

Enabling US Government Participation in Pull Mechanisms for Social Impact Innovation: A Survey of Federal Authorities, Budgetary Barriers, and Potential Solutions

Steven Kosiak and Rachel Silverman

Abstract

United States government support for scientific and technological research and development (R&D)—across sectors including but not limited to energy, agriculture, and health—has the potential to save lives, reduce global poverty, and help address the most pressing global challenges. Traditionally, the US government has funded most R&D via grants and contracts (“push” funding), directly subsidizing and defraying the up-front R&D costs. An alternative approach—“pull” funding—would use the promise of future sales and/or other revenue to indirectly justify up-front expenditures in R&D, thereby “pulling” innovations to market. Despite several theoretical and practical advantages of “pull” funding, US government use of this approach has thus far been limited, in part due to regulatory and legal barriers. Yet across the entirety of the US government, there are nonetheless creative and interesting approaches to support innovation which include pull elements. To help the US government make broader use of pull approaches, this Policy Paper surveys the ways in which US government authorities, budgetary rules, and procurement approaches either facilitate or constrain use of pull mechanisms to support R&D. It specifically focused on the budgetary “scoring” issues that can affect, and sometimes hinder, the use of such mechanisms. It concludes with a discussion of potential legislative changes and workarounds to budgetary scoring challenges that might facilitate expanded use of these mechanisms.

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Background and introduction

Scientific and technological innovation—across sectors including but not limited to energy, agriculture, and health—has the potential to save lives, reduce global poverty, and help address the most pressing global challenges. The nature of innovation is unpredictable and high-risk, requiring front-loaded costs to support research and development (R&D). Broadly, there are two ways to fund investments in R&D, thereby increasing the volume and/or probability of successful innovation.

The first approach, “push funding,” directly subsidizes and defrays the up-front R&D costs. Push funding most often manifests as governmental or philanthropic grants; product development or research partnerships between governments/foundations and non-profit or industry actors; loan guarantees that subsidize the costs of capital; and direct funding of government or foundation research institutions, e.g., the National Institutes of Health or the Bill & Melinda Gates Medical Research Institute. The US government spends approximately \$135 billion each year on various forms of push funding to promote cross-sectoral R&D.¹

While push funding plays a valuable role in supporting a broad innovation ecosystem, its use to support commercial and/or late-stage R&D suffers from three main challenges. First, push funding requires governments or other funders to “pick winners” to receive funding. This can be seen as an unjustified corporate subsidy, especially if the government or public subsequently is expected to pay for the final product at market prices. Practically, “picking winners” also risks distorting the market and driving out competitors, thereby potentially decreasing the likelihood of innovation success. Second, push funding distorts market incentives in ways that may cause inefficiency. Since push funding is “free” for the recipient, they may use such funds to support and continue projects with a very low likelihood of success, well after the point at which they would be discontinued if market forces applied. Third, the role of governments or philanthropies are often vulnerable to the sunk cost fallacy when they serve as co-investors in development of a product or technology, e.g., “we paid for this so we might as well use it,” even if the resulting technology is low-value and inappropriate for the target population.

The second approach, and the focus of this paper, is known as “pull funding.” This approach uses the promise of future sales and/or other revenue to indirectly justify up-front expenditures in R&D, thereby “pulling” innovations to market. Pull funding maintains incentives for innovation success; removes (or at least reduces) the government’s role in “picking winners”; and allows the funder to serve as a more impartial arbiter of whether the resultant innovation is socially valuable.

Most pull funding occurs organically via market forces; for example, the large market of potential customers for an updated iPhone justifies Apple’s continued commercial investments in technological R&D. Somewhat more intermediated by government policy,

¹ Congressional Research Service (2020). Federal Research and Development (R&D) Funding: FY2020.

large US expenditure (private and governmental) on pharmaceuticals and other health technologies supports a robust though sometimes inefficient R&D pipeline for new drugs, therapies, and devices.

However, where market forces alone are insufficient to drive a socially desirable level of R&D, governments (and/or development banks and philanthropies) may wish to explicitly support innovation through “pull mechanisms,” interventions that are intended to increase either the expected size or predictability of revenue/sales contingent on successful innovation. The best-known pull mechanisms are advance market commitments (the AMCs), which offer a guaranteed market (price x volume) for innovations meeting a specific target product profile;² however, this mechanism has rarely been used in practice. Other pull mechanisms may include (but are not limited to) advance purchase agreements; prizes/milestone payments; market entry rewards; and regulatory incentives (e.g., priority review vouchers). Less obviously, governments can also use contracting and reimbursement policy to change the expected market for successful innovation.

Thus far, regulatory and legal barriers have limited the US government’s ability to directly support pull mechanisms like the AMC. Yet across the entirety of the US government, there are nonetheless creative and interesting approaches to support innovation which include pull elements. Sometimes these are explicitly carved out/authorized by Congress; others use creative workarounds that comply with budgetary and legal strictures. A fuller understanding of the barriers to using these mechanisms—and how they can be addressed/reduced—would help the US government to make broader use of these approaches and better support high-value innovation.

In this policy paper—informed by a review of relevant budgetary and appropriations authorities, supplemented by key informant interviews (Box 1)—we survey the ways in which US government authorities, budgetary rules, and procurement approaches either facilitate or constrain use of pull mechanisms to support R&D. We look across sectors and agencies to draw inspiration, noting the relatively extensive usage of pull mechanisms within the defense sector, supported by specific authorities. We focus on the budgetary “scoring” issues that can affect, and sometimes hinder, the use of such mechanisms; we also review and propose potential ways to work around or mitigate these barriers.

² For an early discussion of the concept of Advance Market Commitments, see, Ruth Levine, Michael Kremer, Alice Albright (co-chairs), Making Markets for Vaccines: Ideas to Action, The Report of the Center for Global Development Advance Market Commitment Working Group (Center for Global Development: Washington, DC, 2005), www.cgdev.org/sites/default/files/archive/doc/books/vaccine/MakingMarkets-complete.pdf.

Box 1. A note on methodology

This policy note is based, in part, on the expert views of current and former senior personnel with high-level professional experience at the Office of Management and Budget, the Office of Federal Procurement Policy, the Office of Federal Financial Management, the Department of Defense, the Defense Advanced Research Projects Agency, the Office of the Director of National Intelligence, the National Aeronautics and Space Administration, the State Department, the Department of Education, the House and Senate Budget, Armed Services and Appropriations Committees, industry and the non-profit community.

