

SEPTEMBER 2016

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CSIS

CENTER FOR STRATEGIC &
INTERNATIONAL STUDIES



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A Report of the
CSIS DEFENSE-INDUSTRIAL INITIATIVES GROUP



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Contents

List of Figures	vi
Executive Summary.....	viii
Federal R&D contracts have been disproportionately impacted by the budget drawdown	viii
DoD is in the midst of a six-year trough in its development pipeline for major weapons systems.....	ix
The budget drawdown has caused profound changes to the DoD R&D contracting industrial base	ix
Much of the conventional wisdom was incorrect	x
Introduction.....	1
1. Federal R&D Contracting in Context.....	3
Department of Defense.....	5
Army.....	6
Navy	7
Air Force	8
MDA.....	8
NASA	9
Department of Health and Human Services.....	11
Department of Energy.....	12
2. Literature Review.....	13
Structure of Overall U.S. R&D Funding.....	13
How Does R&D Function during a Recession?.....	14
Benefits of R&D Spending during a Shock	14
Magnitude of R&D Spending.....	15
Prioritization of R&D spending within an organization	17
R&D Spending during Times of Shifting Priorities.....	17
Changes in R&D Funding.....	18
Changes in targets of R&D spending.....	20
Conclusion.....	20
3. How Has the Budget Drawdown Affected Federal R&D Contracting?.....	21
Hypothesis 1: Cuts in R&D due to budget drawdown will be done on a salami slice basis, rather than reflecting a thoughtful prioritization of resources.....	21
Department of Defense.....	22

NASA	26
HHS	27
Findings	28
Hypothesis 2: Newer R&D contracts will bear a disproportionate share of cuts during budget drawdowns.	29
Department of Defense.....	30
NASA	31
HHS	31
Department of Energy	31
Findings	31
Hypothesis 3: Budget drawdowns will lead to shifts away from early-stage, seed-corn R&D, toward mid- to late-stage R&D tied to high-profile programs.	32
Department of Defense.....	32
NASA	33
HHS	33
Findings	34
Hypothesis 4: Large prime vendors will account for increasing shares of federal R&D during budget drawdowns.	34
Department of Defense.....	34
NASA	37
HHS	37
Findings	38
Hypothesis 5: During budget drawdowns, R&D will be increasingly funded out of non-R&D-focused funding accounts.....	38
Department of Defense.....	38
HHS	40
NASA	40
Findings	40
Hypothesis 6: During budget drawdowns, competitively sourced R&D contracts will attract increasing numbers of offerors.....	40
Department of Defense.....	41
NASA	44
HHS	45
Basic Research	46
Applied Research.....	47

Advanced Technology Development.....	47
Advanced Component Development & Prototypes.....	48
System Development & Demonstration	49
Operational Systems Development	50
Operation of Government R&D Facilities	51
Findings	51
Hypothesis 7: The budget drawdown will discourage new entrants into the federal R&D contracting marketplace.....	52
Department of Defense.....	54
NASA	56
HHS	57
Findings	58
Final Thoughts.....	59
Appendix: Methodology.....	60
Inherent Restrictions of FPDS	60
Constant Dollars and Fiscal Years	61
Data Reliability Notes and Download Dates.....	61
Detailed Methods	61
Competition	61
Vendor Categorization	62
About the Project Directors and Authors.....	64

List of Figures

Figure 1-1: Federal R&D Contract Obligations by Customer, 2000–2015.....	3
Figure 1-2: Federal R&D Contract Obligations by Stage of R&D, 2000–2015	4
Figure 1-3: DoD R&D Contract Obligations by Stage of R&D, 2000–2015	5
Figure 1-4: NASA R&D Contract Obligations by Stage of R&D, 2000–2015	10
Figure 1-5: HHS R&D Contract Obligations by Stage of R&D, 2000–2015	11
Figure 3-1: Year-to-Year Rate of Change for DoD R&D Contract Obligations, by Stage of R&D, 2008–2015.....	23
Figure 3-2: Year-to-Year Rate of Change for Army R&D Contract Obligations, by Stage of R&D, 2008–2015.....	24
Figure 3-3: Year-to-Year Rate of Change for Navy R&D Contract Obligations, by Stage of R&D, 2008–2015.....	25
Figure 3-4: Year-to-Year Rate of Change for Air Force R&D Contract Obligations, by Stage of R&D, 2008–2015.....	26
Figure 3-5: Year-to-Year Rate of Change for NASA R&D Contract Obligations, by Stage of R&D, 2008–2015.....	27
Figure 3-6: Year-to-Year Rate of Change for HHS R&D Contract Obligations, by Stage of R&D, 2008–2015.....	28
Figure 3-7: Share of R&D Contract Obligations under New Start Contracts, by Customer, 2001–2015.....	29
Figure 3-8: Share of Defense R&D Contract Obligations under New Start Contracts, by Component, 2001–2015.....	30
Figure 3-9: Defense R&D Contract Obligations, by Size of Vendor, 2000–2015.....	35
Figure 3-10: Army R&D Contract Obligations, by Size of Vendor, 2000–2015	36
Figure 3-11: NASA R&D Contract Obligations, by Size of Vendor, 2000–2015	37
Figure 3-12: Number of Offers Received for Competed Defense R&D Contract Obligations, 2008–2015	41
Figure 3-13: Number of Offers Received for Competed Army R&D Contract Obligations, 2008–2015	42
Figure 3-14: Number of Offers Received for Competed Navy R&D Contract Obligations, 2008–2015	43
Figure 3-15: Number of Offers Received for Competed Air Force R&D Contract Obligations, 2008–2015	44
Figure 3-16: Number of Offers Received for Competed NASA R&D Contract Obligations, 2008–2015	45
Figure 3-17: Number of Offers Received for Competed HHS R&D Contract Obligations, 2008–2015	46

Figure 3-18: Number of Offers Received for Competed Basic Research Contract Obligations, 2008–2015	47
Figure 3-19: Number of Offers Received for Competed ATD Contract Obligations, 2008–2015.....	48
Figure 3-20: Number of Offers Received for Competed ACD&P Contract Obligations, 2008–2015.....	49
Figure 3-21: Number of Offers Received for Competed SD&D Contract Obligations, 2008–2015.....	50
Figure 3-22: Number of Offers Received for Competed Operational Systems Development Contract Obligations, 2008–2015	51
Figure 3-23: Number of New Entrants and Contract Obligations to New Entrants in the Federal R&D Marketplace, 2008–2015	53
Figure 3-24: Number of New Entrants and Contract Obligations to New Entrants in the DoD R&D Marketplace, 2008–2015.....	55
Figure 3-25: Number of New Entrants and Contract Obligations to New Entrants in the NASA R&D Marketplace, 2008–2015.....	56
Figure 3-26: Number of New Entrants and Contract Obligations to New Entrants in the HHS R&D Marketplace, 2008–2015.....	57

Executive Summary

Technological superiority has been a central pillar of U.S. strategy in the post–World War II era. It has allowed the United States to deter, and when necessary defeat, numerically superior forces of potential or actual adversaries. But with other nations building their capabilities and infrastructure at a rapid pace, it is not safe or wise to assume that U.S. technological superiority is a foregone conclusion. Furthermore, as the current budget drawdown has progressed, numerous analysts and policymakers have expressed concern regarding the ability of the U.S. to retain technological superiority, particularly given how research and development (R&D) contracting has been broadly understood to be in serious decline. Broadly speaking, the stated concerns can be summarized as a fear that the R&D necessary to drive future technological breakthroughs, in either the defense or civilian realms, would be jeopardized and would be particularly damaged if agencies disproportionately sacrificed longer-term R&D spending in order to preserve current programs and activities.

To examine what has happened within the federal R&D contracting portfolio, CSIS utilized its decade-plus of experience in analyzing trends in federal contracting. Using federal contract data from the publicly available Federal Procurement Data System (FPDS), this report explains what has happened to federal R&D contracting, and the industrial base that supports those efforts, during the current budget drawdown.

The report is split into two main sections: In the first, the study team looks at the broader trends in federal R&D contracting within the major R&D contracting agencies and components, using a methodology that categorizes R&D contracts by stage of R&D (roughly corresponding to the Department of Defense’s (DoD’s) commonly used R&D Budget Activity Codes). In the second section, CSIS uses the data to test hypotheses, which were derived based on widely expressed concerns about the expected impact of the drawdown on the federal R&D contracting portfolio and the supporting industrial base.

The analysis in this report produced four key findings:

Federal R&D contracts have been disproportionately impacted by the budget drawdown

While federal contract obligations overall have declined precipitously during the current budget drawdown, the impact has fallen more harshly on the federal R&D contracting portfolio. As described in Chapter 1, this is particularly apparent within DoD and the Department of Health and Human Services (HHS). The study found that while overall DoD contract obligations fell by more than a third since 2009, DoD R&D contract obligations declined by more than half. The disparity was even more dramatic within HHS — as overall HHS contract obligations remained largely stable during the drawdown, HHS R&D declined by nearly two-fifths.

NASA represents a notable exception to this trend, as overall NASA contract obligations were virtually flat, NASA R&D contract obligations increased by 21 percent. The contrast to DoD was particularly stark. While NASA was able to grow its R&D contracting portfolio by finding savings in its services contracts, DoD services contracts were actually relatively preserved during the budget drawdown, at the expense of its R&D contracting portfolio.

DoD is in the midst of a six-year trough in its development pipeline for major weapons systems

One of the key conventional wisdom assumptions tested in this study is the idea that federal agencies, and particularly DoD, would seek to preserve mid-to-late-stage R&D projects, especially those tied to high-profile programs, by disproportionately targeting early stage, seed corn R&D for cuts. As described under Hypothesis 3 in Chapter 3, the data shows that the opposite has been true: early stage R&D has seen significant declines, but has been relatively preserved compared to the overall declines in R&D. In fact, within DoD, two categories of mid-to-late-stage R&D, Advanced Technology Development (6.3) and System Development & Demonstration (6.5) have seen cuts of two-thirds or more between 2009 and 2015.

The two main drivers of the massive declines in those two stages of R&D are the cancellation of large R&D programs (such as the Army's Future Combat Systems) and the maturation of R&D programs into procurement (such as the F-35 Joint Strike Fighter). During the budget drawdown period, however, there has been a dearth of new development programs for major weapons systems which replace those that have either graduated into production or been cancelled. As a result, DoD is facing a six-year trough in its development pipeline for major weapons systems.

This trough has manifested differently within the three military services. In the Air Force, significant work and funding for the B-21 bomber is likely to begin within the next couple of years. The Navy has the Ohio replacement ballistic missile submarine program on the horizon, but the start of the program has been pushed back into the early 2020s due to ongoing budget constraints. The Army is in the toughest position of the three, as since the failure of Future Combat Systems, the Army has been largely unable to start or sustain major development programs. With continuing uncertainty about future missions and capabilities, as well as significant budgetary challenges, the Army's trough seems likely to persist for the foreseeable future.

This is particularly worrisome because, as discussed in the literature review in Chapter 2, defense R&D has historically seen a cycle where investments made in growth periods show results during subsequent drawdown periods. For the Army, more so than the other military services, this pattern appears to have been broken during the current budget drawdown.

The budget drawdown has caused profound changes to the DoD R&D contracting industrial base

In addition to examining the effects of the budget drawdown on the government customer, the study team also looked at the impact on the industrial base that supports federal R&D

contracting. Under Hypothesis 4 in Chapter 3, CSIS tested the assertion that large prime vendors would fare better during the budget drawdown, expecting to see contract obligations to the largest vendors (which usually perform the largest, highest-profile development projects) relatively preserved compared to other vendor size categories. In fact, the data shows the exact opposite: within DoD, the share of R&D contract obligations going to the Big 5 defense vendors (Lockheed Martin, Boeing, Northrop Grumman, Raytheon, and General Dynamics) has fallen from 57 percent in 2009 to 33 percent in 2015, largely as a result of the aforementioned six-year trough in DoD's developmental pipeline for major weapons systems. Furthermore, that reduced share is in a DoD R&D contracting marketplace that is less than half as large as it was in 2009.

Over that same period, there has been a marked surge in the share of R&D contracts going to small vendors; that share has risen from 10 percent in 2009 to 17 percent in 2015, by far the highest share for small vendors in the 2000–2015 period. This rise has occurred not just for DoD overall, but also within the R&D contracting portfolios of all three military services. The increasing share for small vendors is not the result of actual increases in obligations during the period; rather, DoD R&D contract obligations to small vendors have declined far less steeply than DoD R&D overall. Nonetheless, this can be seen as a victory for policies that promote small business participation—in an extremely challenging environment, small vendors have managed to largely hold their ground, even as the bigger players were facing sharp declines.

The data regarding small vendors is not all positive, however. As seen under Hypothesis 7 in Chapter 3, there has been a particularly sharp decline in the number of new small vendors entering the federal R&D marketplace in each year over the course of the budget drawdown. Interestingly, those vendors who were classified as small businesses for all of their contracts fared better than those for whom only some of their contracts fell under small business rules. The data also shows that, while contract obligations to new entrants that were “Sometimes Small” fell roughly in line with the declining numbers of new entrants, contract obligations to “Always Small” new entrants were actually preserved relative to the overall federal R&D marketplace. While more research is needed to make any definitive conclusions, this data may indicate that firms that are growing out of the small-business classification have faced particular difficulties during the budget drawdown.

Much of the conventional wisdom was incorrect

CSIS tested seven hypotheses reflecting the conventional wisdom or at least widely expressed concerns, regarding the impact of the budget drawdown on federal R&D contracting and the supporting industrial base. For six of those seven hypotheses, the data either did not provide significant support for the hypothesis or actually strongly pointed in the opposite direction. Only one hypothesis, Hypothesis 7, which looks at new entrants into the federal R&D marketplace, was even partly supported by the data. This result underscores the importance of relying on data for analysis of trends in federal contracting; while anecdotes and the conventional wisdom may tell stories that make intuitive sense, good data is the only way to understand what is really happening. This finding also suggests that management matters, as leaders were able to avoid some of the more commonly feared

outcomes of sequestration and its aftermath through resource management and policy initiatives. However, the overall concern that R&D contracting would be disproportionately impacted by sequestration and its aftermath was proven correct, showing the limits of management alone in mitigating the impact of the budget drawdown on U.S. technological superiority in the face of sudden, massive funding reductions.

Introduction

As the current budget drawdown has progressed, resulting from fiscal restraints imposed by the Budget Control Act, as well as sequestration and its aftermath, numerous policymakers and informed observers have expressed concerns about the effect it will have on federal research and development (R&D) efforts. Across the federal government, but particularly within the Department of Defense (DoD), there have been fears that the sharp downturn in federal contract obligations would disproportionately impact the R&D contracting portfolios within individual agencies and their major components. Using data from the publicly available Federal Procurement Data Systems (FPDS), this report examines trends in federal R&D contracting during the current drawdown and analyzes the degree to which actual data conforms to predicted trends.

In order to analyze trends within R&D contracting portfolios of the four largest federal R&D customers—DoD, Department of Energy (DoE), National Aeronautics and Space Administration (NASA), and Department of Health & Human Services (HHS)—CSIS has developed a methodology to categorize R&D contracts by stage of R&D, using a categorization schema that roughly corresponds to the commonly used DoD R&D Budget Activity Codes (BACs):¹

- Basic Research (6.1)
- Applied Research (6.2)
- Advanced Technology Development (ATD) (6.3)
- Advanced Component Development & Prototypes (ACD&P) (6.4)
- System Development & Demonstration (SD&D) (6.5)
- Operational Systems Development (6.7)
- Operation of Government R&D Facilities (GOCO)²

Chapter 1 of this report looks at the overall trends for federal R&D, both by which federal agency or a major component is doing the contracting and by what stage of R&D the work falls under. Chapter 2 reviews the available literature regarding how budgetary pressures affect R&D spending, in both the public and private sectors. Chapter 3 examines seven hypotheses regarding how federal R&D could be affected by the budget drawdown, based

¹ CSIS does not include contracts for R&D Management Support (6.6) in this analysis.

² Though not classified as R&D in FPDS, CSIS now includes the codes for management/operation of federal R&D facilities in its R&D category, as a significant amount of R&D activity, particularly in DoE, is structured in this manner.

on the conventional wisdom of how R&D contracting would be affected, and tests those hypotheses against the available data.

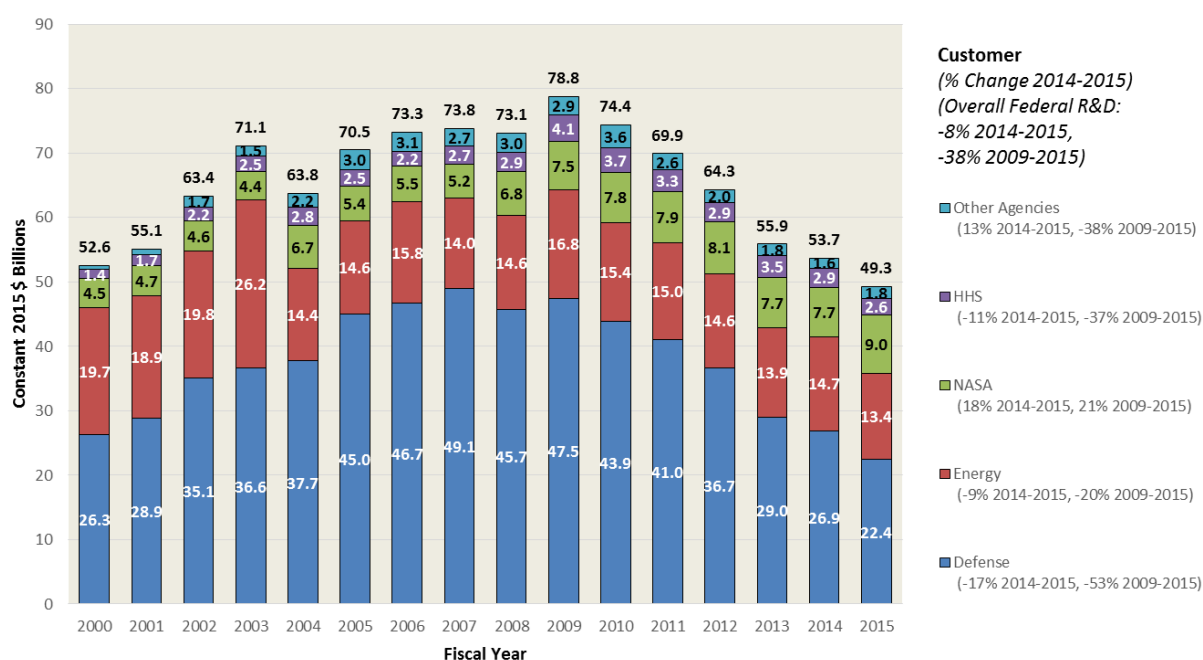
The study concludes that while at the macro level the expectation that sequestration and its aftermath would disproportionately impact R&D contracting was correct, much of the conventional wisdom about the impact of the budget drawdown on federal R&D contracting below the top level has not been borne out. While R&D contracting portfolios in some parts of the federal government saw dramatic cuts, others were relatively preserved, and the distribution of those cuts did not conform to expectations. Similarly, with one notable exception, the impact of the budget drawdown on the composition of the federal R&D contracting industrial base has not followed the course predicted by the conventional wisdom.

1. Federal R&D Contracting in Context

Four federal agencies have accounted for 95 percent or more of total federal R&D contract obligations in every year since 2000: DoD, DoE, NASA, and HHS. Of these, DoD accounts for by far the largest share, with over 50 percent in every year during the 2000–2014 period, reaching as high as 66 percent in 2007, though that share fell to 46 percent by 2015. DoE accounted for 39 percent of total federal R&D contract obligations in 2000, but has accounted for between 20 percent and 25 percent in most years since 2004. NASA, which accounted for between 6 percent and 9 percent of federal R&D contract obligations from 2000–2003, has seen steady growth since then, and has accounted for double-digit shares in every year since 2009, rising to 18 percent by 2015. Meanwhile, HHS has accounted for between 3 percent and 5 percent of total federal R&D contract obligations in all but one year in the 2000–2014 period (6 percent in 2013).

