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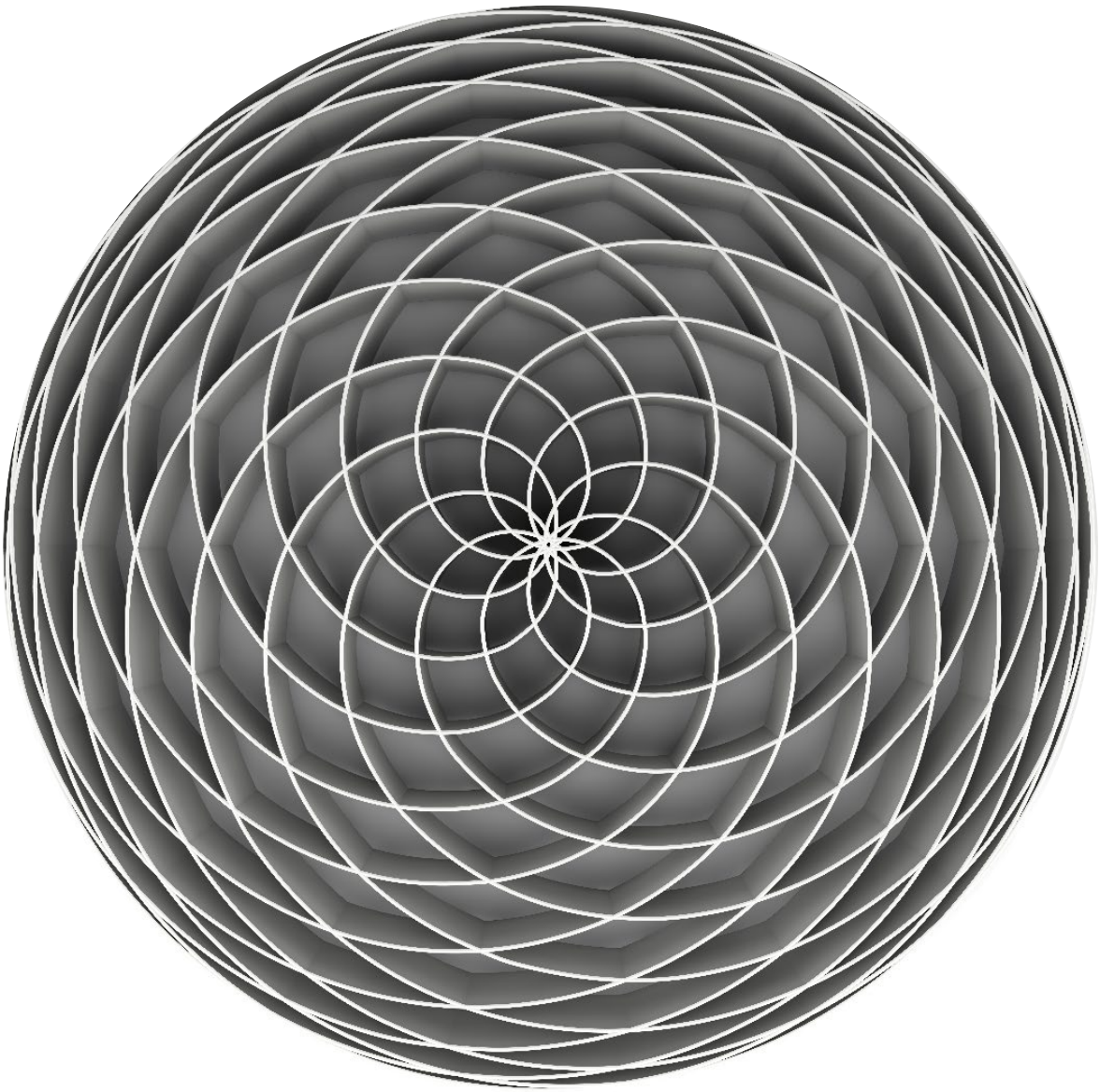

Seeding Markets To Grow Transformational Innovations

MAKING AN IMPACT THAT MATTERS since 1845

Table Of Contents

Introduction

If you are reading this on a tablet or phone, take a minute to appreciate those monuments of government-driven innovation. Nearly every key technology in those devices was created, funded or ordered by a government entity. We all know about GPS and the internet, but the world wide web, touchscreen, lithium-ion batteries, and signal compression all emerged from government[1]. Even Siri began life as a DARPA project before being spun off into its own company and later acquired by Apple[2].

But while these monuments to previous government-catalyzed innovations still shape modern life, government organizations often experience difficulty in similarly catalyzing the innovations that will shape tomorrow's world. Today, many government agencies - and private companies - struggle to overcome the 'valley of death,' keeping promising prototypes from full-scale adoption[3]. The challenge in transitioning technological innovations from prototype funding to sources capable of supporting scale is well studied. While it is beyond the scope of this paper to tackle that problem in detail, our research does point toward there being not one 'valley of death' but several. The same barriers to scale apply not only to technological innovations but to social innovations too, and the problem is not just transitions in funding, but transitions in all critical roles. These barriers have collectively made it quite difficult in particular to scale social innovations – that is innovations with non-technological solutions that address key societal needs from housing to healthcare to protecting natural resources, and require complex cross-sector coordination to execute.

This is doubly problematic because the biggest problems of today demand both technological and non-technological innovations. Societal challenges such as climate change or eroding public trust cannot be solved by new technology tools alone. Rather, they will take new ideas and new technologies working together to improve people's lives. Government still needs to play an important role in shaping and supporting innovations to these massive problems. But in today's environment, where the private sector has emerged as a dominant source of funding for both technological and social innovation, finding these solutions requires government to work in a more integrated, agile way with the private sector. To catalyze the innovations of tomorrow, government needs new tools today.

