. This analysis prompted Senator Elizabeth Warren to dub the nation's fiscal affairs a "tax doom loop."

THE NEW ROBBER BARONS

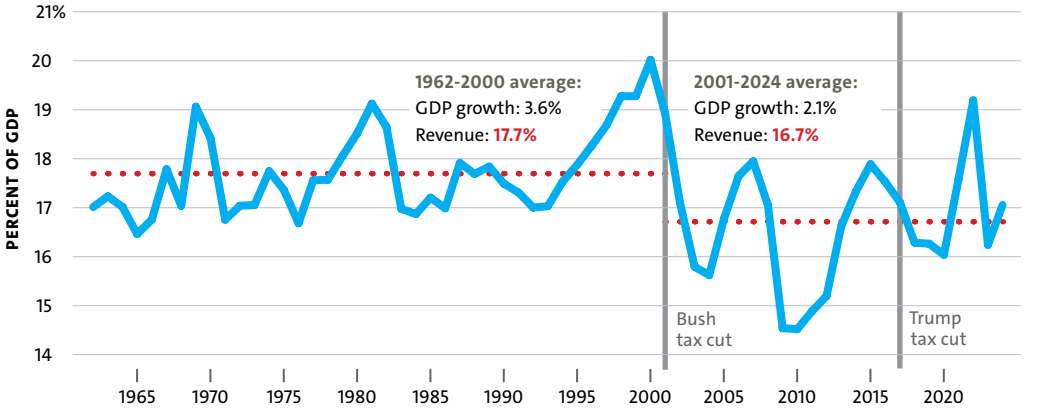
Not only did the tax cuts blow a hole in the budget and fail to lead to faster growth, they also empowered a new upper crust.

Today, the top 0.1 percent – the richest 136,000 U.S. households with an average net worth of more than $46 million – own roughly one-seventh of the nation's wealth. About 1,000 of these Americans are billionaires, who as of January 2026 collectively owned $8.2 trillion in wealth, up from $6.7 trillion just a year prior largely thanks to the soaring stock market.

Today's billionaire class stands out even when compared to the richest people from the first Gilded Age. John D. Rockefeller was worth roughly $900 million in 1913 (or $30 billion in today's dollars), equivalent to 2.3 percent of GDP. That made him the richest American of all time. Until now: Elon Musk's

RECENT TAX CUTS HAVE REDUCED REVENUE

FEDERAL TAX REVENUES AS PERCENT OF GDP



SOURCE: Congressional Budget Office, Supplemental Data Table 1a and author's calculations from "The Budget and Economic Outlook: 2025 to 2035" (January 2025)

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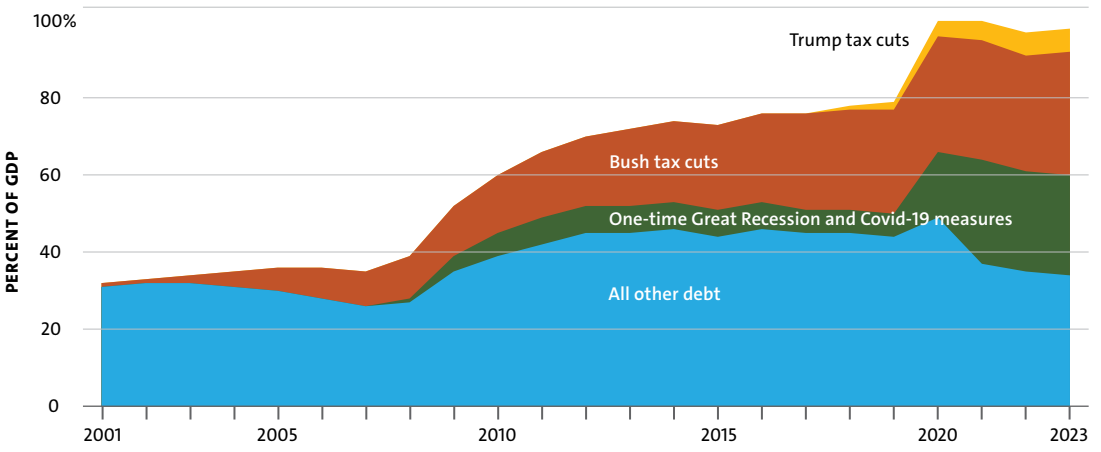
TAX CUTS ARE PRIMARILY RESPONSIBLE FOR GROWING U.S. DEBT

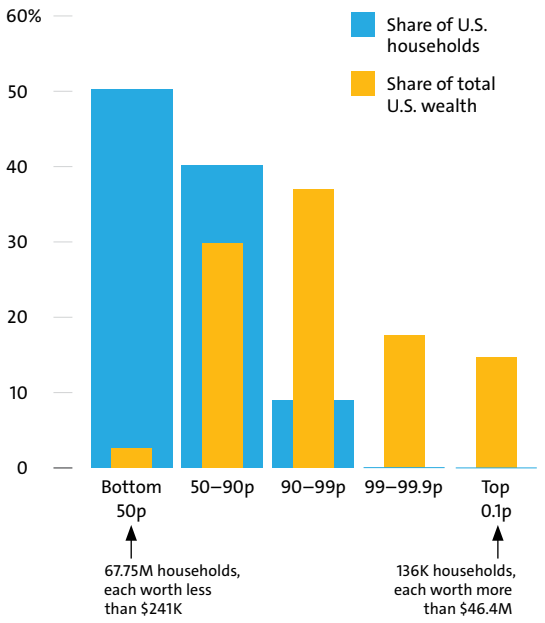
POLICIES CONTRIBUTING TO DEBT HELD BY THE PUBLIC AS A PERCENTAGE OF GROSS DOMESTIC PRODUCT



SOURCE: B. Kogan, "Tax Cuts Are Primarily Responsible for the Increasing Debt Ratio," Center for American Progress (March 2023)

THE WEALTHIEST 0.1% OF HOUSEHOLDS OWN ONE-IN-SEVEN DOLLARS

SHARE OF TOTAL HOUSEHOLDS AND TOTAL WEALTH BY WEALTH PERCENTILE GROUP



SOURCE: Thomas Federal Reserve Board, "Distributional Financial Accounts: Net Worth Shares & Net Worth Levels," Q3 2025

fortune today (around $800 billion) is roughly 2.8 percent of GDP.

TAXING WEALTH

It's not just the size and growth of these fortunes that are unique, but also how the wealth is treated by the tax system. While most Americans pay tax as they earn their income (with money automatically deducted from paychecks), the extremely wealthy largely choose when (or even if) they pay income tax. That's because a considerable portion of their income is in the form of appreciation of real estate, stocks and other financial assets, and those gains are not taxed until the asset is sold (or "realized," in tax parlance). Even when they are taxed, long-term capital gains as well as dividends paid to asset owners enjoy a lower tax rate than that paid on labor income. For those at the top, the difference is between 23.8 percent on gains and 40.8 percent on income.

When this policy of indefinite deferral is combined with what's known as "stepped-up basis," a tax rule that wipes away tax liability on unrealized gains at death, the result is that

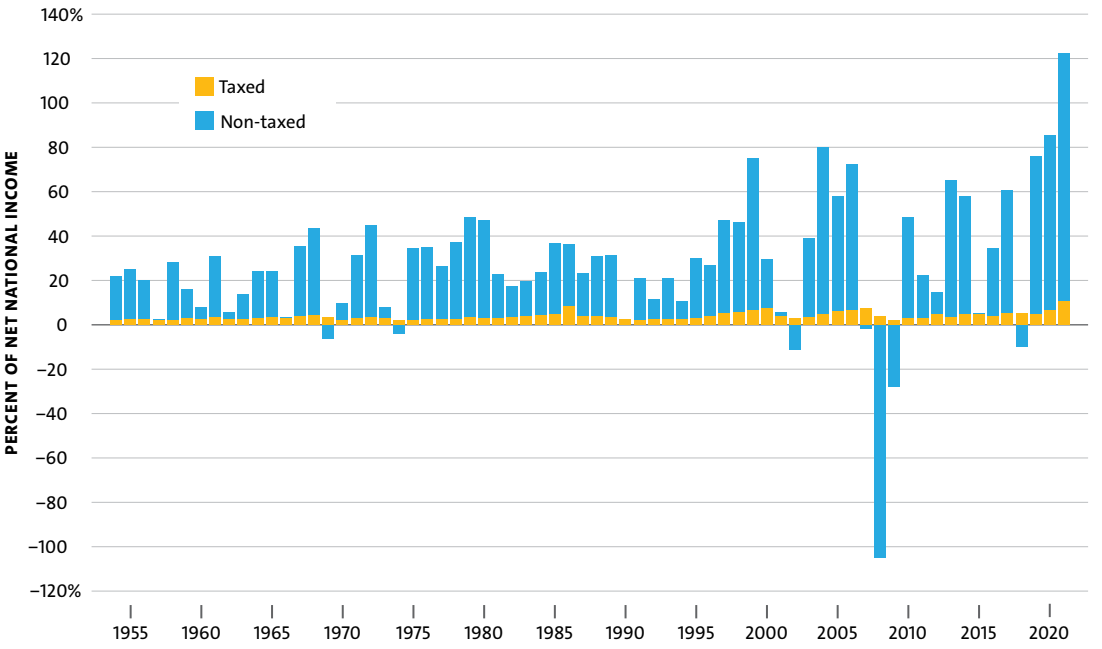
many of the richest Americans will never pay any tax on much of their wealth. When the wealthy find it inconvenient to wait for death to turn their unrealized gains into cash, they can still save on taxes by borrowing using their assets as collateral – a strategy dubbed "buy-borrow-die."