Figure 1-1 shows overall federal R&D contract obligations, broken down by customer, with the federal-wide total for each year at the top of each column:

Figure 1-1: Federal R&D Contract Obligations by Customer, 2000–2015



Source: FPDS; CSIS analysis.

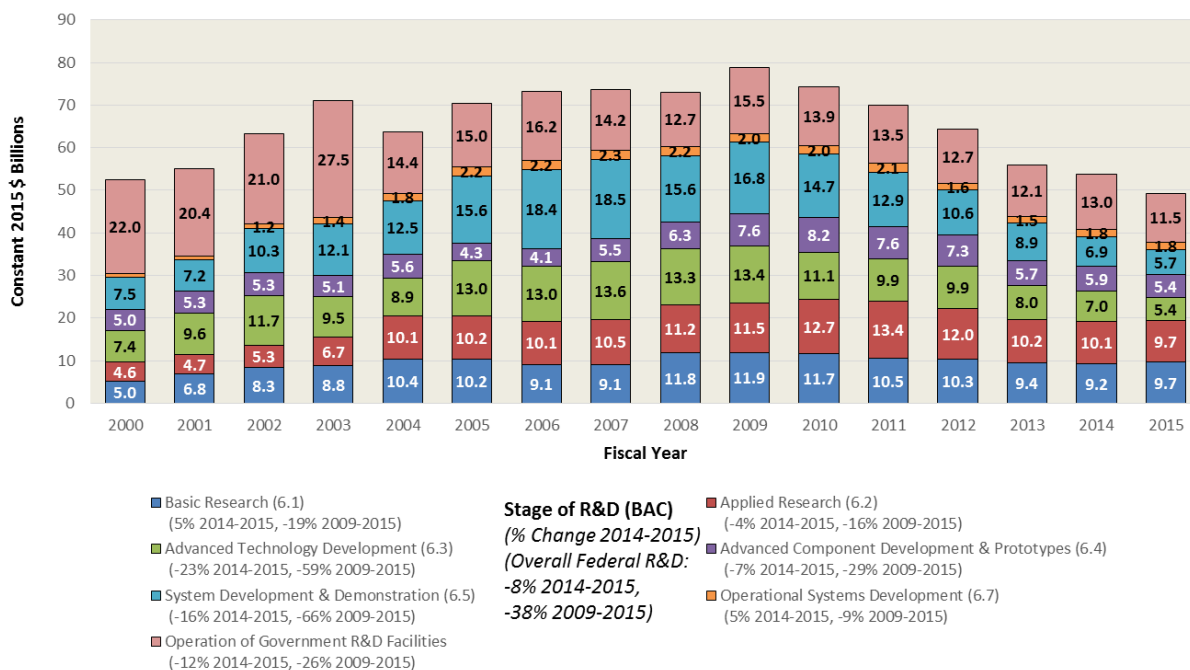
Since their peak in 2009, as overall federal contract obligations declined by 29 percent, federal R&D contract obligations have declined by 38 percent. Interestingly, most of the disproportionate decline in federal R&D contracts occurred prior to the impact of

sequestration—since 2012, as overall federal contract obligations declined by 19 percent, federal R&D contract obligations fell roughly in parallel (-23 percent), with similarly parallel declines in both 2013 and 2014.

In 2015, as overall federal contract obligations fell by 3 percent, federal R&D contract obligations fell by 8 percent, continuing the pattern in recent years of R&D bearing a disproportionate share of the declines in overall federal contract obligations.

To better understand trends within the federal R&D contracting portfolio, CSIS used the widely understood Budget Activity Codes (BACs) as a guide to create a methodology to classify R&D contracts by stage of R&D. Figure 1-2 shows federal R&D contract obligations by stage of R&D:

Figure 1-2: Federal R&D Contract Obligations by Stage of R&D, 2000–2015



Source: FPDS; CSIS analysis.

Despite federal R&D contract obligations declining by 38 percent since 2009, Basic Research (-19 percent), Applied Research (-16 percent), ACD&P (-29 percent), Operational Systems Development (-9 percent), and GOCO (-26 percent) were all relatively preserved. Meanwhile, ATD (-59 percent) and SD&D (-66 percent) both saw dramatic, disproportionate declines. As a share of overall federal R&D contract obligations, Basic Research and Applied Research, combined, rose from 30 percent in 2009 to 40 percent in 2015. Meanwhile, ATD fell from 17 percent to 11 percent, and SD&D declined from 21 percent in 2009 to 12 percent in 2015.

In 2015, as overall federal R&D contract obligations declined by 8 percent, both ATD (-23 percent) and SD&D (-16 percent) fell significantly more steeply. By contrast, obligations for

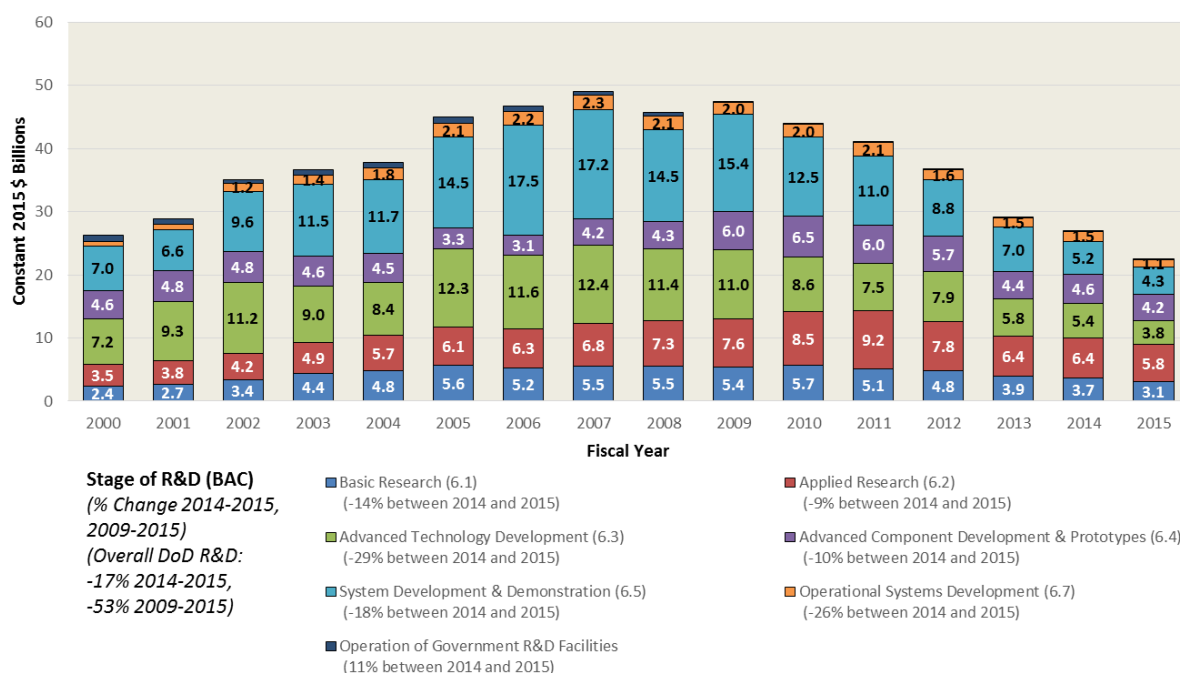
Applied Research (-4 percent) fell at half the rate of overall federal R&D, while obligations for Basic Research (5 percent) actually increased for the first time since 2009.

Overall, the current drawdown has seen a notable shift within the federal R&D contracting portfolio, with a greater share of obligations going to early-stage, seed-corn R&D. The drivers of this trend will be analyzed in the sections that follow, which will look at the R&D contracting portfolios within the major federal R&D customers.

Department of Defense³

Since 2009, DoD R&D contract obligations have declined by 53 percent, notably faster than the 35 percent decline in overall DoD contract obligations over this same period. As a share of overall DoD contract obligations, R&D declined from 11 percent in 2009 to 8 percent in 2015, the lowest share seen in the 2000–2015 period. Figure 1-3 shows the breakdown of DoD R&D contract obligations by stage of R&D:

Figure 1-3: DoD R&D Contract Obligations by Stage of R&D, 2000–2015



Source: FPDS; CSIS analysis.

Since 2009, as overall DoD R&D contract obligations declined by 53 percent, obligations for Applied Research declined by less than half that rate (-23 percent),⁴ while obligations for Basic Research declined by only 42 percent. As a share of DoD R&D contract obligations, the

³ Portions of this section are adapted from CSIS's January 2016 report on overall Defense Acquisition Trends, which drew in part upon research and analysis done in preparation for this research effort.

⁴ DoD contract obligations for Applied Research actually saw a notable spike between 2009 and 2011, due primarily to a one-year spike for space-related R&D, but obligations returned to prior levels in 2012.

two seed-corn categories rose from 27 percent in 2009 to 40 percent in 2015, the highest share in the 2000–2015 period. Basic Research contract obligations have declined at a rate that more closely parallels the overall decline in DoD R&D contract obligations since 2012, but Applied Research obligations have continued to be relatively preserved (-25 percent decline since 2012, compared to -39 percent for overall DoD R&D).

Contract obligations for ACD&P (-31 percent) and Operational Systems Development (45 percent) have similarly been relatively preserved since 2009, though the latter declined by 26 percent in 2015, nearly half-again as steeply as overall DoD R&D (-17 percent). But ATD (-65 percent) and SD&D (-72 percent) have seen massive declines in recent years. The declines in ATD and SD&D accounted for nearly three-quarters of the total decline in DoD R&D contract obligations during the current drawdown.

DoD contract obligations for SD&D (-18 percent) and Basic Research (-14 percent) fell roughly in parallel to overall DoD R&D in 2015, but obligations for ATD fell notably more steeply (-29 percent), while obligations for Applied Research (-9 percent) declined at roughly half the rate of overall DoD R&D.

The enormous decline in SD&D is particularly telling and speaks to the larger trend in DoD R&D contracting—over the past several years, as R&D programs related to MDAPs have either been canceled or matured into production, DoD has been largely unable to start and sustain new development programs, either due to budgetary pressures or to programmatic difficulties. The decline in R&D contract obligations during the budget drawdown thus appears to reflect a six-year trough in the pipeline of new major weapons systems; the dimensions of this trough will be discussed further in the sections that follow.

The following sections will briefly examine trends in R&D contracting within the three military services, plus the Missile Defense Agency (MDA).

Army

The key factor in the massive decline in Army R&D contract obligations (-61 percent since 2009, compared to -55 percent for Army contracts overall) has been the cancellation of the Army's Future Combat Systems (FCS) program. Nearly all the decline in Army R&D contract obligations between 2009 and 2012 is directly attributable to the cancellation and winding down of FCS. In particular, obligations for SD&D have declined by an incredible 95 percent since 2009, as the Army has struggled to start and sustain new development programs for major weapons systems in the wake of FCS's cancellation. The result of these struggles is the current six-year trough in the Army's development pipeline for major weapons systems.

In terms of seed-corn R&D, the trend within the Army is mixed. While Basic Research (-49 percent) has been relatively preserved since 2009, Applied Research (-58 percent) has declined nearly as steeply as overall Army R&D. The decline in Applied Research was not consistent throughout the period, however; Army obligations for Applied Research actually grew between 2009 and 2011, before declining by nearly half in 2013 and falling by another 18 percent in 2015. In 2015, combined obligations for the two seed-corn categories are at their lowest level (\$1.5 billion) in the 2000–2015 period.

In 2015, Army R&D contract obligations were relatively stable (-1 percent), indicating that the decline may have finally reached its floor. In addition to the aforementioned steep decline for Applied Research in 2015, obligations for SD&D also fell by 18 percent, though that only represents a drop from \$220 million to \$180 million. Meanwhile, Basic Research declined moderately (-7 percent), while both ATD (10 percent) and ACD&P (4 percent) rose moderately.

At present, the Army has no major ground vehicle development programs on the horizon and continues to face significant budgetary pressures. With the Army struggling to define the missions it expects to focus on in the future, as well as the capabilities it will need to perform those missions, the trough in the Army's development pipeline for major weapons systems seems likely to continue for the foreseeable future. This is particularly worrisome because, as discussed in the literature review in Chapter 2, defense R&D has historically seen a cycle where investments made in growth periods show results during subsequent drawdown periods. For the Army, this pattern appears to have been broken.

This interruption of the developmental pipeline presents an unusual opportunity for DoD, and particularly for the Army. As spending on war materiel continues to be replaced by funding for next-generation priorities, the Army has little to no developmental money already committed to projects. Thus, the Army has an opportunity to take a step back, draw lessons from the wars in Iraq and Afghanistan, evaluate potential future threats and missions, and determine their requirements and developmental priorities accordingly.

Navy

While overall Navy contract obligations were relatively preserved (-20 percent) since 2009, Navy R&D contract obligations fell by 55 percent over that same period. As a share of overall Navy contract obligations, R&D fell from 14 percent in 2009 to 8 percent in 2014, which is the lowest share for the Navy in the 2000–2015 period.

Whereas obligations for Advanced Research have increased by 6 percent over the 2009–2015 period, obligations for Basic Research have declined by two-thirds since 2009. As with the Army, the Navy saw disproportionate declines in obligations for ATD (-75 percent) and SD&D (-67 percent). Unlike the Army, the Navy has major development programs in the pipeline, such as the Ohio-class ballistic missile submarine replacement. However, to preserve funding for current priorities, the Navy has been forced to push back the timelines for some of its efforts due to budgetary constraints, resulting in the ongoing trough in the Navy's development pipeline.

This trough is particularly visible in 2015—although overall Navy contract obligations were virtually stable (-1 percent), Navy R&D contract obligations declined by 14 percent. This decline was driven by a continued steep decline in both ATD (-22 percent) and SD&D (-30 percent). For SD&D, this represents the largest one-year decline in the period, and since 2014, Navy SD&D has declined by nearly half. In contrast, Navy obligations for Basic Research (3 percent) and Applied Research (4 percent) increased slightly in 2015; the increase in Basic Research is particularly notable, given the steep declines throughout the drawdown period, and represents the first increase to Navy Basic Research contract obligations since 2005.

For the Navy, then, there are two disparate trends within its R&D contracting portfolio. While the decline in Basic Research seems to have hit its floor and begun to rebound, the decline in mid- to late-stage R&D not only continues, but seems to have accelerated.

Air Force

As with the Navy, while overall Air Force contract obligations have been relatively preserved (-30 percent) between 2009 and 2015, R&D contract obligations within the Air Force declined more steeply (-44 percent) over that same period, though less steeply than DoD R&D contract obligations overall. Analogous to Army and Navy, Air Force contract obligations for Applied Research were relatively preserved since 2009 (-17 percent); unlike the Navy, Basic Research was also relatively preserved (-32 percent), and actually increased by 11 percent in 2014 before declining again in 2015. As a share of Air Force R&D contract obligations, seed-corn R&D rose from 41 percent in 2009 to 58 percent in 2014—the highest share in the 2000–2015 period, before falling back to 56 percent in 2015.

Both ATD (-67 percent) and SD&D (-57 percent) declined heavily, with the bulk of the declines coming in the wake of the main impact of sequestration between 2012 and 2013. Unlike both Army and Navy, however, Air Force contract obligations for ACD&P also declined heavily (-67 percent) since 2009.

In 2015, as overall Air Force contract obligations fell by 7 percent, Air Force R&D declined slightly more steeply (-10 percent). Both ACD&P (13 percent) and SD&D (5 percent) saw increases in 2015, while Applied Research fell by 14 percent, bringing Air Force Applied Research down to its lowest level since 2005. Interestingly, Air Force contract obligations for Operational Systems Development, which had fallen by nearly three-fifths between 2010 and 2013 before rising by nearly two-thirds in 2014, and then fell back to 2014 levels in 2015, indicating that the increase in 2014 was just a one-year spike.

The Air Force is also in the midst of a trough in their development pipeline for new major weapons systems, but with contracts recently awarded for major programs like the Long Range Strike Bomber and funding that's supposed to ramp up to significant levels over the next few years, the Air Force seems like it will be the first of the military services to emerge from it.

MDA

MDA contract obligations have not followed the same pattern as the three military services during the current budget drawdown. Overall MDA contract obligations rose by more than a third between 2010 and 2013, but have fallen by 40 percent since, to their lowest levels since 2006. Meanwhile, MDA R&D contract obligations, which fluctuated around \$4 billion between 2010 and 2014, plummeted by 58 percent in 2015, to the lowest level since 2004. R&D contract obligations, which had accounted for over three-fourths of overall MDA contract obligations from 2005–2010, accounted for only 34 percent in 2015, the lowest share since 2004.

The massive decline in MDA R&D is spread across MDA's R&D contracting portfolio. MDA contract obligations for Basic Research fell by 44 percent in 2015, and have fallen by nearly two-thirds since 2013, to their lowest level since 2007. ATD fell by an incredible 86 percent in 2015, to the lowest level in the 2000–2015 period. And ACD&P fell by 65 percent in 2015, to the lowest level since 2006. The only category of R&D with significant obligations that did not see enormous declines was Applied Research, which has risen by nearly 40 percent since 2013.

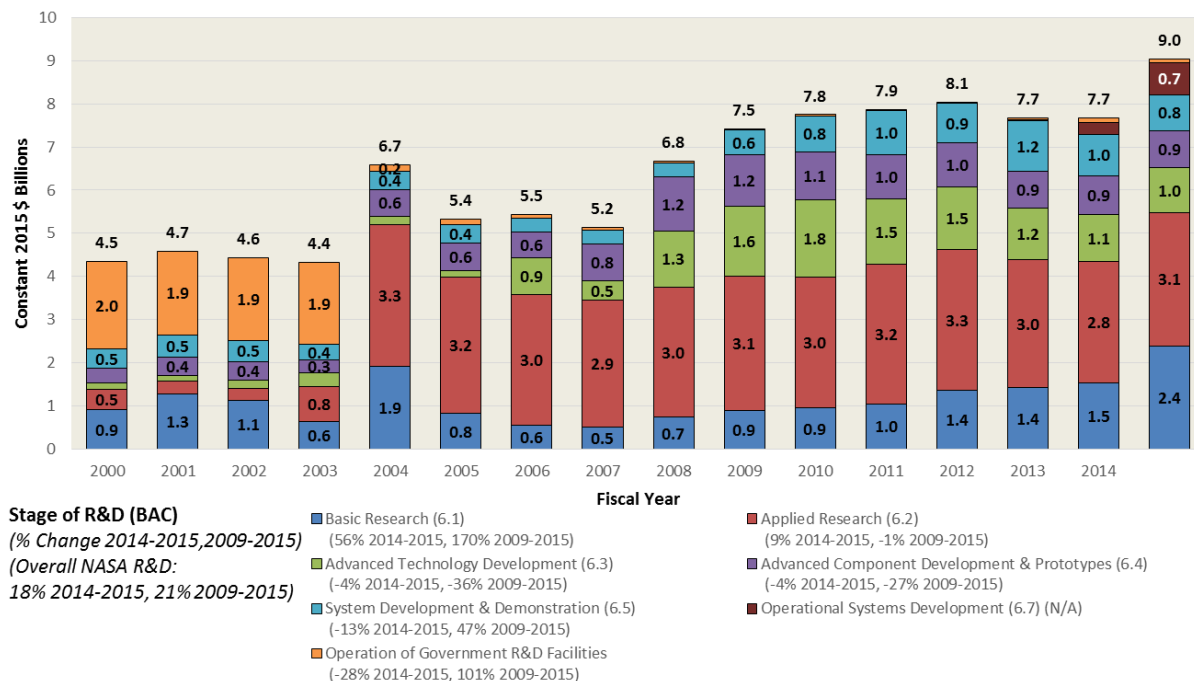
There is not sufficient data to say for certain whether this dramatic decline in MDA R&D contract obligations in 2015 is a one-year anomaly, perhaps due to the timing of contracts or the start of a fundamental shift in MDA's R&D contracting portfolio. But the broad-based nature of the decline would seem to indicate the latter.