The Challenges Of Social Innovation

Social innovations present unique challenges to those trying to cultivate them. The transformations that are needed to solve society's largest challenges in the 21st are unlikely to be solved by technological innovations alone. Take some of the wicked problems in today's world as an example. Problems such as the opioid crisis or affordability in higher education all may include some element of technology. For instance, AI can help identify over-prescribers or at-risk populations to ease the opioid crisis or virtual learning can help bring higher education to a wider population[4]. But, even in these cases, the technologies will only make meaningful impact on the problem when paired with social innovations as well – new enforcement and diversion mechanisms in the opioid crisis and new business models and forms of student support in higher education. The transformational innovations of the future, then, will likely depend on catalyzing both technological and social innovations. And while you can look to your smartphone or air travel for evidence of government's success in catalyzing technological innovations, there are fewer clear examples of social innovation.

For any innovation to be successful, it needs measurable outcomes – not just measurable inputs. This is almost definitional. After all, how can you determine if an innovation was successful without reference to its outcomes? One challenge for social innovation is that outcomes are often not clear. For technological innovation, there are clear physical physical devices - or software - that are the outputs of the innovation process. Transistors come out of factories, microwave ovens appear on store shelves. For social innovations, it can be more difficult to identify what the right outcomes are. Take affordable housing as an example. "Ending homelessness" may be a good slogan, but it is not an achievable outcome for an innovation. Rather, something measurable and attainable such as "having one affordable housing unit available for every two individuals under the 50th percentile of income" could be such an outcome.

The second challenge for social innovations is that without measurable outcomes, it can be difficult to create markets for those outcomes. Technological innovations are typically catalyzed to scale by markets – consumers want to buy transistor radios, companies want the latest business intelligence software, and so on. Those markets become central forces in driving the adoption and improvement of technological innovations. But without defined outcomes, there is nothing for the market to move. Yet, markets can be such a positive force in driving the development of new innovations, it is worth uncovering how markets for social outcomes could be created.

By their very nature of producing tangible goods, technological innovations have a longer history of growing markets. Therefore, we can examine how government helped to catalyze market creation for technological innovations to glean lessons for how to create these markets for the social innovations the 21st century needs.

Section 1

How Government Catalyzed Innovation In The Past

Many of the features of modern life are the result of government-driven innovation and investments. The reach of government innovation goes far beyond just digital technology. Imagine taking a plane trip – everything from the jet engine of the plane to the RADAR that guides it through the air to the air traffic control system that tells it where to fly all came about as the result of government-sponsored efforts[5].

Historically, those government efforts shaped and nurtured innovations directly. The first turbojet engines were developed within the UK's Royal Air Force[6]. GPS still is owned and operated by the US Department of Defense. Air traffic control regulations are made by national governments and in most cases the controllers themselves are government employees as well[7]. Perhaps no single project embodies the direct approach to catalyzing innovation as the Manhattan project.

Seeding A Market Success: Nuclear Power

During World War II, the United States and Germany were engaged in a life-or-death struggle to be the first to build a nuclear weapon. There simply wasn't time for bureaucratic niceties. Instead, legendary Manhattan Project manager General Leslie Groves threw out the rule book and used more than $2 billion in 1940s ($34 billion in today's money)[8] to build a far-flung network that brought together some of the best minds in the country to work for the government. (He managed to do this while keeping the project's ultimate aim a complete secret).

But just because government was driving the project, footing the bill, and providing the facilities doesn't mean that it did all the work itself. The Manhattan Project brought together more than a dozen colleges and universities, two dozen corporate partners and thousands of scientists at federal laboratories and facilities across the country[9].

The Manhattan Project's web-like organizational structure was intended to maximize the potential for innovation. Different companies and universities were given responsibility for producing the discrete components necessary to make the A-bomb. The DuPont Corporation ran the plutonium project, Union Carbide developed gaseous diffusion, Chrysler produced diffusers, and the University of Wisconsin supplied electrostatic generators needed to measure nuclear constants[10]. In some cases, Leslie Groves, the project manager, assigned the same task to several entities as an added competitive spur to innovation[11].

This model was retained in the years following the war owing to the entry of the Soviet Union into the arms race. In fact, of the 60,000 people employed by the Atomic Energy Commission in 1951, all but 5,000 were contractors[12].

But building a nuclear industry took more than just government dollars and an ecosystem of smart players - it took creating a commercial market for nuclear power. This began with the Atomic Energy Act of 1946 which encouraged private companies to build nuclear reactors, but the financial and regulatory risks of nuclear power proved too great for many companies to take up the challenge[13].

To build a nuclear industry, the government had to use several tools at its disposal in a precise order. First it created government-owned demonstration reactors such as SM-1 at Ft. Belvoir, Virginia to show that nuclear power could provide electricity to the national grid[14]. It also used regulatory and policy levers to help build a market. For example, the Price-Anderson Act tasked the US Department of Energy to maintain a commercially-funded insurance pool into which nuclear industry companies would pay in exchange for liability coverage[15]. In effect, the Federal government removed a major risk barrier to greater commercial participation in the nuclear industry while providing protection to consumers all at no cost to taxpayers[16]. The Federal government also provided a baseline market in the form of Navy nuclear reactors to insulate the industry and help it through downturns in the commercial market[17].

While the long-term outlook for nuclear power generation is hotly debated as climate change and renewable energy push and pull on it, the success of government catalyzing an entire industry is clear. The Manhattan Project eventually gave rise to an industry of 94 operating nuclear reactors in the US, accounting for about 20% of US electricity generation[18].

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Seeding A Market Failure: Supersonic Transport

In the 1950s and 1960s the aviation industry was awash in predictions of supersonic airline travel, with 300 passengers flying from New York to Los Angeles in less time than it takes to watch a movie[22]. Spurred on by competition from the British-French development of Concorde, the US Congress spent billions on designs for a supersonic transport (SST).

However, the challenge was that the SST program operated much like the procurement programs for the military bombers that were the direct antecedents of its designs[19]. Rather than trying to build a market for airlines to purchase these planes and passengers to fly on them, the federal government merely funded development, down-selected designs and so on as if it were to purchase the planes directly. The result was that when government funding was cut in 1971, there was no other player that could carry forward development and the project was dead[20].