Though stepped-up basis sounds like a technical issue, it stands at the center of the roiling debate around wealth taxes. That's because unrealized gains make up a large chunk of the total net worth of all Americans today – it was estimated at 27 percent in 2019 and is probably much higher today since the S&P 500 has more than doubled since then. For those in the top 1 percent of wealth holders, the figure was 41 percent. Moreover, roughly half of the unrealized gains held by those in the top 1 percent are concentrated in the top 0.1 percent – and these holdings have been increasing rapidly. As a result, this group pays tax on roughly half of their actual "economic" income (i.e., the increase in their net worth) each year.

Some of this wealth will be taxed eventually – but not much. According to a conservative estimate by the Brookings Institution, of the $36 trillion in unrealized gains held in 2021, $11 trillion are held by those in the top 1 percent who are also over the age of 54, implying that most of this wealth will be bequeathed on a stepped up basis. In generations past, the estate tax would have captured some of these unrealized gains before they were transferred to heirs. But the estate tax has been weakened by Congress and is now easily

TAXED CAPITAL GAINS ARE MOST OFTEN A TINY FRACTION OF NON-TAXED CAPITAL GAINS

ANNUAL CAPITAL GAINS AS A PERCENT OF NET NATIONAL INCOME*



*Net national income is national income minus depreciation. Capital gains are in nominal terms.

SOURCE: C. Campbell, J. A. Robbins and S. Wylde, "The Distribution of Capital Gains in the United States" Working Paper, Washington Center for Equitable Growth (February 2025)

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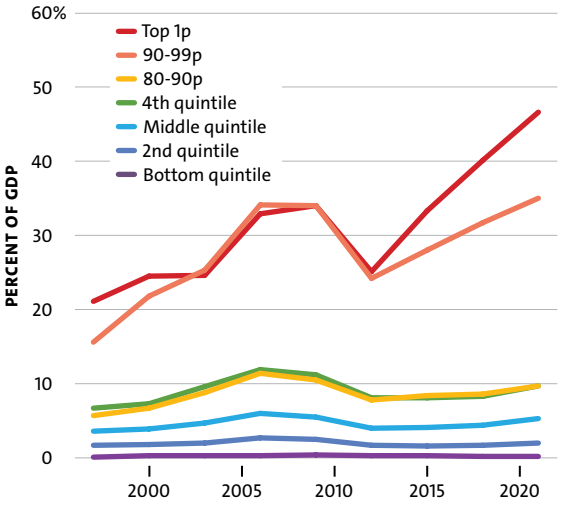
UNREALIZED GAINS HAVE GROWN SUBSTANTIALLY FOR RICHER, OLDER AMERICANS

UNREALIZED GAINS AS A PERCENT OF GROSS DOMESTIC PRODUCT FOR THOSE AGE 55 AND OLDER, BY WEALTH PERCENTILE



SOURCE: William G. Gale, Oliver Hall and John Sabelhaus, "A Preliminary Report on Taxing the Great Wealth Transfer," Table 4-Panel B, Brookings Institution (2024)

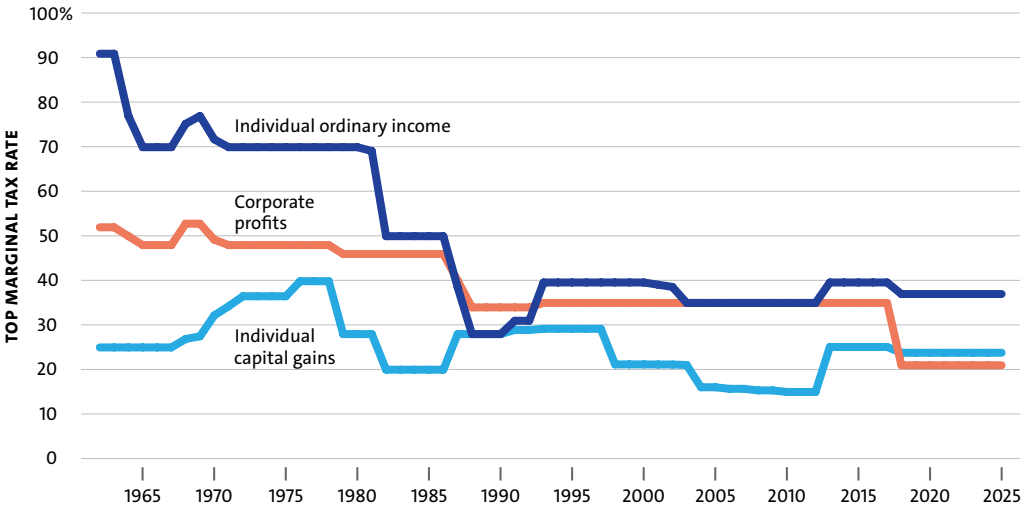
avoided by creating a spiderweb of trusts, among other (legal) tactics.

It was also historically the case that business taxes would have indirectly captured more of the income accruing to the richest Americans. Most economists believe that the burden of the profits tax on standard, limited liability C corporations is largely borne by stockholders. But the top corporate tax rate has been continuously cut and today is just 21 percent. After all the corporate deductions are taken into account, the effective tax rate on corporate profits is considerably lower.

In any event, many rich Americans organize their business holdings in what are called pass-through entities, meaning these firms' profits are reported directly on their owners' personal income tax forms. This introduces a host of tax avoidance opportunities outside the scope of this article. But no one disputes that much of the income generated by these

TOP TAX RATES HAVE BEEN CUT DRAMATICALLY

TOP MARGINAL TAX RATE BY TYPE OF INCOME



SOURCE: Tax Policy Center, "Historical Highest Marginal Income Tax Rates," https://taxpolicycenter.org/statistics/historical-highest-marginal-income-tax-rates; Tax Policy Center, "Corporate Top Tax Rate and Bracket," https://taxpolicycenter.org/statistics/corporate-top-tax-rate-and-bracket; Tax Foundation, "Historical US Federal Capital Gains Tax Rates & Collections, 1913-2025"

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closely held companies does not show up on tax returns. (It also allows the richest Americans to take political cover as "small business owners," since most bona fide small businesses also organize themselves in this way.)

When all income, including unrealized gains and business profits, and all the tax cuts and tax avoidance schemes mentioned above are taken together (but not factoring in outright tax evasion), the overall picture at the top end of the wealth spectrum is much less progressive than is generally assumed. Indeed, there is strong (albeit disputed) evidence that the U.S. tax system turns regressive at the extreme top, with the richest 400 families paying less (24 percent) than average middle-class families (30 percent). This result has been corroborated by other researchers who estimate a 25.5 percent tax rate for the top 0.01 percent of earners.

WHAT CAN BE DONE?

Early in the 20th century, the country faced a similar combined threat from a growing need for public investment and sky-high inequality. In that case, the advent of the personal income tax ushered in decades of strong tax revenues, equitable economic growth, and a relatively stable political order in which Americans could be confident that the rich were paying their fair share of taxes.

Today, policymakers need to similarly rethink the tax system to address the threats we face from low revenue, high inequality, uneven growth and social unrest expressed as right-wing populism. While any plausible tax on billionaires' unrealized gains would not be enough to eliminate the debt and inequality chasms, part of any reform aimed at rebalancing tax burdens and reestablishing trust in the system must target tax preferences (aka loopholes) that in substantial part explain the accumulation of wealth in so few hands.

There are a number of novel – and practical – ways to do this discussed below, but any initiative that fails to tax unrealized gains should be dismissed as a nonstarter in the debate. Even serious conservative commentators recognize this. For example, the center-right Arnold Ventures philanthropy group included an excise tax on borrowing against unrealized gains in their tax reform prescription last year. And Republican former-Senator Mitt Romney has come out in favor of closing the stepped-up basis loophole. For that matter, even Donald Trump once proposed a large, one-time wealth tax on the rich.

In my view, opponents of any of the approaches below, which are admittedly imperfect, should be required to offer up their preferred alternative, given the untenable status quo.

Another way to tax wealth is to tax the annual (realized and unrealized) proceeds from that wealth – sometimes referred to as a "mark-to-market," "accrual," "billionaire" or "billionaires income" tax.

