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The conventional view of what the state should do to foster innovation is simple: it just needs to get out of the way. At best, governments merely facilitate the economic dynamism of the private sector; at worst, their lumbering, heavy-handed, and bureaucratic institutions actively inhibit it. The fast-moving, risk-loving, and pioneering private sector, by contrast, is what really drives the type of innovation that creates economic growth. According to this view, the secret behind Silicon Valley lies in its entrepreneurs and venture capitalists. The state can intervene in the economy—but only to fix market failures or level the playing field. It can regulate the private sector in order to account for the external costs companies may impose on the public, such as pollution, and it can invest in public goods, such as basic scientific research or the development of drugs with little market potential. It should not, however, directly attempt to create and shape markets. A 2012 *Economist* article on the future of manufacturing encapsulated this common conception. "Governments have always been lousy at picking winners, and they are likely to become more so, as legions of entrepreneurs and tinkerers swap designs online, turn them into products at home and market them globally from a garage," the article stated. "As the revolution rages, governments should stick to the basics: better schools for a skilled workforce, clear rules and a level playing field for enterprises of all kinds. Leave the rest to the revolutionaries."

That view is as wrong as it is widespread. In fact, in countries that owe their growth to innovation, the state has historically served not as a meddler in the private sector but as a key partner of it—and often a more daring one, willing to take the risks that businesses won't. Across the entire innovation chain, from basic research to commercialization, governments have stepped up with needed investment that the private sector has been too scared to provide. This spending has proved transformative, creating entirely new markets and sectors, including the Internet, nanotechnology, biotechnology, and clean energy.

Today, however, it has become harder and harder for governments to think big. Increasingly, their role has been limited to simply facilitating the private sector and, perhaps, nudging it in the right direction. When governments step beyond that role, they immediately get accused of crowding out private investment and ineptly trying to pick winners. The notion of the state as a mere facilitator, administrator, and regulator started gaining wide currency

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in the 1970s, but it has taken on newfound popularity in the wake of the global financial crisis. Across the globe, policymakers have targeted public debt (never mind that it was private debt that led to the meltdown), arguing that cutting government spending will spur private investment. As a result, the very state agencies that have been responsible for the technological revolutions of the past have seen their budgets shrink. In the United States, the budget "sequestration" process has resulted in $95 billion worth of cuts to federal R & D spending from 2013 to 2021. In Europe, the EU's "fiscal compact," which requires states to drop their fiscal deficits down to three percent of GDP, is squeezing educational and R & D spending.

What's more, thanks in part to the conventional wisdom about its dynamism and the state's sluggishness, the private sector has been able to successfully lobby governments to weaken regulations and cut capital gains taxes. From 1976 to 1981 alone, after heavy lobbying from the National Venture Capital Association, the capital gains tax rate in the United States fell from 40 percent to 20 percent. And in the name of bringing Silicon Valley's dynamism to the United Kingdom, in 2002, the government of British Prime Minister Tony Blair reduced the time that private equity funds have to be invested to be eligible for tax reductions from ten years to two years. These policies increase inequality, not investment, and by rewarding short-term investments at the expense of long-term ones, they hurt innovation.

Getting governments to think big about innovation is not just about throwing more taxpayer money at more activities. It requires fundamentally reconsidering the traditional role of the state in the economy. Specifically, that means empowering governments to envision a direction for technological change and invest in that direction. It means abandoning the shortsighted way public spending is usually evaluated. It means ending the practice of insulating the private sector from the public sector. And it means figuring out ways for governments and taxpayers to reap some of the rewards of public investment, instead of just the risks. Only once policymakers move past the myths about the state's role in innovation will they stop being, as John Maynard Keynes put it in another era, "the slaves of some defunct economist."

THE FAILURE OF MARKET FAILURE

According to the neoclassical economic theory that is taught in most economics departments, the goal of government policy is simply to correct market failures. In this view, once the sources of failure have been addressed—a monopoly reined in, a public good subsidized, or a negative externality taxed—market forces will efficiently allocate resources, enabling the economy to follow a new path to growth. But that view forgets that markets are blind, so to speak. They may neglect societal or environmental concerns. And they often head in suboptimal, path-dependent directions. Energy companies, for example, would rather invest in extracting oil from the deepest confines of the earth than in clean energy.