Contrast the SST with the success of NASA's Commercial Space Program and you can see in stark relief the importance of building markets[21]. Rather than just directly building a new rocket, NASA explicitly approached the Commercial Space Program with the goal of building a flourishing market for commercial launch providers. By using guaranteed purchases to de-risk development and offering progressively more complex tasks from launch to autonomous resupply to crewed missions, government successfully cultivated a rich and growing industry of commercial space companies.

Section 2

The Lessons Of Market-Making For Tech Innovations

There are several lessons for these market-seeding efforts that can be applied to the search for transformational social innovations.

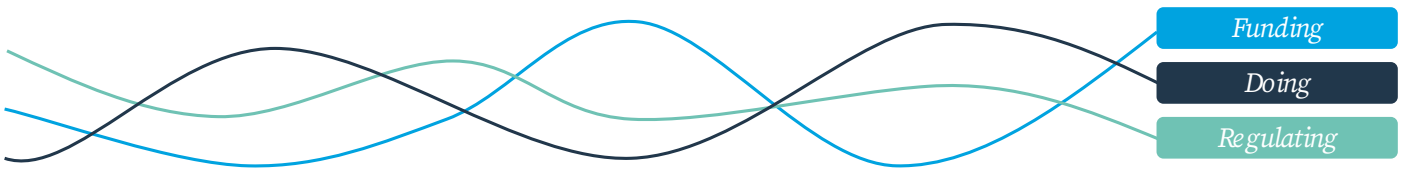
01. Innovations Require Different Roles To Flourish

Regulating, funding, doing. The 'triple helix' of innovation – where government, industry, and academia work together to advance an innovation – is well known. But, from the perspective of an innovation, having those three particular players (government, academia, industry) is less important than having someone filling the three roles (funding, doing, regulating) that those players are typically associated with. Every innovation needs someone to do work "whether research or testing or production," to finance that work, and to regulate it (Figure 1). While the traditional triple helix implies that each player fills a specific role, we have found that players can actually move around filling different roles at different times. For example, the evolution of low-emissivity or 'low-e' coated windows case shows how the different roles came together to deliver a new innovation. Low-e coating reduces emission of heat to improve a window's thermal insulation, keeping heat inside a building in cold weather and can keep heat outside in hot weather[23].

This increase in energy efficiency made low-e windows a high priority during the oil crisis of the 1970s. As a result, the Energy Research and Development Administration (now the Department of Energy) launched a low-e coated window R&D effort at Lawrence Berkeley National Lab (LBNL) in 1976[24]. Over the next decade, funding and research from the US Department of Energy (DoE) came together with research expertise from academia and manufacturing know-how and further funding from industry to create low-e films and windows that dramatically reduced energy consumption.

The low-e window innovation developed in collaboration with national labs, academia, and the private sector has saved Americans billions of dollars and strengthened the country's energy security. It resulted in net savings of $8 billion by 2000. Further, the invention has reduced the energy lost through typical windows by 35%, a whopping 440 billion kilowatt hours (kWH)[25].

Figure 1. Every Innovation Needs Someone Doing, Funding, And Regulating If It Is To Develop



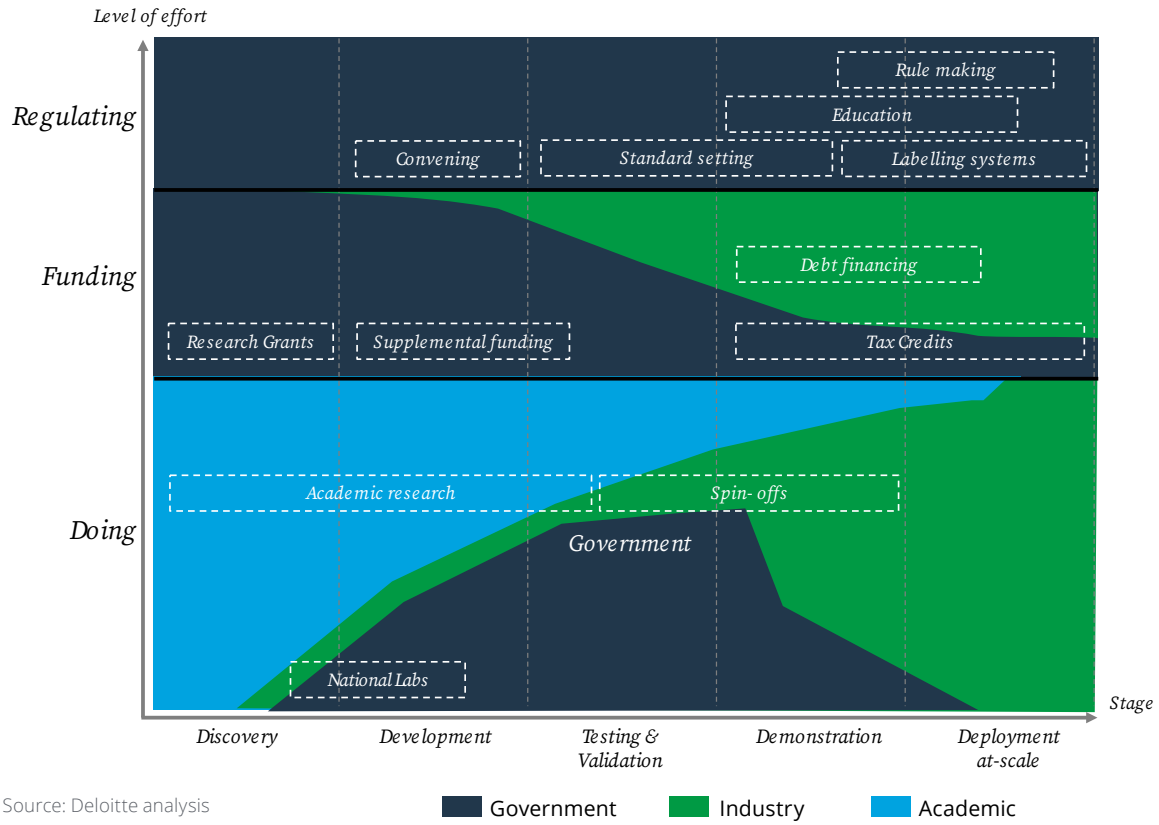
02. Who Plays What Role Changes With An Innovation's Stage

Just because government plays one role at the start of an innovation does not mean that its role is fixed. In fact, as an innovation matures, players are likely to adjust to different roles. The story of low-e windows helps illustrate this. We can think of the development of low-e coatings as being an interplay between industry, academia, and government each doing, funding, and regulating, with those roles shifting between players over time (Figure 2).