A Net Worth Tax

The most straightforward way to tax wealth is a wealth (or "net-worth") tax. As with all taxes, the two key design considerations are how to calculate what is taxed (the tax "base") and what percentage of that base will satisfy the revenue target (the tax rate). Most states already have a wealth tax in the form of property taxes. But while those target residential and commercial land and buildings, most current wealth tax proposals would exempt primary residence and retirement accounts – the two main sources of middle-class wealth.

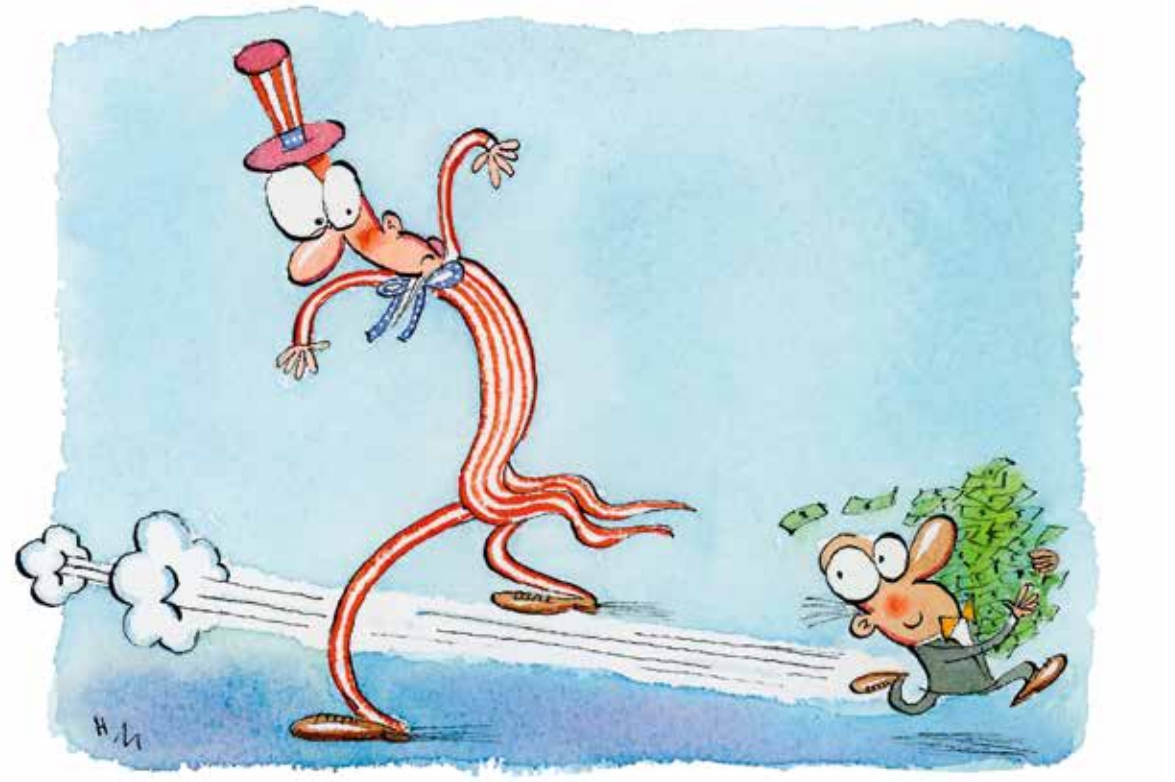
Instead, most wealth tax proposals focus on the key sources of wealth for the superrich, namely stock holdings in public and private businesses. One challenge is valuing certain assets that have not historically been reported to the IRS or for which there is no liquid market to determine price (e.g., artwork and closely held businesses). Exempting too many of these categories could create a perverse incentive for taxpayers to overinvest in these now tax-preferred asset classes.

The most compelling justification for a wealth tax is that it could quickly raise a lot of revenue from the richest of the rich. Even a one-time wealth tax at the state level, such as the one that might get on the ballot in California later this year, would raise upwards of $100 billion. A federal wealth tax of 1 percent on fortunes above $50 million and 2 percent on net worth above $100 million – somewhat similar in design to those proposed by Senators Bernie Sanders and Elizabeth Warren – would raise roughly $3 trillion over 10 years, though projections heavily depend on assumptions about breadth of the tax base, compliance and enforcement.

One particular challenge with state-level wealth taxes is that they could lead their rich targets to move to lower-tax states. But evidence on the "fleeing millionaire" phenomenon is actually fairly weak. Though a few big names may leave a state upon the imposition of a wealth tax, there are ways to design effective exit taxes, the net revenue will still be positive and there could even be some positive spillovers from losing residents who are most responsible for bidding up prices in local real estate markets. That said, the race-to-the-bottom, jurisdiction-shopping problem is a reason a federal wealth tax would be superior to a state one.

The larger problem with wealth taxes has been the questionable ability of jurisdictions to efficiently enforce a tax that the wealthy would surely try to game – for example, by moving assets offshore or undervaluing privately held businesses. But some European countries, such as Spain and Switzerland, have overcome these challenges, designing effective and durable wealth taxes.

In terms of real economic behavior – rather than just tax-motivated accounting – there is little reason to think the rich wouldn't still invest the vast bulk of their fortunes as productively as they know how (you can only consume so much). In fact, a tax could lead to



greater efficiency rather than less. The rich would no longer face the perverse incentive to hold assets until death, eliminating what economists call the "lock-in effect."

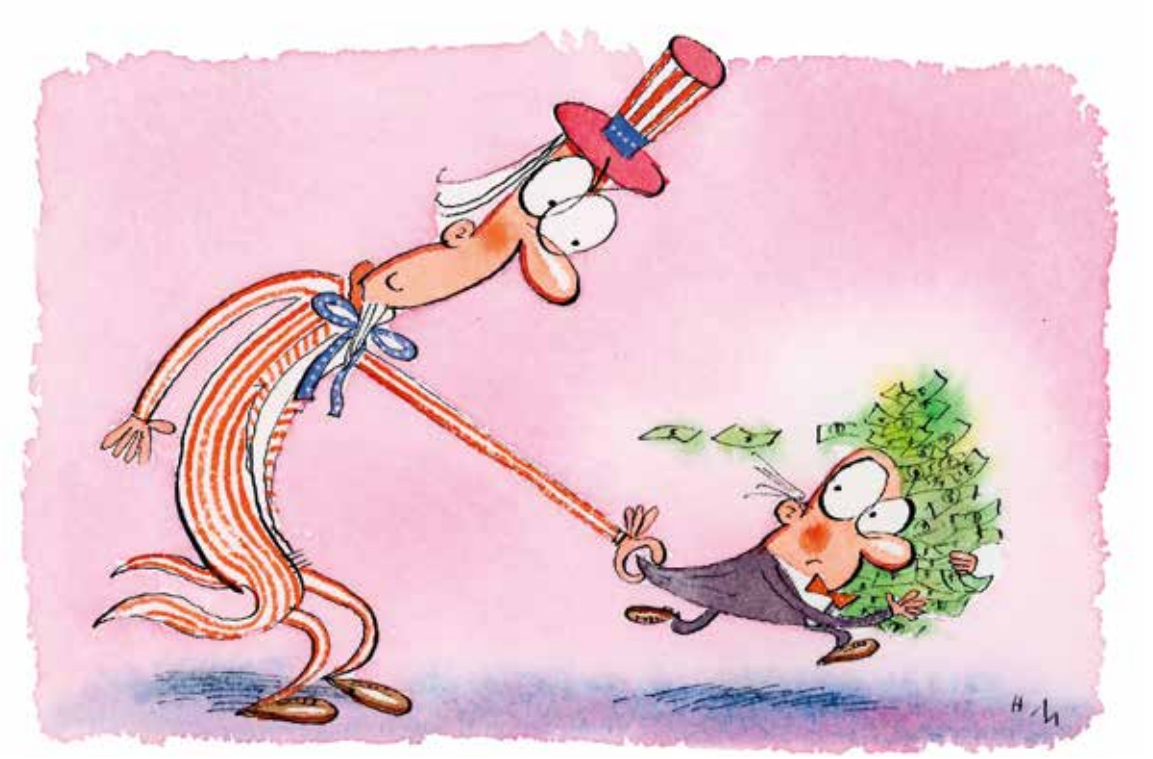
At the federal level, the problem is less economical and more political in nature: the Supreme Court, in its current composition, seems likely to impose an imaginary realization restriction on Congress's taxing power in order to block the implementation of a wealth tax (or any tax on unrealized gains), should one be passed.

Comprehensive Tax on Capital Income

Another way to tax wealth is to tax the annual (realized and unrealized) proceeds from that wealth – sometimes referred to as a "mark-to-market," "accrual," "billionaire" or "billionaires income" tax. This is more in keeping with the income tax tradition in the U.S. in which gains are calculated in relation to cost "basis," which is usually the purchase price. But a wealth tax could be designed to achieve an identical result economically: a 1-percent tax on an American with $100 million in end-of-year net assets (producing $1 million in tax) is the same as a 10-percent tax on that same taxpayer's annual capital income if their portfolio grows by 11 percent (going from $90 million to $100 million over the course of the year). Of course, a recurring wealth tax that hits even in years in which the taxpayer's investments lose money would likely raise more money than an annual capital income tax, especially if the capital income tax regime gives taxpayers credit for losses.