In addressing societal challenges such as climate change, youth unemployment, obesity, aging, and inequality, states must lead—not by simply fixing market failures

You didn't build that: an iPhone in Washington, D.C., October 2013

REUTERS / KEVIN LAMARQUE

but by actively creating markets. They must direct the economy toward new "techno-economic paradigms," in the words of the technology and innovation scholar Carlota Perez. These directions are not generated spontaneously from market forces; they are largely the result of deliberate state decisions. In the mass-production revolution, for example, the state invested in both the underlying technologies and their diffusion across the economy. On the supply side, the U.S. military-industrial complex, beginning in World War II, invested in improvements in aerospace, electronics, and materials. On the demand side, the U.S. government's postwar subsidization of suburban living—building roads, backing mortgages, and guaranteeing incomes through the welfare state—enabled workers to own homes, buy cars, and consume other mass-produced goods.

As Michael Shellenberger and his colleagues at the progressive think tank the Breakthrough Institute have documented, despite the mythmaking about how the shale gas boom is being driven by wildcatting entrepreneurs operating independently from the state, the U.S. federal government invested heavily in the technologies that unleashed it. In 1976, the Morgantown Energy Research Center and the Bureau of Mines launched the Eastern Gas Shales Project, which demonstrated how natural gas could be recovered from shale formations. That same year, the federal government opened the Gas Research Institute, which was funded through a tax on natural gas production and spent billions of dollars on research into shale gas. And the Sandia National Laboratories, part of the U.S. Department of Energy, developed the 3-D

geologic mapping technology used for fracking operations.

Likewise, as the physician Marcia Angell has shown, many of the most promising new drugs trace their origins to research done by the taxpayer-funded National Institutes of Health, which has an annual budget of some $30 billion. Private pharmaceutical companies, meanwhile, tend to focus more on the D than the R part of R & D, plus slight variations of existing drugs and marketing.

Silicon Valley's techno-libertarians might be surprised to find out that Uncle Sam funded many of the innovations behind the information technology revolution, too. Consider the iPhone. It is often heralded as the quintessential example of what happens when a hands-off government allows genius entrepreneurs to flourish, and yet the development of the features that make the iPhone a smartphone rather than a stupid phone was publicly funded. The progenitor of the Internet was ARPANET, a program funded by the Defense Advanced Research Projects Agency (DARPA), which is part of the Defense Department, in the 1960s. GPS began as a 1970s U.S. military program called Navstar. The iPhone's touchscreen technology was created by the company FingerWorks, which was founded by a professor at the publicly funded University of Delaware and one of his doctoral candidates, who received grants from the National Science Foundation and the CIA. Even Siri, the iPhone's cheery, voice-recognizing personal assistant, can trace its lineage to the U.S. government: it is a spinoff of a DARPA artificial-intelligence project. None of this is to suggest that Steve Jobs and his team at Apple were not brilliant in how they put together existing technologies. The problem, however, is that failing to admit the public side of the story puts future government-funded research at risk.

For policymakers, then, the question should not be whether to pick particular directions when it comes to innovation, since some governments are already doing that, and with good results. Rather, the question should be how to do so in a way that is democratically accountable and that solves the most pressing social and technological challenges.

A SMARTER STATE

State spending on innovation tends to be assessed in exactly the wrong way. Under the prevailing economic framework, market failures are identified and particular government investments are proposed. Their value is then appraised through a narrow calculation that involves heavy guesswork: Will the benefits of a particular intervention exceed the costs associated with both the offending market failure and the implementation of the fix? Such a method is far too static to evaluate something as dynamic as innovation. By failing to account for the possibility that the state can create economic landscapes that never existed before, it gives short shrift to governments' efforts in this area. No wonder economists often characterize the public sector as nothing more than an inefficient version of the private sector.

This incomplete way of measuring public investment leads to accusations that by entering certain sectors, governments are crowding out private investment. That charge is often false, because government investment often has the effect of "crowding in," meaning that it stimulates private investment and expands the overall pie of national output,

which benefits both private and public investors. But more important, public investments should aim not only to kick-start the economy but also, as Keynes wrote, "to do those things which at present are not done at all." No private companies were trying to put a man on the moon when NASA undertook the Apollo project.