It started with the DoE both funding and doing the initial research via LBNL. But in the early 1980s, a group of students from the Massachusetts Institute of Technology formed a company as part of their research project to develop low-e glass film technology. After failing to get any private funding, the company reached out to DoE for investments and were granted $700,000 in initial R&D funding, with a condition that the company would partner with a national lab. The company chose to work with LBNL and with the lab's support released the first low-e film in the market that could be fixed to a window[26]. In essence, government shifted its role from both doing and funding to just funding while an academia-spawned company took on the doing role.

Driven in part by the success of the MIT startup and the government's education efforts, two major private firms began to manufacture low-e glass and energy efficient windows. By the mid-1980s, private companies had poured $150 million into the market[27]. To reach adoption at scale, commercial industry took over both the funding and doing roles.

Figure 2. The Story of Low-e Windows Shows How Who Plays the Doing, Funding, and Regulating Roles Can Shift As the Innovation Evolves



Source: Deloitte analysis

On the demand side, the DoE used its power of regulation to authorize an industry council to create uniform standards to test, label and rate windows so customers could make informed decisions. Since then, many states have made it mandatory to label and rate windows by industry council standards. The labeling system was complemented by the federal ENERGY STAR certification that allows energy efficient products to be marked and marketed with a distinct logo and name. Jointly run by the DoE and Environmental Protection Agency (EPA), the ENERGY STAR program also offers tax credits to incentivize the adoption of energy-efficient windows. ENERGY STAR standards for windows were also added to building to drive use of energy efficient materials[28]. All these measures created a robust market for the windows that now account for 50% of sales in commercial and 80% in residential markets[29].

The same is true for social innovations. Although the players may be different from technological innovations, they are just as likely to adjust their roles through an innovation's life cycle. For example, just as government funding of academic research may shift to industry funding as products mature towards commercialization, similarly the central role that philanthropy plays in funding many social innovations can shift to government or industry funding as ideas grow to be implemented at scale.

Section 2

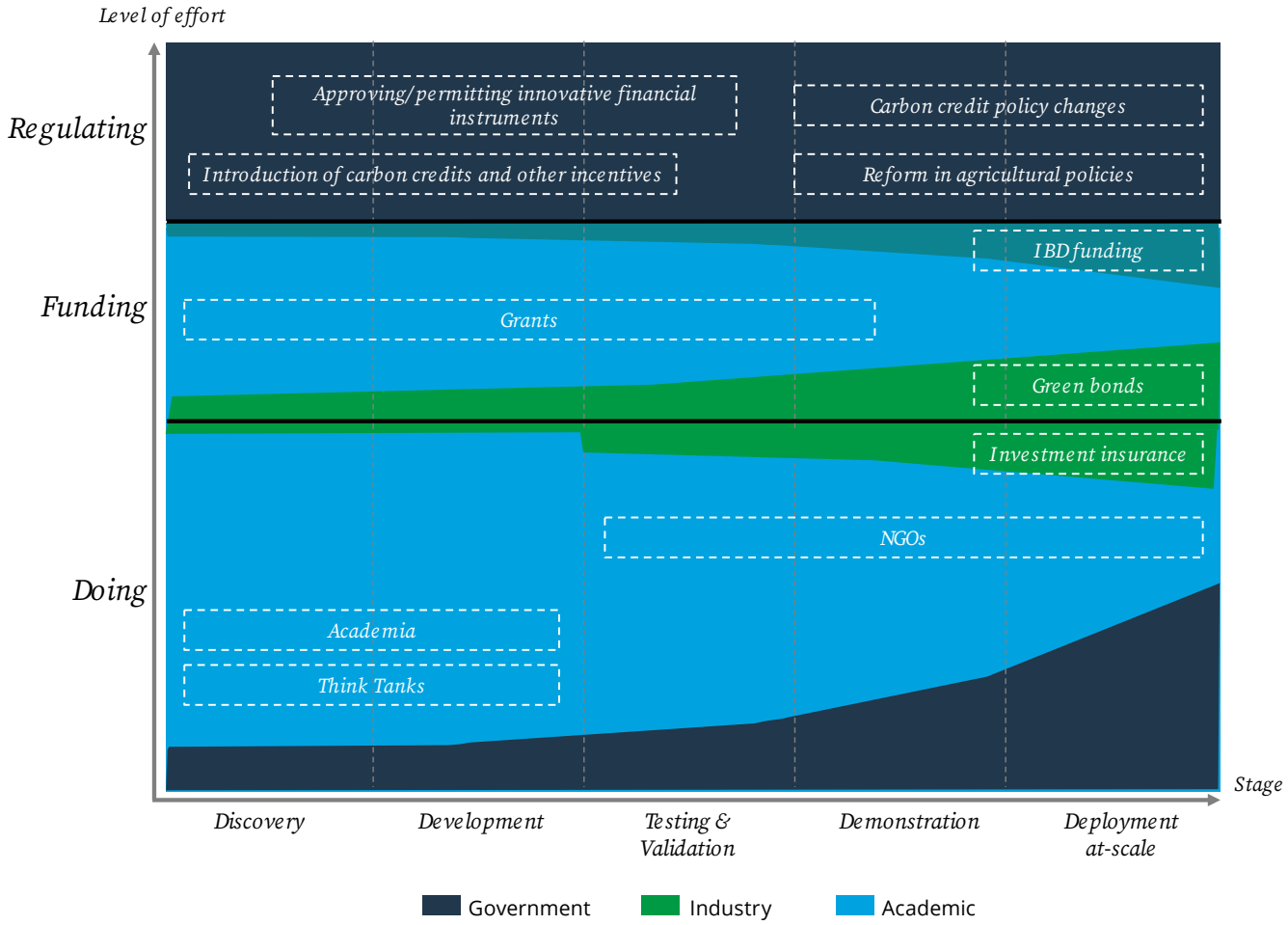
03. Even When Government Isn't 'Doing,' It Has A Role To Play In Supporting Innovation