NASA

NASA's R&D contracting portfolio is the most comparable with DoD's in terms of the types of projects undertaken, if not in overall scale. Basic Research and Applied Research have combined to account for over half of NASA's contract obligations in all but one year in the 2000–2014 period, peaking at 73 percent in 2005. In recent years, Applied Research has accounted for around 40 percent of overall NASA R&D contract obligations, though that share has fallen to 34 percent by 2015, with ATD and ACD&P declining as a share. SD&D obligations grew as a share of overall NASA R&D contract obligations, from 5 percent in 2008 to 15 percent in 2015, before falling back to 9 percent by 2015.

Figure 1-4 shows NASA R&D contract obligations, by stage of R&D:

Figure 1-4: NASA R&D Contract Obligations by Stage of R&D, 2000–2015⁵



Source: FPDS; CSIS analysis.

The trend in contract obligations within NASA is almost entirely dissimilar to what was observed for DoD. Overall NASA contract obligations have only declined slightly since 2009 (-2 percent), and NASA R&D contract obligations have actually increased by 21 percent over that period; NASA is the only major R&D contracting agency to see an increase in R&D contracts during the budget drawdown. NASA R&D contract obligations rose steadily since 2007, with the most significant growth occurring between 2007 and 2009. NASA R&D contract obligations grew by 9 percent between 2009 and 2012, fell by 6 percent in 2013, and by a further 1 percent in 2014, before rising by 18 percent in 2015, to their highest level in the 2000–2015 period. Since 2012, R&D has accounted for over half of NASA contract obligations, the highest shares since the early 2000s.

The increase in R&D contract obligations within NASA since 2009 has been driven by significant increases in Basic Research (170 percent) and SD&D (47 percent), while obligations for Applied Research (-1 percent) were relatively stable, and obligations for ATD (-36 percent) and ACD&P (-27 percent) declined notably. In 2015, the sharp rise in overall NASA R&D contract obligations was driven by a 56 percent increase in obligations for Basic Research,

⁵ FPDS originally showed an \$8.7 billion contract in 2004 for "Operation of Government R&D Facilities," which was a data anomaly related to NASA's migration from their previous contract data system into FPDS. In the prior system, large, multiyear contracts were entered as a single aggregated entry at the end of the contract; this entry represented the prior five years of obligations for NASA's contract with the Jet Propulsion Lab (JPL). CSIS has worked with NASA contract officials at the JPL to correct the error by moving the \$8.7 billion back to 2003, which was the last year of the contract, in FPDS. While properly spreading the money across the 1999–2003 contract term in FPDS is not feasible, CSIS has made that adjustment in its own database. CSIS would like to thank the contract officials at NASA HQ and at the JPL for their diligence and assistance in tracking down this data anomaly.

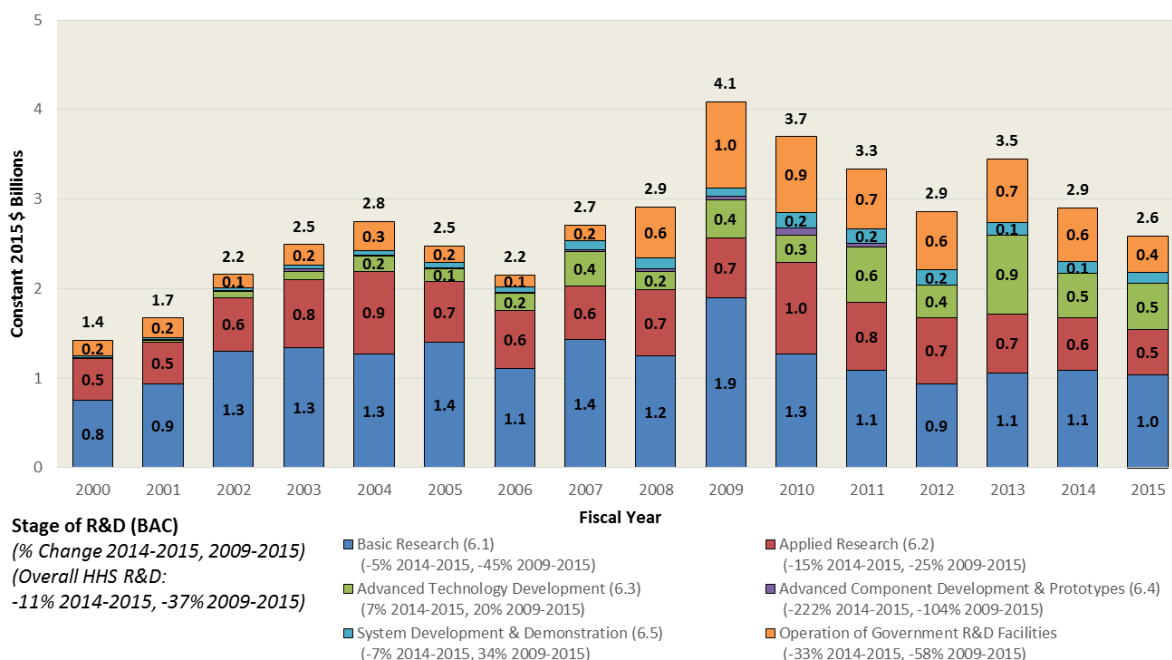
along with a 178 percent increase in obligations for Operational Systems Development, which had not been a significant part of NASA's R&D contracting portfolio until 2014. SD&D, which had quadrupled between 2008 and 2013, has fallen by 28 percent to 2015.

Overall, NASA's R&D contracting portfolio has weathered the budget drawdown incredibly well, and the sharp increase in 2015 bodes well for the continued funding of NASA's R&D efforts.

Department of Health and Human Services

HHS's R&D contracting portfolio has diversified notably in recent years. In 2000, Basic Research and Applied Research combined to account for 86 percent of HHS R&D contract obligations; by 2015, that share had declined to 59 percent. The share of obligations for ATD and "Operation of Government R&D Facilities" have both increased significantly, starting in the mid- to late 2000s, from single digits to as high as the mid-20 percent range. As a share of overall HHS contract obligations, R&D has declined steadily throughout the period, from a high of 26 percent in 2004 to 12 percent in 2015. Figure 1-5 shows HHS R&D contract obligations, by stage of R&D:

Figure 1-5: HHS R&D Contract Obligations by Stage of R&D, 2000–2015



Source: FPDS; CSIS analysis.

Since 2009, as overall HHS contract obligations fell by 3 percent, HHS R&D contract obligations fell by 37 percent, albeit after 33 percent increase between 2008 and 2009. Basic Research declined by 45 percent between 2009 and 2015, but that was primarily the result of a return to normal obligations levels after a one-year spike in 2009; between 2012 and 2015,

as overall HHS R&D contract obligations were virtually flat, obligations for Basic Research increased by 11 percent. Obligations for Applied Research were relatively preserved (-25 percent), while obligations for ATD increased by 120 percent. ATD obligations were notably volatile during this period, doubling between 2010 and 2011, falling by a third in 2012, increasing by 144 percent in 2013, and then falling by 45 percent in 2014.

In 2015, as overall HHS contract obligations were flat, HHS R&D contract obligations declined by 11 percent, to the lowest level since 2006.

Department of Energy

DoE is unique among the major federal R&D contracting agencies in that only a small percentage of its R&D contracting portfolio actually goes to direct contracts for R&D. Instead, the vast majority of DoE's R&D contract obligations go to "Operation of Federal R&D Facilities," which are primarily the various national laboratories. Because of the nature of these contracts, CSIS has limited visibility to the nature of the R&D being performed, although conversations with experts have indicated that most of the R&D activity in the national laboratories would probably be categorized as Basic Research or Applied Research.⁶

DoE's R&D contracting portfolio is also unique in that almost all of its obligations in recent years have been under contracts that originated in 2008 or earlier. In 2014, for example, less than 2 percent of the \$14.5 billion in DoE R&D contract obligations came from contracts signed after 2008, and 35 percent came from contracts that originated in 2000 or earlier. As such, DoE R&D contracting data has limited explanatory value regarding the effects of the current drawdown, since almost all of the obligations in recent years come from options being exercised under contracts that originated before the drawdown began.

⁶ The DoE totals for "Operation of Federal R&D Facilities" also likely include some production activity related to nuclear weapons, but CSIS has no way to reliably separate these out from the R&D activity undertaken as part of these contracts. As such, for the purposes of this analysis, CSIS will categorize the "Operation of Federal R&D Facilities" obligations in their entirety as R&D.

2. Literature Review

Research and development funding, though critical for the continual improvement of practices, assets, and technology, seems to be fundamentally more vulnerable than procurement funding, whose expenditure affects an organization's immediate operational needs. This characteristic of R&D would likely be true regardless of whether an organization is governmental or not. To better inform the basis of this study, this literature review briefly examines the current state of research on R&D funding for both public and private sectors during times of economic or budget downturns, and in times of shifting priorities, to determine how governmental trends compare with private-sector trends. Despite the abundance of literature discussing both public and private R&D funding, as a whole there are few reports that specifically examine R&D funding during times of budgetary decline or how R&D is affected when an organization's priorities shift.

Structure of Overall U.S. R&D Funding

Except for an unusual dip in the 1970s, U.S. R&D funding, including both public and private R&D expenditures, has historically remained around 2.5 to 3 percent of GDP.⁷ Although many scholars and policymakers were concerned about the impact on federal R&D with the implementation of the Budget Control Act (BCA) and the 2012 sequester, there has in fact been an increase government-wide in R&D funding throughout the past few years, and R&D growth has even outpaced GDP growth. Government R&D budgets have generally grown since 1993, but throughout the 2008 financial crisis, growth was substantially slower than in both pre- and post-crisis years. This trend indicates that financial turmoil can significantly affect federal spending in research and development.

The contradiction between rising R&D funding and falling government budgets is explained by another factor affecting overall U.S. R&D funding. Federal funding is being either overshadowed or replaced by private-sector investment. An analysis by Mark Boroush and Francisco A. Moris closely examined U.S. science and engineering indicators in 2014. The two authors noted that the years 2009 and 2010 were a period of stagnation for U.S. R&D expenditures, which was due to a drop in business R&D spending because of the 2008 financial crisis. Development is the largest share of R&D funding, and it is dominated by investments of the business sector; the U.S. government funding plays a critical role in more basic research and development, which is most often performed at universities and colleges, rather than actual federally operated research facilities.⁸

The private sector dominates R&D funding in more than just development, and currently it is the largest overall driver of R&D in the United States. In a separate study, Boroush examined

⁷ "U.S. R&D Small Increase in 2014," *R&D Magazine*, December 9, 2013, Vol. 55, Issue 6, 38.

⁸ Mark Boroush and Francisco A. Moris, "Chapter 4: Research and Development: National Trends and International Comparisons," in *2014 Science & Engineering Indicators*, National Science Foundation, 2014, <http://www.nsf.gov/statistics/seind14/content/chapter-4/chapter-4.pdf>.

how in 2013, businesses that conducted R&D domestically made up 71 percent of the total national investment in R&D, in contrast to the 11 percent contributed by the federal government. The increasing importance of business sector R&D is a long-term trend that's been occurring since 1993, and since then business's R&D growth rate has surpassed the growth rates for both total R&D and GDP. This shows the important role of R&D in the private sector and "in turn, reflects the unabated increase of R&D-dependent goods and services in the national and global economies."⁹ However, "[t]here is historic evidence, including in recent years, that industrial R&D spending is correlated with the current economy and the stability of its outlook. Any economic destabilization from government shutdowns or defaults, international conflict or other factors could change the trajectory of private-sector R&D spending."¹⁰ Given decline in public R&D spending in recent years, it is clear that private-sector R&D trends are driving the overall U.S. trend.

How Does R&D Function during a Recession?

Benefits of R&D Spending during a Shock

The literature is largely in agreement, for both the public and private sectors, regarding the benefits of maintaining R&D funding during difficult fiscal periods. Dan Steinbeck of the Information Technology & Innovation Foundation makes the case that, despite the U.S. military's superiority, defense innovation is declining with the decline in R&D expenditures. Steinbeck explains that the Department of Defense invested in high levels of R&D in the 1970s and 1980s, which fed into the private-sector technology boom in the early 1990s. However, with the fall of the Soviet Union and a growing sense of global political cooperation and peace defense, budgets shrank substantially in the 1990s, and Congress began to shift its priorities for R&D funding away from defense to focus on other federal institutions like the National Institutes of Health. However, the attacks of September 11, 2001, caused defense R&D expenditures to once again expand rapidly as the United States delved into two prolonged wars. Defense R&D expenditures eventually reached \$83 billion in 2009, but have since declined 28 percent since that peak.

In the public sector, for defense R&D, "benefits . . . have been historically realized during a drawdown of forces because the majority of R&D investment is made during buildups. However, since the ratio of investment in R&D to the rest of defense contract spending has been lower over the past two decades than in prior decades, the benefits that could be reaped from a drawdown in the coming years are likely to be fewer."¹¹ This dynamic both

⁹ Mark Boroush, "U.S. R&D Increased in 2013, Well Ahead of the Pace of Gross Domestic Product," Info Brief, NSF 15-330, National Center for Science and Engineering Statistics, September 8, 2015, <http://www.nsf.gov/statistics/2015/nsf15330/nsf15330.pdf>.

¹⁰ "U.S. R&D Small Increase in 2014," *R&D Magazine*.

¹¹ Dan Steinbeck, "The Challenges for America's Defense Innovation," The Information Technology & Innovation Foundation (2014): 1–35, <http://www2.itif.org/2014-defense-rd.pdf>.

drives and potentially complicates the effects of a growing modernization bow wave that may put further pressure on R&D funding in a budget-constrained environment.¹²

On the private-sector side, Professors Graham Morbey and Sanjiv Dugal conducted a study that found that companies that spent more on R&D during the 1982 recession performed better postrecession than those who did not invest in research and development. Their model examined the influence of various variables, including net sales, size, and the technical environment, among others, on R&D investments, also called intensities, of 172 companies during the recession in the 1980s. All were large, established companies and were chosen to ensure that R&D spending would be substantial enough to be measured as a percentage of company sales. Morbey and Dugal found that during a recessionary period, the companies that performed significantly better were those who spent a higher percentage of sales on research and development.

Three years later, Morbey and Dugal updated the previously discussed report using the same research methodology. This study continued their research on private R&D funding and attempted to reassess what happens to R&D spending during a recession. The authors' approach was as such: "The year 1991 was chosen for analysis because it is the only year since 1982 in which there has been a decline (1.2 percent) in real gross national product." Additionally, they classified companies based on their sales growth as leaders (doubled GNP), laggards (less than half GNP), or also-rans (intermediate, or 50 percent to 99 percent GNP), depending on the rate of growth of their GNP over a 10-year period. Like the previous study, their results depicted that sales declines are much less likely for companies that invest significantly in R&D. Additionally, this study asserts that, to prevent sales from declining throughout a recession, R&D intensity levels must be above 3 percent of that company's sales.¹³ The fact that the study found, in two separate cases, that businesses that invest in R&D during economic downturns have higher sales after the downturn is significant.

Magnitude of R&D Spending

Walter D. Valdivia and Benjamin Y. Clark at the Brookings Institution argue that, although priority and prestige are usually granted to R&D funding in federal budgets because of its mostly consistent bipartisan support, a result of the Budget Control Act (BCA) of 2011 is that it is realistic to expect federal R&D funding to have gone one of two ways: either grow at the rate of inflation or experience an overall decline. They suggest that sequestration is changing how R&D politics work and how agencies bid for increased R&D funding. Given the fixed budget caps, which dropped sharply in 2013 and then grew at the rate of expected inflation, they conclude that any agency successfully seeking R&D increases will inevitably steal R&D funding away from a different agency. At the end of the day, they argue that R&D funding is a

¹² Todd Harrison, "Defense Modernization Plans through the 2020s: Addressing the Bow Wave," CSIS, January 2016, https://csis-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/160126_Harrison_DefenseModernization_Web.pdf.

¹³ Graham K. Morbey and Sanjiv S. Dugal, "Revisiting Corporate R&D Spending during a Recession," *Research Technology Management*, July/August (1995) Vol. 23.

zero-sum game in the current constrained and limited resource environment.¹⁴ Over the past few years of the BCA, DoD has been forced to slow, defer, or cancel new R&D programs, despite the Pentagon's continued calls for increasing innovation.¹⁵

Overall, Valdivia and Clark believe "that R&D budget decisions are decentralized," insofar as there is no central authority that effectively dictates R&D budget decisions government wide, though there may be some degree of interdependence, particularly between components within agencies. Therefore, departmental strategies to compete for R&D funds differentiate somewhat, generally operating through either concealment or self-promotion. Departments with R&D programs will often self-promote their programs and make the case that their funding is too essential for their department to lose. On the other hand, some departments try to downplay their R&D budgets, almost in an "out of sight, out of mind" mentality in order to save the funding from being cut in times of budgetary constriction. Now that the United States is in a period of stagnant budgets, Valdivia and Clark believe that the best case is for federal R&D to level off and for agencies to keep their R&D purchasing power at the current levels. The worst case, however, is for R&D funding to be targeted by agency budget cuts and, therefore, removed entirely.

Despite post-9/11 boom in Defense spending, that sector has not been an exception to the overall rule of private funding overtaking public budgets. Looking specifically at R&D investments by defense contractors, R&D expenditures have not kept pace with the increase overall of U.S. R&D investment since 2001. When compared to the commercial technology sector (Google, Microsoft, Intel, Cisco, IBM, and more), defense and other federal contractor expenditures on R&D make up substantially less of a percentage of sales. A factor that may be keeping federal contractor R&D spending low is the government's use of Lowest Price Technically Acceptable (LPTA) bid analysis, which encourages companies to minimize their costs and overhead expenditures (which includes contractor R&D expenditures). This means that often, in order to receive certain contracts from DoD and the federal government, companies have an incentive to constrain R&D expenditures in order to be competitive in solicitations where price is the dominant factor in winning the contract.¹⁶ However, the use of LPTA analysis is not tracked by the government and contractor concerns extend to bid analysis that treats cost as a predominant factor even if LPTA is not formally used. This data gap prevents testing of this supposition.

Moving beyond the Defense sector, other federal R&D priorities are included in the America COMPETES Reauthorization Act, which in 2010 authorized appropriations for specific targeted accounts that involve technology, education, and science from FY2011 to FY2013. Some of the largest accounts involved in the COMPETES Act are the National Institute of Health, National Science Foundation, National Institute of Standards and Technology, and the Department of Energy's Office of Science.¹⁷ This act intended to double R&D spending

¹⁴ Walter D. Valdivia and Benjamin Y. Clark, "The politics of federal R&D: A punctuated equilibrium analysis," Center for Technology Innovations at the Brookings Institution, June 2015, http://www.brookings.edu/~media/research/files/papers/2015/06/17-politics-federal-research-development-valdivia-clark/r_dpoltics.pdf.

¹⁵ Steinbock, "The Challenges for America's Defense Innovation."

¹⁶ Ibid.

¹⁷ "U.S. R&D Small Increase in 2014," *R&D Magazine*.

for these specific accounts over 11 years; however, with declining budgets, this goal will now take around twice that amount of time to accomplish. Budgetary restrictions have affected presidential priorities, as the threat of sequestration and subsequent continuing resolutions have caused delays in the annual appropriations process, which impacts the ways agencies execute their R&D budgets. Due to the unstable budget environment, delays and cancellations of planned R&D operations and the acquisition of equipment plagues agencies.¹⁸ In the private sector, Morbey and Dugal also found that there was little to no relationship between company size and R&D intensity, nor was there a relationship between profitability and R&D intensity. The latter finding is surprising, given the assertion above that LPTA and lower profit margins drives a decrease in R&D spending. The study also found a negative correlation between a company's product diversification and their R&D intensity during a recession. This highlights the importance of a company's R&D expenditures, and also that during a recession companies that operate in multiple, diverse industries are more likely to reduce R&D funding. Comparatively, those businesses that have a strong market share in a concentrated industry will typically increase their R&D funding during a recession in order to capitalize on the market and remain a leading producer.¹⁹

Prioritization of R&D spending within an organization

Valdivia and Clark point out that political polarization has become a growing trend throughout the past few administrations and this is "likely to drive a very slow growth of the fiscal deficit (without raising taxes) and perhaps even a recurrence of across the board cuts if sequestration is not revoked."²⁰ This political polarization leads to a highly contentious budget environment, incurring more scrutiny on all aspects of the budget, which makes R&D budgets more vulnerable to reductions. On top of this, because R&D results can take years to actualize, they become easy targets for congressional budget cuts because R&D programs can seem unproductive in the short term.