Without the right tools for evaluating investments, governments have a hard time knowing when they are merely operating in existing spaces and when they are making things happen that would not have happened otherwise. The result: investments that are too narrow, constrained by the prevailing techno-economic paradigm. A better way of evaluating a given investment would be to consider whether it taught workers new skills and whether it led to the creation of new technologies, sectors, or markets. When it comes to government spending on pharmaceutical research, for example, it might make sense to move past the private sector's fixation on drugs and fund more work on diagnostics, surgical treatments, and lifestyle changes.

Governments suffer from another, related problem when it comes to contemplating investments: as a result of the dominant view that they should stick to fixing market failures, they are often ill equipped to do much more than that. To avoid such problems as a regulatory agency getting captured by business, the thinking goes, the state must insulate itself from the private sector. That's why governments have increasingly outsourced key jobs to the private sector. But that trend often rids them of the knowledge necessary for devising a smart strategy for investing in innovation and makes it harder to attract top talent. It creates a self-fulfilling prophecy: the less big thinking a government does, the less expertise it is able to attract, the worse it performs, and the less big thinking it is allowed to do. Had there been more information technology capacity within the U.S. government, the Obama administration would probably not have had such difficulty rolling out HealthCare.gov, and that failure will likely lead to only more outsourcing.

In order to create and shape technologies, sectors, and markets, the state must be armed with the intelligence necessary to envision and enact bold policies. This does not mean that the state will always succeed; indeed, the uncertainty inherent in the innovation process means that it will often fail. But it needs to learn from failed investments and continuously improve its structures and practices. As the economist Albert Hirschman emphasized, the policymaking process is by its nature messy, so it is important for public institutions to welcome the process of trial and error. Governments should pay as much attention to the business school topics of strategic management and organizational behavior as private companies do. The status quo approach, however, is to focus not on making the government more competent but on downsizing it.

PROFIT AND LOSS

Since governments often undertake courageous spending during the riskiest parts of the innovation process, it is key that they figure out how they can socialize not just the risks of their investments but also the rewards. The U.S. government's Small Business Innovation Research program, for

example, offers high-risk financing to companies at much earlier stages than most private venture capital firms do; it funded Compaq and Intel when they were start-ups. Similarly, the Small Business Investment Company program, an initiative under the auspices of the U.S. Small Business Administration, has provided crucial loans and grants to early stage companies, including Apple in 1978. In fact, the need for such long-term investments has only increased over time as venture capital firms have become more short term in their outlook, emphasizing finding an "exit" for each of their investments (usually through a public offering or a sale to another company) within three years. Real innovation can take decades.

As is the nature of early stage investing in technologies with uncertain prospects, some investments are winners, but many are losers. For every Internet (a success story of U.S. government financing), there are many Concordes (a white elephant funded by the British and French governments). Consider the twin tales of Solyndra and Tesla Motors. In 2009, Solyndra, a solar-power-panel start-up, received a $535 million guaranteed loan from the U.S. Department of Energy; that same year, Tesla, the electric-car manufacturer, got approval for a similar loan, for $465 million. In the years afterward, Tesla was wildly successful, and the firm repaid its loan in 2013. Solyndra, by contrast, filed for bankruptcy in 2011 and, among fiscal conservatives, became a byword for the government's sorry track record when it comes to picking winners. Of course, if the government is to act like a venture capitalist, it will necessarily encounter many failures. The problem, however, is that governments, unlike venture capital firms, are often saddled with the costs of the failures while earning next to nothing from the successes. Taxpayers footed the bill for Solyndra's losses yet got hardly any of Tesla's profits.

Economists may argue that the state already receives a return on its investments by taxing the resulting profits. The truth is more complicated. For one thing, large corporations are masters of tax evasion. Google—whose game-changing search algorithm, it should be noted, was developed with funding from the National Science Foundation—has lowered its U.S. tax bill by funneling some of its profits through Ireland. Apple does the same by taking advantage of a race to the bottom among U.S. states: in 2006, the company, which is based in Cupertino, California, set up an investment subsidiary in Reno, Nevada, to save money.

Fixing the problem is not just a matter of plugging the loopholes. Tax rates in the United States and other Western countries have been falling over the past several decades precisely due to a false narrative about how the private sector serves as the sole wealth creator. Government revenues have also shrunk due to tax incentives aimed at promoting innovation, few of which have been shown to produce any R & D that would not have happened otherwise. What's more, given how mobile capital is these days, a particular government that has funded a given company might not be able to tax it since it may have moved abroad. And although taxes are effective at paying for the basics, such as education, health care, and research, they don't begin to cover the cost of making direct investments in companies or specific

technologies. If the state is being asked to make such investments—as will increasingly be the case as financial markets become even more focused on the short term—then it will have to recover the inevitable losses that arise from this process.