Even when government isn't 'doing' it always has a role to play in supporting innovation. After all, tackling big problems takes collectively agreeing on what the priorities should be – one major function of government. Deborah Wince-Smith, CEO of the Council on Competitiveness, describes how "since the days of Vannevar Bush, innovation on national 'missions' ranging from defense to health to energy to infrastructure have been driven by the priorities and vision of government. This was true in the United States in the 1940s for the Manhattan Project and in the 1980s for integrated circuits. And it is true in other countries as well such as the Emirates where leadership investments and vision helped transform the economy[30]".

Take the development of the COVID vaccine. Academia and private healtcare companies led the research and development of the vaccine. However, governments around the world played a pivotal role in taking vaccines from the discovery phase to deployment. Many governments provided grants to academia and private companies to develop the vaccine. The US and UK government also helped vaccines reach scale by funding significant expansions in pharmaceutical manufacturing capacity in exchange for ownership of the earliest doses[31]. The US Federal government also helped build manufacturing capacity for components needed in distribution, such as glass vials[32]. Finally, government healthcare regulators used their regulatory authority to ensure timely approval of safe vaccines.

These lessons are not confined to the past but can also help shape future actions as innovations struggle to scale. Take nature financing, or paying to protect critical natural resources, as an example. The umbrella of nature financing can cover a range of innovative financial instruments including debt-for-nature swaps, energy saving insurance, and green bonds among others. While many of these instruments were initially developed by non-profits and/or philanthropy, governments can play a vital role in increasing their acceptance as these innovations mature. Governments can provide an enabling environment and regulations to encourage innovation in the green financing space and see how such instruments can be scaled. Further, governments can incentivize private investment by developing and enforcing standards and mechanism that require industries to value nature in their operations and in their end-to-end supply chains. Governments can also consider the concept of 'sandboxing nature' to allow innovative financial organizations to further develop new financial innovations to increase funding for conservation and climate[33].

Figure 3. The Example of Nature Financing Shows How Players May Shift the Roles They Play As a Social Innovation Matures



Source: Deloitte analysis

Section 3

An Evolving Landscape Changes Which Tools Are Most Effective

Whether it is doing, funding, or regulating, government has a clear role to play in supporting innovation at every stage of the life cycle. However, a changing innovation landscape means that the old models of collaboration may no longer be as effective. Deborah Wince-Smith of the Council on Competitiveness predicts that "the next generation of semiconductors will drive a transformation in AI and other systems, but to link the innovation, design, and production of those chips will require a new era of public-private partnership[34]". This new era of public-private partnership also shifts the type of tools available to governments to steer those partnerships.

The set of tools available to government can be categorized by what type of government power they use and whether they exert that power directly or indirectly (Figure 3).

Figure 4. A Sampling Of Tools To Show How Government Can Use Its Legal, Financial, Or Delivery Powers To Support Innovations Either Indirectly Or Directly

	Authority	Financial	Delivery
Direct	• Enforcement • Rules making • Making government IP available for commercial use	• Grants • Procurement	• Government services • Information provision
Indirect	• Labeling requirements • Codes on conduct • Voluntary standards	• Government patents free to all • Vouchers • Tax credits • Loan guarantees	• Data exchange platforms • Coordination • Convening • Joint ventures • PPPs

Source: Deloitte analysis

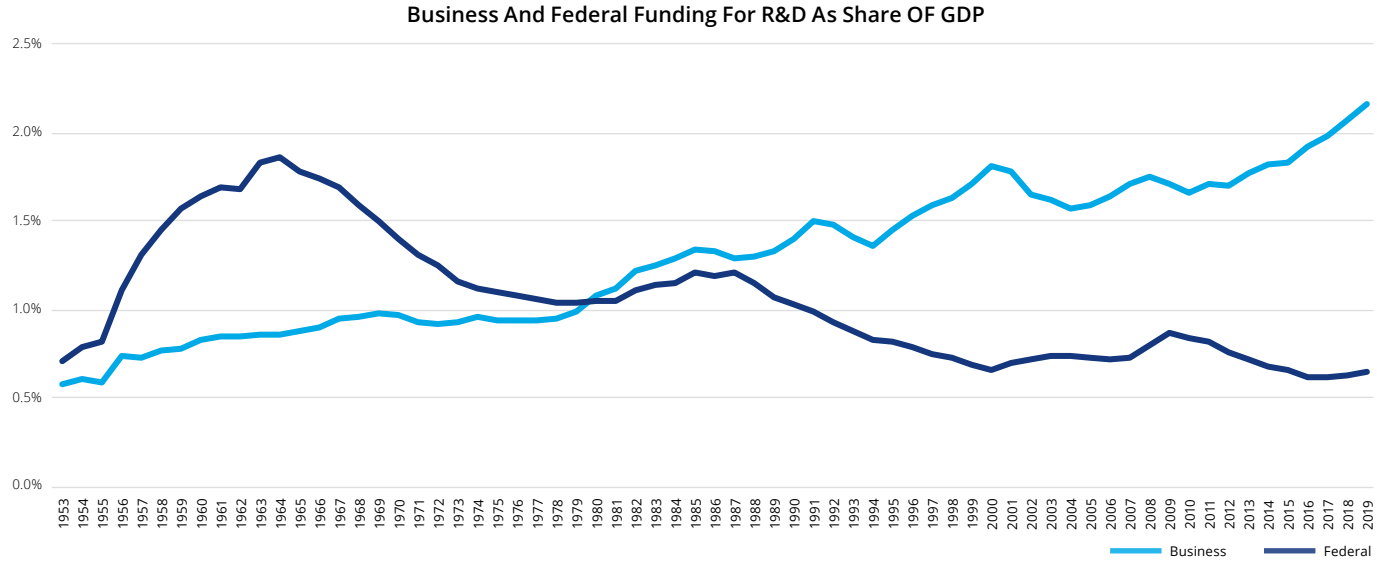
Shifting R&D Spending Patterns Are Making Indirect Tools More Important For Technological Innovations