Some economic models find that a wealth tax is more efficient than a tax on capital income. That's because it hits lower performing asset portfolios harder than higher performing ones, thus putting more money in the hands of the most productive investors and disempowering the rentiers who are not making best use of their capital.

While a tax on unrealized gains faces many of the same administrative and judicial hurdles as a wealth tax, there is more room for clever workarounds. For example, Brian



Galle of UC Berkeley Law has proposed a way to tax deferred gains that only requires payment of the tax at realization (which would include death) but incentivizes taxpayers to pay earlier. To ensure taxpayers who fail to prepay can't continue to benefit from indefinite deferral, an extra fee on the buildup of the asset is levied upon realization. This kind of voluntary prepayment approach should both bring in short-term revenue and pass constitutional muster.

A more traditional mark-to-market tax, though perhaps doomed in the courts, could be designed to raise considerable revenue. For example, charging ordinary income tax rates on deferred gain from taxpayers with more than $16.5 million in gross assets would bring in $3 trillion over 10 years.

Transfer Taxes at Death

A simpler but less lucrative approach would be to tax unrealized capital gains at the transfer of these assets at death rather than during the life of the taxpayer. The modern estate tax was created in 1916 to do just that. But this tax on wealth has been decimated by conservatives over the past few decades, with now only 0.14 percent of those dying owing tax.

Taxing unrealized gains at death through an estate tax, inheritance tax or some other mechanism – while also tightening rules around trusts and charitable giving, two of the most popular ways the rich avoid the estate tax today – would bring the U.S. into closer alignment with other countries. For example, Canada does not have an estate tax, but it does tax unrealized gains at death – a policy that a recent analysis found was effective because it reduced the incentive to hold assets indefinitely. One recent proposal in the U.S. calls for taxing unrealized gains at higher rates at death than in life to reinforce this anti-lock-in effect.

According to the Congressional Budget Office, a tax on accrued capital gains at death in the U.S. would raise $536 billion over 10 years. This number is considerably lower than the wealth tax estimates above partially because

the revenues materialize more slowly (i.e., the government needs to wait for taxpayers to die).

That raises an ancillary political problem: the rich would have ample time to lobby Congress to reverse or water down the tax. A policy that replaces stepped-up basis with carry-over basis, meaning heirs would eventually have to pay tax on the appreciation that occurred during the life of the decedent but would not have to pay at the transfer at death, would face an even harsher version of this problem (and it is estimated to only raise $197 billion over 10 years).

That said, Norway replaced stepped-up basis with carry-over basis in 2006 and still managed to raise considerable revenue as Norwegians realized – and paid taxes on – gains they otherwise would have deferred. (Norway also has a wealth tax, and there is evidence that this combination of policies can actually enhance efficiency.)

Enhanced Tax on Business Profits

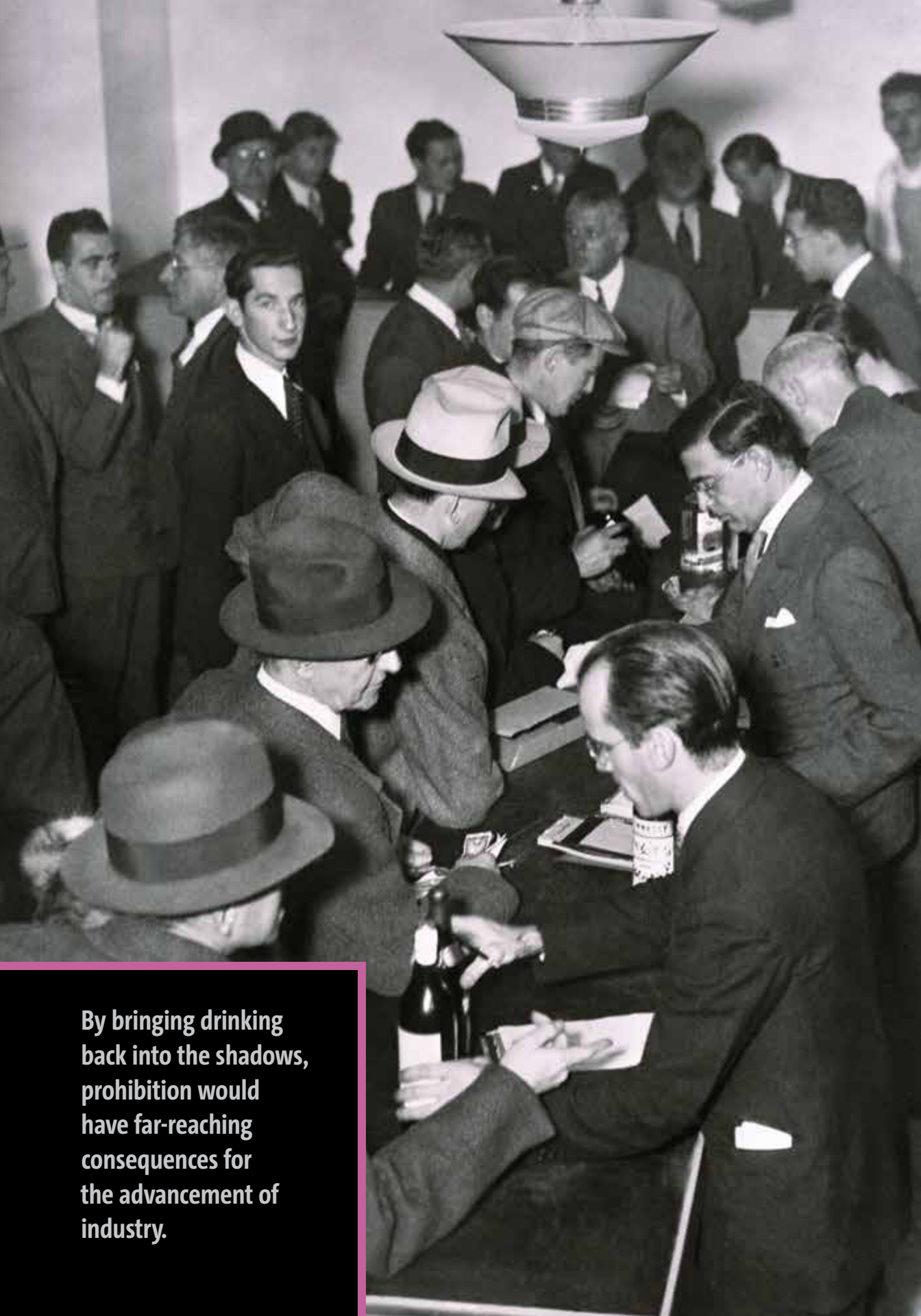
Finally, given the aforementioned importance of business income for the richest Americans, policymakers could ensure more fulsome taxation of business entities, avoiding some of the thorny questions that arise when taxing shareholders in their individual capacity. As mentioned above, so-called subchapter C corporations, which include all public firms, already face a 21 percent entity-level tax, which ensures that some tax is paid on corporate profits even if shareholders escape capital gains taxes. Very few companies actually pay the full 21 percent rate given many deductions, offshoring opportunities and other goodies embedded in the code – but that is a fixable problem.

A more substantial complication is that a large and growing segment of business income is taxed via what are called pass-through firms, meaning the owners pay tax on their business income on their individual returns. These business structures – often limited liability companies organized as partnerships for tax purposes – allow for various tax avoidance schemes that, among other things, convert ordinary business income into capital gains. Many of the richest Americans have ownership interests in these privately held businesses, and so instituting an entity-level tax by, for example, requiring pass-throughs above a certain size to pay taxes as C corporations would capture some otherwise avoided tax. This more unified business tax structure would also improve economy-wide efficiency by leveling the playing field between firms and eliminating tax arbitrage opportunities.

An outdated version of this proposal was projected to raise $300 billion over 10 years, but that figure would be higher in today's dollars and the policy could be combined with other tax increases on large businesses. So while not as glitzy or targeted as a wealth tax, fixing the nation's business income tax system could raise considerable revenue while closing a key tax loophole currently exploited by the rich.

SOONER RATHER THAN LATER

The societal problems created by concentrated wealth, an eroding tax base and lagging economic growth are not going away; reckonings are coming, both in fiscal and political terms. We already see that in high interest rates and populism. The traditional income tax has not been up to the challenge, and so policymakers must think creatively about how to reach the unrealized capital gains that have become such an important part of the wealthy's fortunes. There are a number of good options for policymakers to choose from that avoid the obvious pitfalls. The question is whether we have the will to act.