We start with explicit consideration of three distinct pull mechanisms: Prizes, Milestone Payments and Advanced Market Commitments (AMCs). As an upfront caveat, we acknowledge here that these three mechanisms represent only a subset of the potential pull approaches that might be used to support federally funded R&D. Nonetheless, they represent a cross-section of the most prominent pull approaches and the broader scope for pull mechanisms within the US government. For each, we offer a description of what it is and how it works; summarize the mechanism’s statutory authority; and discuss the extent of its usage and barriers to greater use within the US government. We conclude with a discussion of potential legislative changes and workarounds to budgetary scoring challenges that might facilitate expanded use of these mechanisms.

1. Prizes

Background and authorities

Prizes are open competitions in which the winner(s) receive an award upon achieving a specific, preset objective; they are intended to encourage scientists, engineers and others to pursue important (but thus far unrealized) scientific, technical and other societal goals. Prizes differ from traditional grants and contract-funded R&D in a variety of ways. Perhaps most importantly, Prize awards are paid out only if and when the objective specified in the competition is met.

Under the America COMPETES Reauthorization Act of 2010 (P.L. 111–358), US agencies enjoy government-wide authority to conduct prize competitions (see appendix for a list and description of some of the major authorities related to the use of Prizes and other pull mechanisms). The COMPETES Reauthorization Act provides all federal agencies with the authority to carry out prize competitions “to stimulate innovation that has the potential to advance the mission of the respective agency.”³ This authority was updated and clarified in

³ 15 U.S.C. §3719; federal agency as defined under 15 U.S.C. §3719 excludes legislative branch agencies, Legal Information Institute, Cornell Law School, <https://www.law.cornell.edu/uscode/text/15/3719> (accessed June 8, 2021).

2017 under the American Innovation and Competitiveness Act (P.L. 114–329). The updated Act requires that prizes in excess of \$1 million be approved by the agency head; prizes in excess of \$50 million can only be offered after 30-days’ notice to Congress.⁴

In addition to this government-wide authority, a range of Departments and Agencies separately possess their own respective prize authorities, often pre-dating the COMPETES Act. Agencies with their own prize authority include the Departments of Defense, Energy, Health and Human Services, Transportation, and Commerce, as well as the National Aeronautics and Space Administration (NASA) and the National Science Foundation.⁵

Usage and barriers

Measured by a range of different metrics, the Federal government’s use of prizes has increased significantly, if not entirely evenly, in recent years:

- The Federal government has conducted a total of about 1,000 prize competitions since 2010.⁶
- Between 2011 and 2018, the number of competitions held under COMPETES Act authority grew from 7 to 67,⁷ while the overall dollar value of those competitions increased from \$10 million to \$37 million.⁸
- The number of Departments and Agencies conducting prize competitions increased from 7 to 22 between 2011 and 2018.⁹
- The number of prize competitions conducted across the federal government under all authorities grew from 97 in 2014 to 125 in 2018,¹⁰ with the combined total value of awards more than doubling (from \$32 million to \$69 million).¹¹

Notwithstanding this growth, the use of the authority appears to remain relatively limited. Prize awards account for only a tiny fraction of overall federal R&D—on average about \$5 for every \$10,000 spent on R&D in 2018. Similarly, the size of the individual prize awards has remained quite small—just \$82,000 for COMPETES Act prizes and \$226,000 under agency-specific prize authorities. Awards of this size do not even approach the \$1 million level at which under the COMPETES Act requires Agency heads to approve the offers, let alone the \$50 million level at which Congress must be notified.

The relatively limited use of prize authority can likely be attributed to the combined effect of several different factors. First, prize competitions are generally viewed as potential

⁴ Marcy E. Gallo, “Federal Prize Competitions,” Congressional Research Service, April 6, 2020, p. 3.

⁵ *Ibid.*, p. 6.

⁶ General Service Administration, “About Challenge.gov,” Challenge.gov, <https://www.challenge.gov/about/>

⁷ Gallo, “Federal Prize Competitions,” p. 6.

⁸ *Ibid.*, p. 7.

⁹ *Ibid.*, p. 6.

¹⁰ *Implementation of Federal Prize and Citizen Science Authority: Fiscal Years 2017–18*, (Office of Science and Technology Policy: Washington, DC, June 2019, p. 13.

¹¹ *Ibid.*, p. 12.

complements to—not substitutes for—primary R&D funding through traditional mechanisms (peer-reviewed grants and procurement contracts). Second, prizes are not always considered to be an appropriate mechanism to address research and innovation objectives—for example, in cases where a clear, effective approach to addressing a challenge has already been established, there are a limited number of potential participants who could address the challenge, and/or the pool of potential participants is composed of actors unable or unwilling to cover necessary upfront costs.¹² Third, designing an effective prize competition can be a complex undertaking requiring considerable care and diligence—for example, determining the correct size of the cash award, developing fair contest rules, and resolving intellectual property rights.¹³ This level of effort may be considered excessive, particularly when most Prize awards are for relatively low dollar values; the requirements may also seem daunting for risk-averse civil servants who feel more comfortable with traditional approaches. Fourth, requirements for agency head approval and/or Congressional notice may dissuade agencies from pursuing higher-value Prize competitions.

Finally, concerns about budgetary scoring may also limit agencies' use of prize authority. Current budgetary scoring rules—discussed at greater length later in this paper—generally require the full cost of a program to be counted upfront, when a legally binding commitment is made. For most federal acquisition programs this requirement makes sense and represents a reasonable approach to ensuring transparency and accountability. However, in the case of prizes (as well as milestone payments and AMCs), the fact that money must be put aside upfront and not deployed for other purposes—even where there is considerable uncertainty over when (or even if) the money will be spent on a prize—creates an opportunity cost that may serve as a substantial disincentive.

It is unclear, in practice, how much (if any) responsibility this potential scoring issue bears for the relatively limited use of prize authority to date. To a great degree, implementers of prize competitions can and do limit the kind of uncertainty noted above through the design of the competitions. Competitions can be designed with relatively less challenging goals; they can also be awarded on the basis of the best entry (rather than absolute success in achieving the goal). Both approaches greatly reduce or even eliminate such budgetary uncertainty. To date, most prize competitions have been time-limited, and few have been cancelled due to the lack of a winner, suggesting that agencies generally seek to limit budgetary scoring risk through such approaches.

However, it is entirely plausible that this approach has been adopted to accommodate existing budgetary constraints—thereby constraining use of Prizes for more challenging (and perhaps higher-impact) scientific and technical objective. More challenging competitions—with consequent uncertainty about when, or even if, the prize would ultimately be awarded—would present far greater budgetary scoring issues.

¹² Kwasi Mitchel, Sahil Joshi and Nes Parker, "The Craft of Incentive Prize Design: Lessons from the Public Sector," Deloitte Insights, <https://www2.deloitte.com/us/en/insights/topics/social-impact/the-craft-of-incentive-prize-design.html> (accessed June 8, 2021)

¹³ *Ibid.*, pp. 1–2.

