Revisiting the government's role in catalyzing modern innovation

A toolkit for public sector organizations to energize ecosystems and spur innovation

A report by the Deloitte Center for Government Insights with the Council on Competitiveness

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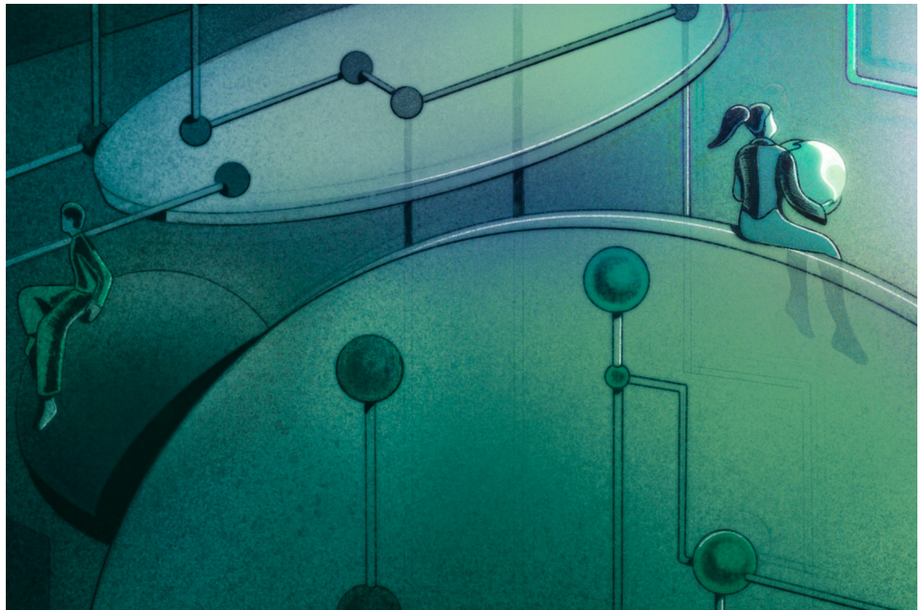
Introduction

From virtual assistants to jet engines to the internet, government has often played an important role in driving major innovations, the effects of which often extend far beyond the public sector.[1] Though each of these innovations began as government-funded undertakings, the real value was realized only when the commercial sector adopted these new technologies and spread them more broadly.

But the nature of innovation has changed in recent years. In the post–World War II era, government often spurred innovation directly through its own research and development (R&D), or through targeted funding of research and development. Though still possible, this linear journey of innovation through government, academia, and industry is less common today. That's because we live in a more complex, interrelated world—and we have entered an era of innovation by ecosystem.

In the past, catalyzing innovation often resembled striking a match—a single act that turns into a roaring fire. But today, innovation is more like building a fire in a storm—the stage needs to be carefully set, a match set to it, and then the delicate early flickers nurtured until they become a self-sustaining blaze.

Far from being irrelevant, the difficulty of coordinating an entire innovation ecosystem means that government has as important a role as ever in innovation. But, in many cases, the tools available to government are the products of an older age. Catalyzing innovation in the era of ecosystems calls for new thinking to match the new reality. Government should have a new understanding of how innovation happens and a new set of tools to accelerate important innovation ecosystems.



How does innovation in an ecosystem happen?

There is no single, universal path for innovation. That said, there are three important points that ring true for many innovation pursuits today:

Innovation isn't a linear process

The popular image of innovation involves a scientist making a brilliant discovery that then is translated into a product made in a huge factory and ultimately bought by millions of consumers. This image clings on stubbornly because it's a perfect fit for stories that demand a beginning, a middle, and an end, in that order. The linear model of innovation gives you exactly that with discovery, manufacturing, and adoption. Each time we describe the history of an innovation, the very act of telling the story pushes us toward this linear model.

But while it's well-suited for storytelling, it's a poor fit for how innovation *actually occurs*. In practice, engineering inventions can spark new discoveries in basic science. The adoption of early-stage products, and even their failure, can provide the engineering know-how needed to create later innovations. In reality, the innovation process isn't linear; it can bounce between scientific discoveries, engineering improvements, and even breakthroughs in marketing and financing.

There will always be incremental innovation that linearly builds on what came before—the next generation of smartphones with a bigger screen or sharper camera, for example. But even when the improvement in performance is linear, the story of how that improvement came to be may not be. Take the camera on your smartphone for example; each year, image resolutions keep getting better. But this improvement is not just a function of packing in more light sensors into the phone. Rather, the big jump in image quality seen in the mid-2010s was the result in a shift to "computational photography" where many images were stitched together to create a higher-quality final image.[2] The shift to computational photography was not a linear process of scientific breakthrough to engineering to final product. Rather, it took engineering breakthroughs packing more memory and computing power into phones to allow academic researchers to create new image-processing algorithms and so on.[3]

Smartphone photography is just one example of many illustrating nonlinear paths to innovations. In their book, *Cycles of Invention and Discovery*, Venkatesh Narayanamurti and Toluwalogo Odumosu illustrate the nonlinear nature of innovation through the story of modern communications technologies where the engineering breakthrough of transistors sparked both engineering advances *and* basic science discoveries that led to the integrated circuits and fiber optic cables that are the foundation of today's internet.[4] In fact, we can see the nonlinear course of innovation when consumer demand drives a new innovation. Rather than following a neat path from lab bench to factory to market, several industries from video on demand to curbside retail pickup have been driven by changing consumer preferences.[5]

Innovation can require many players in many roles

The nonlinear nature of innovation means that modern innovation is not one and done but is the product of

many iterations of scientific discovery, engineering expertise, marketing, and funding. These four roles are central to the successful adoption of innovation.