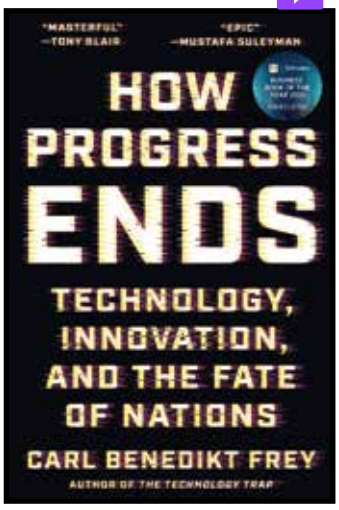
By bringing drinking back into the shadows, prohibition would have far-reaching consequences for the advancement of industry.

How Progress Ends:
Technology, Innovation, and the Fate of Nations

BY CARL BENEDIKT FREY

Carl Benedikt Frey, a Swedish-German economist-technologist who teaches at Oxford, is just 41 – young for a superstar in the dismal profession. But he caught the zeitgeist with "The Future of Employment: How Susceptible Are Jobs to Computerization?", an article he co-authored (with Michael Osborne) back in 2013. That research represented the most serious (and disquieting) effort to date to quantify the likely impact of automation; they estimated that 47 percent of U.S. jobs were vulnerable. And Frey has been in the thick of the argument about how to adapt to artificial intelligence ever since. His new book, *How Progress Ends: Technology, Innovation, and the Fate of Nations*,* which is excerpted here, is about an entirely – well, mostly – different subject, but no less ambitious in its reach. Here Frey engages in the ever-more-relevant debate about whether free markets or top-down planning is better suited to create and sustain economic growth. And his answer, delivered in delightfully accessible prose, is as surprising as it is convincing.

— *Peter Passell*



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Arguments about technological progress and economic development often fall along a familiar divide, an intellectual echo of a Cold War now

more than 30 years behind us. They either exalt decentralized systems, in which small firms experiment and proliferate with little interference from the government, or they extol centralized bureaucratic systems in which strong states direct the economy through rational industrial policy. Such arguments are bound to come up short, for they mistakenly assume that the optimal form of economic governance is invariant across time and place. Instead, I argue, these two ideal types each have their own ecological niche – that is, they are each well suited to different environments.

Stated simply, centralized bureaucratic management is most advantageous for exploiting low-hanging technological fruit and spearheading catch-up, while decentralized systems are better for exploring new technological trajectories – which is the only way to make progress once the technological frontier is reached.

A system that was optimal in one stage of development will almost inevitably prove ill-suited for what lies ahead. When this happens, it must either adapt or perish. This also means that the primary sources of stagnation that threaten progress will look quite different, depending on the form of governance and the prevailing stage of development.

PROHIBITING INNOVATION

On January 17, 1920, the Volstead Act marked the start of national prohibition in America. In historical memory, the movement to prohibit alcohol is most strongly associated with women's groups and Protestant denominations, but its most ardent proponents included another, perhaps more surprising sect: economists.

Among the most vocal was Irving Fisher, a prominent scholar and former president of the American Economic Association. When Fisher organized a roundtable discussion on the subject during the AEA Annual Meetings of 1927, he was unable to find a single economist to argue the case against it. All present agreed that alcohol was harmful, not just to health but to economic efficiency.

Much like during the Covid-19 pandemic, the poor, crammed into small apartments, endured the greatest hardships. Indeed, for the wealthy, the Roaring Twenties were perhaps the greatest, gaudiest spree in American history, as famously depicted in F. Scott Fitzgerald's *The Great Gatsby*. Even before prohibition went into force, the upper classes commonly stockpiled alcohol for legal home consumption. President Woodrow Wilson, for instance, moved his stash to his private Washington residence at the end of his term, while his successor, Warren Harding, took his own large supply to the White House.

The disappearance of the saloon, meanwhile, disrupted ordinary people's daily lives and social networks. And by bringing the habit of drinking back into the shadows, prohibition would have far-reaching consequences for the advancement of industry.

The saloon had a long social tradition in America. In the words of one contemporary, it was "the rooster-crow of the spirit of democracy," rivaled only by the church as the

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The upper classes commonly stockpiled alcohol for legal home consumption. President Woodrow Wilson, for instance, moved his stash to his private Washington residence at the end of his term.

place where the working class met after work. As is evident from saloon names like "Mechanics' Exchange" and "Stonecutters' Exchange," many establishments catered to specific occupations or industries. Skilled workers and craftsmen went there not just to drink but to socialize and exchange ideas. And because these workers were responsible for developing the most inventive contrivances of the era, it should be no surprise that innovation took a hit as saloons across the country were forcibly shut down.

Taking advantage of the fact that U.S. states introduced prohibition at different times, economist Michael Andrews found that such bans were followed by an 18 percent decline in patenting. Not only did collaborative innovation suffer, but patenting among solo inventors plummeted as they ceased to socialize at the saloon and were exposed to fewer ideas. The rate of patents only rebounded to its prior level half a decade later,

once people rebuilt their social networks.

Although decisions are always easier to judge with the benefit of hindsight, economists of the Roaring Twenties should have anticipated the costs of this antisocial policy. *Principles of Economics* (1890), the dominant economic textbook of the time, had been in circulation for nearly three decades. In it, Alfred Marshall – one of the founding fathers of neoclassical economics and perhaps the most influential economist of his generation – famously wrote that "each man profits by the ideas of his neighbors: he is stimulated by contact with those who are interested in his own pursuit to make new experiments."

Marshall's writings, of course, focused on the social networks of industrial districts. But drinking establishments performed the same function during the Enlightenment, which preceded the rise of modern industry, though their importance faded in Europe as coffee houses sprung up across the continent.

Historian Brian Cowan has shown in some detail how this bitter Turkish beverage came with a "culture of curiosity" that accompanied a growing and increasingly interconnected commercial world. In Britain it first took root in academic circles. Oxford, with its vibrant experimental scientific community and unique strength in orientalist scholarship, provided particularly fertile soil for coffee consumption, although London, where a national virtuoso community began investigating this peculiar new beverage, was not far behind. On the other side of the Atlantic, however, neither tea houses nor coffee houses became as popular. The same role was filled by taverns and saloons.

The importance of social networks for innovation is no mystery. As Montesquieu wrote in his 1748 classic, *The Spirit of the Laws*, "commerce cures destructive prejudices." Contact with other people turns the unfamiliar into the familiar, so that regular trading relationships make the prejudices that come with isolation disappear along the way.

Stanford's Mark Granovetter demonstrated that a network with a plethora of weak ties generates a greater circulation of information than a network with a few strong ones.

Higher trust, in turn, reduces what economists call transaction costs and allows societies to scale up beyond the family or even the nation. Much early learning happens within the family. But over time, parents worldwide have outsourced more of the socialization process to schools and other institutions.

Google co-founders Sergey Brin and Larry Page, for instance, both had the fortune of having parents working in science and technology. Yet as they grew up on different sides of the Iron Curtain – Brin in Moscow, Page in the Midwest – it was Stanford that brought them together in 1996. While vertical learning, by which skills and knowledge are passed down within the family over generations, dominated knowledge-transmission for much of human history, horizontal learning now rules supreme.

In one of the most cited studies in sociology, published in 1973, Stanford's Mark Granovetter demonstrated that a network with a plethora of weak ties generates a greater circulation of information than a network with a few strong ones. From an innovation perspective, this is paramount because the possibilities for new discoveries expand when populations become more intercon-

nected. In a world where wealth is derived from ideas rather than land and objects, one of our most important resources is our social network, which acts as our "collective brain." And when networked people are free to explore, they test more technological pathways.

As the case of Prohibition illustrates, innovation happens in serendipitous ways – which is probably why Irving Fisher and his peers ignored it. They were more concerned that Prohibition would reduce what economists call "static efficiency." Benjamin Franklin's dictum that "time is money" captures the essence of the concept. Static efficiency is achieved when machinery and labor are put to optimal use, so that as much as possible is produced at a given point in time. Under this logic, time spent at the local saloon was wasted – even if those barroom conversations sparked ideas that would increase productivity in the future.

The AEA roundtable participants simply reasoned that because alcoholism makes factory discipline harder to maintain, the economic consequences of failing to act would be dire. Yet the real engine of economic growth, which distinguishes modern societies from their earliest ancestors, is *dynamic efficiency* – the kind that comes with technological progress over time. And this kind of progress necessarily requires a loss of static efficiency. If all everyone did was repetitive assembly, few new ideas would emerge. We have to sacrifice some output today to explore and develop new technologies that allow us to do things better tomorrow.