2. Milestone payments

Background and authorities

Like other pull mechanisms, milestone payments are received only after meeting a prespecified goal. In this respect, they can resemble the use of prizes. However, there are several important distinctions. While prize competitions are generally open to anyone willing and able to enter the competition—and the winner (or winners) are often determined through meeting a single goal—milestone payments are generally incorporated into programs with limited participation and a series of incremental payment-linked goals, each of which must be met to reach the final objective.

Milestone payments can be contrasted with “progress payments” made under traditional contracts and grants. Progress payments are simply made on an agreed-upon percentage basis over the period during which the work is carried out; they are not tied to particular technical or performance goals, or to specific deliverables. Like other push mechanisms, progress payments represent an essentially cost-reimbursement approach.

The authority to use milestone payments dates from 1958, when Congress granted the National Aeronautics and Space Administration (NASA) “Other Transaction” authority for “advanced research projects.”¹⁴ OTs are generally defined by what they are not: they are not standard contracts, grants, or cooperative agreements.¹⁵ They are intended to provide the government with enhanced means of fostering innovation, rapid experimentation and other goals that can sometimes be stifled by the need to comply with, among other things, the Federal Acquisition Regulations (FAR).

In 1989, OT authority was granted to the Defense Advanced Research Project Agency (DARPA), and in 1994 extended to the Defense Department more broadly; it was also expanded beyond research to include prototyping.¹⁶ Since then, OT authority has also been granted to a range of other Departments and Agencies, including the Departments of Energy, Health and Human Services, Homeland Security, and Transportation, as well as the Federal Aviation Administration, the Domestic Nuclear Detection Office, and the Transportation Safety Administration.¹⁷ In subsequent years, OT authorities have been amended and further expanded numerous times.¹⁸ And in 2020, Congress enacted the Pilot

¹⁴ Lauren A. Mayer, Mark V. Arena, Frank Camm, Jonathan P. Wong, Gabriel Lesnick, Sarah Soliman, Edward Fernandez, Phillip Carter, and Gordon T. Lee, *Prototyping Using Other Transactions* (RAND: Santa Monica, CA, 2020), p. 5.

¹⁵ *Ibid.*, p. 4.

¹⁶ *Ibid.*, p. 5.

¹⁷ Moshe Schwartz and Heidi M. Peters, “Department of Defense Use of Other Transaction Authority: Background, Analysis, and Issues for Congress,” *Congressional Research Service*, February 22, 2019, p. 36.

¹⁸ In some cases, offices, agencies, commissions, and other federal government entities may also have OT or related authorities that are only associated with certain programs or projects. *Ibid.*

Program on Strengthening the Defense Industrial and Innovation Base, which, among other things, encouraged greater use of OTAs.¹⁹

OTs permit the use of a broad range of agreements, incentives and other arrangements that would not be permitted under the FAR. For example, in addition to the authority to use milestone payments, OTs allow acquisition managers to amend or exclude clauses that are required in traditional procurements (such as termination clauses, cost-accounting standards, intellectual property, and audit requirements) and to make use of joint ventures, partnerships and consortia.²⁰ Although they are only one of many areas where OTs offer the government greater freedom and flexibility, milestone payments are recognized as a potentially important mechanism.

As the Defense Departments' OT Guide notes, the use of milestone payments can substantially contribute to the effectiveness of research and prototyping efforts:

“Well-structured, payable milestones can serve the dual purpose of meeting cash flow needs of the performer and as a management tool to verify achievements on the critical path to project success. Failure to achieve milestone/technical goals forces a management analysis and decision.”²¹

Perhaps the most frequently cited example of the successful application of milestone payments is in NASA's Space Act OT with SpaceX, which resulted in development of the Falcon 9 space launch vehicle. OT milestone payments can be targeted to a variety of different goals. In the Space Act OT, for example, both technical and financial milestones were used—the former triggered by technical successes and the latter by SpaceX's success in bringing specified amounts of third-party capital into the project.²²

In 1996, the FAR was amended to allow the use of performance-based payments.²³ Although the FAR's performance-based payments also represents a pull mechanism, the intent behind them is far more limited. In contrast to OT milestone payments, which have multiple potential functions and can be used in conjunction with a wide range of other innovative arrangements that fall outside the FAR, the use of PBPs under the FAR is tightly constrained. They can only be used for fixed-price contracts, and while improving technical and schedule performance has been cited as one goal, it is by no means the only goal. The use of performance-based payments under the FAR appears to be viewed as an alternative to progress payments in a limited set of circumstances where enhancing innovation is not a

¹⁹ Pub. L. 115–91, div. A, title XVII, § 1711, Dec. 12, 2017, [131 Stat. 1811](#), as amended by Section 213 of the FY21 National Defense Authorization Act.

²⁰ *Ibid.*, p. 3.

²¹ Richard L. Dunn, “Milestone Payments: Understanding a Powerful Technique,” Strategic Institute, www.strategicinstitute.org/other-transactions/milestone-payments/ (accessed June 8, 2021)

²² *Ibid.*

²³ *Ibid.*

primary motivation. As the Defense Department's own *Performance Based Payments Guide* states, in the case of procurement programs, for example:

“The ideal candidate for [performance-based payments] is a mature, stable production program where the fabrication, assembly and test processes are well established. Ideally the contractor will have already completed one or more production lots. This should permit events and their timing to be easily identified. Furthermore, the actual cost by month on the prior contracts should make the financing need at each event easier to determine.”²⁴

Usage and barriers

The use of OTs has followed a somewhat uneven path, but in recent years the trend has been clearly upward. In the case of the Department of Defense for example, the number of OTs implemented increased from 12 in 2013 to 94 in 2017,²⁵ with total obligations provided under OTs reaching \$2.1 billion by the end of that period.²⁶ The use of milestone payments, which as noted above is only one of a variety of innovative approaches permitted through OTs, is not (apparently) tracked separately. However, since the ability to use this mechanism is a key feature of OTs, it seems likely that the use of milestone payments has similarly grown in recent years. By contrast, the use of performance-based payments under the FAR appears to have remained limited.²⁷

Notwithstanding the growth in the use of OTs and (presumably) milestone payments noted above, OTs still account for only a very small share of federal spending on goods and services (less than 1 percent even in the case of DoD) and obstacles remain. Most obviously, although the number of agencies with OT authority has increased, it is still not possessed by all agencies. Perhaps a greater obstacle—and a key reason why such authority has not been granted to more agencies—is a lingering concern that OTs may provide too much freedom in how transactions are structured and implemented. Among other things, these concerns led the House Armed Services Committee to recently urge:

“the Department to reiterate through established guidelines that OTA is not a means for circumventing appropriate use of the Federal Acquisition Regulations, and that full and open competition should be used to the maximum extent possible to maintain a sense of integrity, fairness, and credibility in the Federal Procurement process.”²⁸

²⁴ *The Performance Based Payments Guide*, Department of Defense, 2014, p. 10,

[https://www.acq.osd.mil/dpap/cpic/cp/docs/Performance_Based_Payment_\(PBP\)_Guide.pdf](https://www.acq.osd.mil/dpap/cpic/cp/docs/Performance_Based_Payment_(PBP)_Guide.pdf)

²⁵ Schwartz and Peters, “Department of Defense Use of Other Transaction Authority: Background, Analysis, and Issues for Congress,” p. 12.