But this does not mean that one player has to do it all. These roles can be played by many different players. Take R&D as an example. Major R&D breakthroughs can come from academia, commercial industry, or government. The transistor was the product of commercial R&D at Bell Labs; the low-power displays that created e-readers emerged from academia via MIT; and Siri, the voice-activated smartphone assistant, originated from government through work at the Defense Advanced Research Projects Agency (DARPA).[6]

The picture can be further complicated by the fact that players can each play multiple roles. For example, academic researchers don't just do research, they can also be entrepreneurs building products and shaping markets.

Players can not only play multiple roles but can also transition to a particular role over time. Take the oft-mentioned "valley of death" between R&D and commercialization, the point at which government-backed funding runs out before an innovation can attract commercial investment. In essence, this valley of death can be deadly to innovations because it's the point at which the funding role *shifts between players*. Seen in this light, the valley of death isn't a unique phenomenon: It's just one of a larger class of role transitions. Not only can funding move from government to industry, but R&D can move from university to industry; market shaping from a government's national strategy to a company's advertising campaign. And unless these transitions are managed effectively, any of them can prove fatal.

Success depends on achieving a self-sustaining market

An innovation isn't successful unless it's adopted and *used*. Those guiding it should have the resources needed to continue adoption and development over time. In many contexts, this means creating a self-sustaining market for the innovation.

A common critique of government efforts to spur innovation is that they "shouldn't pick winners." Creating a market for an innovation can help avoid this pitfall and can actually lead to more successful, enduring innovations as well. For example, compare the Super Sonic Transport (SST) program of the 1970s with NASA's commercial space efforts in the mid-2000s and early 2010s.

Rather than trying to build a commercial market for the airliner, the US government approached the SST as if it were a military project, setting requirements and soliciting proposals from designers.[7] But the government's commitment to the project waned over time and the program died before a thriving commercial market could be established.[8] NASA's programs for commercial space, by contrast, *began* with the goal of creating a flourishing market. NASA used tools such as guaranteed purchases to lessen the financial risks for the development of progressively more complex tasks until a rich and growing ecosystem of commercial space companies bloomed.[9] This shift in thinking was captured by Nick Skytland, chief technologist at NASA's Johnson Space Center: "No longer do we measure our success just by NASA's budget but by the total space economy and the growth of that."[10]

Ecosystems are powerful, but managing them is often harder

Innovation is increasingly the result of an ecosystem. Ecosystems involve diverse participants with their own incentives, which means that promoting innovation could require shaping the incentives correctly. To speed up innovation often requires getting "the right players playing the right roles."

But finding the right incentives to coax the right players into the right roles can be more difficult than ever as the number of players grows and the tools available to government leaders shift.

More players with diverse incentives

Each player comes to the table with their own unique mix of risk and incentives. As the number of players involved in innovation increases, the overall group may become more productive, but it also can become more challenging to manage. From our interviews, we've seen just how diverse these incentives can be:

- **Founders and startups.** Matt Wren, founder of immersive technology startup VRAR Chicago, describes the risk/reward calculus facing small companies: "As a founder, my main incentive is just to solve problems. There's a strong draw to work with government, since they're pushing boundaries and can also offer large contracts that would give my company two years of runway in some cases. However, the risk is also massive because the budgeting and contracting processes make government so difficult to work with. There's a careful balancing act as a startup: you often want to pursue government contracts, but if you put too many eggs in that basket and the contracts don't materialize soon enough, you can go out of business waiting or get driven overseas to find faster moving customers."[11]
- **Venture capital and other investors.** In a recent speech before the Council on Competitiveness, Dr. Arati Prabhakar, director of the White House Office of Science and Technology Policy (OSTP), drew on her personal experience: "Between 2001 and 2010, I saw lots of VC interest in technologies. Often, they could get a product but could not scale because scaling required capital-intensive manufacturing at a time when risk was still high. So often those technologies left to go somewhere overseas where either capital costs were lower because of cheap labor or where capital was more available."[12]
- **Industry.** Mike Brown, former chief executive officer (CEO) of Symantec and former director of the Department of Defense's (DoD) Defense Innovation Unit, says that investor priorities may hurt incentives for industry: "We need to rethink capital markets and what we are incentivizing. Capital markets are after the shortest possible return. And as a former CEO of a tech company, if you're not delivering that return quickly, you will be fired and replaced. The SEC needs a measure of building long-term value of a company—and that measure needs to be as important as earnings per share this quarter."[13]
- **Academia.** Academic researchers often face intense pressure to publish widely cited research. That pressure, however, creates incentives to achieve high citation counts that may dilute efforts toward genuine breakthroughs.

- **Government.** Government leaders face perhaps the widest scope of both incentives and risks. Even national labs do not do science purely for their own sake, but for wider public benefit. "National laboratories play a pivotal role in assuring that the discoveries and breakthroughs from their R&D ultimately benefit the nation and its citizens," said Paul Kearns, laboratory director at Argonne National Laboratory. "From basic science to technology transitions, US competitiveness is a goal and an outcome of the collaborations the labs foster across industry, academia and local communities."[14]

- **Workers.** Individual workers also require incentives. Nick Pinchuk, chairman and chief executive of toolmaker Snap-on, believes that celebrating the value of technical careers can help spur growth: "We don't need to give workers the skills of tomorrow. The jobs are already out there today. What we need to do is convince people that these careers make a real difference, providing significant value to themselves, individually, and to our nation, collectively."[15]

Government's tools are becoming more indirect

Government has a baked-in incentive to foster innovation. Like most players, governments can benefit from innovation directly as new technologies improve services and save money. But government *also* benefits when its citizens do. So, government may support innovations that grow the economy or improve standards of living even when that innovation doesn't affect government directly. As a result of this double incentive, government often finds itself playing a central coordinating role in innovation ecosystems.