There are various ways to do so. One is to attach strings to the loans and guarantees that governments hand out to businesses. For example, just as graduates who receive income-contingent student loans get their repayments adjusted based on their salaries, the recipients of state investments could have their repayments adjusted based on their profits.

Another way for states to reap greater returns involves reforming the way they partner with businesses. Public-private partnerships should be symbiotic, rather than parasitic, relationships. In 1925, the U.S. government allowed AT&T to retain its monopoly over the phone system but required the company to reinvest its profits in research, a deal that led to the formation of Bell Labs. Today, however, instead of reinvesting their profits, large companies hoard them or spend them on share buybacks, stock options, and executive pay. Research by the economist William Lazonick has borne this out: "The 449 companies in the S&P 500 index that were publicly listed from 2003 through 2012 . . . used 54% of their earnings—a total of $2.4 trillion—to buy back their own stock."

An even bolder plan would allow the state to retain equity in the companies it supports, just as private venture capital firms do. Indeed, some countries adopted this model long ago. Israel's Yozma Group, which manages public venture capital funds, has backed—and retained equity in—early stage companies since 1993. The Finnish Innovation Fund, or Sitra, which is operated under the Finnish parliament, has done the same since 1967, and it was an early investor in Nokia's transformation from a rubber company into a cell-phone giant. Had the U.S. government had a stake in Tesla, it would have been able to more than cover its losses from Solyndra. The year Tesla received its government loan, the company went public at an opening price of $17 a share; that figure had risen to $93 by the time the loan was repaid. Today, shares in Tesla trade above $200.

The prospect of the state owning a stake in a private corporation may be anathema to many parts of the capitalist world, but given that governments are already investing in the private sector, they may as well earn a return on those investments (something even fiscal conservatives might find attractive). The state need not hold a controlling stake, but it could hold equity in the form of preferred stocks that get priority in receiving dividends. The returns could be used to fund future innovation. Politicians and the media have been too quick to criticize public investments when things go wrong and too slow to reward them when things go right.

THE NEXT REVOLUTION

Past technological revolutions—from railroads to the automobile to the space program to information technology—did not come about as the result of minor tinkering with the economic system. They occurred because states undertook bold missions that focused not on minimizing government failure but on maximizing innovation. Once one

accepts this more proactive state purpose, the key questions of economic policy get reframed. Questions about crowding out private investment and unwisely picking winners fall by the wayside as more dynamic questions—about creating the types of public-private interactions that can produce new industrial landscapes—rise to the top.

Today, many countries, from China to Denmark to Germany, have settled on their next mission: green energy. Given the potential benefits and the amount of money at play, it is crucial that governments back this mission the right way. For starters, they must not only pick various technologies or sectors to invest in but also ask what they want from those sectors. For example, if what governments want from the energy sector is a stable energy supply, then shale gas will do, but if the mission is to mitigate climate change, then it won't. In fact, mission-oriented policies need to foster interactions among multiple fields. NASA's mission to the moon required the interaction of many different sectors, from rocketry to telecommunications to textiles. Likewise, the green energy revolution will require investment not just in wind energy, solar power, and biofuels but also in new engines, new ways of more efficiently maintaining infrastructure, and new ways of making products last longer. Accordingly, the state should take its cue from the venture capital world and diversify its portfolio, spreading capital across many different technologies and enterprises.

In making green investments, governments should fund those technologies that the private sector has ignored and provide a strong, clear direction for change, letting various entrepreneurs experiment with the specifics. Governments should provide ambitious targets, not in the old command-and-control style but through a combination of carrots and sticks. The German government has followed this approach in its energy-transition initiative, or *Energiewende*, which is designed to phase out nuclear energy and substitute it with renewables; it is doing this by setting lofty goals for carbon emissions reductions and subsidizing technological development of wind and solar power.

More broadly, governments should strike agreements that allow them to share in the profits from their successful investments. And most of all, they should build the public agencies of the future, turning them into hotbeds of creativity, adaptation, and exploration. That will require abandoning the current obsession with limiting the state's intervention to fixing problems after they have happened—and smashing the popular myth that the state cannot innovate.