R&D Spending during Times of Shifting Priorities

When a government or organization shifts focus from one aspect to another, the logical assumption is that funding would shift to the new priority, as well. Literature that studies this effect is minimal, but does coincide with the logic that with rebalance of any organization, its resources will also rebalance.

In July 2015, the White House released a memorandum outlining Multi-Agency Science and Technology R&D priorities for the FY2017 budget.²¹ These priorities include: global climate change, clean energy, earth observations, advanced manufacturing and industries of the future, innovation in the life sciences, bio and neurosciences, national and homeland

¹⁸ John F. Sargent Jr., "Federal Research and Development Funding: FY 2016," CRS Report No. R43944, Washington, DC: Congressional Research Service, 2015, <https://www.fas.org/sfp/crs/misc/R43944.pdf>.

¹⁹ Graham K. Morbey and Sanjiv S. Dugal, "Corporate R&D Spending during a Recession," *Research Technology Management* 35, no. 4 (Jul/Aug 1992): 42–45.

²⁰ Valdivia and Clark, "The politics of federal R&D: A punctuated equilibrium analysis."

²¹ Shaun Donovan and Dr. John R. Holden, "Memorandum for the Heads of Executive Departments and Agencies: Multi-Agency Science and Technology Priorities for the FY 2017 Budget," Executive Office of the President of the United States, July 9, 2015, <https://www.whitehouse.gov/sites/default/files/omb/memoranda/2015/m-15-16.pdf>.

security, IT and high-performance computing, ocean and arctic issues, and R&D for informed policymaking and management. The White House dictated that other agency priorities are commercializing federal R&D findings, sharing best practices, and fostering innovation. Additionally, fostering and growing STEM education is recognized as a priority for Science and Technology (S&T) research and development budgets. Budget arguments show the Obama administration's attempts to shift priorities away from defense spending and onto other domestic nondefense programs.

For DoD in particular, these priorities are reflected in the president's FY2017 budget released in February 2016. The Third Offset, DoD's series of innovation initiatives, is being funded in FY2017 through investments in improving capabilities in anti-access/area-denial, cyber and EW, human-machine teaming, swarming technologies, and others.²² The president is requesting \$72.4 billion in R&D funding for nondefense spending. Of the requested total, \$8 billion is for the National Science Foundation, \$19 billion for NASA, and \$33.1 billion for the National Institutes of Health. Additionally, the budget supports investments in general science, health, environment, and other prioritized R&D listed in the above paragraph.²³ It seems that, despite the priority shift away from defense R&D spending, overall federal R&D funding remains relatively high.

Changes in R&D Funding

John F. Sargent Jr., of the Congressional Research Service, addresses the FY2016 budget's federal research and development funding in his annual budget publication. When evaluating the changing budgets and their effects on R&D funding, he notes a few key aspects. First, that from FY2009 until FY2015, the U.S. government's R&D funding decreased overall; but in the FY2016 budget, the United States increased R&D spending across multiple agencies. Second, 95.6 percent of the total funding for R&D went to only a few key departments and agencies in the president's 2016 budget request. DoD was the recipient of the largest share of R&D funding from the U.S. government, and in 2016 the president's budget request allocated 49.5 percent of all R&D funding to the Defense Department. Despite this, several other federal agencies also received significant amounts of R&D funding: the Department of Health and Human Services (HHS) was allocated 21.3 percent (and most of it went to the National Institute of Health), the Department of Energy (DoE) was allocated 8.6 percent, the National Aeronautics and Space Administration (NASA) was allocated 8.4 percent, the National Science Foundation (NSF) was allocated 4.3 percent, the Department of Agriculture (USDA) was allocated 2.0 percent, and finally, the Department of Commerce (DoC) was allocated 1.5 percent.

Furthermore, the largest increase in R&D funding from FY2015 to FY2016 was the Department of Defense, with a \$4.6 billion increase. The Department of Energy had the second-largest increase at \$861 million. The requested amounts and changes in funding display presidential priorities. This is most apparent with DoD, DoE, and USDA, whose R&D

²² *Inside the Pentagon*, Vol. 32, No. 7, February 18, 2016.

²³ John P. Holdren, "The 2017 Budget: Investing in American Innovation," The White House, February, 9, 2016, https://www.whitehouse.gov/sites/default/files/microsites/ostp/fy_17_ostp_slide_deck.pdf.

sees significant increases in the FY2016 budget, while DHS R&D funding received a substantial decrease. Specifically, within the Defense Department's R&D funding, S&T budgets appear to be the favorite of congressional policymakers; in FY2016, Congress authorized more funding for DoD S&T accounts than what was requested by the president.²⁴

As shown above, defense continues to receive half of annual federal R&D funding, while health-related R&D takes up a majority of the rest of nondefense funding. It is notable that health-related R&D has been increasing over the last two decades, showing a gradual shift in priorities.

Despite the abundance of literature on R&D trends and R&D management, the CSIS study team did not find significant amounts of information pertaining to the specific effects of R&D funding once confronted with shifting priorities, especially within the private sector. This could be due to a multitude of reasons, including but not limited to: the higher level of privacy of private-sector companies, other influences on business R&D, or a study topic so specific that there has yet to be any similar high-level external studies on the matter. However, the team has presented the limited literature on the subject that was found below. The Industrial Research Institute (IRI) conducts an annual survey focused on research and development trends within the United States, but most companies surveyed also have a global reach. Ninety-six total companies participated in the 2015 survey, and although a few are not the same companies that participated in the previous surveys, IRI feels that there are enough responses from a large cross section of industries to provide general trends and insights. Most of these companies are medium to large corporations with an average of over \$50 million in annual R&D funding. In their 2015 survey, the report indicated that leaders in R&D were concerned with the stagnation or decline of R&D support going into 2015, yet they remained slightly more optimistic about funding stability or increases than they had been in previous years.

In the past, IRI's survey reported expected positive growth from 2011 to 2013, before R&D expectations dipped into the negatives for the upcoming year, 2014. The IRI's 2013 survey reported that companies and their R&D leaders were expecting a decline, or at best inertia, as they continued into the next year. 2014 revealed a similar despairing outlook for 2015; in fact, participants largely reported that they anticipated little to no change in their budgets for the upcoming year. However, the report does not indicate whether these changes are a result of shifting priorities, or of an unhurried relief due to the slowly strengthening economy. Despite the IRI report indicating that companies had a slightly more optimistic tone for growth in 2015, this year's data indicated that as in the past few years' data, research and development leaders express significant concern regarding the balancing of their organizations' short- and long-term R&D objectives.²⁵

²⁴ Sargent et al., "Federal Research and Development Funding: 2016."

²⁵ "2015 R&D trends forecast: Results from the industrial research institute's annual survey," *Research Technology Management* 58, no. 1 (2015): 24–33.

Changes in targets of R&D spending

Another longstanding priority of the federal government has been to shift R&D funding to small, entrepreneurial companies. This is becoming more and more successful, and funding levels to the Small Business Innovation Research and the Small Business Technology Transfer programs are much larger now than they were during the years of their inception: the early 1980s and the mid-1990s respectively.²⁶ Another shift in priorities is clear with the Pentagon's efforts to reinvigorate their relationship with Silicon Valley and the Defense Innovation Unit Experimental (DIUx), whose goal is to create and facilitate relationships between the Defense Department and innovators in Silicon Valley. DoD and other agencies are making significant efforts to contract with smaller businesses across the board.

Within the energy sector, the United States invested about \$1 billion less in research and development in 2007 than it did in the late 1990s. Nemet and Kammen, from the University of California at Berkley, indicate that in both the public and private sector, this shift in priority has been pervasive across almost every energy technology category. This is particularly notable because during this time, overall R&D funding was increasing within the United States. They also address the relationship between public and private funding of research and development, concluding that while government funding can be essential in early stage R&D, the intensity of its funding signals priorities to the private sector, who then respond to it. Therefore, if federal support for R&D programs declines in certain sectors, like the energy sector, private corporations may often shift their priorities to also reflect a decline in support for this research. This is "particularly concerning if we are to employ an innovation-based strategy," because a lack of federal support and focus decreases innovation in sectors that could become crucial in the future (i.e., energy-related challenges that stem from climate change).²⁷

Conclusion

There was not much to find in terms of literature on research (both private and public) and development funding during times of economic downturns and internal priority shifts. Most literature on R&D funding addresses overall trends, cases of investments in specific companies, managing R&D funding, and other general pieces on the impacts of funding R&D. Overall, the minimal amount of relevant information already completed on these specific topics reinforces the importance of CSIS's current work on these issues.

²⁶ Boroush and Moris, "Chapter 4: Research and Development: National Trends and International Comparisons," in *2014 Science & Engineering Indicators*.

²⁷ Gregory F. Nemen and Daniel M. Kammen, "U.S. energy research and development: Declining investment, increasing need, and the feasibility of expansion," *Energy Policy* 35, February 7, 2007, 746–55.

3. How Has the Budget Drawdown Affected Federal R&D Contracting?

CSIS has conducted a review of the relevant literature, involving both the public and private sectors, to identify current theories on how declining resources would affect R&D contract spending. Experts in federal contracting and budgeting were asked to validate the theories identified in the course of the literature review. From this analysis, the study team developed hypotheses regarding how declining resources would affect federal R&D contracting overall, and the R&D contracting portfolios within agencies specifically.

This section looks at a selection of these hypotheses and evaluates whether the predictions made by the study team (based on the current understanding of the issue from the available literature) were borne out by the data on the current budget drawdown. The seven hypotheses that this section will examine are:

1. Cuts in R&D due to budget drawdown will be done on a salami slice basis, rather than reflecting a thoughtful prioritization of resources.
2. Newer R&D contracts will bear a disproportionate share of cuts during budget drawdowns.
3. Budget drawdowns will lead to shifts away from early-stage, seed-corn R&D to mid- to late-stage R&D tied to high-profile programs.
4. Large prime vendors will account for increasing shares of federal R&D during budget drawdowns.
5. During budget drawdowns, R&D will be increasingly funded out of non-R&D-focused budget accounts.
6. During budget drawdowns, competitively sourced R&D contracts will attract increasing numbers of offerors.
7. The budget drawdown will discourage new entrants into the federal R&D contracting marketplace.

Hypothesis 1: Cuts in R&D due to budget drawdown will be done on a salami slice basis, rather than reflecting a thoughtful prioritization of resources.

For the purposes of this hypothesis, the study team uses the term salami slice to refer to a series of cuts where a roughly equal portion is cut across the board, rather than having some

portions of the portfolio relatively preserved or impacted. Given that the sequestration, in particular, was implemented as an across-the-board cut, CSIS hypothesized that agencies would respond to budgetary pressures by taking roughly equal cuts across their R&D contracting portfolios. If this hypothesis were to hold true, the study team expects to find that, across the different stages of R&D and within different major components, cuts to R&D were roughly in parallel to the overall decline over the period, as well as in each particular year.

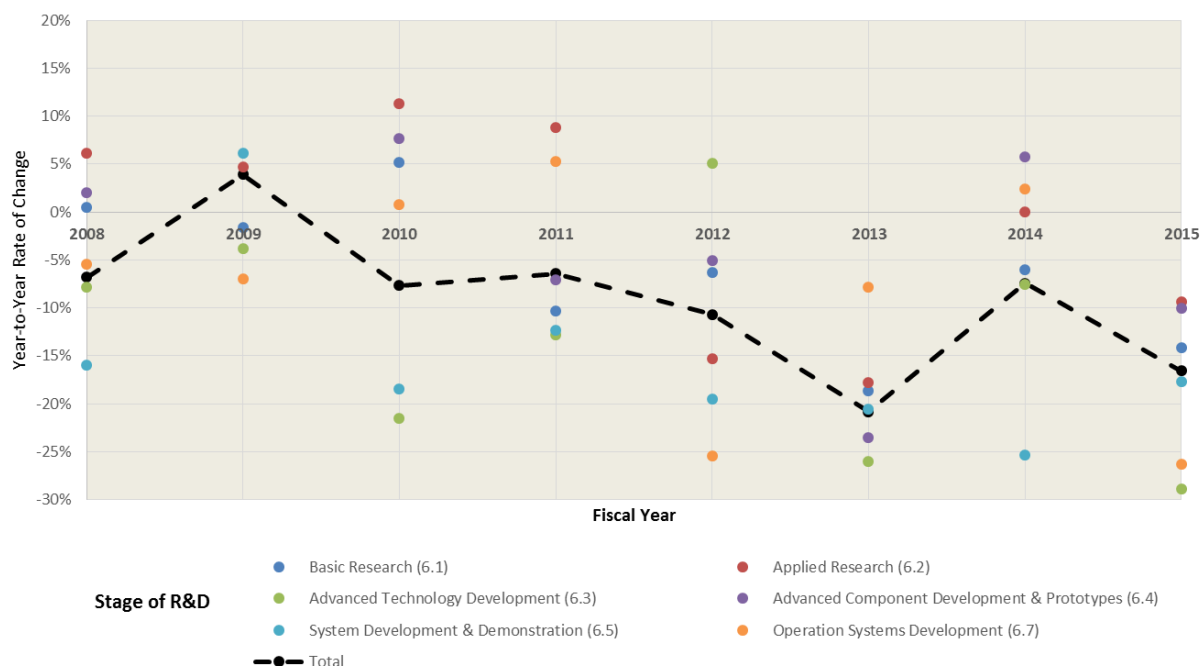
To measure this, CSIS examined the rate of change for each stage of R&D with significant levels of obligations in the 2008–2015 period. CSIS considers years where the majority of categories examined had rates of change within five percentage points of the overall rate of decline for the agency/component to be evidence of salami slice cuts.

Department of Defense

The overall DoD R&D contracting portfolio did not show evidence that cuts were done on a salami slice basis in the period since 2012. While Basic Research has declined roughly in parallel to overall DoD R&D contract obligations since 2012, Applied Research, ACD&P, and Operational Systems Development have all declined notably more slowly than overall DoD R&D. At the same time, contract obligations for ATD and SD&D have declined significantly more steeply than overall DoD R&D. As discussed in Chapter 1, this does not appear to be the result of “thoughtful prioritization of resources”; rather, it appears that the disparate levels of cuts across DoD’s R&D contracting portfolio are primarily the result of late-stage development programs for major weapons systems either maturing out of development or being cancelled, with a dearth of new major development programs starting in recent years.

Looking at DoD year by year, however, tells a slightly different story:

Figure 3-1: Year-to-Year Rate of Change for DoD R&D Contract Obligations, by Stage of R&D, 2008–2015



Source: FPDS; CSIS analysis.

The black dashed line shows the rates of change for overall DoD R&D in each year. As can be seen from the chart, most years show, at most, one or two categories where the rate of change was within five percentage points of the overall rate of change, with none falling within that range in 2010. There is one notable exception: in 2013, five of the six categories showed declines that were within five percentage points of the overall rate of decline, with four of the five within three percentage points. The only outlier was Operational Systems Development, which is by far the smallest category of the six. This result was not unexpected, as 2013 is the first year where the impact of sequestration can be seen in DoD's contract data, and given the across-the-board nature of the cuts required under sequestration, it is not surprising that the declines in that year would show strong signs of a salami slice pattern.

Interestingly, while the overall DoD R&D contracting portfolio showed signs of salami slice cuts, at least in 2013, that pattern does not appear to hold true across the board within the R&D contracting portfolios of the military services.

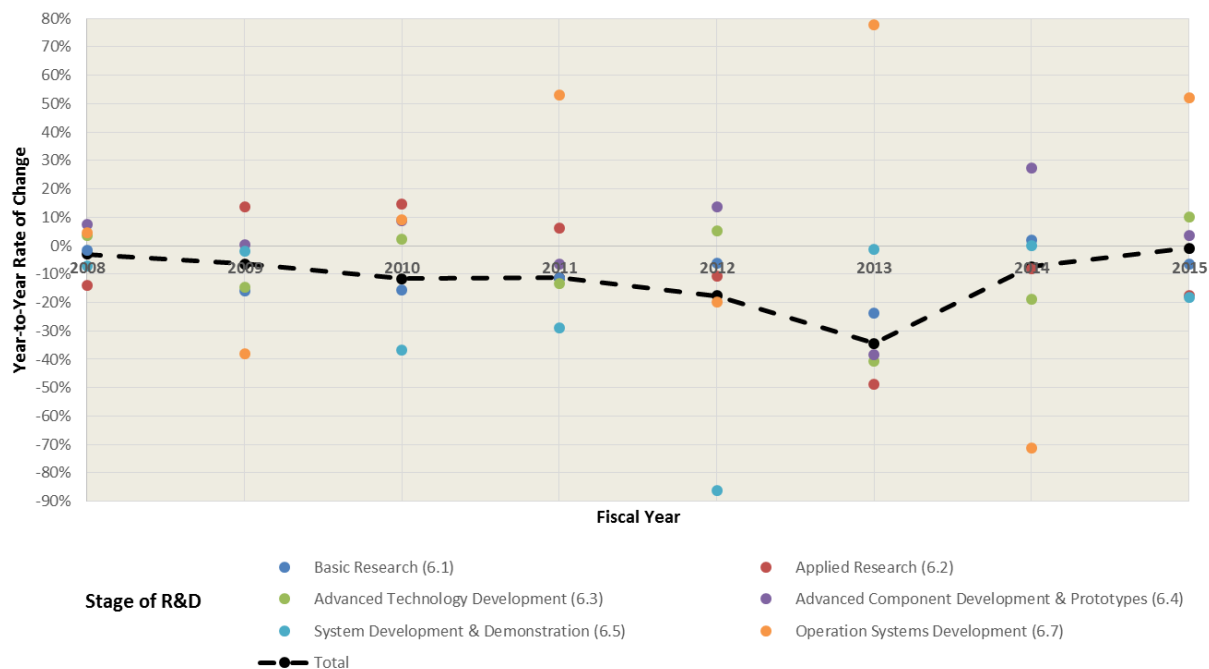
Army

Within the Army, R&D contract obligations declined notably more steeply than in DoD overall since 2012. During sequestration and its aftermath, Army contract obligations for Basic Research, ACD&P, and Operational Systems Development have declined notably more slowly than overall Army R&D. SD&D was also relatively preserved over that same period, but that is

a factor of the near-complete disappearance of SD&D contract obligations prior to 2012, due to the cancellation of the FCS program and the Army's inability to start and sustain new development programs for major weapons systems in recent years. Meanwhile, contract obligations for Applied Research and ATD declined significantly more steeply than overall Army R&D.

Looking at the rates of change for the different categories of R&D year by year tells a similar story, as seen in Figure 3-2:

Figure 3-2: Year-to-Year Rate of Change for Army R&D Contract Obligations, by Stage of R&D, 2008–2015



Source: FPDS; CSIS analysis.

Unlike overall DoD, there were only two years where even two of the categories of R&D showed rates of change within five percentage points of the overall rates of change (2008 and 2011), and only in 2011 were even half of the categories within that range. In 2013, only one of six categories showed a rate of change within five percentage points of the overall rate of change for Army R&D, with four of the six changing by at least 10 percentage points from the previous year.