In the era of Vannevar Bush and his 1945 report to the president, *Science: The Endless Frontier*, the federal government often drove innovation directly through its own R&D efforts. These efforts proved effective, leading to the commercialization of a range of technologies in the half-century following World War II. As the innovation landscape changed and the number of players proliferated, however, the incentives of those players changed as well. As the rate of commercial investment went up, government's share of total R&D spending fell.[16] The declining importance of its R&D funding made government less effective in steering the industries' overall direction.

As government performed less direct R&D itself, commercial industry didn't always fill the void. As Mike Brown noted above, market incentives aren't always aligned to long-term, capital-intensive R&D efforts: "In 1960, we were spending 2% of our GDP on research at academic institutions; today, that number is 0.35%," he says. "And we're still benefiting from technologies developed for the space program in the 1960s, namely, semiconductors and the internet. But we've reached a dilemma: Do we, in the interests of shareholders, continue to squeeze more value out of historical innovations, where every last marginal penny matters—OR—in a world where adversaries are actively trying to displace us in technology, change incentives in our capital markets to focus on longer-term investment horizons that build national capabilities?"[17]

At the same time, government has faced adverse incentives of its own. Complex innovation ecosystems make it harder for government leaders to estimate the value of their next dollar of direct spending—and budget pressures make it harder to justify. As Jenn Gustetic, NASA's director of Early State Innovations and Partnerships, says, "It's difficult to model outcomes of research funding, so government leaders can't prove exactly what level of research dollars is needed for a breakthrough. And since we're *all* under some budget pressure, we increasingly try to use more indirect tools."[18]

Indirect tools, such as tax incentives and loan guarantees, are attractive to government leaders because they can shape market behavior with little or no upfront cost to the government (see sidebar, "List of common government tools"). But using indirect tools effectively requires government leaders to have a deep understanding of the dynamics of their innovation ecosystem. Not only should they know how players might react to an indirect tool but how others could react to *that* reaction, and so on.

LIST OF COMMON GOVERNMENT TOOLS

In his book, *The Tools of Government*, social scientist Lester Salamon conducted a detailed examination of all the tools government leaders can deploy to achieve public goals, drawing a distinction between those tools that *directly* achieve a goal and those aimed at encouraging a third party to achieve the goal.[19]

While the distinction may sound academic, indirect tools have emerged as the dominant government tool in recent decades (figure 1). One indirect tool, tax expenditures—revenue lost due to exclusions, exemptions, deductions, credits, deferrals, and preferential tax rates—dwarfs almost all the others. In 2021, federal tax expenditures amounted to US$1.4 trillion in foregone revenue, compared to US$1.6 billion in discretionary spending, a number itself including many other indirect tools.[20]

Understanding when to use which indirect tools is, therefore, one of the most important skills in managing a complex innovation ecosystem.

Figure 1

Indirect tools are becoming a growing part of government's toolbox at every level

Direct tools	Indirect tools
Direct provision of services	Social regulation
Government corporations	Contracting
Economic regulation	Loan guarantees
Public information	Grants
Direct loans	Tax expenditures Fees and charges Insurance Tort law Vouchers Government-sponsored enterprises

Source: Lester M. Salamon, *The Tools of Government: A Guide to the New Governance* (New York: Oxford University Press, 2002).

A deeper understanding of ecosystem dynamics

To use indirect tools effectively, government leaders should have a detailed understanding of how specific innovation ecosystems work.

But this understanding can be hard to achieve, especially for government leaders who can only see their own portions of the system. "The big gap for government leaders is an understanding of market behavior," says Patrick Littlefield, former executive director of the Department of Veterans Affairs Center for Innovation.[21]

The power of government incentives can make them keen to play a coordinating role in innovation, for instance, but those same incentives can put them out of step with the rest of the players. The scale of government purchases means they can play a key role in helping a natural market develop. But "for founders and startups it's all go all the time," says Robert Wines, a senior analyst at Fedtech. "They need government to provide the IP, but government operates on a different timescale, so meshing those together can be hard."[22]

To catalyze innovation the way the government wants and the public demands, government leaders may need some help in managing these complex ecosystems.

Deploying new tools for a new era of innovation

Each innovation ecosystem is different. The quantum computing industry has different players with different incentives than the semiconductor or renewable energy industries. So rather than a specific playbook, what government could use is a *repeatable process* to determine how and when to use which tools.

It's like finding your way through the woods. The specific map you need could change depending on where in the world you are, but the basic principles of land navigation stay the same and can help you get around *wherever* you are.

To help catalyze innovation, that repeatable process typically includes:

1. Identifying players and deciding collectively on goals;
2. Understanding players' risks and incentives; and
3. Crafting interventions to shape market behavior.

By following these steps, government leaders can help steer a complex mix of players with different risks, incentives, and abilities toward innovation.

1. Identify players and decide collectively on goals

Why? Innovating presupposes that we know what problems to solve. In public innovation, the problem is compounded by the number of different players who may have different perspectives on what "good" means. Does it mean better performance, cheaper costs, or something entirely different? For private institutions, a strategic plan can help answer those questions, but for public innovation, the "good" can only be defined collectively. There may be disagreements, but just as communities make collective decisions about budgets, they can and should make collective decisions about their priorities for innovation.

Tools: For centuries, communities of all sizes have used different consensus-forming tools to decide on collective visions. These can include political processes, such as the White House Office of Science and Technology Policy's national strategies for various technologies, or new, tech-driven collaborative vehicles, such as the vTaiwan platform the government of Taiwan uses to build consensus on important issues such internet regulation.[23] But it can *also* mean simply convening the key players in the same room.