²⁶ *Ibid.*, p. 1.

²⁷ Dunn, “Milestone Payments: Understanding a Powerful Technique.”

²⁸ Schwartz and Peters, “Department of Defense Use of Other Transaction Authority: Background, Analysis, and Issues for Congress,” p. 9.

Another barrier to broader application of milestone payments appears to be related to difficulties inherent in their use. Acquisition managers are often unfamiliar with the mechanism and how to most effectively use it.²⁹ The complexities sometimes involved in effectively identifying and monitoring milestones may also have contributed to the limited use of performance-based payments under the FAR.³⁰

Concerns over budgetary scoring rules may also be an obstacle. As with prizes, the uncertainty associated with milestone payments could create a significant disincentive for their use. However, again as with prize authority, it is unclear how much of impact, if any, these potential issues have had in shaping agency decision-making about the use of milestone payments. Acquisition officials have considerable flexibility in managing the level and type of uncertainty associated with the use of milestone payments—both through determining the level of difficulty associated with achieving the milestones and the size of the payment specified for doing so.

“How rigorous should milestone payments be? Rigor can have various implications. . . . One or more *soft* milestones at the front end of an agreement may be necessary to acquire long lead time items to finance a poorly financed small company. The payable event may be something like hold an organizational meeting or update the operating plan contained in the proposal. In many projects that are fully funded by the government it may make sense for the cumulative milestone payments and their estimated cost to be closely aligned. However, in projects with a high risk of technical failure that may not be the case. Likewise, where successful performance may result in a breakthrough worth many times the cost of achieving it, cumulative milestone payments may be less than estimated cost, a kind of informal cost sharing.”³¹

The use of OTs, including their growth in recent years, has generated some considerable controversy. However, very little of the controversy appears to focus on budgetary scoring issues. This suggests that, as with the use of prize authority, agencies employing OT milestone payments have adopted an approach that to some extent minimizes the kinds of uncertainty that could, in theory, make budgetary scoring a greater concern. Again, the question remains as to whether this approach has been adopted because it fits with the agencies’ general views about how best to structure milestone payments in order to maximize their effectiveness, or whether the approach has instead been adopted—at least in part—because of existing budgetary scoring rules, and whether changing those rules might lead agencies to use milestone payments differently or more frequently.

²⁹ Dunn, “Milestone Payments: Understanding a Powerful Technique.”

³⁰ Ibid.

³¹ Dunn, “Milestone Payments: Understanding a Powerful Technique.”

3. Advanced Market Commitments (AMCs)

Background and authorities

An AMC is a mechanism used by a government or other entity to guarantee a viable market for a product if and when it is successfully developed. As in the case of prizes, milestone payments, and other pull mechanisms, AMC payments are made only after the product has been successfully developed. AMCs are designed as an incentive for the development of products, such as vaccines, other medicines, or medical technologies, with high upfront cost, for which there is not currently a viable or sufficiently predictable commercial market to incentivize socially optimal R&D investment (or, alternatively, a substantial government market as is represented by, for example, the Defense Department in the case of high-tech military equipment and services).³² An AMC funded by five countries and the Gates Foundation was, for example, used to encourage the development of a lower cost pneumococcal vaccine tailored to the needs of low- and middle-income countries.

There are, at present, at least three different sources of federal authority for entering into AMCs.

- **Project BioShield** permits the Department of Health and Human Services to obligate funding to purchase chemical, biological, radiological, or nuclear (CBRN) countermeasures—such as diagnostic tests, drugs, vaccines, and other treatments—as much as eight years before development has been completed.³³
- **The Lantos Hyde Global Leadership Against HIV/AIDS, TB, and Malaria Reauthorization Act of 2008** permits the Secretary of the Treasury to negotiate with the International Bank of Reconstruction and Development (World Bank), the GAVI Vaccine Alliance, and other interested parties to establish advanced market commitments (including legally binding contracts) to purchase vaccines to combat HIV/AIDS, tuberculosis, malaria, and other related infectious diseases.³⁴
- **The Defense Production Act** permits the Department of Defense (DoD) and other agencies working through DoD, to make purchases and purchase commitments that enhance and support national defense, domestic preparedness, response, and recovery from natural hazards, terrorist attacks, and other national emergencies.³⁵

³² Put differently, defense industry contractors are incentivized to develop new technologies both by the “push” provided by traditional cost-reimbursement type development contracts and the “pull” implicit in the existence of a large market for specialized military goods (e.g., high-tech weapons) and services supported and sustained by the US military.

³³ Project BioShield was amended by the Pandemic and All-Hazards Preparedness Act (PAHPA; P.L. 109–417), which, among other things, allowed for the use of milestone payments to be used to cover up to half of the total award. Frank Gottron, “Project BioShield: Authorities, Appropriations, Acquisitions, and Issues for Congress,” Congressional Research Service, May 27, 2011, p. 2–3.

³⁴ 22 U.S. Code § 7624—Facilitating vaccine development, Legal Information Institute, Cornell Law School, <https://www.law.cornell.edu/uscode/text/22/7624> accessed June 8, 2021).

³⁵ Michael H. Cecire and Heidi M. Peters, “The Defense Production Act of 1950: History, Authorities, and Considerations for Congress,” Congressional Research Service, March 2, 2020, pp. 10–11.