With rare exception, the transformational technological innovations of today stemmed from government work begun prior to 1978: jet engines came from US and UK research investments in the 1940s; GPS began as the Navy's NAVSTAR project in 1974; and the internet began with DARPA's research in the late 1960s[35]. Why is this important? Because after 1979 and 1980, government no longer played the leading role in US R&D (Figure 5). In 2019, the commercial sector accounted for the largest shares of funding for applied research (55.0%) and development (85.5%)[36]. The federal government still leads the funding for basic research at 40.7% but it has come down drastically from the heights of 1980 when federal government's share was 70.3%[37]. The result is that government's direct levers for directing innovation have become less powerful because industry has had a stronger voice in directing where to invest for innovations. For example, just the top five 'big tech' firms individually spend as much on R&D as NASA or the DoE[38].

A similar story emerges in funding innovation for social causes. The top 25 philanthropists have donated $169 billion in their lifetimes. Globally, the philanthropy sector has more than $1.5 trillion in assets, roughly the same as the annual budget of the US government[39]. With such scale, it is perhaps no surprise that philanthropy can influence the public agenda for innovation in dramatic ways[40]. Nor are these trends likely to abate. Even during the pandemic, total charitable giving in the US grew 5.1% in 2020, to $471 billion[41].

With these strong non-government funding streams occupying some of most common niches for directly catalyzing innovation, government has had to develop indirect levers to steer innovation.

Figure 5. Government's Diminishing Share Of R&D Funding Has Made Many Direct Tools Less Effective At Steering The Course Of Technological Innovations



Source: National Center for Science and Engineering Statistics (NCSES). 2021.

The Stage Of An Innovation Also Changes Which Tools Are Most Effective

Massive funding from companies and philanthropy are not the only trends that can impact which tools are most effective - the evolution of an innovation itself can influence it. Regulation applied too early in an innovation's lifecycle can either stymie development or lead experimenters to regulatory arbitrage where they move activities from heavily-regulated geographies and sectors to less regulated ones. Similarly, applying direct funding too late in an innovation's lifecycle can lead to it stalling rather than accelerating. That is exactly the lesson from the SST story. While commercial SST programs were in the development and testing phase, they did not need direct government funding but rather indirect market-making activities to create the market for SST. Without a viable commercial market for SST, as soon as government funding of $1 billion dried up in 1971, the commercial projects withered quickly[42].

In the end, we are left with a story where both the stage of an innovation and the direct/indirect nature of tools influence how government should approach supporting an innovation. You can see these shifts at play in the story of nature financing (Figure 6). Government's enduring role as a regulator lends importance to policy-making tools to encourage sustainable agricultural and fisheries practices throughout the development of nature financing.

But other roles can shift through the lifecycle of an innovation. In the case of nature financing, for example, as industry and non-governmental organizations (NGOs) took over the roles of funding and maintaining a green environment, government's direct financial tools became less effective in the shadow of more private funding. But this does not mean that government is not in a position to financially influence the innovation, it just means that government should deploy its indirect tools to help shape the innovation. In the case of nature financing, indirect tools such as tax incentives, loan guarantees, and carbon credit transfers all played an important part in spurring adoption of novel nature financing instruments and thus preserving biodiversity.

Figure 6. As Government's Role Changes Over The Course Of Innovation, Its Most Effective Tools Will Also Shift. The Table Below Shows A Sample Of Tools Available To Government During The Development Stage Of Nature Financing With Those Tools That Become May Less Effective At This Stage Highlighted In Gray.

	Authority	Financial	Delivery
Direct	• Reform agricultural policies • Authorizing innovative financial instruments	• Grants • Procurement	• Government services • Information provision
Indirect	• Carbon credit policy changes	• Multi-lateral lending • Loan guarantees • Carbon credit transfers	• Coordination • Convening • PPPs