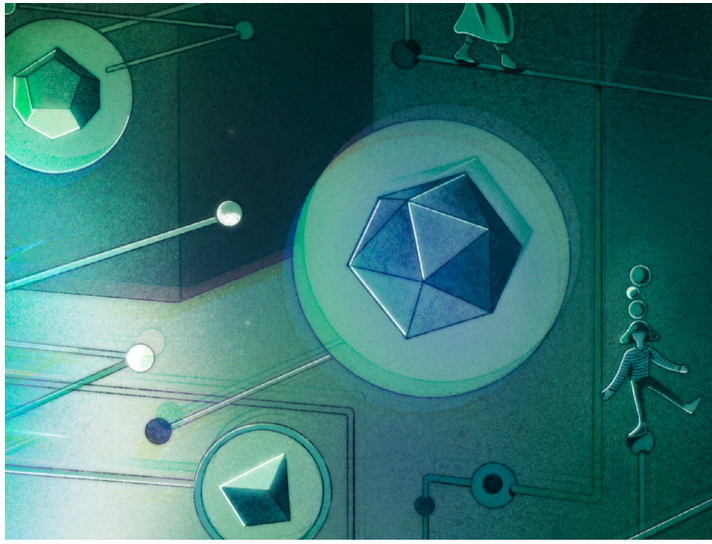
See it in action: Collective decision-making can be relatively easy in small groups, but how can we reach collective decisions at the scale of industries or even whole regions? That was the challenge facing Dr. Erwin Gianchandani, the National Science Foundation's (NSF) assistant director for Technology, Innovation and Partnerships, as he and his colleagues, including the director of NSF, Dr. Sethuraman Panchanathan, sought to catalyze "innovation engines"—regional coalitions to engage in R&D, bring their innovations to society, and develop the workforce needed to apply them.[24] The answer turned out to be building it into the program itself. As communities applied to receive funding to create regional innovation engines, they were steered toward creating structures for their bids that would *force* collective decision-making. As Dr. Gianchandani describes: "It's certainly important for all the participants in that engine to work together around a clear vision. That's built into the format and the governance structure of the NSF Engines. Within an NSF engine, we want a CEO who is empowered to drive things forward and bring together different players—different advisory groups and org structures each engine should possess. There's a governance board responsible for gathering that consensus from all participants within the NSF engine, and then there's an advisory board used to gather input from those outside the NSF engine."[25]

2. Understand the players' risk and incentives

Why? Agreeing on desired outcomes is important, but it's only the first step. For example, the cybersecurity of critical infrastructure is widely seen as a desirable outcome—yet we've made little progress in the 30 years since it became a policy priority.[26] This continued vulnerability isn't because people don't understand that cybersecurity is important, it's because many of the players have conflicting incentives.[27]

The same can be true in innovation. We saw earlier how players' diverging incentives can result in promising innovations being driven overseas or failing in the "valley of death." Government leaders should understand the risks and incentives facing *all* the players in the ecosystem.

The first step toward coordinating players is the creation of a new organization or business process. Yet historical evidence shows that these don't tend to work well, especially at scale. Federal use of "Other Transaction Authority," for instance, may help speed acquisition, but it has largely failed to attract large numbers of nontraditional vendors because it doesn't address their risks and incentives.[28] As startup founder Matt Wren says, "simply creating yet another bureaucratic rapid prototyping organization is not going to solve the problem. Startups, particularly innovative technology companies, need direct access to customers and a clear path to revenue."[29]



To better understand the incentives facing real people, you often have to interact with them. That ability to use real human relationships to bridge groups is what makes the Defense Advanced Research Projects Agency program managers successful, and it works in other areas of innovation as well.[30] Allison Winstel, chief of staff of the hardtech innovation center mHUB, which has helped 450+ startups launch over 1,500 products, raise US$1.49B in capital, and hire over 5,190 employees, attributes this success to personal connections and understanding each stakeholder's incentives: "At mHUB, we understand that accelerating innovation is a collaborative effort. We've built an ecosystem across startups, industry, investors, and community partners, all which play a role in catalyzing change and building structure around a common challenge. The key is creating mutually beneficial partnerships, which means that we need to think about what each stakeholder values in relation to a shared challenge to create a shared vision of how to tackle it. Our most successful and longer-term partnerships come out of thinking about what each partner will gain—whether it's access to talent or new technologies or deal flow or something else—and what will bring the greatest value to our startup community. Ultimately, it's relationship building and aligning stakeholders. Talking with people to understand their values and incentives comes out in conversation faster than you think."[31]

Government can't simply *require* people to build new relationships. But it *can* create the rules and infrastructure that encourage individuals to span multiple groups. These "bridgebuilders" can help uncover each player's incentives and goals. That's what the NSF aims to do with the Regional Innovation Engines program, as Gianchandani says: "At the core of every innovation engine is a set of organizations that we want to bring together: universities, industry, nonprofits and so on. We want them to come together organically yet also intentionally and give rise to an innovation ecosystem, and hopefully that will become self-sustaining. But that transition will require support and capacity-building."

"For example, we know that certain capabilities are important. It's important to have a CEO for the NSF engine. It's important to think about diversity, equity, and inclusion. It's important to think about measures of success, to think about we how evaluate the work we're doing, and so on."

"The Builder Platform is NSF's attempt to create a common set of resources and capabilities that we can provide to each engine so that the engine itself can provide those needed resources to the ecosystem. It's designed to be a human-centered network, connecting real people in the innovation engines with real people with the capital, data, partners, and other tools the engines need to spur innovation."[32]

Tools: Government leaders can use numerous tools to get an accurate picture of the risks and incentives of an innovation ecosystem. These can include any tools that help bring structure to the complex mix of economic and social forces that shape markets—political economy analysis, causal loop diagrams, user feedback, qualitative interviews, and more. The precise tool or mix of tools could vary with the specific situation.