Usage and barriers

Notwithstanding these various authorities, the federal government's use of AMCs has been very limited. The most significant use appears to be the purchase chemical, biological, radiological, and nuclear countermeasures under Project BioShield, with individual awards ranging from as little as \$1 million to as much as \$900 million.³⁶ More recently, the US agreed to support the GAVI-coordinated vaccine effort (known as COVAX), including its AMC component, which is designed to help ensure COVID-19 vaccine distribution among lower-income countries—with Congress appropriating \$4 billion to help fund the US contribution.³⁷ Under Operation Warp Speed, the U.S. government negotiated advance purchase contracts with a number of pharmaceutical companies to acquire as yet undeveloped COVID vaccines. For example, it committed up to \$2.1 billion for 100 million doses from Sanofi-GSK, \$1.95 billion for 100 million doses from BioNTech-Pfizer, \$1.6 billion for 100 million doses from NovaVax, and \$1.2 billion for 300 million doses from AstraZeneca-Oxford.³⁸ To be sure, the approach used by the U.S. government in Operation Warp Speed was multifaceted and included significant push funding (both to develop some of the vaccines and to expand manufacturing capacity), but by committing in advance to the purchase of vaccines still undergoing development it also includes a strong AMC-like pull incentive.

As in the cases of prize authority and milestone payments, a variety of factors have contributed to the federal government's limited use of AMCs. Among other things, the complexity of designing an effective AMC that includes the right price, development milestones, and specifications for the product can be highly challenging; likewise, budgetary scoring may also serve as a disincentive—perhaps to an even greater extent than for prizes or milestone payments. In comparison to these other pull mechanisms, there is certainly stronger prima facie evidence that budget scoring issues may pose a significant barrier to the use of AMCs. This is for the simple reason that the AMC's most frequently discussed among policymakers, advocacy groups and others, as well as addressed through existing statutory authority (and actually used in the case of chemical, biological, radiological, and nuclear countermeasures and the US contribution to the GAVI-coordinated (COVAX) vaccine effort), tend to be focused on the provision of vaccines and other medicines—the development of which typically requires large investments.

Such AMCs are likely to be successful in incentivizing the development of the specified products only if they include relatively large and costly purchase commitments. Moreover, there may be more uncertainty associated with the likelihood and/or timing of success than is typically the case with prizes and milestone payments (at least as these mechanisms are

³⁶ “Federally Funded Innovation Inducement Prizes,” Congressional Research Service, June 29, 2009, p. 18.

³⁷ Anna Rouw, Jennifer Kates, Josh Michaud, Adam Wexler, “COVAX and the United States,” Kaiser Family Foundation, February 18, 2021, <https://www.kff.org/coronavirus-covid-19/issue-brief/covax-and-the-united-states/>

³⁸ Nicholson Price, Rachel Sachs, Jacob S. Sherkow, and Lisa Larrimore Ouellette, “COVID-19 Advanced Purchases Explained,” August 20, 2011, <https://blog.petrieflom.law.harvard.edu/2020/08/11/covid19-vaccine-advance-purchases-explained/>

currently typically structured). And if AMCs are more likely to be characterized both by a need for large awards and greater uncertainty about if and when success will be achieved, they are more likely to be negatively affected by existing budgetary scoring rules.

4. A deep dive into budgetary scoring challenges

This section provides a more detailed discussion of the budgetary scoring issues touched upon earlier, and provides some preliminary thoughts concerning legislative changes or work-arounds that might help mitigate the challenges posed by existing scoring rules for the various pull mechanisms discussed above.

In common with pull mechanisms generally, the three pull mechanisms discussed in this analysis are characterized by funding needs that are contingent on successful development or performance outcomes—prize money is awarded only if and when the goals set out in the competition have been met, milestone payments are provided only when the specified milestone has been reached, and vaccines or other technologies or services are purchased only if and when they have been successfully developed. This creates several potential problems from a budget scoring standpoint. This is because federal law generally requires that a legally binding commitment of money can only be made if funding to cover the cost of the commitment has already been appropriated. Such appropriations “score” the year the appropriation is first made and available for obligation (even if the money is likely to be spent much later); further, most budget accounts limit the period for which appropriated funds remain available.

This means that an agency that conducts a prize competition, or one of the other measures discussed here, will generally have the cost of the prize (or milestone payment, or AMC) scored upfront when the competition is initiated, even if it might be several years or more before the goal is likely to be met and the money actually spent (in the form of a prize award, milestone payment or executed AMC). Moreover, under current rules, the scorekeeping cost will be the full cost of the specified prize, milestone payment or AMC, even where there is some (perhaps significant) possibility that the goals will never be achieved and the money never spent. Finally, unless the account through which the effort is being funded is a “no-year” account—and most are not—committed funding will “expire” and return to the Treasury if the competition goal remains unmet during the period of availability.

Although there are various dimensions to the potential budgetary scoring challenges, the crux of the problem is the uncertainty associated with whether and when an award or other payment will be paid. As discussed earlier, these mechanisms have (to date) been implemented in ways that appear to substantially limit both of these uncertainties. If the expectation and desire of federal agency officials is to continue to execute these mechanisms in this manner, there may be little need to consider changes to budget scoring rules—and likely little appetite either at the Office of Management and Budget (OMB) or in Congress to consider any significant changes.

On the other hand, if there is a desire to move beyond the current approaches to using prize authority and milestone payments, and perhaps to encourage experimentation with efforts that are both larger and have more uncertain outcomes, scoring changes are more likely to be needed, and perhaps sellable. The case for modifying existing budgetary scoring rules may be greatest for AMCs. As noted earlier, given the nature of the objectives usually discussed for AMCs, they may be the most negatively affected by exiting scoring rules.

5. Fixes and workarounds

Given the potential benefits of expanded pull mechanism use, as described in the previous section, we here consider three possible fixes to budgetary scoring problems discussed above: no-year appropriations, credit-type scoring, and a workaround via a third-party entity. These proposals represent a first-cut, preliminary review; more detailed and context-specific analysis is still required before deciding on an optimal approach or combination of approaches for any given use case.

Table 1. Comparative advantages of potential pull mechanisms

Approaches	Description	Advantages	Risks and Challenges
Prizes	Open competitions in which the winner(s) receive an award upon achieving a specific, preset objective	<ul style="list-style-type: none"> • No upfront funding needed • May encourage a wide variety of disparate and untraditional players to compete • Encourages flexibility and innovation 	<ul style="list-style-type: none"> • Some potential participants may lack upfront funding needed to compete • Could result in inefficient duplication of efforts in some cases • Budgetary scoring may discourage use
Milestone Payments	Competitions with limited participation and a series of incremental payment-linked goals, each of which must be met to reach the final objective	<ul style="list-style-type: none"> • Payments made only contingent on specified goals being met • Ability to achieve complex goals in multi-stage process 	<ul style="list-style-type: none"> • Identifying and monitoring appropriate milestones is more complicated than simply providing progress payments • Budgetary scoring may discourage use
Advance Market Commitments	Government or other entity guarantees a viable market for a product if and when it is successfully developed	<ul style="list-style-type: none"> • Creates link between product quality and developer's revenues • Creates market for vital public goods • Requires sponsors to pay only if a desired product is developed 	<ul style="list-style-type: none"> • Promises must be credible • Must be designed to cover appropriate products • Requires explicit financial commitment • Budgetary scoring may discourage use