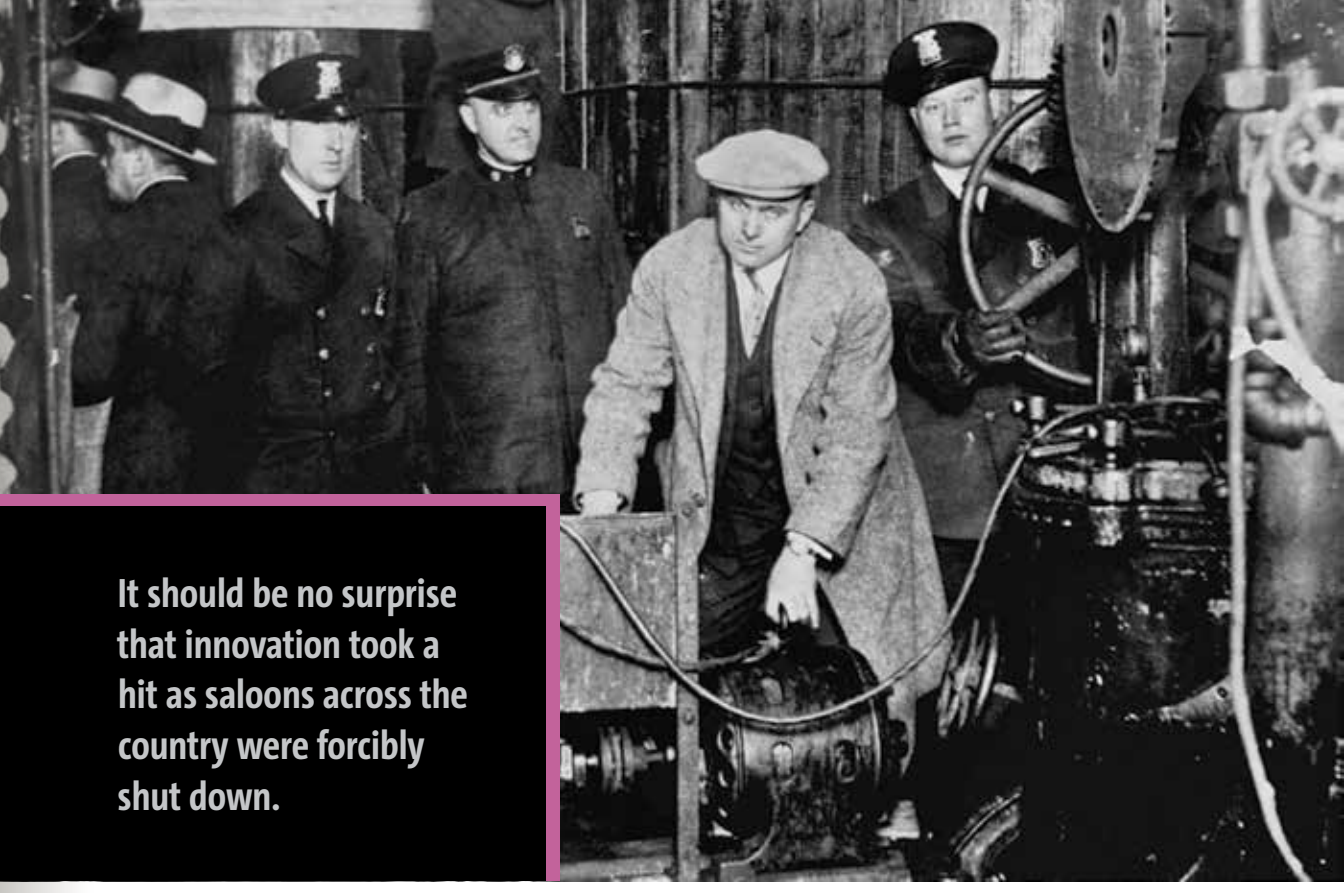
THE MAKING OF mRNA

The remarkable journey that led to the vaccines that rescued humanity from the Covid-19 pandemic is a testament to this point. Although the most efficacious vaccines were produced in months, the breakthrough technology behind them had been decades in the making. At the heart of this story is Katalin Karikó, a Hungarian biochemist whose pioneering research made the coronavirus vaccines of BioNTech and Moderna possible. Karikó, who joined BioNTech in 2014, had been studying RNA molecules since the 1980s, but her funding dried up in Hungary. Undeterred, she emigrated to the United States in 1985 to take up a post at Temple University in Philadelphia, overcoming a host of obstacles including strict currency controls because Hungary remained behind the Iron Curtain. Yet even in the United States, where there were significantly more funding opportunities, she found that harnessing mRNA to fight disease was "too far-fetched for government grants, corporate funding, and even support from her own colleagues."

After six years on the faculty at the University of Pennsylvania, she was denied tenure in 1995. Without funding to support her research, her superiors believed mRNA was a dead end. But Karikó remained convinced that mRNA held the key to future therapeutics. It was a stroke of luck that brought her together with Drew Weissman in 1997; Weissman had recently joined the university to work on dendritic cells, which are critical to the body's immune system.

They met not while drinking at the saloon, but during an equally serendipitous activity – taking turns on a Xerox machine. They began talking about their work and, eventually, in Weissman's words, "decided to try adding her mRNA to my cells."

The early results were not encouraging. They even suggested that it might be impossible to turn RNA molecules into therapeutics, which helps explain why mRNA research remained a scientific backwater for so long. "It was too inflammatory, too difficult to work with," so people just gave up, Weissman explains. But Karikó and Weissman did not,



It should be no surprise that innovation took a hit as saloons across the country were forcibly shut down.

and in 2005 a breakthrough came at last.

By making chemical modifications to mRNA, they discovered that they could insert it into the dendritic cells without triggering an immune response. This would allow them to trick the cells into thinking that the molecules had been made inside the body instead of the lab, which in theory meant that the technology could be used for therapeutic purposes.

In retrospect, this discovery should have turbocharged their careers. But even after the publication of their findings, their funding applications kept being rejected. Part of the challenge was that the technology was still experimental, and so its applications were still uncertain. A meeting between Karikó and an intellectual property officer at her university is telling in this regard. The officer kept asking, "What's it good for?" without getting a clear answer.

Although the patent was finally granted, the decisive next step was taken in 2008 by another scientist, Derrick Rossi, a researcher at Harvard Medical School who was trying to use mRNA to make stem cells. He had never heard of Karikó and Weissman at the time. Their 2005 research paper had gone largely unnoticed, even in the scientific community. Instead, Rossi was inspired by Shinya Yamanaka, a Japanese scientist, who, like Karikó, would go on to win the Nobel Prize in Medicine.

Yamanaka had demonstrated that it was possible to turn human cells into an embryonic stem cell-like state by inserting four genes. The problem was that the genes he inserted ended up back in the DNA, which increased a person's risk of cancer. Rossi figured that by using mRNA instead, it would be possible to reprogram human skin cells to act as though they were stem cells. But he soon ran into the same problem that had long perplexed Karikó and Weissman: "The cell was responding as though a virus was coming in, they were killing themselves."

Looking for a solution, Rossi stumbled on their 2005 paper, and with some chemical

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modifications, he made their approach work. To turn his discovery into a medical reality, however, Rossi needed funding, and was introduced to Noubar Afeyan – a venture capitalist who would found a company, Moderna, to commercialize the science behind mRNA.

This path to discovery could not have been choreographed or planned. Chance played a big role, just as it did in America's saloons before prohibition. Yet it is also true that what happened thereafter followed a much more predictable pattern. If the chain of events that culminated in Karikó and Weissman's discovery, not to mention Rossi's application of it, would have been impossible to conceive beforehand, the development and rollout of the coronavirus vaccine concerned a much narrower challenge. And because the challenge could be clearly defined, research efforts could be planned accordingly and executed at staggering speed.

On a Friday in late January 2020, Ugur Sahin, the co-founder and CEO of BioNTech, learned that a new coronavirus had been discovered in China. The following Monday, he summoned his board to make an announcement: BioNTech, which had previously focused on the next generation of cancer treatments, would make developing a Covid-19 vaccine its new priority. What he called Project Lightspeed started at BioNTech's laboratories in Mainz, Germany, just days after the SARS-CoV-2 genetic sequence was first made public. From that point forward, the task was "to remove all elements of chance" by making innovation a regular process of disciplined attack. By late February, 20 vaccine candidates had been identified, of which four were selected for a trial.

Taking a candidate into production, however, required the capacity to test, develop, produce, and distribute vaccines at mass scale, which neither Moderna nor BioNTech possessed. To overcome this deficit, BioNTech partnered with pharmaceutical giant Pfizer, while Moderna relied on Operation Warp Speed, a U.S. government program set up by the Trump administration. If the process of exploration was largely horizontal, exploitation was almost entirely vertical: it required large-scale bureaucracy and managerial hierarchies to succeed.

FROM HAYEK TO WEBER

The case of mRNA also underlines another critical point about technological progress, which is that every breakthrough begins life facing ubiquitous uncertainty. We cannot know if something new will catch on until someone has taken the risk of investing in it. In 1999, for example, the venture capital firms Sequoia Capital and Kleiner Perkins each invested $12.5 million in Google. When Sequoia sold its stake six years later, it was worth over $4 billion and had returned 320 times the initial investment.