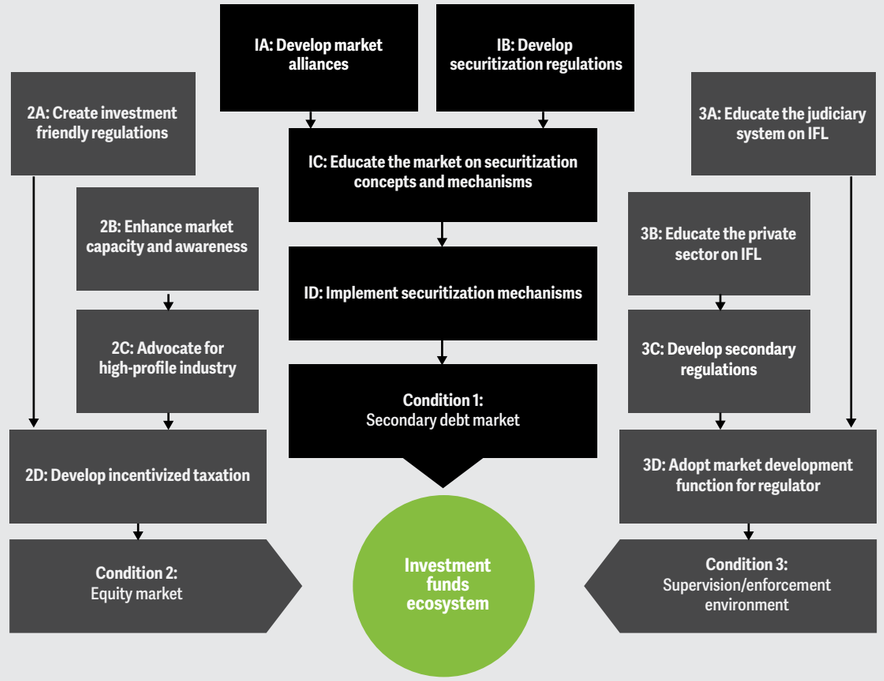
See it in action: Just as emerging technologies may need to attract external investment, so too must emerging market nations attract capital investment to grow their economies. For decades, the government of Georgia sought to spur economic growth, but lacked the infrastructure needed to encourage modern, flexible capital markets. In working with the US Agency for International Development, the Georgian government followed a three-step path to craft interventions to its capital markets.

First, it identified the interested stakeholders and analyzed their interactions. Next, root-cause analysis helped illustrate how the players' competing incentives combined to hinder market development. Finally, the team was able to show the interactions between these various root causes to choose which interventions were most likely to be effective. Using these findings, Georgia's parliament crafted the 2020 Law on Investment Funds, which helped lay the foundation for more vibrant capital markets and greater economic growth (figure 2).[33]

This figure shows the connections among root causes of capital market constraints. The more interconnected the causes, the bigger the problem they can create for the investment funds ecosystem—portrayed graphically in the size of the bubble.

Figure 2

Mapping how individual incentives combined into ecosystem root causes helped craft the 2020 Law on Investment Funds in Georgia



Source: Deloitte Consulting LLP, "Systems approach policy value chain analyses: Investment funds law," Prepared for the United States Agency for International Development, August 14, 2020.

3. Craft interventions to shape market behavior

Why? As the Georgia example demonstrates, an understanding of players' risks and incentives can help identify useful interventions. But the complex dynamics of markets are unlikely to be moved by a single intervention by one player. The nonlinear nature of innovation means that success is most likely to come from a series of actions by different players over time.

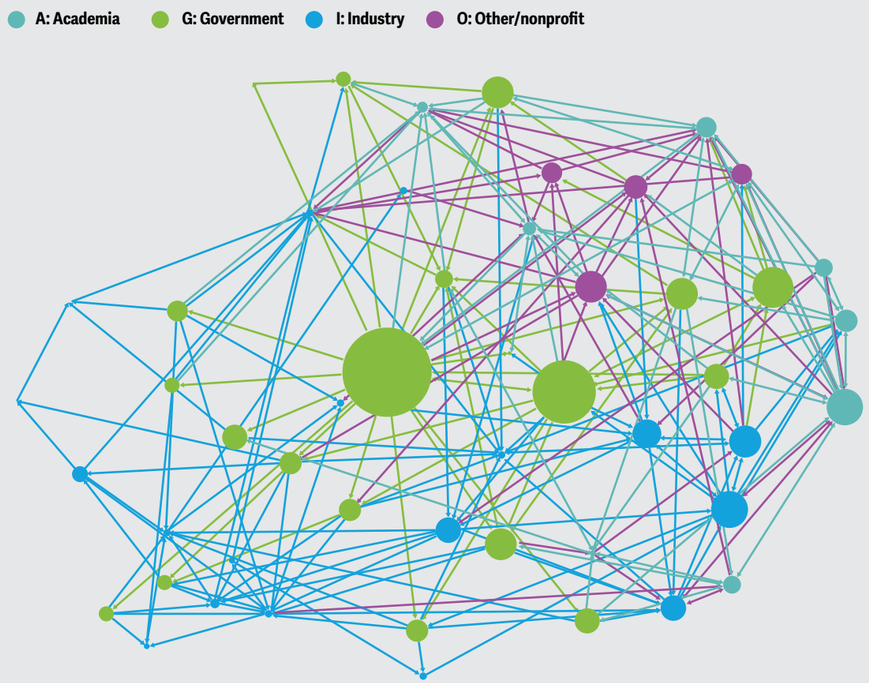
A challenge in crafting interventions, then, isn't to choose a single intervention, but rather to manage the interactions among all the different interventions of different players. After all, each comes to an innovation ecosystem with a unique set of tools that operate in unique ways. For example, only government can provide tax exemptions.