No-year appropriations

As noted earlier, most funds appropriated by Congress are available for obligation for only a fixed period of time, typically one to several years. For example, in fiscal year 2017, 51 percent of annual federal funding for non-entitlement programs³⁹ was provided through one-year accounts, 19 percent through two-year accounts, 14 percent through accounts with fixed periods of three or more years, and 15 percent through no-year accounts, in which the authority to obligate is indefinite (i.e., remains until all funding is expended).⁴⁰ Because the authority to obligate and spend no-year funding never expires, its use could significantly mitigate one of the major barriers existing scoring rules otherwise pose for prizes and the other pull mechanisms discussed in this paper—the possibility that a competition could prove too challenging to produce a winner, or be cancelled for other reasons, resulting in expired appropriations.

A simple example may help illustrate the advantage of no-year appropriations in addressing this problem. In the case, for instance, of an appropriations account with a three-year period of availability, if an agency obligated funding appropriated in fiscal year 2021 to guarantee the purse of a prize competition and sometime in fiscal year 2024 or later the competition was cancelled—for example, because it was a time-limited competition for which the deadline had passed, or because it no longer seemed useful or relevant (e.g., because of developments in other types of technologies, or other changed circumstances)—the obligated funding would expire.

By contrast, if the budget authority appropriated in fiscal year 2021 was no-year funding, the money that had been originally obligated for the competition could be “de-obligated” from the cancelled competition and “re-obligated” to another new competition. Moreover, this process could, in theory, be repeated multiple times until the funding was eventually expended as a payout for a successful competition. Thus, the use of no-year appropriations accounts would essentially ensure that no budget authority would ever be lost as the result of competitions that failed to produce winners, and it would provide agencies with great flexibility in terms of how they designed any such competition—in terms of both how challenging they were and how long the competitions would be held open.⁴¹

Since the use of no-year appropriations would mean that all budget authority appropriated for prize competitions, milestone payments or AMCs would eventually be spent, it would also ensure that budget scoring ultimately aligned with actual costs (rather than overstating

³⁹ Entitlement programs include, for example, Social Security, Medicare and Medicaid. Non-entitlement (“discretionary”) federal programs account for the vast majority of spending by State (USAID), Defense, Energy, NASA, NIH, and many other departments and agencies, including most of those with large research and development efforts.

⁴⁰ Congressional Budget Office, “Period of Availability of Appropriated Funds,” Letter to the Honorable Steve Womack, May 21, 2018, p. 1, <https://www.cbo.gov/publication/54155>

⁴¹ As an alternative or supplement to the use of no-year appropriations, another option would be to provide the authority for agencies to use some portion of expired or expiring appropriations to cover the costs of contingent appropriations (e.g., funding contingent on a prize competition being successfully completed) for which funding might not otherwise be available. Richard L. Dunn, “Market Shaping: Transforming Markets Through Public and Private Partnerships,” *The Strategic Institute for Innovation in Government Contracting*, p. 6.

those costs because of the possibility of budget authority expiring). The use of no-year appropriations would not, however, entirely fix all the concerns noted earlier. Specifically, the full cost of prize competitions and the other measures would still be charged up front—even though it may be years before the competition would be successfully completed and the money for the award needed. Over time, however, it would substantially mitigate even this problem; as time passed, more and more competitions would be completed and awards paid, likely bringing annual budget appropriations into much closer alignment with actual prize disbursements for any given year.⁴²

Credit type scoring

Rather than focusing on preventing budget expiration, a credit-type scoring approach would discount the score to account for the possibility that appropriated funds will never be expended. This would in some ways be roughly analogous to the budgetary treatment afforded to loan and loan guarantee programs, where the score charged to the account is not the overall amount of the loan or loan guarantee, but rather the expected cost of the program associated with the risk of default.

For example, imagine that only half of the competitions were expected to achieve their goals and thus result in awards being paid. A credit-type approach would score the appropriation at 50 percent of the total amount offered in awards. To provide useful guidance to policymakers, cost estimates of different programs and policies must be comparable—“It is essential that \$100 in costs for one program mean the same thing as \$100 in costs for another program.”⁴³ By discounting the cost of prize competitions and similar pull mechanisms to account for the possibility that goals might not be met, this budgetary treatment would yield lower—but more accurate and comparable—estimates of the actual cost of such efforts. In turn, these lower budgetary scores would presumably lead to greater use of such mechanisms.

An obvious difficulty with designing such an approach would be determining an appropriate rate with which to discount the scoring. Although estimating the appropriate scores for federal loans and loan guarantees can be complicated and even controversial, the general approach, involving inputs such as data on default rates, is relatively well understood. By contrast, evaluating the odds of whether prize competitions would be successful (and thus require the disbursement of funding) would be both a novel and potentially more complicated undertaking.

One way around this difficulty might be to use a more mechanical approach by, for example, starting off with a particular rate, such as 50 percent, and adjusting it over time based on experience. There are a variety of ways this could be done (of varying levels of complexity),

⁴² A simple example might be useful to illustrate this point. If, for example, it is assumed that for every \$100 million dollars of budget authority appropriated in a given year, \$20 million would be disbursed the first year, and \$20 million each of the succeeding nine years, the difference between annual budget authority and annual spending would be dramatic in year one (\$100 million in budget authority but only \$20 million in disbursements). However, if the same level of budget authority and the same spending pattern were sustained in subsequent years, by year five both budget authority and disbursements would equal \$100 million.

⁴³ Kogan, Richard, Paul N. Van de Water, and James R. Horney, “House Bill Would Artificially Inflate Cost of Federal Credit Programs.” Center for Budget and Policy Priorities, June 8, 2013, p. 6.

but the essential idea would be to use a rolling average (covering, for example, five or 10 years) that reflected the share of budget authority provided each year that was actually expended. Each year, the score associated with new budget authority appropriated into the account would be adjusted upward or downward based on the most recent rolling average.⁴⁴ Measured on a medium or long-term basis, at least, such an approach could yield a relatively accurate alignment between budgetary scoring and actual costs incurred.

An advantage of this approach over the use of no-year appropriations is that under this option the upfront scoring would be lower, even if the resources available for obligation were kept the same—since the scoring would be adjusted downward by some proportion to take into account the probability that some of budget authority would end up expiring. However, as noted earlier, this advantage would to some extent be temporary as, over time, in the case of no-year appropriations, annual budget authority and disbursement levels would come into closer alignment. A potential disadvantage of this approach is that it might be more difficult to win Congressional approval since it would mark a more dramatic departure from current budgetary practices than simply allowing greater use of no-year appropriations.