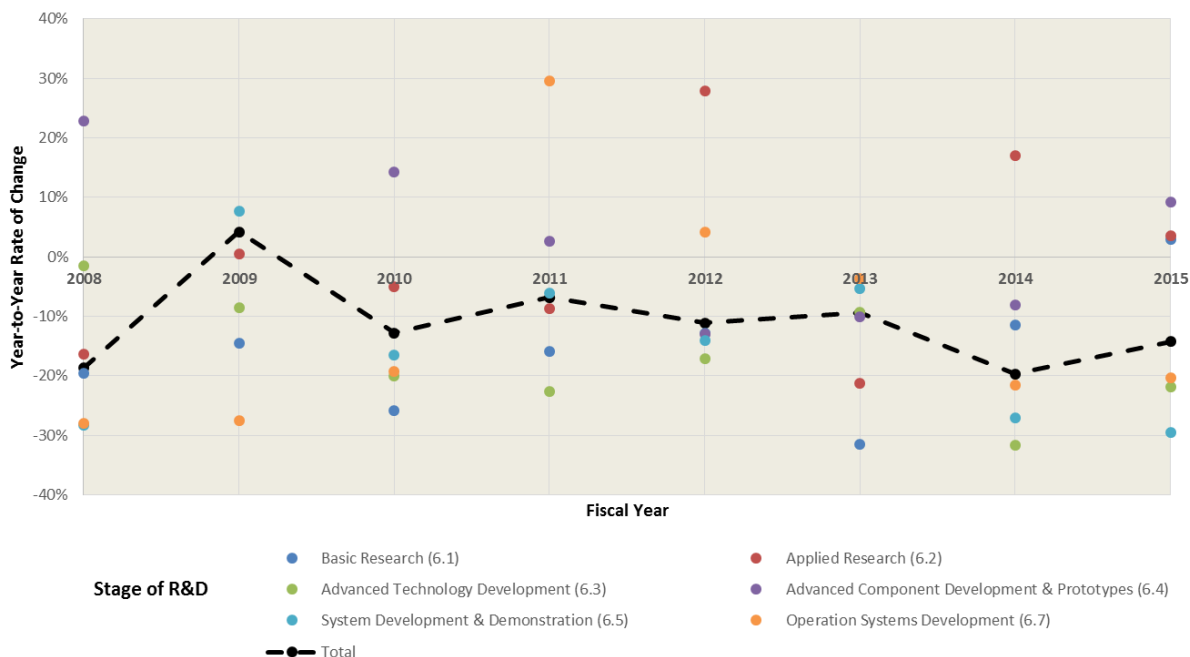
Navy

Although the distribution of cuts is different within the Navy's R&D contracting portfolio since 2012, the degree to which the cuts are unevenly distributed is similar to the Army. Between 2012 and 2015, Navy contract obligations for Basic Research and Operational Systems Development declined roughly in parallel to overall Navy R&D. Obligations for Applied

Research and ACD&P were relatively preserved, with Applied Research, in particular, declining at less than one-third the rate of overall Navy R&D. By contrast, obligations for ATD and SD&D both declined by more than half since 2012.

Looking at the rates of change for the different categories of R&D year-by-year, however, tells a somewhat different story, as seen in Figure 3-2:

Figure 3-3: Year-to-Year Rate of Change for Navy R&D Contract Obligations, by Stage of R&D, 2008–2015



Source: FPDS; CSIS analysis.

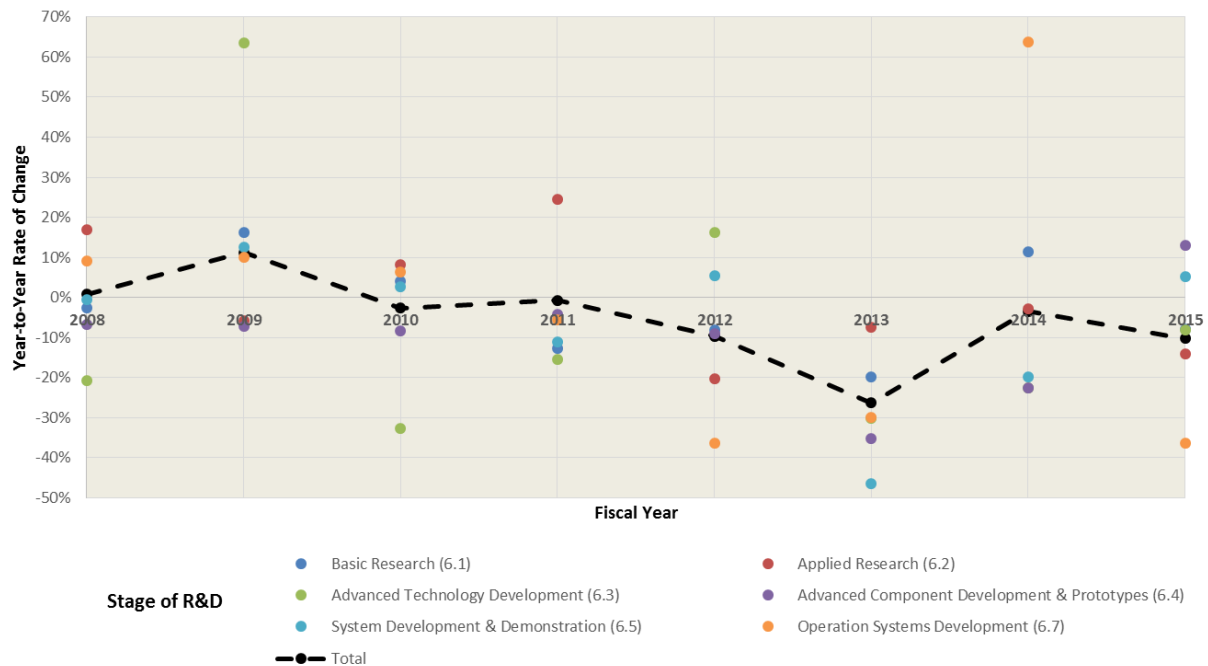
In both 2012 and 2013, three of the six categories of R&D saw rates of change within five percentage points of the overall rate of change, and in both years, a fourth category saw a 6 percent change. Thus, in both the year before the impact of sequestration and the first year of that impact, the Navy's R&D contracting portfolio showed moderate evidence that the cuts were done on a salami slice basis.

Air Force

Contract obligations for Basic Research, Applied Research, and Operational Systems Development within the Air Force all declined significantly less steeply than overall Air Force R&D since 2012. Meanwhile, obligations for ATD, ACD&P, and SD&D all declined notably more steeply than overall Air Force R&D, with SD&D declining at a rate half-again as steep as overall Air Force R&D.

Similarly, the Air Force's R&D contracting portfolio did not show significant evidence of salami slice patterns of change in recent years, as shown in Figure 3-4:

Figure 3-4: Year-to-Year Rate of Change for Air Force R&D Contract Obligations, by Stage of R&D, 2008–2015



Source: FPDS; CSIS analysis.

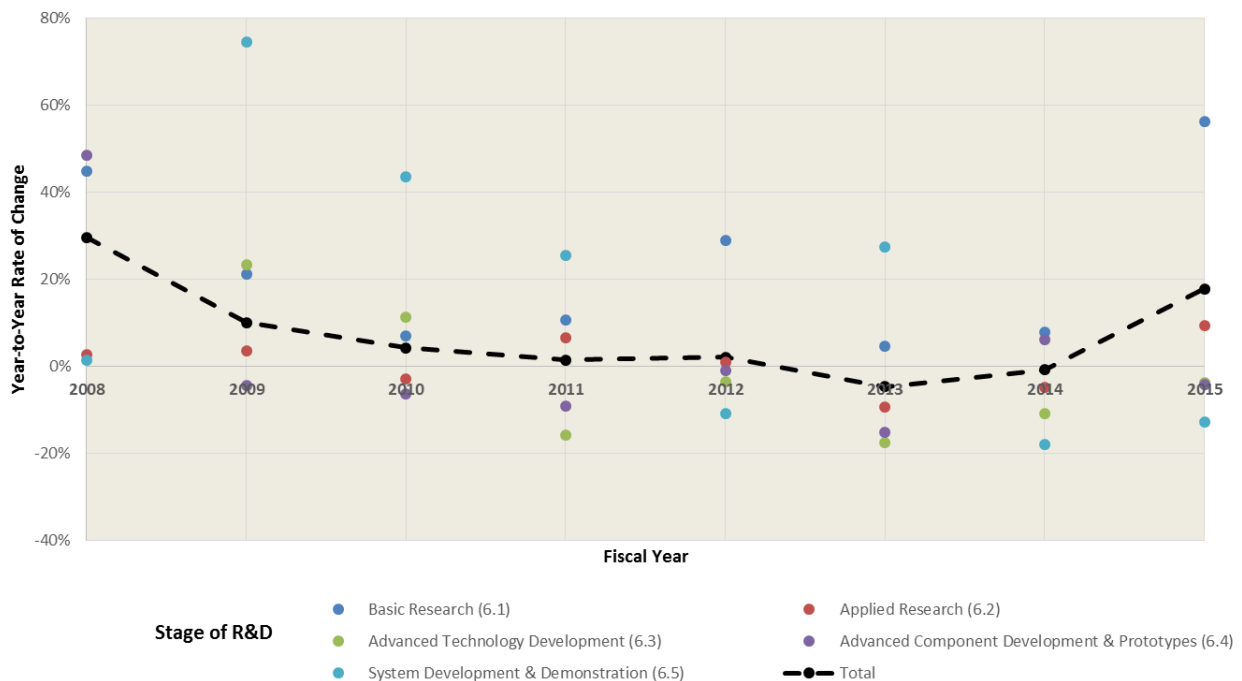
In both 2012 and 2013, only two of the six categories of R&D changed by five percentage points or fewer, though in 2013, four categories changed by less than 9 percent. The only year where even three of the six categories changed by five percentage points or fewer was 2015, and the remaining three categories changed by over 15 percent in that year.

NASA

NASA's R&D contracting portfolio saw a significant increase between 2012 and 2015, but much like DoD and its major components, the cuts to NASA do not appear to have been done on a salami slice basis. Obligations for Basic Research increased significantly from 2012–2015, while obligations for the other four categories either declined moderately (Applied Research and SD&D) or significantly (ATD and ACD&P.)

Unlike overall DoD, there is no evidence of cuts being done on a “salami slice basis” within NASA's R&D contracting portfolio in any year, as seen in Figure 3-5:

Figure 3-5: Year-to-Year Rate of Change for NASA R&D Contract Obligations, by Stage of R&D, 2008–2015



Source: FPDS; CSIS analysis.

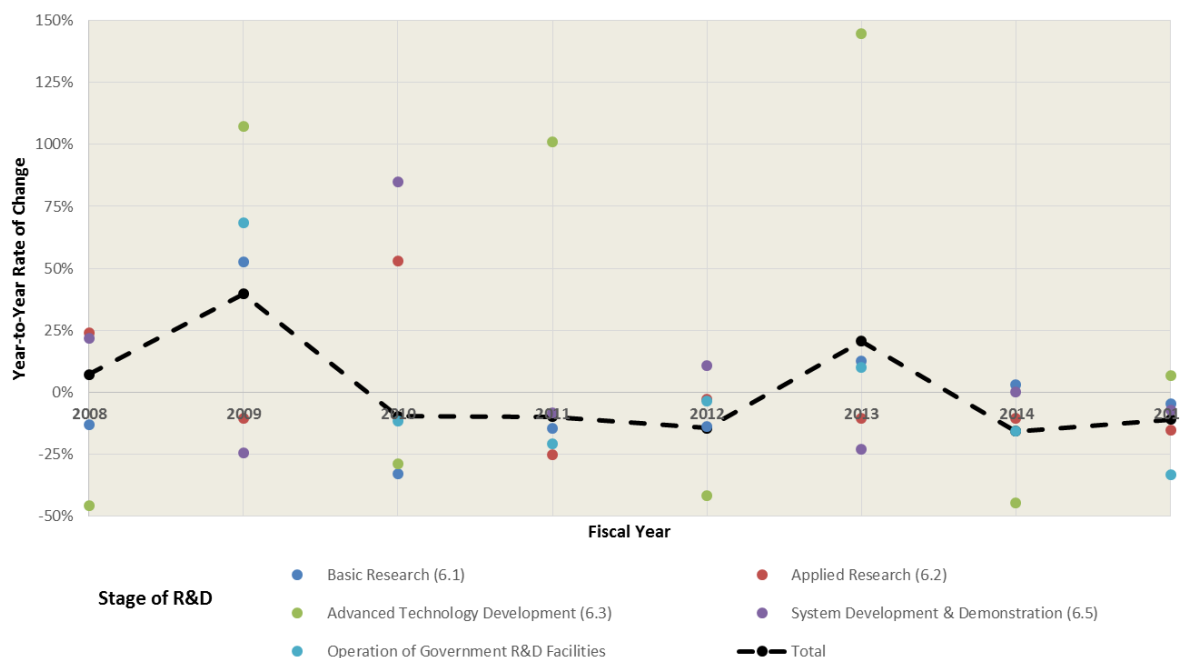
2012 was the only year observed where even two of the five R&D categories showed changes within a five-percentage-point range of the overall decline in NASA R&D. In three separate years (2008, 2009, and 2015), none of the R&D categories showed change of five percentage points or fewer from the previous year.

HHS

In the wake of sequestration and its aftermath, HHS R&D contract obligations declined moderately between 2012 and 2015. But this decline masks the wildly disparate increases and decreases between the categories of R&D that make up significant portions of the HHS R&D contracting portfolio. Both Basic Research and ATD increased over that same period, with ATD increasing by nearly half. Meanwhile, Applied Research, SD&D, and GOCO all declined at near or above three times the rate of overall HHS R&D.

As Figure 3-6 shows, these highly divergent rates of change are also present when looking at the data from year to year:

Figure 3-6: Year-to-Year Rate of Change for HHS R&D Contract Obligations, by Stage of R&D, 2008–2015



Source: FPDS; CSIS analysis.

2011 and 2015 are the only years where two of the five R&D categories with significant obligations had rates of change within the five-percentage-point range. Interestingly, 2013 is one of three years where none of the five categories had rates of change within that range; unlike DoD, the across-the-board nature of the sequestration cuts did not appear to significantly influence the distribution of changes within the HHS R&D contracting portfolio.

Findings

The data provides limited support for the hypothesis that cuts to R&D during the budget drawdown were done on a salami slice basis. Neither NASA nor HHS showed any evidence to support the hypothesis, and while the decline for DoD in 2013 does appear to have been largely proportional across the board, neither the Army nor Air Force showed similar trends. The Navy showed some indications that the declines in R&D contract obligations in 2012 and 2013 were done on a salami slice basis, but overall, the declines during the current budget drawdown have not been evenly distributed among the different stages of R&D.

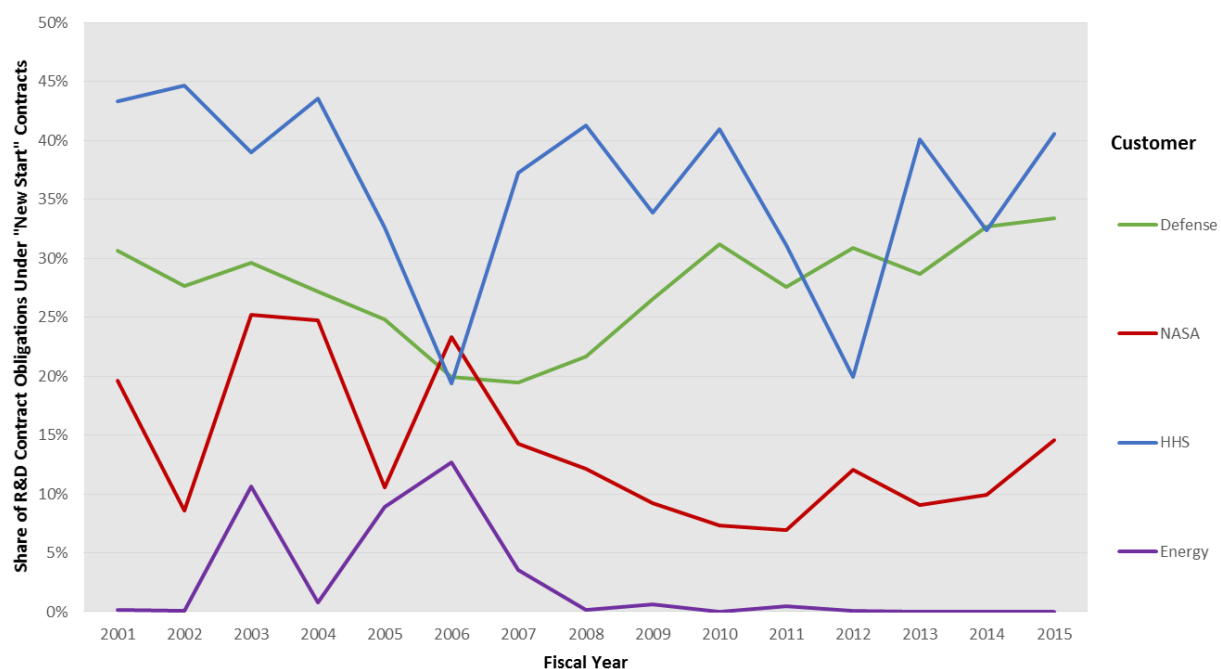
CSIS considered testing this hypothesis at the programmatic level, at least within DoD, but the volatility of contract obligations due to the timing of contracts makes this unworkable. One potential avenue of study that might allow for analysis at the programmatic levels is to look instead at budgetary data, which would be less volatile from year to year and might better reflect changes in funding prioritization.

Hypothesis 2: Newer R&D contracts will bear a disproportionate share of cuts during budget drawdowns.

The basis of this hypothesis, as elucidated by Valdivia and Clark in Chapter 2, is the idea that established, ongoing R&D programs develop constituencies and stakeholders, both inside and outside of government, that have an interest in seeing the programs continue and succeed. As such, when cuts have to be made during a budget drawdown, it makes sense that constituencies and stakeholders would try to protect their favored established programs. CSIS thus theorized that during a budgetary downturn, newer R&D contracts would bear a disproportionate share of the declines in R&D contract obligations. If this hypothesis were true, CSIS would expect that, within the major R&D contracting agencies and their major components, the share of R&D contract dollars obligated under “new” contracts in each fiscal year would decline during the current budget drawdown. CSIS refers to these new contracts in each year as “new start” contracts.

Figure 3-7 shows the share of contract dollars in each fiscal year that were obligated under contracts originating in that fiscal year, for each of the major R&D contracting agencies:²⁸

Figure 3-7: Share of R&D Contract Obligations under New Start Contracts, by Customer, 2001–2015



Source: FPDS; CSIS analysis.

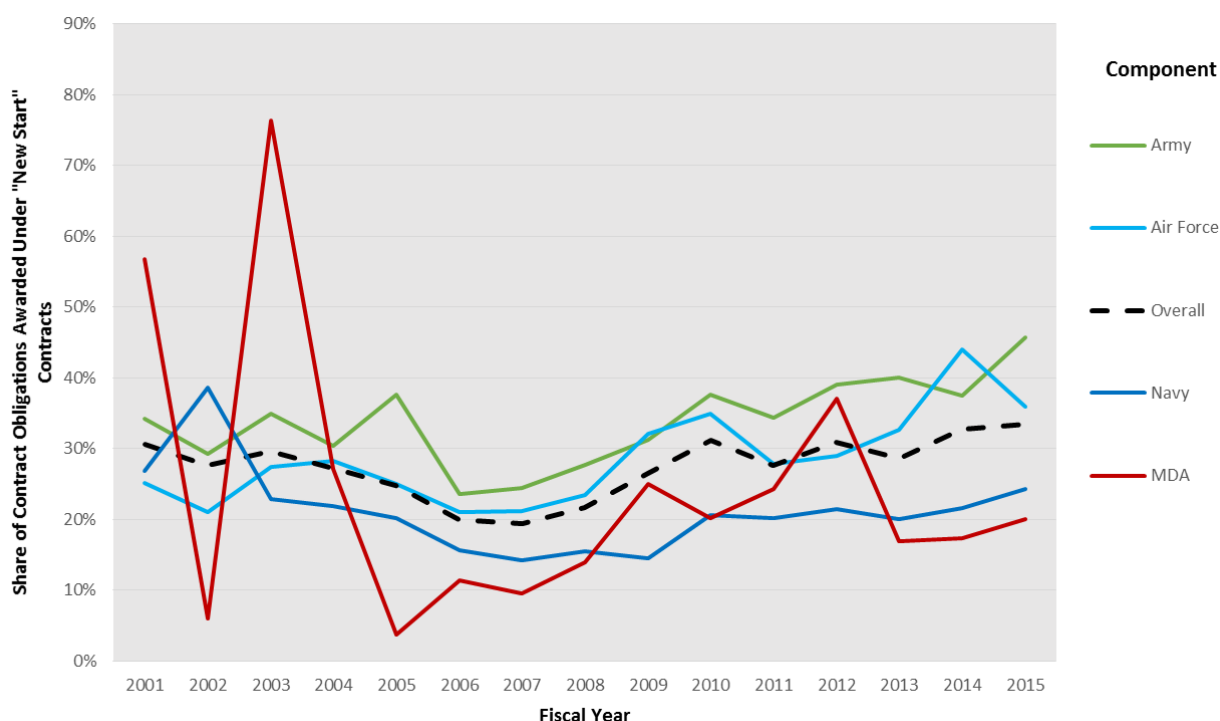
²⁸ Because FY2000 is the first year in the FPDS dataset that CSIS uses, it is excluded from this analysis, as all contract obligations in that year are shown as originating in FY2000, even if they come from a contract that began earlier.