Furthermore, the tools of each player can have knock-on effects on the actions of other players. If government

funds research grants, it's likely to cause academics to pursue more of that research, and perhaps even to create new majors or open new research centers. Graduates in those new majors, in turn, can influence industry to create workforce development programs to integrate new skills into their workforces, and so on. One example is the explosion in data science talent. As the National Science Board and others began to recognize the economic importance of data in the early 2000s, universities began to take note. The proliferation of data science programs in the 2010s was soon producing graduates that could help both industry and government drive innovation even further.[34] By examining the connections among these tools, we can create a network graph that illuminates the dynamics of innovation ecosystems (figure 3).

Figure 3

A network map of innovation tools highlights the interdependencies between players and roles. No single player can achieve an end without influencing (and therefore working with) another player.



Source: Deloitte analysis.

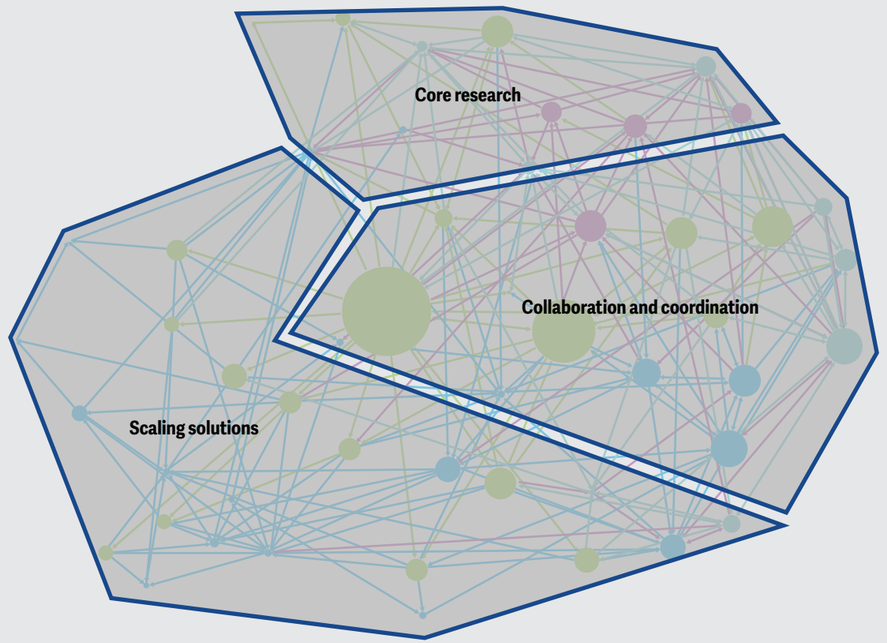
Managing this cascade of interventions, then, should be a *prime goal* of government leaders seeking to catalyze innovation. They should understand incentives and tools enough to set in motion—and continue to shape—the players' actions so that they tend toward the creation of a self-sustaining market.

Tools: Many tools can influence market development, and they'll likely vary from ecosystem to ecosystem. It's important, then, to find tools that allow leaders to understand how all the actions of different stakeholders can interact—the tools to manage the tools, so to speak. These can include root-cause analysis as used in the Georgia example—directed graphs such as seen in the common "paths of innovation," or other analytical techniques.

These techniques can help government leaders uncover specific interventions based on the needs of an innovation ecosystem—whether it needs help with research, collaboration, or scaling solutions (figure 4).

Figure 4

Understanding how player tools interact can help leaders select the right intervention



Source: Deloitte analysis.

See it in action: The process of choosing the right interventions to build a self-sustaining industry can be illustrated by the story of the domestic drone industry. In the 2010s, the DoD realized it had a problem: the market dominance of a single foreign-drone manufacturer meant that the military struggled to find small drones from other sources to meet its needs.

Policymakers felt that the solution was clear: The department would have to help foster a domestic drone industry. The risks that had previously stalled domestic companies were fragmentation and low demand, so any intervention would have to address that risk. Part of the task fell to Mike Brown at the Defense Innovation Unit: "Encouraging a domestic industry is one thing we took on at DIU via the Blue UAS program in 2020. We initially qualified five companies as being capable of meeting needs, a number that would later grow to 13. We put those on a Blue UAS list and on a GSA schedule that anyone could buy. Then we invested in some PR so that everyone in government knew that these vendors were out there and prequalified. In that way, we were trying to aggregate demand to provide better economic incentives for the industry."[35]

But the government did more than simply acting as a buyer; it also deployed regulatory tools. The FY 2020 National Defense Authorization Act banned the procurement of certain foreign drones by DoD and the Department of Energy in most cases; in 2021, Executive Order 13981 broadened the ban on using select foreign-made drones to *all* federal agencies.[36]

Through legislation and other programs, the federal government provided infrastructure to support domestic manufacturers. One key aspect is the business infrastructure needed to scale new drone products. As FedTech's Robert Wines says, "Government agencies provide infrastructure by funding venture building and accelerators like us. They fund us and we provide some of the infrastructure the ecosystem needs."[37]

And so, DoD obtained access to domestic small drone makers, while the drone companies secured enough demand to grow. The result was a self-sustaining domestic drone industry that dropped the global market share of the domain foreign-drone manufacturer from more than 80% to 54% in 2021.[38]

PUTTING EVERYTHING IN THE RIGHT ORDER: COMMON PATHWAYS OF INNOVATION

The idea that successful innovation takes not one intervention—but several chained together has another interesting consequence. Since the reactions caused by different tools will tend to be similar even across different industries, common pathways of innovation tend to emerge. And importantly for government, several of these pathways illustrate how government can use its roles as buyer, regulator, or infrastructure provider to jumpstart successful innovations.