Third-party entity

This third approach would attempt to bypass existing scoring barriers by essentially avoiding them. Under this approach, federal agencies would make commitments to fund future prize awards, milestone payments and AMCs through means that fall short of legally binding obligations. As such, the commitments would not score as budget authority. This might, for example, consist of a commitment to provide a prize award or purchase a new vaccine that is developed in the future, but to make the commitment “subject to appropriations.”

To attract participants to compete for these prizes, however, this aspirational commitment would be backstopped by either an existing or newly established third-party entity that would provide a legally binding commitment, and assume the risk that a specified goal would be met but no federal funding provided. A variety of different forms have been suggested for third-party entities that could support innovative development finance initiatives, including existing international financial institution, international development agencies, and public-private organizations.⁴⁵ Alternatively, an entity similar to an insurance company could, in theory, be created to backstop such non-binding commitments.⁴⁶ In this case, private investors could be used to backstop these commitments—with the investors covering the

⁴⁴ This would be somewhat akin to how the funding level for the Department of Homeland Security’s Disaster Relief Fund (DERF) were at one time calculated—in part by averaging the funds spent by the program in the preceding five-year period.

⁴⁵ See, for example, Benjamin Leo, “Can Donors Be Flexible within Restrictive Budget Systems? Options for Innovative Financing Mechanisms, Center for Global Development, Working Paper 226, October 2010, pp. 16–22.

⁴⁶ Ibid.

cost if the government funding falls through, in return for sharing part of the award should the government’s non-binding commitment be honored.⁴⁷

A major advantage of this approach is that it would require that appropriations to cover the cost of prize awards, milestone payments or AMCs would only need to be provided if and when success were achieved in accomplishing the specified goals. However, there are also significant potential shortcomings with this approach. Perhaps the most significant limitation is that it might be difficult to find an existing entity or entities that would be amenable to playing this type of role, especially on a broad, ongoing basis—since the downside risks could be both difficult to evaluate and potentially costly.⁴⁸ In the case of an insurance-type entity or one financed by private investors, this downside risk would be mitigated, but only at a (potentially significant) cost to the U.S. government. In the former case, the extra costs would accrue because, in addition to the cost of covering awards associated with successful competitions, the U.S. government would have to pay insurance premiums—which would need to be sufficient to cover both the cost of evaluating risks (i.e., that a prize would be awarded but no government funding provided) and to provide a profit for the insurance company. In the latter case, the extra costs would accrue because in the event of a successful competition, the U.S. government would need to pay enough to cover not only the award itself, but the cost of evaluating risks and a return to investors. In either case, taking steps to highlight the political commitment—e.g., by enacting related authorization language—could help reduce the perceived risk that the government would ultimately fail to appropriate the committed funding, and thus lower the “transaction costs” associated with the approach. But it would not eliminate those costs. This approach would also likely be more complicated to carry out, and novel, than either of the other two—at least if it involved the use of an insurance company or private investors—and thus perhaps also the most difficult to sell to Congress.

6. Discussion and conclusion

On paper, our survey of relevant legislation and budgetary practices suggests that agencies have quite broad authority to use pull mechanisms in support of US government R&D objectives. The COMPETES Act offers government-wide Prize Authority; other legislation, more narrowly focused on global health and health security, allows for use of AMCs. Nevertheless, the limited use of such mechanisms points to a negative incentive environment that both explicitly and subtly dissuades agencies from pursuing more innovative approaches. Further, actual use of pull mechanisms, as observed across the US government, suggests a “small-ball,” risk-averse, and thus ultimately low-impact approach—missing opportunities to use pull mechanisms in support of the biggest innovation

⁴⁷ Such an entity might be roughly patterned after those that have been proposed to attract private investors to help finance Social Impact Bonds (SIBs). See, Elizabeth Lower-Basch, “Social Impact Bonds: Overview and Considerations,” CLASP, March 7, 2014, p. 2.

⁴⁸ The use of such entities to backstop U.S. commitments in special cases or on an ad hoc basis might be less problematic—for example in cases where the U.S. government’s commitment appears (though not legally binding) quite robust, the risks manageable, and the prize competition, milestone payment or AMC fits well within the focus of the International Financial Institution or other entity’s focus.

challenges that could improve wellbeing and security both within the US and around the world. We note that this is a particular barrier with respect to global health innovations, which generally require relatively long development cycles and large R&D budgets—both of which would be problematic under current budget rules.

First, we find that budgetary barriers pose a financial disincentive to the use of pull mechanisms. Under current rules, funding for a pull mechanism must be made available and fully scored when the commitment is made, even if the actual prize would be paid out many years in the future—or, perhaps, never awarded. This represents a substantial opportunity cost vis-à-vis the current year’s budget; funds must be set aside essentially in escrow rather than used to support current year programming. Further, most appropriations expire after one to three years; if such funds remain unobligated, they are subsequently returned to the treasury. The threat of expiration limits agency flexibility and means, among other things, that funding obligated for competitions that fail to produce a winner cannot be easily re-obligated to more promising competitions, and may be lost; the “use it or lose it” rules also increase the riskiness of a pull mechanism from an agency’s perspective, especially when there is substantial uncertainty about whether a goal will be achieved within the permissible period.

Second, we note substantial technical barriers to use of pull mechanisms. Despite increasing usage across the US government, pull mechanisms still represent only a miniscule portion of R&D funding. Most agency staff lack experience and expertise in the technically demanding aspects of incentive and competition design—requiring a very different skill set than traditional grant making/procurement and project management. We did not identify any dedicated training or skills-building approaches to strengthen these capacities; nor do we observe a strong, dedicated, and established community of practice with expertise in design and management of pull mechanisms. Even with requisite legal authority—and even if they were freed from financial disincentives—agency staff may still not feel empowered and capable of pursuing pull mechanisms as an alternative to traditional operating models. In some areas, agency limitations on the use of cost-effectiveness criteria may also provide a disincentive.⁴⁹

Third, we observe a generally complacent and risk-averse environment, with few incentives to “go out on a limb” in pursuit of an alternative R&D approach—particularly in the absence of a high-level political or managerial imperative. Agency staff are largely accustomed to (and believe in) traditional grant and contracting approaches. Though agency staff at times appear intrigued by pull mechanisms, these alternative approaches remain attractive mostly as a novelty and are not generally perceived as viable competitors to traditional business models, particularly given the financial disincentives and technical barriers described above.