Yet such numbers simply underscore that Google was not a sure bet in 1999. Other companies like Yahoo! and AltaVista dominated the search-engine space at the time, and several experienced venture capitalists decided not to invest. When Google's marketing manager, Susan Wojcicki, asked one of Bessemer Venture's partners to meet with Page and Brin, who had rented space in her garage, he allegedly joked, "How can I get out of this house without going anywhere near your garage?"

In the uncertain world of discovery, not even the smartest people can be expected to get things right every time. But Bessemer Venture's failure to see the promise of Google's search engine did not contain its rise. Brin and Page were fortunate to operate in a decentralized economic system where many investors could bet on different technologies.

Had Brin's family not left Soviet Russia, chances are he would not be the co-founder of Google, just like Karikó is unlikely to have pioneered mRNA in socialist Hungary.

Behind the Iron Curtain inventors needed permission for almost anything, and if they were turned down by the state, they had few alternative options. So, fewer bets were naturally made. This helps explain why none of the great commercial inventions of the 20th century were made in planned economies. Decentralized systems allow for thousands of barren trials so that one might eventually succeed; centrally planned ones do not. As Friedrich von Hayek put it, the dispersed nature of what people know cannot be overcome "by first communicating all this knowledge to a central board which, after integrating all knowledge, issues its orders." It must be solved by "some form of decentralization."

Hayek, of course, was writing at end of World War II, when bureaucratic planning had reached new commanding heights. But his insights remain as relevant today. As then, there are many instances where experts are better placed to make decisions about what must be done, pandemics and the climate crisis being two prominent examples. Yet in other cases, where no real consensus has been formed, the decision to rely on expert opinion merely shifts the problem to selecting the experts. And when a field or a discovery is new, this is a particularly difficult task.

Karikó and Weissman's seminal paper was long unknown, not only to the outside world but even within the scientific community. In fact, their tenacity depended on ignoring the expert naysayers. To make mRNA work, in Hayek's words, they had to go through a "voyage of exploration into the unknown." And because exploration requires sacrificing time and resources today in hopes of greater gains tomorrow, government planners and corporate managers alike struggle to oversee and motivate inventors who hold deeper expertise than anyone else.

So it is not surprising that, as MIT's Daron Acemoglu and collaborators have shown, companies operating at the cutting edge choose to decentralize decision-making. When dealing with radically new technologies, whose benefits and applications are uncertain, bureaucratic planning almost always fails.

Hayek's teacher, Ludwig von Mises, surely agreed. Writing in 1944, Mises opened his book Bureaucracy with the following line: "Nobody doubts that bureaucracy is thoroughly bad and that it should not exist in a perfect world." If this was true, the world he observed around him certainly did not change for the better. Even when the war ended, bureaucratic management persisted, not only through state control of strategic industries but in the private sector as well.

A paradox of the postwar era is that it symbolizes the historic confluence of oppressive factory work, cascading productivity, and shared prosperity in the West, as well as oppressive political regimes and rapid growth in the centrally planned economies of the East. This age of planning produced America's Golden Age, Germany's *Wirtschaftswunder*, Italy's *il miracolo economico*, France's *les trente glorieuses*, Spain's *el milagro*, not to mention Japan's and Korea's great leaps, or indeed that of the Soviet Union. Around the world, "the visible hand of management replaced what Adam Smith referred to as the invisible hand of market forces," to borrow historian Alfred Chandler Jr.'s memorable phrase.

Of course, even Smith's pin factory, depicted in *The Wealth of Nations* (1776), had a visible hand of its own. In it, pin-making was divided into many small sequential steps, allowing workers to specialize and so boost productivity. But everything was done in-

house, not through the invisible hand of the market. In a pure market system, there would be no managers overseeing production. Each step would be handled by individuals buying and selling to one another based on changing prices.

For instance, in pin production, the wire-drawer would auction off the wire to a buyer, who would then take it to be cut, and later sell the cut pieces to a specialist in sharpening. At each stage, new bids, payments, and transport would be involved just to move from one part of pin-making to the next. Of course, no factory in the world is organized this way and for good reason: any gains from the division of labor would be swamped by endless rounds of haggling, transporting, and quality checks. That, as Ronald Coase explained in "The Nature of the Firm" (1937), is why companies and hierarchies exist. They let people cooperate under ongoing contracts rather than one-off transactions, and they permit the use of new technologies, like factories, on a massive scale.

To some students of history, this example might seem familiar. Indeed, one of the hidden truths about the capitalist enterprise is that its internal organization bears a striking resemblance to the crude material balance calculations used by Soviet planners. Inside the firm, there are no market prices to signal where time and resources are best allocated. Instead, individuals are given objectives that they strive to fulfill in exchange for a fixed salary, job security, and the prospect of career advancement. Employees engage in trading favors and disfavors to climb the ranks of the bureaucracy, while superiors use social engineering tactics, exert pressure, and shape incentives, much like an authoritarian state – though workers in a market system generally do have many more outside options, and so they can leave at will.

Moreover, one of the market economy's great strengths, as Coase emphasized, is the ability of firms to choose between bureaucratic command-and-control and a system based on horizontal transactions. Under Soviet planning, there was no such choice. And in a decentralized system, firms are ultimately subject to market discipline, with those that incur losses shrinking or vanishing – a fate not shared by state-run bureaucracies that are permitted to operate at a loss. Yet it is also true that governments at times operate under intense geopolitical competition, which has its own disciplining effect. The Soviet Union, for instance, effectively exploited many technologies made in the West, and even made some strides of its own, while competing with America for global hegemony.

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In the end, innovation is not only about ideation but also about converting these ideas into practical, reliable products that are available and affordable. And when efforts shift from exploration to exploitation, vertical lines of command trump horizontal lines of exchange. During the late 19th century, for example, independent inventors were the primary explorers of new technologies, and they relied on licensing their discoveries to the major corporations of the day that turned these patents into marketable products.

As these technologies matured, competition shifted from innovation to price, spurring

centralization and consolidation, transforming what Hayek called a "market economy" consisting of individual actors and small firms into an economy of command-and-control organization in large companies connected by market exchange.

The simple insight that centralization and consolidation naturally follow periods of decentralization has profound implications for economic development. It means that the economic organization that excels at inventing the industrial future is not necessarily the most suitable for catching up to an existing target. In fact, backwardness creates opportunities for latecomers to leapfrog exploration and imitate innovators' successes since they can use centralizing institutions from the onset. Latecomers, in other words, can take different paths to prosperity. The Crown of England did not gather a group including barons, bishops, bankers, and tinkerers to create the modern world. But after Britain had spearheaded the Industrial Revolution, that is effectively what Japan did with the Meiji Restoration.

To see how this transition from exploration to exploitation favors fundamentally different forms of organization, consider the

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As prohibition rolled out across the U.S. states, it was followed by an 18 percent decline in patenting. A half a decade went by before patent applications rebounded to their former level.

postwar period, which, as noted, was a time when capitalism around the world bureaucratized. Many of the technologies underpinning global growth were made in America before the war and invented through decentralized exploration. Few breakthroughs have transformed the world more than the automobile, and no place had a more remarkable impact on its ascent than Detroit.

In the early 20th century, the dynamism of the Motor City was strikingly similar to that of Silicon Valley in the age of computers. In both, job hopping was the norm, which allowed ideas to spread like fire from one firm to another. Many inventors and engineers who left incumbents did so to set up their own shops. Yet if one obscure start-up deserves to be singled out, it would surely be the company of Henry Ford, which managed to survive the early shakeout and went on to build some of the wonders of the world.

When the Highland Park factory with its moving assembly line opened on Manchester Street in 1910, *The New York Times* marveled, "it offers a striking illustration of the solidity of this pioneering company and the methods it adopts for the care of its customers." Indeed, Highland Park soon produced the Model T at a sufficiently low price for it to become the people's vehicle.

Testifying to American technological leadership as well as to the transition from exploration to exploitation was the remarkable stream of visits from foreign delegations to Ford's new factories. In the 1930s, countless foreigners spent weeks, sometimes months at Ford's new, vertically integrated River Rouge factory.

In June 1937, Ferdinand Porsche led his own group of Volkswagen engineers to Detroit on a state-sponsored mission as the protégé designer of Adolf Hitler, whose ambition was to produce a German "people's car." Rather than searching for new ideas, Porsche was on the hunt for machinery and skilled technicians for his own factory, which was already in the planning stage. Around the same time, the Italian carmaker Fiat led another delegation, including Vittorio Bonadè Bottino, a leading architect in Fascist Italy, tasked by Benito Mussolini with designing the enormous Mirafiori factory at the outskirts of Turin. There were also convoys of Soviet bureaucrats, who through an extensive technology transfer agreement created Russia's own "River Rouge" with the opening of the Gorky Automobile Factory (Gaz) in 1932.

As H. J. Freyn, a prominent consultant who had spent an extensive period in the Soviet Union advising on industrial development, astutely put it in 1931: "A modern business enterprise can scarcely be operated or managed by applying the principles of democracy." Fascists on the right and communists on the left heralded a new century of central authority and planning.