Government as a buyer: Satellite communications

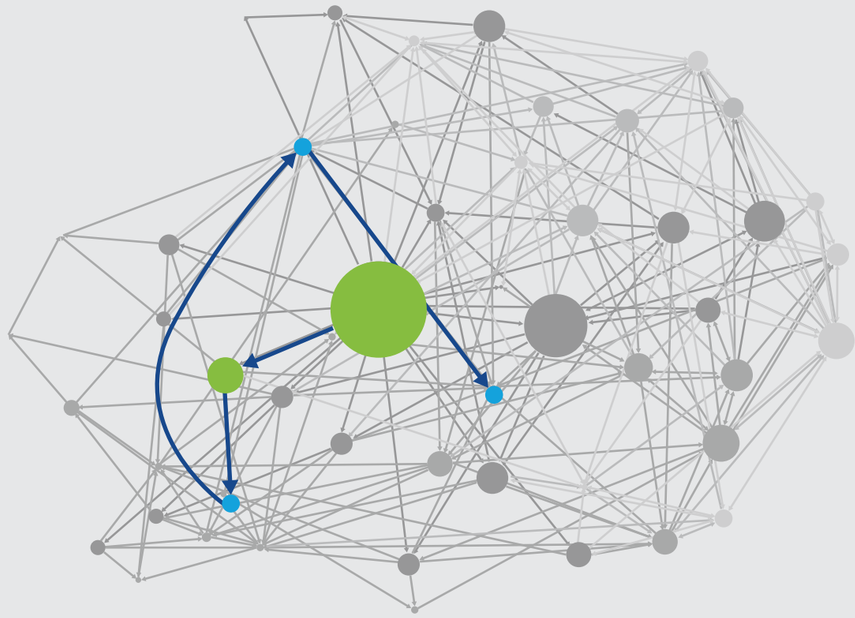
In the late 1990s, the US DoD conducted a series of studies on the communications requirements needed to fight and win two simultaneous conflicts.[39] These found that the military's own communications resources wouldn't be sufficient; commercial providers would be needed to augment its capabilities. In the same period, early experiments with the use of commercial satellite communications were starting to bear fruit.[40] By the turn of the millennium, military planners already were focusing on how to incorporate commercial communications into their operations.

This meant that the almost insatiable demand of the US military for communications provided a guaranteed market for commercial satellite communication providers. This market was so important that when the original Iridium SCC constellation of satellites declared bankruptcy in 1999, it was rescued by a US$72 million contract from DoD.[41] The funds not only secured Iridium's future as a commercial provider, but also allowed it and other companies to invest in the R&D and engineering needed to grow their systems to a scale sufficient to win adoption in a wider market (figure 5).

Figure 5

Government catalyzed the development of commercial satellite communications

Government-backed industry-led pathway



Source: Deloitte analysis.

Government as a regulator: Malaria vaccine

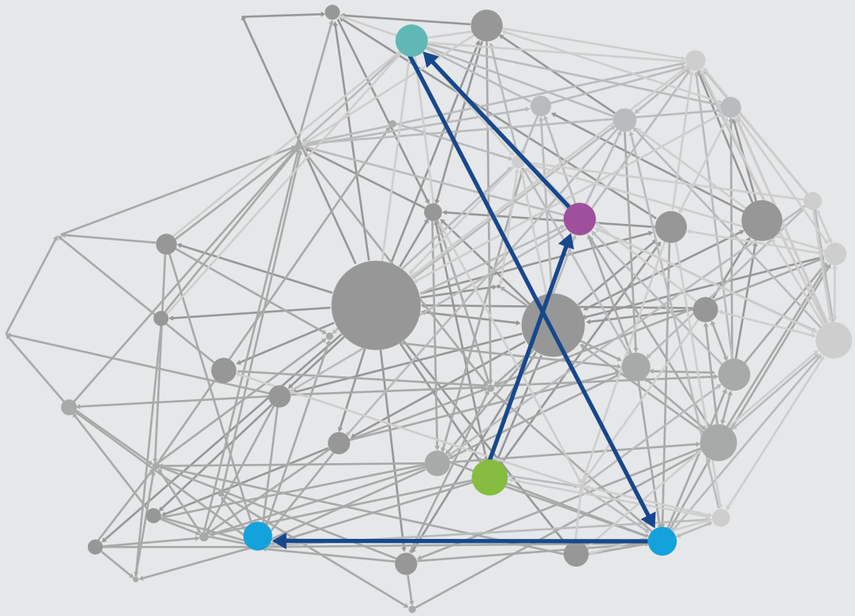
Many national governments encourage investments in public health challenges through a mix of tools such as tax incentives, prizes and challenges, national strategies, and direct funding.[42] The development of a malaria vaccine began in 1980, when US government researchers identified a protein on the surface of the parasite that causes malaria and realized it might be useful for a vaccine. They sequenced the protein's gene in 1984, and enlisted Smith, Kline & French (later GlaxoSmithKline) to work on a vaccine.[43]

More than a dozen attempts failed until a promising candidate emerged in the 1990s. Many trials followed to test safety and efficacy; finally, the World Health Organization worked with governments in Ghana, Malawi, and Kenya to pilot the vaccine in 2019. The regulatory structures around testing and approval of the vaccine were critical to proving the vaccine's effectiveness and attracting further investment from corporate and international donors to fund more than 10 million doses for children.[44]

Figure 6

Government's role as a regulator can be key to breakthroughs made by others

Philanthropy-led investment pathway



Source: Deloitte analysis.