Together, the combined impact of these explicit and implicit forces is likely responsible for the limited use of pull mechanisms to date despite relatively permissive legislative authority. Even

⁴⁹ For example, CMS is precluded from explicitly using cost-effectiveness criteria in its treatment coverage decisions.

when pull mechanisms are used, our findings are suggestive—though not conclusive—that they may also steer agency staff to relatively short-term, low-risk objectives that will almost certainly be achieved. This approach limits the scope and ambition of pull mechanisms to pursuit of relatively few, marginal, and narrow R&D goals versus high-risk “moonshots” with the largest potential for social impact—and where pull mechanisms, in both theory and practice, may have a substantial advantage vis-à-vis push mechanisms at stimulating high-impact innovation.

Our findings suggest that a more ambitious approach is possible, but embracing it will require budgetary tweaks, technical support to agencies, and high-level political buy in. In the final section of the paper, we suggest several budgetary approaches that could mitigate financial disincentives to use of pull mechanisms; several are consistent with existing Congressional practice (e.g. no-year budget authority), suggesting reasonable political feasibility. To support the technical design of pull mechanisms, the US government could consider development of a dedicated central technical team of economists, budget professionals and others with relevant expertise for short-term deployment to agencies; such a team could sit within the White House Office of Science and Technology Policy (OSTP) and follow the model of the Presidential Innovation Fellows,⁵⁰ for example. Finally, high-level political support—ideally from the White House via OSTP, but at very least from agency heads—can facilitate more risk-taking by agency staff in pursuit of high-priority US government R&D goals. To this end, it is notable that the highest-value pull mechanisms used to date—the Space X milestone payments and the Operation Warp Speed advance purchase agreements for vaccine candidates—were for high-profile, high-priority endeavors with very high-level political support.

The US government should also begin a serious effort to engage and improve the skill set of the federal acquisition workforce so that departments and agencies have not just the authority to use the pull mechanisms outlined in this paper, but the technical know-how and comfort-level with each of these mechanisms to make their use a consistent and significant part of the federal government’s acquisition toolkit. Among other things, this is likely to mean strengthening training about these mechanisms, as well as raising the profiles of these mechanisms, within, for the Federal Acquisition Institute, the Office of Federal Procurement Policy, and Chief Acquisition Officer Council, and the Interagency Acquisition Career Management Council, as well as through each agency’s own acquisition training and management entities.

Finally, it is worth stressing that the US government can leverage its purchasing power to support innovation in ways that fall short of an explicit, binding pull mechanism. As is common practice in the defense sector, the US government can issue target product profiles for products which do not currently exist and indicate an intent (appropriations permitting) to purchase such products if made available. While this does not represent a binding commitment, it may nonetheless send a strong market signal about the potential for future federal procurement, helping to de-risk market uncertainty—at least to some extent. This could be particularly valuable, for example, among large global health agencies which dedicate substantial portions of their budgets to health commodity procurement.

⁵⁰ <https://presidentialinnovationfellows.gov/>

Appendix. Authorities for the use of selected pull mechanisms

Department/Agency	Description	Year	Public Law/Statute
Defense and other Agencies	Authority for Defense and civilian agencies to use AMCs for national defense and other emergencies	1950	Defense Production Act, 81–774/ 50 U.S.C. §§4501 et seq.
NASA	Other Transaction Authority	1958	NASA Act, PL 85–586/42 U.S.C. §2473
DARPA	Other Transaction Authority	1989	PL 101–181/10 U.S.C. §2371
Defense	Other Transaction Authority	1994	Federal Acquisition Streamlining Act, 103–355
FAA	Other Transaction Authority	1996	PL 104–264/49 U.S.C. §106(1)
Transportation	Other Transaction Authority	1998	PL 105–178/23 U.S.C. §502
DARPA	Prize competition authority	1999	PL 106–65/10 U.S.C. §2374a
TSA	Other Transaction Authority	2001	PL 107–71
Homeland Security	Other Transaction Authority	2002	PL 107–296
NIH	Other Transaction Authority	2003	PL 108–199
Other Executive Agencies	Permits use of OTAs by civilian agencies in limited circumstances	2003	FY2004 National Defense Authorization Act, PL 108–136
HHS	Project BioShield AMC authority for CBRN-related purchases	2004	Pandemic and All-Hazards Preparedness Act, PL 108–276
Energy	Prize competition authority	2005	PL 109–588/42 U.S.C. §16396
NASA	Prize competition authority	2005	PL 109–55/51 U.S.C. §20144
Energy	Other Transaction Authority	2005	PL-109–58/42 U.S.C. §7256
HHS	Prize competition authority	2006	PL 109–417/42 U.S.C. §247d-7e
Defense	Prize competition authority	2006	PL 109–364/10 U.S.C. §2374a
NSF	Prize competition authority using donated funds	2007	America Competes Act, PL 110–69
	AMC authority for purchase of HIV/AIDS and other vaccines	2008	Lantos-Hyde Act, 22 U.S.C. § 7624
Government-wide	Prize competition authority	2010	America Competes Act Reauthorization, PL 111–358
Transportation	1% < Hwy Trust Fund for prize comp	2012	PL 112–141/23 U.S.C. §502
Government-wide	Updates and clarifies America Competes Act	2017	American Innovation and Competitiveness Act, PL 114–339
Commerce	Prize competition authority	2018	PL 115–141/6 47 U.S.C. §1509

Sources: For citations for Other Transaction Authorities, see L. Elaine Halchin, “Other Transaction (OT) Authority,” Congressional Research Service, July 15, 2011, pp. 6–19, <https://fas.org/sgp/crs/misc/RL34760.pdf>, and Moshe Schwartz and Heidi M. Peters, “Department of Defense Use of Other Transaction Authority: Background, Analysis, and Issues for Congress,” Congressional Research Service, February 22, 2019, pp. 36, <https://crsreports.congress.gov/product/pdf/R/R45521>; for citations for prize competition authority, see, “Federal Prize Competitions,” Congressional Research Service, April 6, 2020, pp. 6–19, 4–6; for AMC citations, see, Frank Gottron, “Project BioShield: Authorities, Appropriations, Acquisitions, and Issues for Congress,” Congressional Research Service, May 27, 2011, p. 2–3, <https://fas.org/sgp/crs/terror/R43607.pdf>, Legal Information Institute, Cornell Law School, <https://www.law.cornell.edu/uscode/text/22/7624> accessed June 8, 2021), and Michael H. Cecire and Heidi M. Peters, “The Defense Production Act of 1950: History, Authorities, and Considerations for Congress,” Congressional Research Service, March 2, 2020, pp. 10–11, <https://fas.org/sgp/crs/natsec/R43767.pdf>.