Source: Deloitte analysis

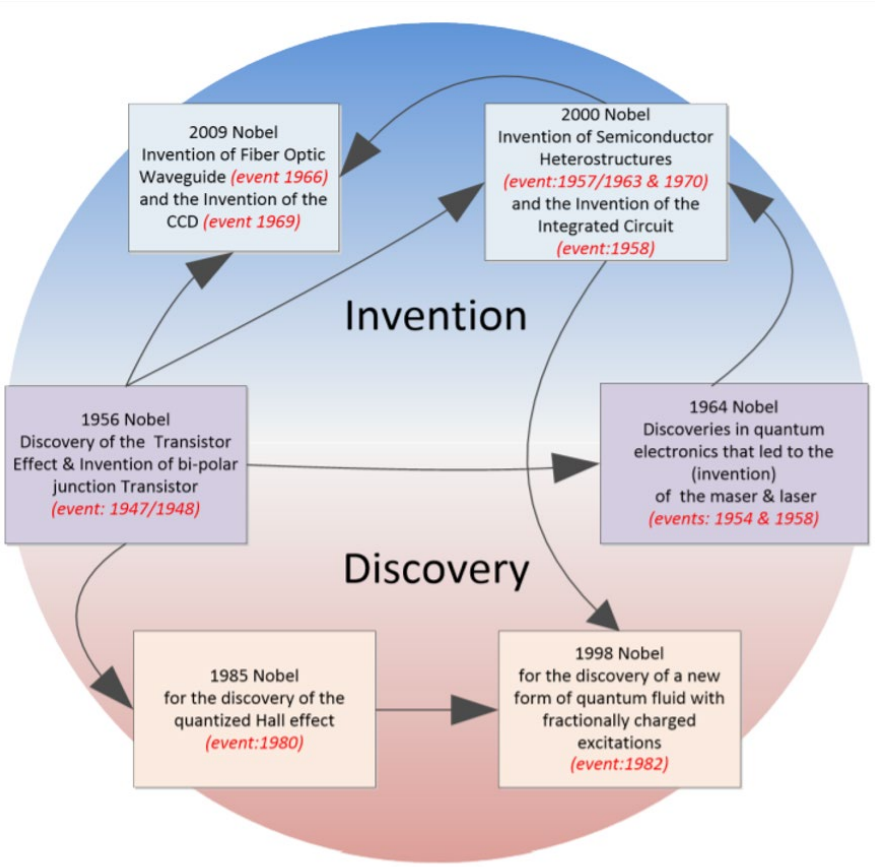
Section 4

Getting Started: Practice The Art Of Innovation

The development of technological innovations can offer important lessons for catalyzing social innovations, but it is important to avoid the bad habits of technological innovation as well. Too often the development of technological innovations is depicted as a smooth, almost inexorable process. This can make it seem like understanding the stage of an innovation or choosing the right tool to support it is a clear-cut exercise. Nothing can be further from the truth, both for technological and especially social innovations.

While retrospective narratives describe innovations moving smoothly from discovery to adoption, that is almost never the case. Many of us may have a mental model of iron-hulled steamships quickly replacing old wooden sailing ships. But in reality, there was more than a century of co-existence where innovations in one influenced the design of the other[43]. The same story plays out in the development of modern electronics. There was no seminal scientific discovery that was then commercialized and adopted at scale. Rather, there was a jumble of discoveries that spurred inventions, and inventions that spurred further discoveries (Figure 7).

Figure 7. The Cycle Of Invention And Discovery That Led To Modern Electronics Shows That There Is No Smooth Path For Innovations



Source: Venkatesh Narayanamurti, Tolu Odumosu & Lee Vinsel. The Discovery-Invention Cycle: Bridging the Basic/ Applied Dichotomy. The Belfer Center for Science and International Affairs, Harvard Kennedy School. February 2013.

So if we are serious about catalyzing social and technological innovations, we should not try to turn innovation into an assembly line with clear tools at discrete steps. The public sector is not the only agent, or even the primary agent, in the development of many innovations. Just like a gardener monitors soil moisture and Ph, to succeed at catalyzing innovation government should:

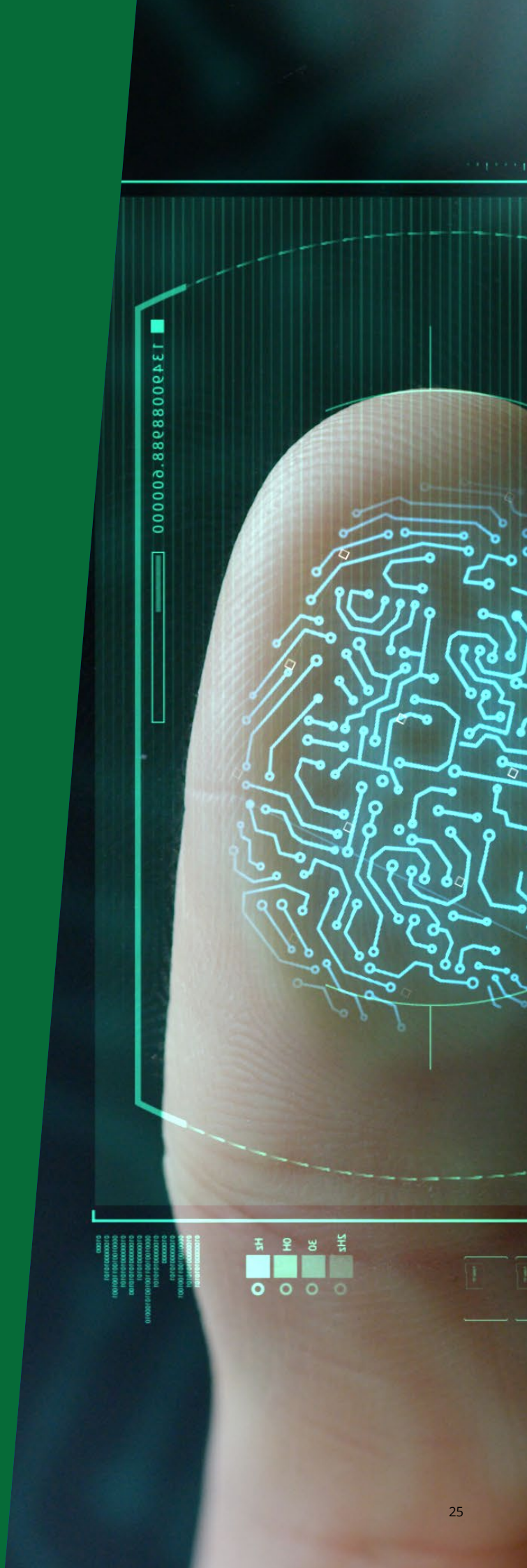
- Be outcome focused. Creating a market for an innovation is a key mechanism to spur its continued development and adoption at scale. Without defined outcomes, creating that market is all but impossible.
- Don't look for a single solution, look for combinations. The most transformational ideas in history are almost never a single technology – or even a single idea for that matter. Being outcome focused will also help government support not just one technology, but an outcome that several technologies and new ideas can come together naturally to achieve.