While much of the productivity growth over the centuries can be attributed to incremental product and process improvements by large, established organizations, these alone are insufficient.

For theorists of the interwar period like Karl Polanyi, there was a sense of a momentous institutional reversal as laissez-faire imploded and gave way to a new age of competitive technological upgrading orchestrated by activist governments. Mussolini, who started out as the editor of an Italian socialist newspaper only to become the first leader of the fascist world, was at least consistent in his views on decentralization. "The Doctrine of Fascism," an essay he published in 1932, is emblematic for its attacks on liberalism, individualism, and democracy as "outgrown ideologies of the 19th century."

Yet a closer look at the 19th century reveals a similar pattern of development. While England had clearly been moving closer to laissez-faire, latecomers also leveraged the advantages of backwardness by adopting technologies invented in Britain. And they relied heavily on the symbiotic relationship between big business and the state to do so.

Take Prussia, where Karl vom und zum Stein, Karl August von Hardenberg, and their successors prompted a revolution from above and used a variety of means to drive industrial catch-up. They handed over government-purchased technologies to private companies and created institutions to mobilize scarce resources "all in order to pressure Prussian industry to modernize its production method." Similarly, after Bismarck's unification, Germany – justly regarded as a liberal autocracy – did much to spur the growth of big business, which was capable of absorbing and exploiting new technologies at greater pace and scale than its British competitors.

Max Weber, writing in the wake of these developments, unsurprisingly emphasized both the role of bureaucracy and capitalism in Western civilization. The well-defined hierarchical structures of bureaucracy, he noted, "are capable of attaining the highest degree of efficiency and is in this sense formally the most rational known means of exercising authority over human beings."

Yet despite Weber's admiration for the superior efficiency of bureaucracy, he also feared that its spread could stifle the dynamism of capitalism and thwart innovation over the long run. And in this he was right. While much of the productivity growth over the centuries can be attributed to incremental product and process improvements by large, established organizations, these alone are insufficient. Breakthrough innovations are the foundation upon which such incremental advancements are built.

One can improve a horse carriage in terms of design and functionality, but eventually one needs a radical innovation to create a motorcar, or progress will stall. And tellingly, none of the leading makers of either bicycles or horse carriages became leading producers

of automobiles. Great leaps in technology usually come from challengers, as is evident from the endless churn among the companies that make up the S&P 500.

In recent times, this phenomenon has played out in various industries, from the development of highly effective Covid-19 vaccines by startups, to the rise of e-commerce championed by outsider Amazon, to the transformation of the media landscape by the likes of X (formerly, Twitter), Meta, and YouTube. Even in capital-intensive industries such as space and electric vehicles, established players such as Boeing, Lockheed Martin, GM, and Volkswagen have been outpaced by challengers like SpaceX and Tesla.

The same appears true at the forefront of artificial intelligence, where startups like OpenAI and Anthropic are now challenging Meta and Google. In theory, large companies have the financial strength to make bigger and riskier bets. But in reality, they tend to play it safe. As Chicago's Ufuk Akcigit and Harvard's William Kerr have shown in a detailed study of patented inventions, challengers have a competitive advantage in spawning major technological breakthroughs.

Today's tech giants may still innovate, but their growth comes at a cost. As they absorb more of the world's top talent, those they hire become less inventive than they previously were at startups.

Weber understood why. Bureaucracy thrives on stability, not risk. As technologies mature and processes become standardized, managers gain greater control over production and efficiency. But when a field is still evolving and experimentation is key, measuring performance is much harder. In these uncertain conditions, strict oversight can backfire – surveillance discourages collaboration, keeping workers focused on narrow, well-defined tasks instead of exploring new ideas.

Centralized bureaucracies that operate on clear rules and predictable workflows therefore struggle when conditions change. Projects requiring multiple layers of approval or broad internal consensus rarely push boundaries. True innovation often requires breaking rules, not following them. When Lingfei Wu and colleagues analyzed some 65 million scientific papers, patents, and software projects from the postwar years to the Internet era, they found that solo inventors and decentralized teams consistently generated more disruptive ideas and technologies, whereas larger and hierarchical ones focused on developing existing ones. Like large movie studios, they produced sequels instead of new narratives.

Challengers tend to prevail for another strategic reason. Incumbents are often reluctant to pursue new breakthroughs for fear of putting existing revenues from older technologies at risk. Kodak is a classic example. Although they moved into research on computers in the 1960s and developed a digital camera in 1975, the product was dropped. Executives feared cannibalizing the company's main source of income, its photographic film business.

To protect revenues in the short run, management ended up sacrificing the company in the long run, filing for Chapter 11 bankruptcy in January 2012. The great inventor Thomas Edison was implacably hostile to the alternating electrical current systems that George Westinghouse was developing because they challenged the direct current system of his own General Electric. And when an industry is dominated by a few behemoths like GE, there is a real risk that conservatism inside one company ends up reducing the pace of innovation in the economy as a whole.

To be sure, Edison's concern was not just

that GE faced a lower return on investment relative to outsiders with no rents to cannibalize. It was also a matter of pride and recognition. It is therefore perhaps unsurprising that young inventors, who are less intellectually invested in the status quo, are typically more creative. Even in science, where the profit motive is less prevalent, established scholars act as guardians of the existing order.

Recent research shows that it often takes the passing of a star for outsiders to challenge the leadership in a field and so advance the frontiers of our knowledge. Max Planck was on to something when he suggested that science progresses one funeral at a time. Over the long run, progress entails creative destruction in both science and technology.

THE ROAD TO STAGNATION

A longstanding debate in economics has revolved around the existence of hierarchies. While neoclassical economists such as Ronald Coase and Oliver Williamson have argued that corporations help achieve economies of scale and drive down costs, thus increasing the accessibility of goods to the populace, neo-Marxians like Stephen Hymer and Stephen Marglin have suggested that hierarchies emerge as a means of power and resource monopolization at the expense of society.

According to the latter group, the growth of corporations has resulted in a loss of human welfare. They echo the words of historian Eric Hobsbawm: "It is often assumed that an economy of private enterprise has an automatic bias towards innovation, but this is not so. It has a bias only towards profit."

Yet these views are not mutually exclusive. In fact, they are both essential if we want to understand the rise and fall of growth. Early in the technology lifecycle, exploration thrives in a decentralized environment. But once a prototype proves viable, the focus shifts. The next challenge is scaling production, cutting costs, and increasing efficiency – and this is where centralization and corporate consolidation take over.

At first, this comes with tangible benefits to society. As Joseph Schumpeter pointed out, the capitalist achievement did not consist of providing "more silk stockings for queens but in bringing them within the reach of factory girls in return for steadily decreasing amounts of effort." Beyond driving down consumer prices, consolidation streamlines research and development, reducing wasteful duplication across competing firms.

Indeed, as a vaccine's efficacy nears 100 percent, further investment in incremental improvements yields diminishing – or even negative – returns, diverting resources away from other critical areas. At this point the easy gains are gone, and the focus shifts once more from perfecting production to protection.

When this happens, big companies stop innovating and start lobbying. Instead of investing in productive pursuits, they resort to anti-competitive tactics and pressure the government for regulation that shields them from competition. One need not be a cynic to think that it is no coincidence that politically connected companies take out fewer patents.

Economist Mancur Olson made perhaps the clearest argument about how vested interests can strangle progress. His conclusion was short but sour: when interest groups entrench themselves across industries, stagnation follows. A recurring theme of his book, *Rise and Decline of Nations,* is that decentralization is necessary for further progress as a country approaches the technological frontier. But this is rarely in the interest of incumbents who dislike competition and favor the status quo.

Stagnation happens when institutions fail to adapt to new technological realities or cre-

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Prohibition illustrated Alfred Marshall's observation that "each man profits by the ideas of his neighbors: he is stimulated by contact with those who are interested in his own pursuit to make new experiments."

ate the space to explore new avenues of progress, generally because incumbents seek to prevent competition from outsiders. In fact, the capacity for institutional change in the wake of new technological realities can go far in explaining why America has been the technology leader for over a century.

However, latecomers can skip the costly trial-and-error phase by adopting technologies developed elsewhere, often with state intervention accelerating the process. Indeed, what is entirely absent from Olson's account is precisely the role of the state. Yet, constant revolution from above took the Soviet Union – where Stalin's terror made sure that no interest groups could organize safely – some way toward the technological frontier under intense pressure from geopolitical competition.

Just as special interests can lobby governments to thwart competition in the private sector, states can check the clout of private enterprise – a policy Xi Jinping has vigorously pursued since surging to power in 2012. The challenge for powerful autocrats is a different one. To stay in power they must invest heavily in surveillance technologies that allow them to control the private sector and society to prevent mobilization against the regime. This might, under specific circumstances, give the economy a boost in the short run, as some sputniks are delivered. But it also risks undermining its dynamism over the long run.

Come on in, the water's warm

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Blue Lagoon at night, Iceland.

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In this issue