Department of Defense

The overall DoD R&D contracting portfolio does not show a consistent trend of reduced obligations for new start contracts during the current budget drawdown. The share of DoD R&D contract obligations in each year awarded under new start contracts declined from 55 percent in 2001 to a low of 21 percent in 2007. The share began to increase in subsequent years, and that increase continued through the early years of the budget drawdown, rising to 32 percent by 2010. Over the next three years, that share fluctuated between 28 percent and 32 percent, peaking at 33 percent in 2015.

Figure 3-8 shows the share of R&D contract obligations awarded under new start contracts, for each of the major DoD R&D contracting components:

Figure 3-8: Share of Defense R&D Contract Obligations under New Start Contracts, by Component, 2001–2015



Source: FPDS; CSIS analysis.

The share of Army R&D contract obligations under new start contracts declined, albeit not consistently, over the years prior to the current budget drawdown, falling from 48 percent in 2001 to 24 percent in 2006. The share obligated under new start contracts rose in subsequent years, and continued to rise during the current budget drawdown, reaching a high of 40 percent in 2013, falling back to 38 percent in 2014, and rising to a new high of 46 percent in 2015.

For the Navy, new start contract obligations accounted reached a high of 39 percent in 2002, but that share declined precipitously, to 14 percent by 2007. The share was fairly steady from 2007–2009, before rising gradually over the next several years, to 24 percent by 2015.

Within the Air Force’s R&D contracting portfolio, the share obligated under new start contracts fluctuated strongly throughout the period observed. The share fell from 35 percent in 2009 to 28 percent in 2010, but rose steadily in the following years, to 44 percent in 2014, before falling back to 35 percent in 2015.

For MDA, after the anomalous 2001–2003 period, the share awarded under new start contracts rose from 4 percent in 2005 to 25 percent in 2009, fluctuated over the next couple of years, rose to 37 percent in 2012, and has hovered between 17 percent and 20 percent since.

For DoD overall, and for each of the major components examined, there is no evidence to support the hypothesis. In fact, that data shows the opposite trend: as the budget drawdown progressed, increasing shares of contract obligations in each year were under new start contracts.

NASA

Since 2008, the share of NASA contract obligations awarded under new start contracts has remained between 6 percent and 12 percent each year, with no discernable pattern (aside from relative stability) during the budget drawdown. In 2015, that share rose to 15 percent, the highest share since 2006.

HHS

HHS R&D contract obligations under new start contracts have been highly volatile throughout the 2001–2015 period, likely a function of the smaller obligations totals involved. Since 2008, the new start share has fluctuated between 32 percent and 41 percent in all but one year (20 percent in 2012); like NASA, aside from that relative stability, there is no discernable pattern present. Between 2014 and 2015, the share rose from 32 percent and 41 percent.

Department of Energy

The DoE data in Figure 3-1 shows the degree to which the DoE R&D contracting portfolio is dominated by long-running contracts. Between 2008 and 2015, new start contracts never exceeded 0.7 percent of total DoE R&D contract obligations in any year, and accounted for 0.02 percent or less in four of the last six years.

Findings

The data provides no support for the hypothesis that new start contract obligations would be disproportionately impacted by reductions during the budget drawdown. DoD and its major

components all showed varying degrees of growth in the share of R&D contract obligations under new start contracts, while NASA and HHS showed no trend either way.

A potential avenue for future research on this topic would be to examine Awards and Task Orders separately, as new start means different things for definitive contracts versus indefinite delivery vehicle (IDV) contracts.

Hypothesis 3: Budget drawdowns will lead to shifts away from early-stage, seed-corn R&D, toward mid- to late-stage R&D tied to high-profile programs.

This hypothesis was borne out of statements by experts and policymakers, particularly within DoD, who publicly expressed concern that so-called seed-corn R&D would be disproportionately targeted for cuts as budgets declined. The theory behind this belief is similar to the one underpinning Hypothesis 2: that in a period of declining resources, established R&D programs tied to high-profile projects, with established constituencies and stakeholders, would be prioritized over newer, longer-term, more speculative R&D projects that might not see practical results for years. If this hypothesis proves true, the study team would expect to see Basic Research and Applied Research (the two categories that CSIS classifies as seed-corn R&D) bear a disproportionate share of the declines in R&D contract obligations within the major R&D contracting agencies.

Department of Defense

Seed-corn R&D within DoD declined at slightly less than half the rate of overall DoD contract obligations between 2009 and 2015, but that decline was not evenly distributed between the two categories; Basic Research declined by over two-fifths during the period, while Applied Research declined at around half that rate. Between 2012 and 2015, seed-corn R&D within DoD continued to be relatively preserved (-29 percent), but the decline was much closer to the rate of decline for overall DoD R&D (-38 percent). Basic Research continued to decline more steeply than Applied Research, with the former declining at a rate only slightly less than the rate for overall DoD R&D.

Within the Army's R&D contracting portfolio, the trend was somewhat different. While seed-corn R&D declined moderately more slowly than overall Army R&D contract obligations between 2009 and 2015, that decline was roughly in parallel with overall DoD R&D since 2009. Contract obligations for Applied Research actually declined roughly in parallel to overall Army R&D contract obligations, whereas Basic Research was relatively preserved, a reverse of the trend seen in DoD overall. Since 2012, seed-corn R&D has actually declined more steeply than overall Army R&D (-47 percent vs. -40 percent), driven by a decline of over three-fifths in contract obligations for Applied Research. This is also partially a factor of mid- to late-stage R&D having all but disappeared during the earlier part of the period; put simply, there's very little left to cut in mid- to late-stage R&D within the Army.

The data within the Navy more closely tracks with the data for DoD overall. In both the 2009–2015 and 2012–2015 periods, Navy seed-corn R&D declined notably less steeply than

did overall DoD R&D; in particular, since 2012, Navy seed-corn R&D has only declined by 15 percent, compared to 38 percent for Navy R&D overall. Interestingly, while Applied Research was relatively preserved in both periods, as it was for DoD overall, Basic Research actually declined notably faster than overall Navy R&D contract obligations in the 2009–2015 period, and in parallel to the overall decline since 2012.

Seed-corn R&D contract obligations within the Air Force were strongly preserved in both the 2009–2015 and 2012–2015 periods; since 2009, seed corn has declined at half the rate of overall Air Force R&D. Both Basic Research and Applied Research were relatively preserved; Basic Research saw significant declines that were nonetheless less steep than for overall Air Force R&D, while Applied Research actually increased notably between 2009 and 2011 before declining sharply in recent years, reaching the lowest level since 2005 in 2015.

For MDA, the picture is somewhat distorted by the massive decline in R&D contract obligations in 2015 that was discussed in Chapter 1. Contract obligations for Basic Research doubled between 2009 and 2010 and stayed at that level through 2013; since then, obligations for Basic Research have declined by nearly two-thirds, to their lowest level since 2007. By contrast, MDA obligations for Applied Research have risen by 41 percent since 2012, including a 29 percent increase in 2015, even as overall MDA R&D contract obligations cratered.

NASA

NASA is unique among the major R&D contracting agencies, in that its overall R&D contract obligations actually increased slightly over the 2009–2015 period. Over that same period, contract obligations for seed-corn R&D increased at nearly double the rate of overall NASA R&D. Applied Research was flat over the 2009–2015 period, but that was outweighed by a 170 increase in obligations for Basic Research. Between 2012 and 2015, seed-corn R&D increased half-again as steeply as overall NASA R&D; Basic Research increased by over three-quarters over the period, driven by a 56 percent increase in 2015, while Applied Research actually declined by 6 percent.

HHS

HHS is the only agency or major component where the hypothesis appears to hold at least partly true. Between 2009 and 2015, as overall HHS R&D contract obligations declined by 37 percent, seed-corn R&D declined by 40 percent, driven by a 45 percent decline in Basic Research. That figure is somewhat deceptive, however, because 2009 represented a significant one-year spike in HHS obligations for Basic Research. Between 2012 and 2015, overall HHS R&D contract obligations and seed-corn R&D declined roughly in parallel (-10 percent and -8 percent, respectively), but that masks significant differences between Basic Research and Applied Research. Basic Research contract obligations have increased notably (11 percent) over the period, while HHS contract obligations for Applied Research declined by nearly a third, to their lowest level since 2001.

Findings

Of the agencies and major components examined, only HHS saw seed-corn R&D bear a disproportionate share of the declines in R&D contract obligations during the budget drawdown. In all other cases, excepting the anomalous Army case since 2012, seed-corn R&D was actually relatively preserved, often to a significant degree. In many cases, however, there were significant disparities between the trends for Basic Research and Applied Research. This may indicate that, to the degree that the preservation of seed-corn R&D represents deliberate choices, the prioritization varied notably between different R&D contracting customers.

Hypothesis 4: Large prime vendors will account for increasing shares of federal R&D during budget drawdowns.

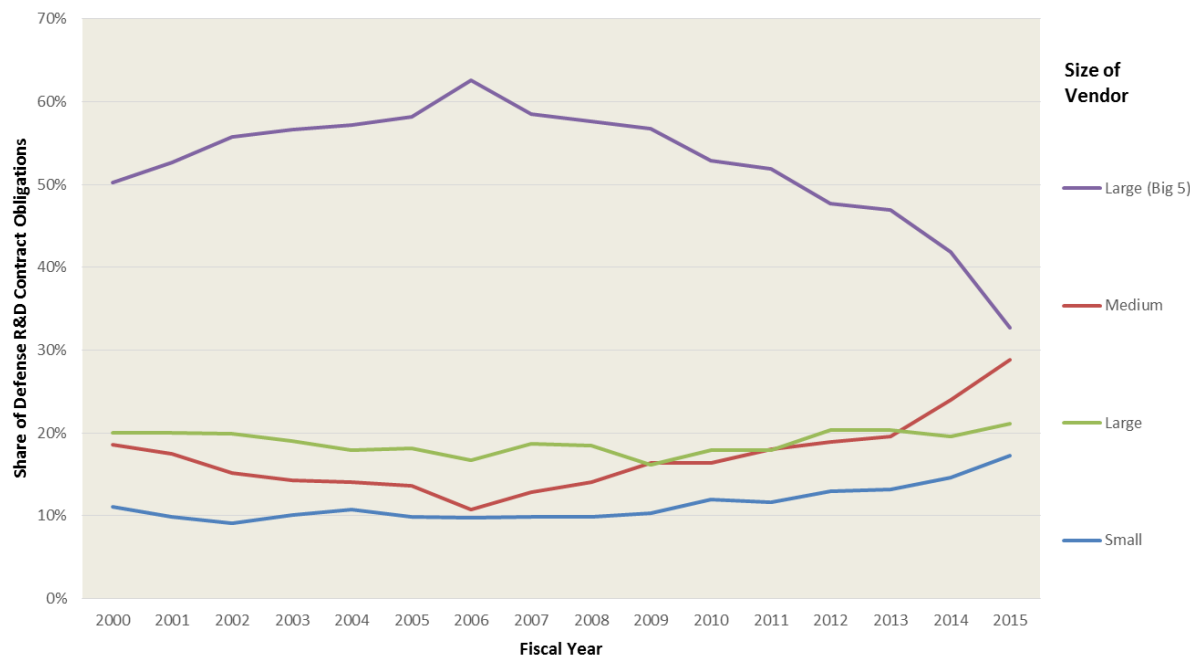
This hypothesis can be considered a companion to Hypothesis 3, because they could both be effects of a similar cause. Because large, high-profile, mid- to late-stage R&D programs are the most likely programs to have developed constituencies and stakeholders that would fight to protect them during a budget drawdown, Hypothesis 3 theorized that those R&D contracts would be relatively protected. And since those large, high-profile R&D programs are likely to be performed by large, high-profile prime vendors, Hypothesis 4 theorizes that R&D contract obligations to those same large, high-profile prime vendors would be relatively preserved.

Department of Defense

Figure 3-9 shows DoD R&D contract obligations to prime vendors, from 2000–2015, broken down by the share going to the different vendor size categories:²⁹

²⁹ CSIS classifies vendors into four size categories: “Small” vendors follow the government’s classification for small businesses, with a couple of adjustments implemented by the study team; “Large” vendors are any vendors with over \$3 billion in annual revenue, from all sources; and “Medium” vendors are any vendors that are neither small nor large. The fourth category, the “Big 5” vendors (Lockheed Martin, Boeing, Northrop Grumman, Raytheon, and General Dynamics), are separated out from “Large” due to the outsized role they play in federal contracting overall.

Figure 3-9: Defense R&D Contract Obligations, by Size of Vendor, 2000–2015

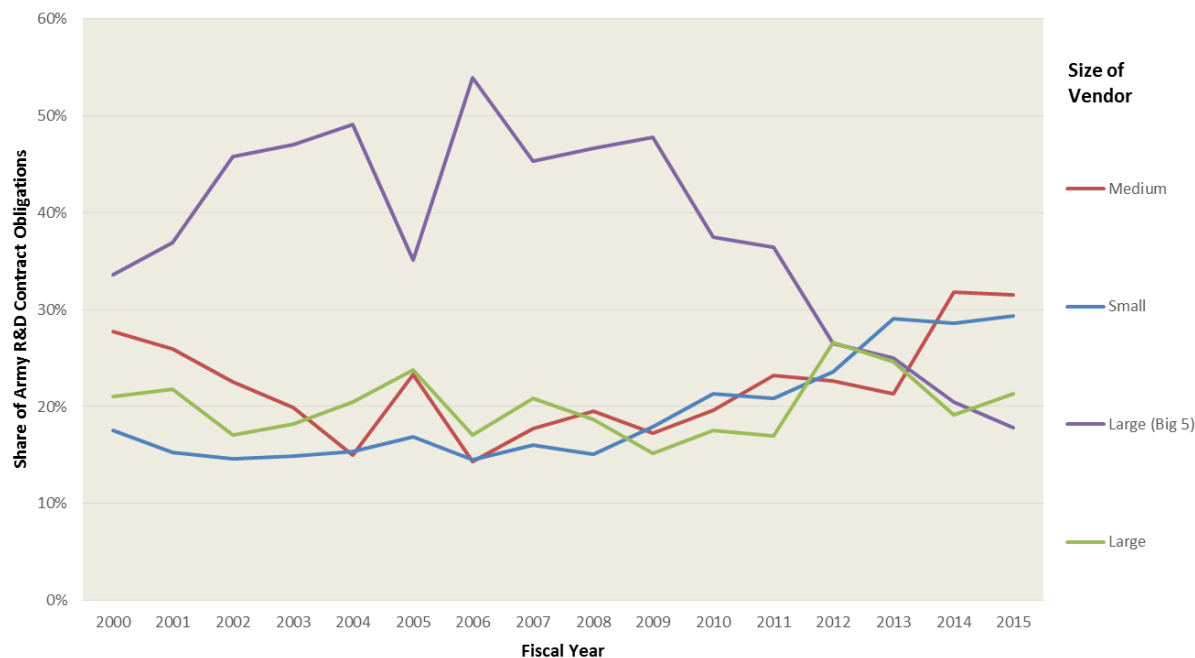


Source: FPDS; CSIS analysis.

Contrary to Hypothesis 4, DoD has actually seen a dramatic decline in the share of contract obligations going to large prime vendors. While the “Large” category has held steady through the drawdown and throughout most of the 2000–2014 period, the share of R&D contract obligations going to the Big 5 vendors has fallen from 57 percent in 2009 to 33 percent in 2015, only a few percentage points higher than the share awarded to medium vendors. This is primarily the result of the previously discussed six-year trough in DoD’s development pipeline for major weapons systems: in recent years, as many large development programs were either cancelled or matured into production, DoD has been largely unable to start and sustain new large-scale development programs. And because those large-scale development programs for major weapons systems are predominantly performed by the Big 5 vendors, those vendors have borne the brunt of the decline in DoD R&D contract obligations.

Unsurprisingly, given the trough in the Army’s development pipeline for major weapons systems, this trend is present to an even greater degree within Army R&D, as seen in Figure 3-10:

Figure 3-10: Army R&D Contract Obligations, by Size of Vendor, 2000–2015



While the share of Army R&D contract obligations awarded to large vendors has remained relatively steady in recent years (aside from a brief spike in 2012 and 2013), the share awarded to the Big 5 vendors has fallen from 48 percent in 2009 to just 18 percent in 2015. Due to the Army’s particularly severe issues with starting and sustaining new development programs in recent years, and the continued uncertainty about future missions and capabilities, this trend is unlikely to reverse in the near future.

Both Small and Medium vendors have seen their shares of Army R&D contract obligations surge during the drawdown. This is primarily an effect of declining less steeply than the Big 5 during the drawdown (-37 percent and -43 percent, respectively, since 2009, compared to -85 percent for the Big 5), rather than any actual increase in R&D contract obligations going to Small or Medium vendors.

The Navy and Air Force have seen declines in the share of R&D contract obligations to the Big 5 vendors more in line with the trend for DoD R&D overall. Within the Navy’s R&D contracting portfolio, the share of R&D contract obligations going to the Big 5 vendors fell from 65 percent in 2009 to 37 percent in 2015. For the Air Force, the share going to the Big 5 vendors fell from 47 percent in 2009 to 27 percent in 2015. In both cases, the share awarded to Large vendors has been relatively stable over the period until 2015: the Navy saw a notable increase in the share of obligations awarded to Large vendors in 2015, from 26 percent to 33 percent, while the Air Force saw a significant decline in Large share, from 18 percent to 13 percent.

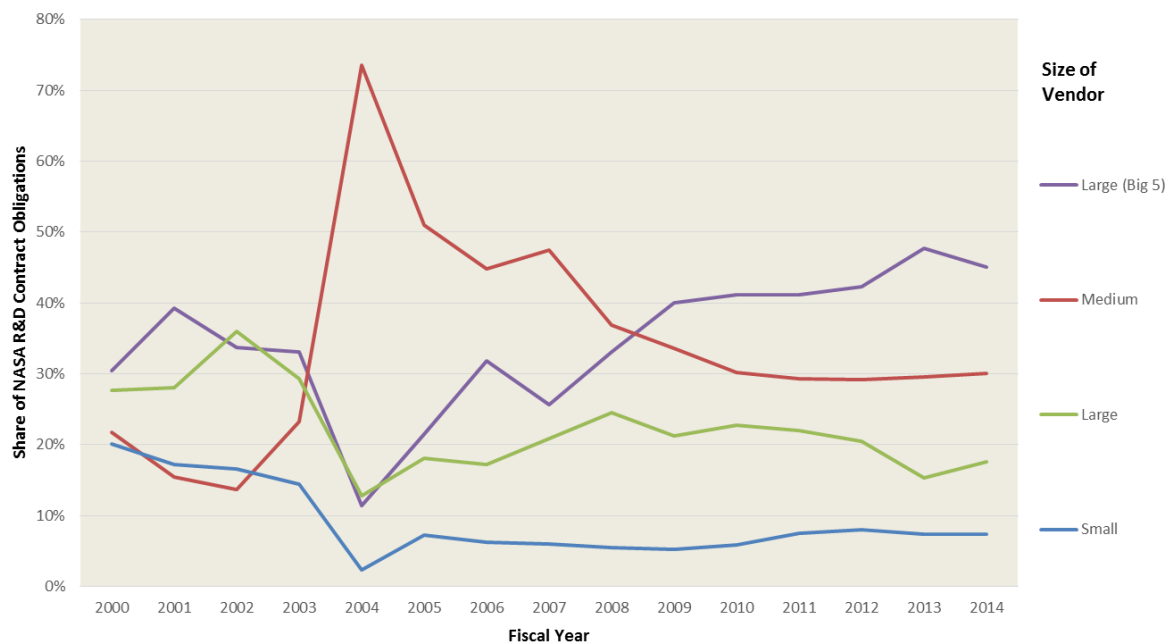
MDA R&D has traditionally been dominated by the Big 5, which accounts for between 84 percent and 90 percent of contract obligations between 2005 and 2014. In 2015, as overall

MDA R&D contract obligations declined by more than half, the share awarded to the Big 5 fell from 84 percent to 70 percent, still much higher than for any of the three military services.