Mind the gaps. Pay special attention to the stages where roles shift between different players. This can be a shift in funding from philanthropy to government or a shift in doing from academia to industry. But it is at these times that the progress of an innovation is most at risk. The Department of Defense has termed just one of these transitions, from small scale research funding to full-scale acquisition funding, as the 'valley of death' because it has 'killed' so many innovations[44].

- Reshape incentive structures.
  - Internal – Reshape internal incentives like performance evaluations and bonuses to encourage leaders to make external connections and try new things. For example, NASA executives have external collaboration featured prominently in their annual evaluation criteria.
  - External – Incentives outside the organization can be either supportive or toxic to innovation as well. For example, while everyone recognizes that cybersecurity is important, many critical infrastructure sectors still lag due to competing incentives. Industry-spanning efforts such as Cybersecurity and Infrastructure Security Agency's Joint Cyber Defense Collaborative can help build bridges between players and reshape incentives in an industry toward collective goals44.

- Pay attention to the social relationships of real people. Finally, because of the massive scale often involved, it can be easy to think of the players involved in innovation as boxes on an organizational chart. But the true players are always real people with real relationships. Understanding and mapping those relationships can not only help build trust where necessary, but also identify where connections need to be made, or where novel ideas may be hiding.

Government has a phenomenal history of catalyzing innovations that shaped the modern world, but the challenges of the 21st century are beyond the power of any single player. Rather, to help shape the next century, government needs to understand who plays what role, when, and with what tools. Get it right and, like a flower emerging from a seed bed, we may see some truly spectacular and unexpected innovations in our future.



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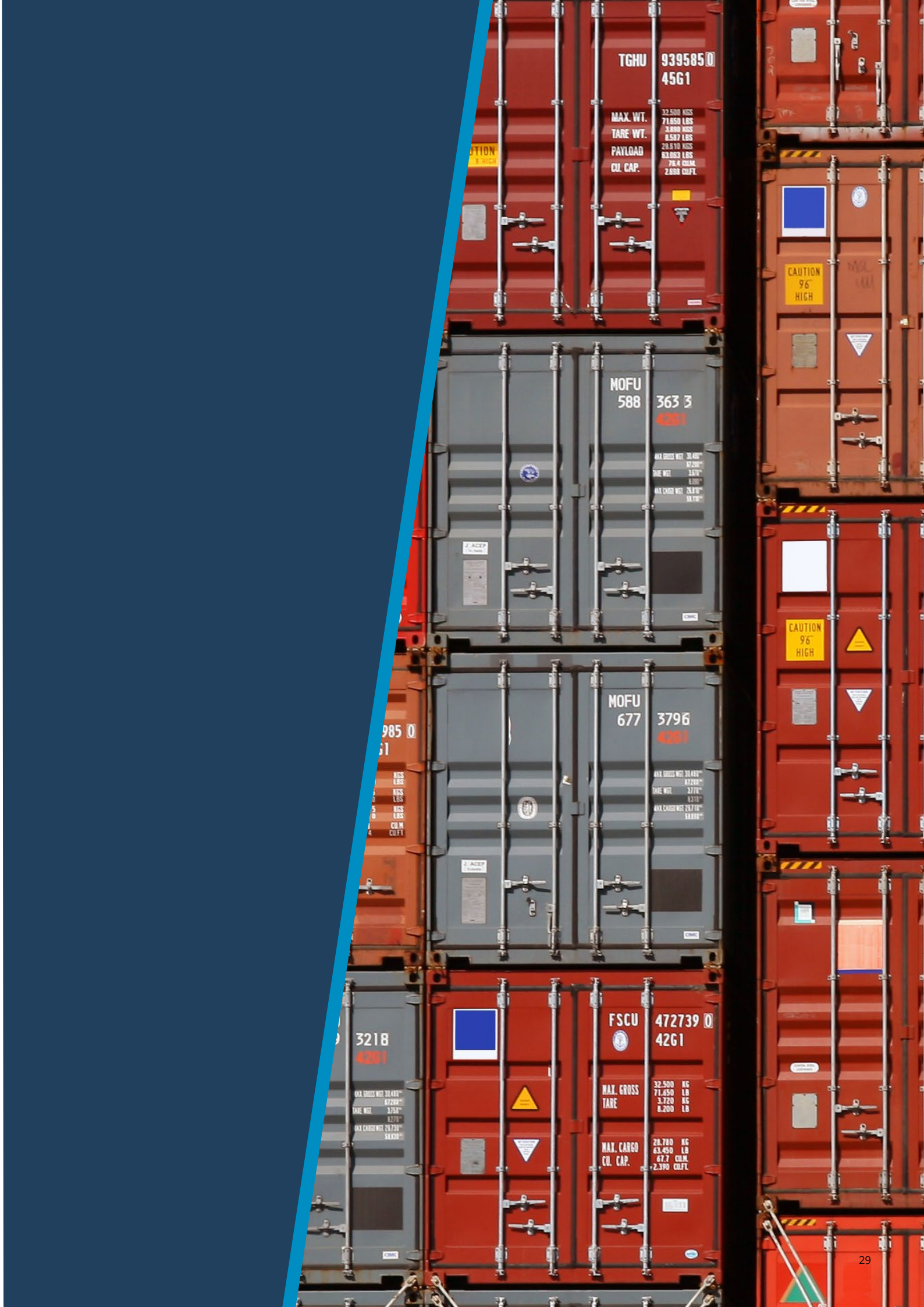
Authors

William D. Eggers
Executive Director
Deloitte Center for Government Insights
weggers@deloitte.com

Joe Mariani
Senior Research Manager
Deloitte Center for Government Insights
jmariani@deloitte.com

Pankaj Kamleshkumar Kishnani
Assistant Manager
Deloitte Center for Government Insights
pkamleshkumarkish@deloitte.com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