Government as infrastructure provider: The cell phone industry and the wireless spectrum

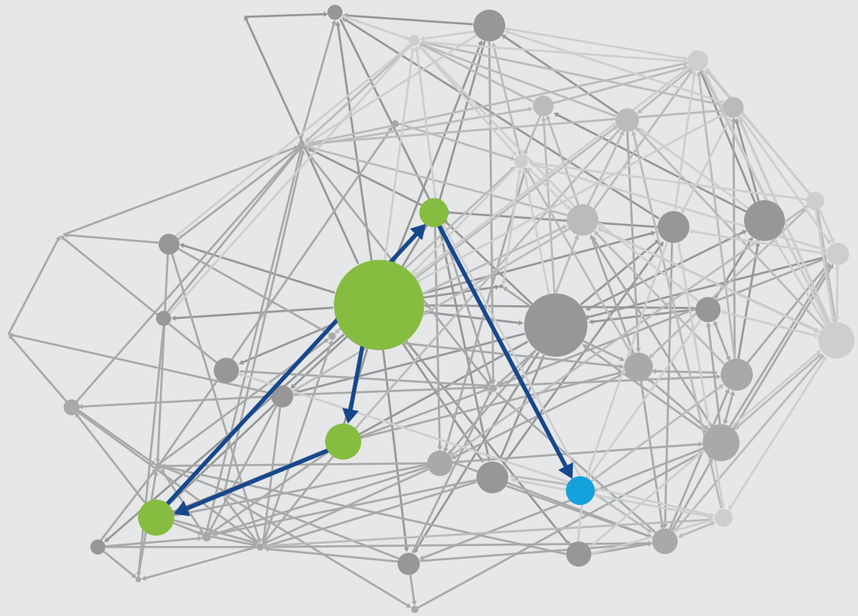
The wireless spectrum is the cellular phone industry's lifeblood. While small-scale cellular-phone experiments had gone on for decades, the first consumer-scale cell networks in 1984 wouldn't have been possible without spectrum allocation by the Federal Communications Commission (FCC). The FCC was more than a passive participant; it actively reallocated spectrum from underused bands such as UHF TV to support the innovative new phones.[45] As demand for cellular service grew, the FCC innovated again, creating auctions in 1994 to make more spectrum available, generate revenue for taxpayers, and spur market competition.[46]

The FCC isn't the only government agency to spur innovation by providing infrastructure. The National Science Foundation underwrote the development of MRI machines by providing more than US$90 million in research and test infrastructure to inventors, while the US Department of Energy offers the use of national lab facilities to startups developing innovations.[47]

Figure 7

Government spurred the development of consumer cell phones

Infrastructure-led pathway



Source: Deloitte analysis.

A path forward

Coordinating massive innovation ecosystems often requires skills and structures that many public organizations might currently lack. Agencies may need to make changes before they can execute the three-step process to catalyze an innovation ecosystem; these changes can be thought of as "table stakes" for innovation. Some of the most common recommendations voiced in our research were:

- **Structural reform.** The three-step process for managing an innovation ecosystem highlights the central role that collaboration plays in innovation. Without collaboration, you cannot identify players, come to a consensus on goals, understand the dynamics of an ecosystem, or shape its behavior. No single organization can coordinate the complex interactions of every innovation ecosystem but creating the structure to provide the tools needed to coordinate those ecosystems is critical.

  The federal government should create several organizations to provide the infrastructure needed to coordinate innovation ecosystems.[48] For example, a National Competitiveness and Innovation Council out of the White House could create a national vision that innovation ecosystems could align to. Then other organizations could provide the tools needed to manage coordination in a particular industry or sector. For example, a National Innovation Radar could provide tech-scouting tools while a Technology Statecraft Initiative could help map the dependencies between diplomatic and economic interventions.

- **Procurement reform.** Government's size and scope can make its role as a buyer incredibly important to innovation. Yet, the often-ponderous procurement process can place it at odds with the needs of startups and small businesses. Mike Brown recounts a story of when his team "worked on a small quad-copter project for the Army. It took 10 years to get through the requirements, acquisition, and budgeting processes, which took 30 months alone. Over the same period, the commercial industry leader introduced seven new models for one-tenth the costs."[49]

  Reforms to speed the procurement process could help reduce risk for startups and give venture capitalists (VCs) and other funders an incentive to adopt longer-term views when supporting new innovations.

- **Hiring reform.** Government also should consider hiring workers that can speak the languages of the other players. This means workers with tech skills to talk with entrepreneurs; with academic experience to work with universities; and with financial knowledge to be able to understand the motives of VC and other funders. Right now, the slow hiring process and restrictive general schedule pay scale isn't conducive to bringing those with the right skills and connections into government. But several agencies have shown that rapid hiring and competitive pay *are* possible. Both DoD and the Department of Homeland Security have created specialized hiring pathways for cyber talent, while the Department of Energy has created a Clean Energy Corps to rapidly grow the talent needed for infrastructure projects.[50]

- **Talent reform.** Finally, ecosystems change, and the skills needed will evolve. This means that government should consider new HR talent management processes to encourage workers to build bridges to new players and learn new skills. For example, NASA incorporates metrics on external collaboration into its performance reviews for executives to encourage bridgebuilding.[51]

With these capabilities in place, government organizations can catalyze innovation in a given industry. In doing so, they can help ensure the nation's competitiveness and the prosperity of its communities, both now and in the future.

Endnotes

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Acknowledgments

The authors would like to thank **Pankaj Kishnani, Kannan Thirumalai,** and **Narasimha Mulakaluri** for their invaluable help in the analysis of this article.

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