NASA

Figure 3-11 shows NASA R&D contract obligations, from 2000–2015, broken down by the share going to the different vendor size categories:

Figure 3-11: NASA R&D Contract Obligations, by Size of Vendor, 2000–2015



Source: FPDS; CSIS analysis.

Unlike DoD and its major components, NASA actually does show increasing shares of R&D contract obligations going to large prime vendors, concentrated in Basic Research and SD&D. This increase, however, began before the current budget drawdown; the Big 5 vendors accounted for only 26 percent of NASA contract obligations in 2007, but that share rose to 48 percent by 2013, before a decline over the last two years, to 41 percent in 2015. Thus, it appears that the rising share of NASA R&D contract obligations going to large prime vendors is not attributable to factors relating to the budget drawdown.

HHS

The Big 5 vendors have never accounted for more than 1 percent of HHS R&D contract obligations. HHS has seen an increase in the share of R&D contract obligations awarded to large vendors, but this is a trend that started prior to the current budget drawdown. The primary factor in this increase is the increase in contract obligations for GOCO in 2008 and 2009, of which over three-quarters were awarded to large vendors. None of the other major categories within the HHS R&D contracting portfolio have seen consistent and notable

increases or decreases in the share of obligations awarded to large prime vendors during the current drawdown.

Findings

The data provides no support for the hypothesis that large prime vendors would see increasing shares of R&D contract obligations during the current budget drawdown. In fact, within DoD and its major components, the largest vendors have seen their shares decline precipitously. This is primarily a reflection of the six-year trough in the development pipeline for major weapons systems that has been discussed at length earlier in this report. NASA and HHS both saw increases in the shares of obligations going to large prime vendors, but those increases began before the start of the budget drawdown.

The relative preservation of R&D contract obligations to small vendors, at least within DoD, can be seen as a victory for policies that promote small business participation—in an extremely challenging environment, small vendors have managed to largely hold their ground, even as the bigger players were facing sharp declines.

Hypothesis 5: During budget drawdowns, R&D will be increasingly funded out of non-R&D-focused funding accounts.

The theory of Hypothesis 5 is that, as budgets decline, agencies may look to fund R&D out of budget/funding accounts that are not traditionally R&D focused, in order to make up for funding shortfalls in the R&D-focused accounts and preserve funding levels for high-priority R&D programs. If this hypothesis were accurate, the study team would expect to see increases in the share of R&D contracting obligations funded out of particular funding accounts that were not traditionally the primary funding sources for R&D contracts within the agency.

A couple of methodological notes related to this analysis:

- The fields that allow for the merging of contract obligations and budget data only began to be filled in reliably in FY2011 for non-DoD agencies, and FY2012 for DoD.
- CSIS focuses on funding accounts, rather than the higher-level budget accounts, because of the increased data granularity, and also because there is no consistent budget account schema between agencies.

Department of Defense

Unsurprisingly, nearly two-thirds of DoD R&D contract obligations are funded out of the various DoD Research, Development, Test, and Evaluation (RDT&E) accounts, with the Air Force and Defense-wide accounts accounting for the largest shares. The share of DoD R&D contract obligations funded out of the Defense-wide RDT&E account rose from 21 percent in 2012 to 28 percent in 2014, but fell back to 23 percent in 2015. The share funded out of the Air Force RDT&E account increased steadily since 2012, from 21 percent to 25 percent in

2015. Meanwhile, the share funded out of the Navy's RDT&E account fell from 18 percent in 2012 to 15 percent in 2014 before rebounding back to 18 percent in 2015, while the share funded out of the Army's RDT&E account has been relatively steady between 6 percent and 7 percent.

There was a mix of increases and decreases in other DoD funding accounts with nontrivial levels of R&D contract obligations, though most were relatively stable. The share of R&D contract obligations funded out of the Navy's Aircraft Procurement account doubled from 2 percent to 4 percent, between 2012 and 2014, but dropped below 1 percent in 2015. The share funded out of the Air Force's Missile Procurement account fell from 4 percent in 2012 to below 1 percent in 2015. Additionally, the share funded out of the Army's Operations and Maintenance (O&M) account fell from 5 percent to 3 percent, while the share funded out of the Navy's Working Capital Fund rose from less than one percent in 2012 to nearly 3 percent in 2015.

Army

Within the Army's R&D contracting portfolio, the share of contract obligations funded out of the Defense-wide RDT&E account has nearly doubled since 2012, from 11 percent to 20 percent, while the share funded out of Army O&M has fallen from 20 percent to 14 percent. Among the accounts that are the source of smaller shares of Army R&D contract, there have been a number of notable shifts over the period:

- The shares funded out of the Defense Health Program and Defense-wide O&M accounts each rose from 2 percent to 5 percent.
- The share funded out of Air Force O&M rose from less than 1 percent to 4 percent.
- The share funded out of the Navy's Other Procurement account declined from 5 percent to virtually nil.

Navy

The shares of Navy R&D contract obligations funded out of particular accounts have been extremely volatile from year to year in the 2012–2015 period, so there are no clear trends across the period.

Air Force

To the greatest degree among the three military services, funding for Air Force R&D contract obligations is concentrated in the Air Force's own RDT&E account—over the 2012–2015 period, 58 percent of R&D contract obligations were funded out of that account, and that share has risen in recent years, from 53 percent in 2012 to 62 percent in 2015. Of the remaining accounts, the only notable shift was in the Air Force's Missile Procurement account; the share of Air Force R&D contract obligations funded out of that account fell from 11 percent in 2012 to 2 percent in 2015.

HHS

For the most part, the shares of HHS R&D contract obligations funded out of HHS funding accounts have been relatively consistent from 2011–2014, with a few exceptions. The share funded out of the National Institute of Health’s (NIH) National Institute of Drug Abuse rose from 1 percent in 2011 to 4 percent in 2014 and 2014, while the share funded out of the main NIH account fell from 25 percent in 2012 to between 19 percent and 20 percent in 2013 and 2014, before rebounding back up to 23 percent in 2015. Additionally, the share of HHS R&D contract obligations funded out of the Public Health and Social Services Emergency Fund, which was 11 percent in 2012, has risen to 27 percent by 2015.

NASA

Unlike the other two agencies, there have been significant shifts in the distribution of R&D contract obligations within NASA’s major funding accounts. The share of R&D contract obligations funded out of the Cross Agency Support account rose from 11 percent in 2011 to 22 percent in 2014, before falling back to 19 percent in 2015, and the share funded out of the general Science account rose from 17 percent in 2011 to 33 percent in 2015. Meanwhile, the share funded out of the Exploration account fell from 27 percent to 20 percent, the share funded out of the Human Space Flight account fell from 11 percent to 7 percent, and the share funded out of the Science (Aeronautics and Exploration) account fell from 19 percent to 0 percent. These changes appear to reflect changes in spending priorities and accounting shifts, rather than being related to the impact of the budget drawdown.

Findings

Though the data is mixed, there is no consistent trend that supports the hypothesis that R&D contract obligations are being increasingly funded out of nontraditional accounts during the current budget drawdown.

Hypothesis 6: During budget drawdowns, competitively sourced R&D contracts will attract increasing numbers of offerors.

The basis of hypothesis 6 is a simple one: as total obligations for federal R&D contracts decline, the vendors capable of performing such contracts would be more likely to bid on the contracts that are still being offered, in an effort to maintain their share of a declining market. If this hypothesis were true, the study team would expect to see the number of offers received for competitively sourced R&D contracts increase as the drawdown progressed.

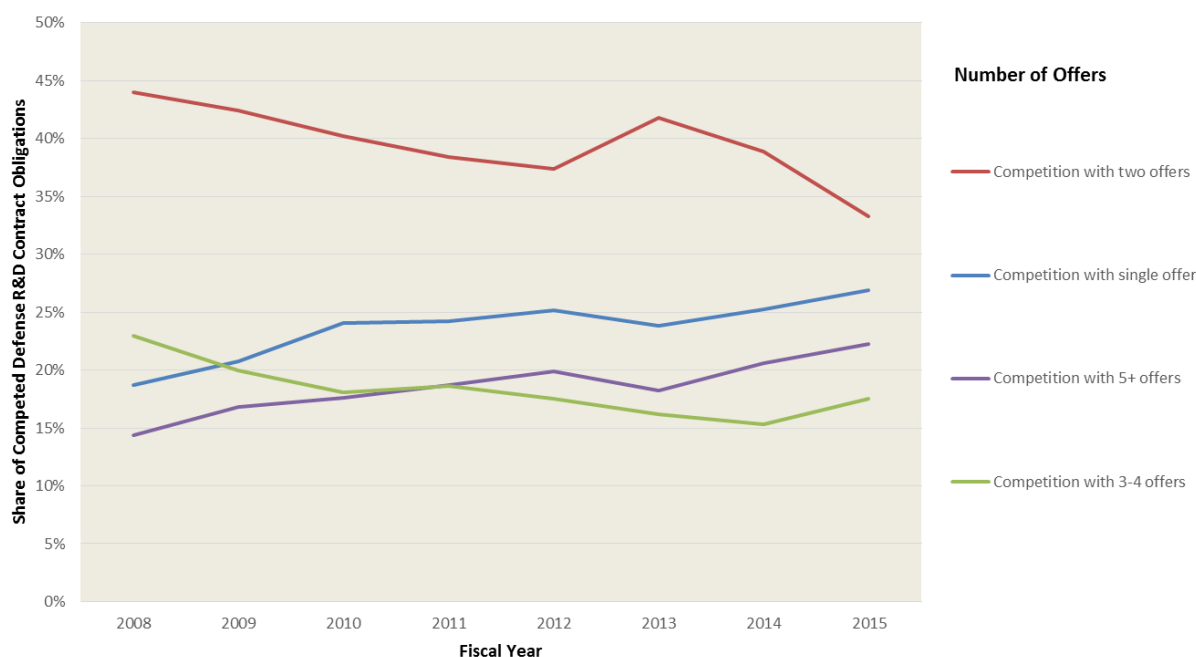
To measure this, CSIS has examined competitively sourced federal R&D contracts, broken down both by customer and by stage of R&D, and examined how many offers those contracts received. This analysis also examines disparities between overall rates of competition (all competitively sourced contracts) and what CSIS terms “effective competition”—that is, competitively sourced contracts receiving at least two offers. See the

methodology section in Appendix I for more details on how CSIS approaches analysis of competition data within FPDS.

Department of Defense

The overall level of competition for DoD R&D contract obligations has increased slightly during the current budget drawdown, from 58 percent in 2009 to 63 percent in 2015. Over that same period, however, the level of effective competition (that is, competitions that received at least two offers) has remained mostly flat, hovering between 44 percent and 46 percent in all but one year during the 2009–2015 period. Figure 3-12 shows the cause of this disparity:

Figure 3-12: Number of Offers Received for Competed Defense R&D Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

The difference between overall rate of competition for DoD R&D contract obligations and the rate of effective competition is attributable to the large, and growing, share of DoD R&D contracts awarded after competitions with only one offeror. Since 2008, the share of competitively sourced DoD R&D contracts awarded after receiving only one offer has risen from 19 percent to 27 percent, which is troublingly high. When a competitively sourced contract receives only one offer, it indicates either a contract written in such a way that makes it unattractive to potential offerors, or one that should have been justified as a sole-source contract, because there was never any realistic prospect of getting more than one offeror.

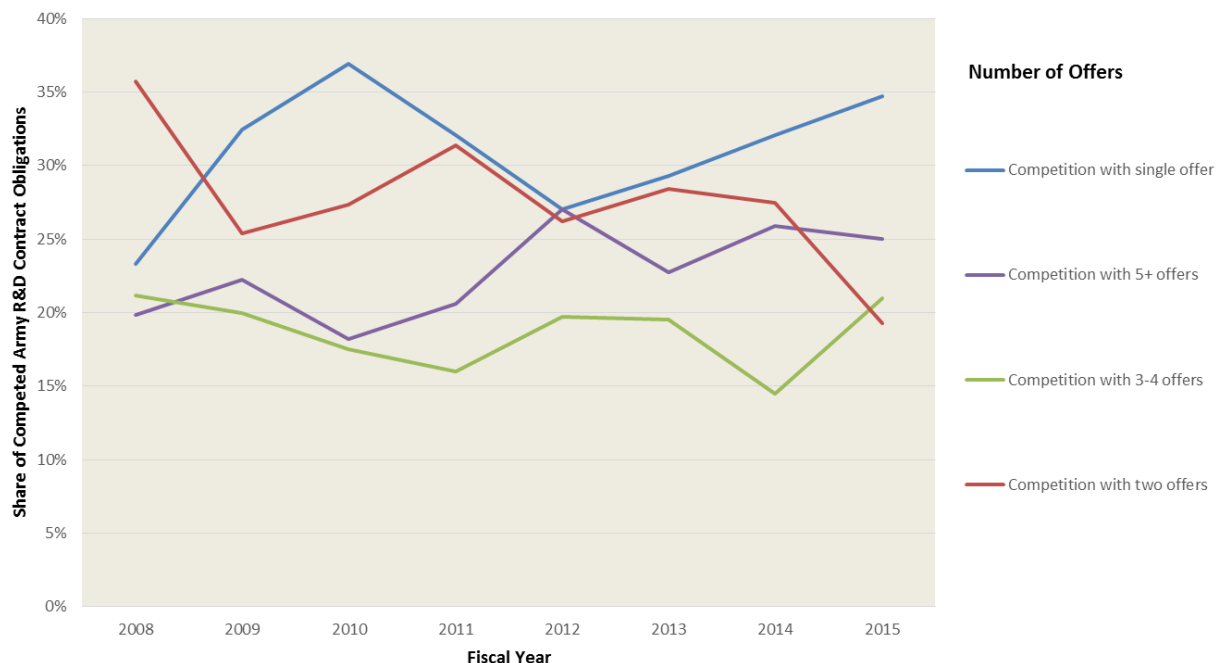
Interestingly, while the shares of competitively sourced DoD R&D contracts receiving either two offers or three to four offers have declined notably over the period, the share awarded after receiving five or more offers has increased significantly, from 14 percent in 2009 to 22 percent in 2015.

For overall DoD, there is no clear trend in support of the hypothesis; while the share of competitively sourced contracts receiving five or more offers has increased notably, so too has the share receiving only one offer.

Army

Much like overall DoD, the Army's R&D contracting portfolio shows a significant disparity between the share of contracts awarded after competition and the share awarded after effective competition. In 2015, while 64 percent of Army R&D contract obligations were competitively sourced, only 42 percent were effectively competed. Figure 3-13 shows the breakdown of competitively sourced Army R&D contracts:

Figure 3-13: Number of Offers Received for Competed Army R&D Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

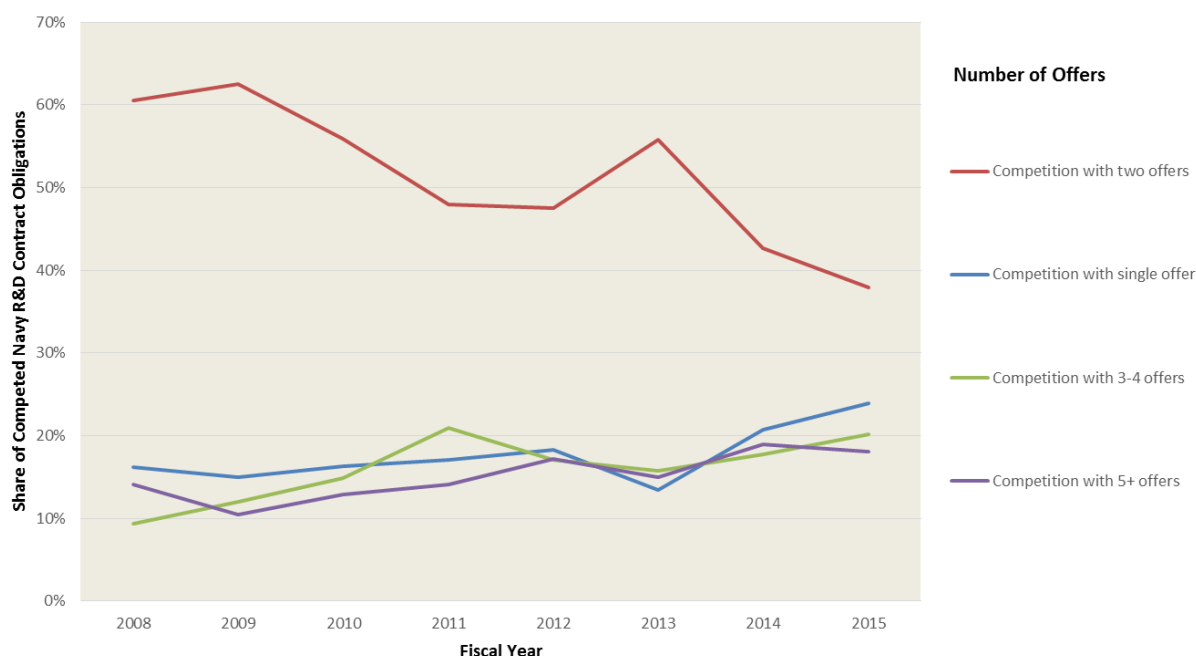
As with DoD R&D overall, the drawdown period has seen a significant increase in the share of competitively sourced Army R&D contract obligations that received only one offer; though there was significant volatility during the period, the rate nonetheless increased from 23 percent in 2008 to 35 percent in 2015. Also similarly to DoD R&D overall, there has also been a notable increase in the share of competitively sourced contract obligations that received at

least five offers; that share has increased from 20 percent in 2008 to 25 percent in 2015, and was as high as 27 percent in 2012.

Navy

As with the Army and DoD overall, the share of Navy R&D contract obligations that were competitively sourced (65 percent in 2015) was significantly higher than the share that was effectively competed (49 percent in 2015). Figure 3-14 shows the breakdown of competitively sourced Navy R&D contracts:

Figure 3-14: Number of Offers Received for Competed Navy R&D Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

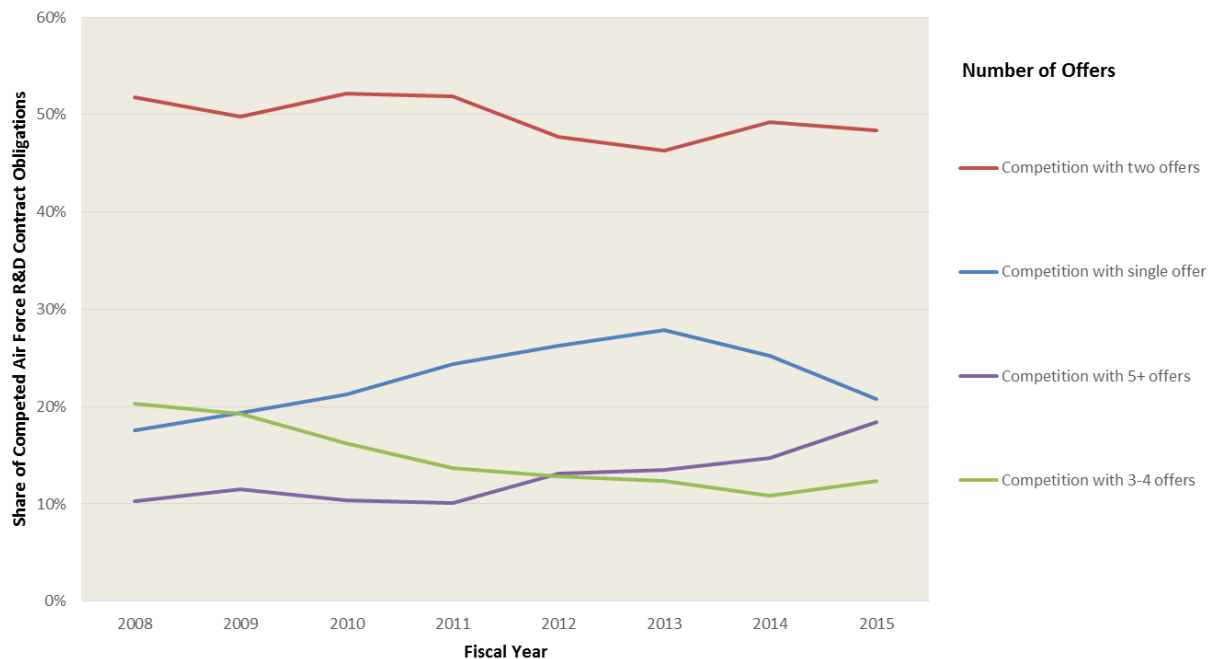
The share of competitively sourced Navy R&D contract obligations receiving only one offer has risen significantly during the current drawdown, from 16 percent in 2008 to 25 percent in 2015. Two offerors for competitively sourced Navy R&D contracts has been the norm historically, to a greater degree than for overall DoD or the Army, but the share receiving two offers has declined dramatically in recent years, from 61 percent in 2008 to 38 percent in 2015. The shares receiving three to four offers (from 9 percent in 2008 to 20 percent) and five or more offers (from 14 percent in 2008 to 18 percent in 2015) have seen increases over the same period.

As with DoD overall, there is no clear trend of increasing numbers of offers for competitively sourced Navy R&D contracts; the growth in the share receiving either three to four offers or five or more offers is counterbalanced by the growth in the share receiving only one offer.

Air Force

The gap between the rate of competition for Air Force R&D contract obligations (60 percent) and the rate of effective competition (49 percent) is notably less for the Air Force than for the Army or Navy. Figure 3-15 shows the breakdown of competitively sourced Air Force R&D contracts:

Figure 3-15: Number of Offers Received for Competed Air Force R&D Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

Around half of competitively sourced Air Force R&D contract obligations receive two offers, a share that is largely unchanged over the period observed. Single-offer competition increased dramatically between 2008 and 2013, from 18 percent to 28 percent, before falling back to 21 percent by 2015. Competition with three to four offers has steadily declined (from 20 percent in 2008 to 12 percent in 2015), while the share receiving five or more offers has increased notably (from 10 percent to 18 percent.)

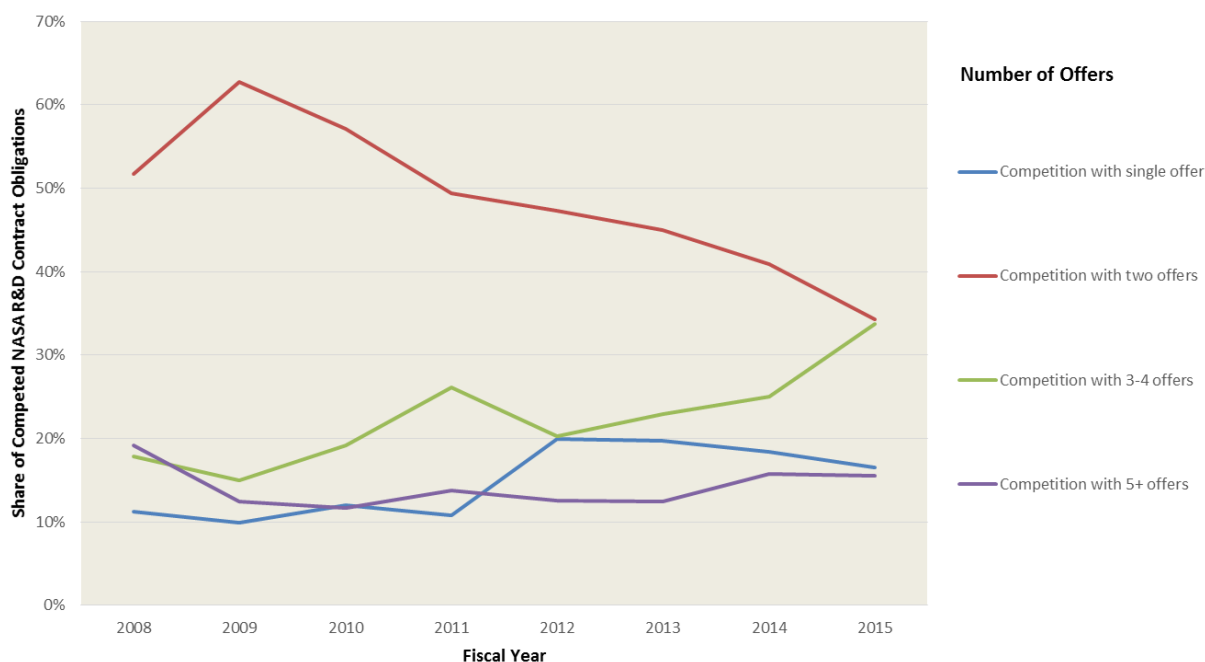
The Air Force shows some evidence in support of the hypothesis; by 2015, when the share of Air Force R&D contract obligations receiving only one offer has returned to near pre-drawdown levels, the share receiving five or more offers had increased notably.

NASA

Within NASA's R&D contracting portfolio, the gap between the rate of competition (56 percent) and the rate of effective competition (46 percent) is notably narrower than for DoD

or any of the military services. Figure 3-16 shows the breakdown of competitively sourced NASA R&D contracts:

Figure 3-16: Number of Offers Received for Competed NASA R&D Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

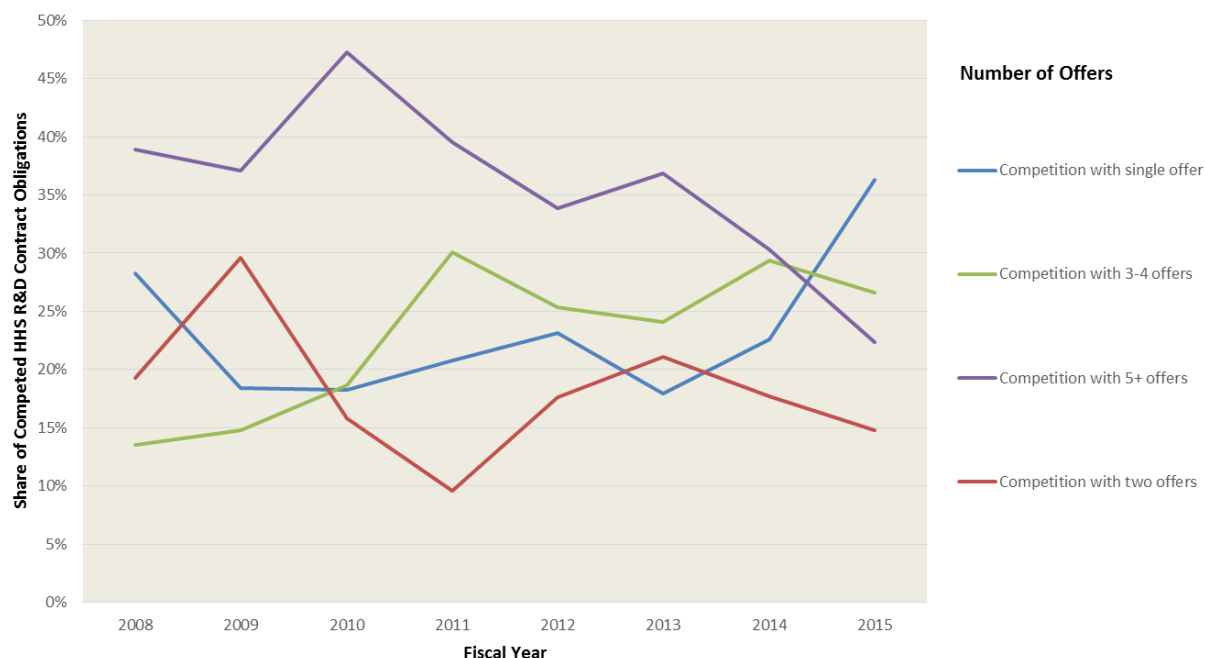
The current drawdown period has seen a significant shift in the pattern of number of offerors for competitively sourced NASA R&D contracts. The share of competitively sourced contracts that receive two offers, which was as high as 63 percent in 2009, has fallen to 34 percent in 2015, while the share receiving three to four offers has more than doubled, from 15 percent in 2009 to 34 percent in 2015. Single-offer competition is a significant issue in NASA R&D contracting, with the share of competitively sourced contracts receiving only one offer rising from 10 percent in 2009 to 20 percent in 2012 and 2013, but that share has declined slightly since, to 16 percent in 2015.

NASA's R&D contracting portfolio thus shows clear evidence in support of the hypothesis.

HHS

HHS R&D contracts have seen a high rate of effective competition since 2008, hovering near 60 percent in most years, aside from two one-year dips to slightly above 50 percent. Over that same period, the overall rate of competition for HHS R&D contracts has remained near 70 percent in each year. Figure 3-17 shows the breakdown of competitively sourced HHS R&D contracts:

Figure 3-17: Number of Offers Received for Competed HHS R&D Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

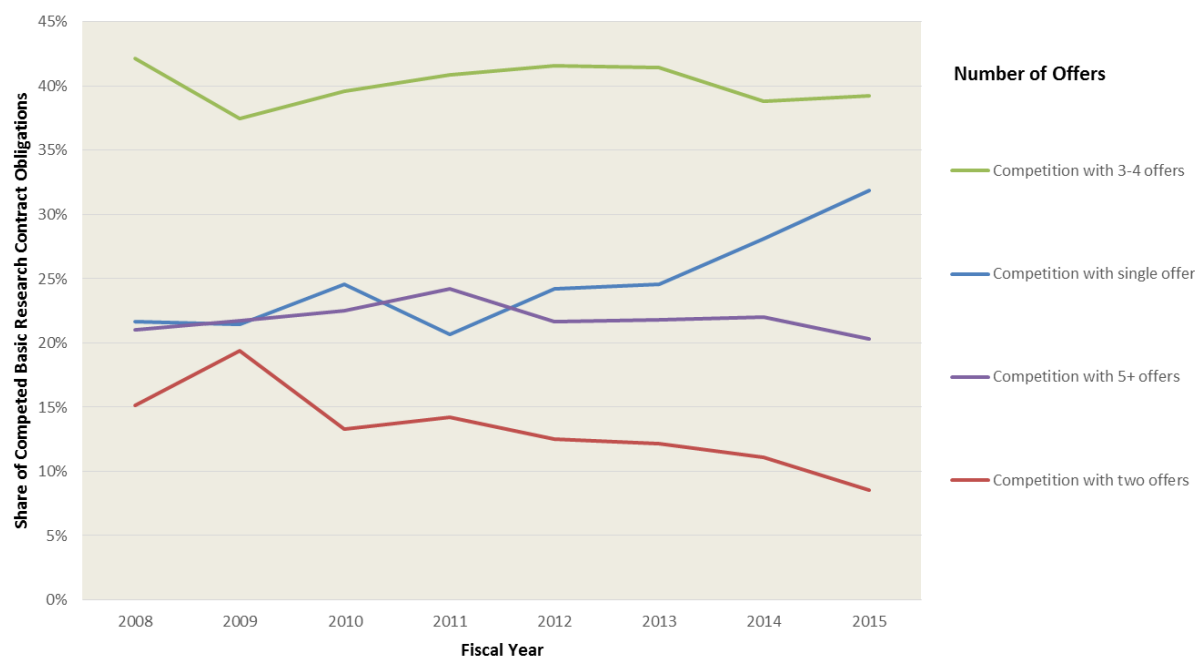
The share of competitively sourced HHS R&D contract obligations receiving only a single offer was relatively stable from 2009–2013, but has increased dramatically since, from 18 percent in 2013 to 36 percent in 2015, the highest share of any of the major federal R&D customers in this period. At the same time, the share receiving five or more offers fell from 37 percent to 22 percent. This shift was not simply the result of relative declines, but a real shift within the HHS R&D contracting portfolio—as overall HHS R&D contract obligations have declined by 25 percent since 2013, competitively sourced obligations receiving five or more offers have declined by 52 percent, while those receiving only one offer have increased by 61 percent.

The sections that follow examine competition trends for federal R&D contracts, broken down by stage of R&D.

Basic Research

Across the federal government, contracts for Basic Research have seen a declining rate of effective competition over the course of the budget drawdown, from 53 percent in 2008 (a high for the period) to 42 percent in 2015, which is more in line with historical rates. The rate of overall competition has also declined over that same period, from 68 percent to 61 percent. Figure 3-18 shows the breakdown of competitively sourced Basic Research contracts:

Figure 3-18: Number of Offers Received for Competed Basic Research Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

Unlike most of the agencies and components examined above, Basic Research showed no increase in the shares of competitively sourced contracts receiving either three to four offers or five or more offers. Like the other categories, there was a significant increase in the share receiving only one offer, from 22 percent in 2008 to 32 percent in 2015, with the increase concentrated in the period since 2011. This rise coincides with a decline in the share of competitively sourced Basic Research contracts receiving two offers from a high of 19 percent in 2009 to 9 percent in 2015. To a greater degree than most of the agencies and components, Basic Research contracts show a pattern that directly contravenes the stated hypothesis—a significant and steady decline in the number of offerors for competitively sourced contracts during the budget drawdown.

Applied Research

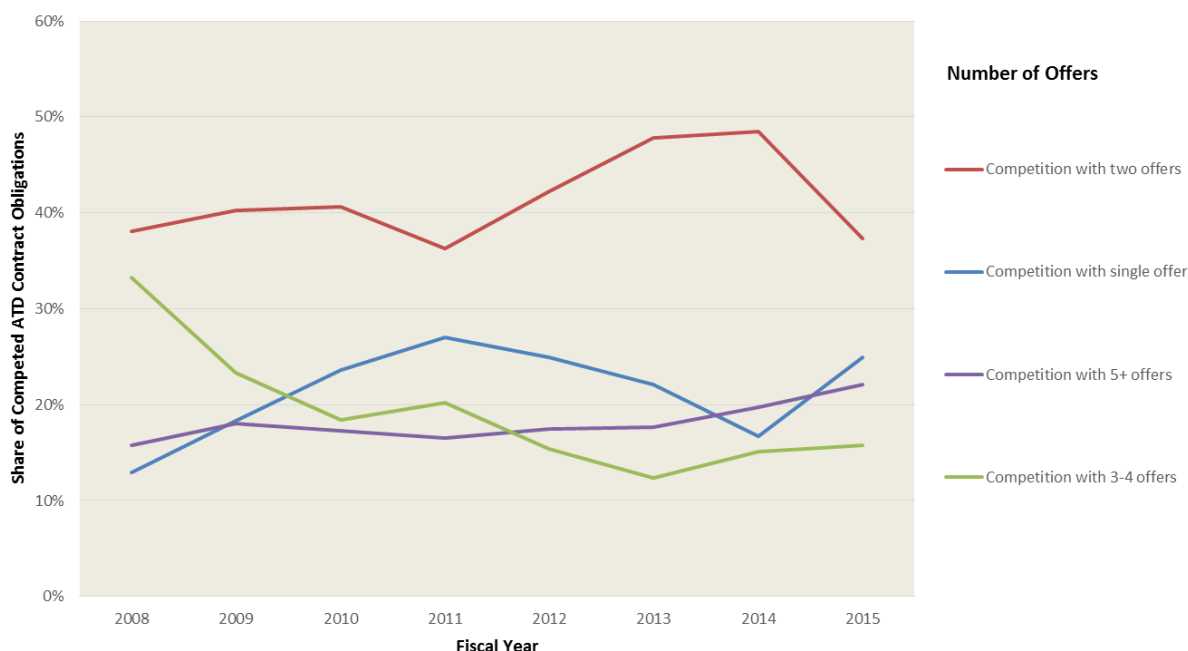
The data shows no significant shift in the number of offers received for competitively sourced Applied Research contracts during the budget drawdown.

Advanced Technology Development

The overall rate of competition for ATD contract obligations has risen sharply since 2008, from 65 percent to 82 percent in 2015. Meanwhile, the share of ATD contract obligations receiving effective competition only rose slightly over the same period, from 57 percent in

2008 to 61 percent in 2015, albeit with significant volatility from year to year. Figure 3-19 shows the breakdown of competitively sourced ATD contracts:

Figure 3-19: Number of Offers Received for Competed ATD Contract Obligations, 2008–2015



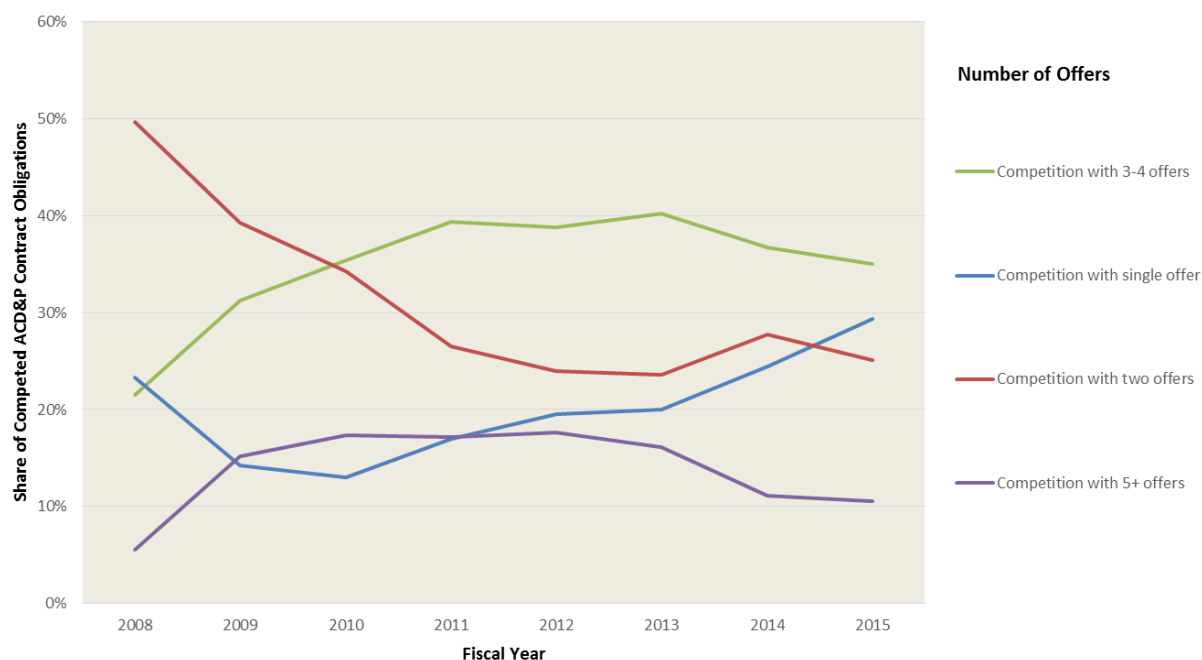
Source: FPDS; CSIS analysis.

There has been a significant decline in the share of competitively sourced ATD contract obligations receiving three to four offers, from 33 percent in 2008 to just 16 percent in 2015. Over that same period, the share receiving only one offer has risen from 13 percent to 25 percent. There has also been a small increase in the share receiving five or more offers, but overall, the data shows a trend of decreasing numbers of offerors for competitively sourced ATD contracts.

Advanced Component Development & Prototypes

The share of ACD&P contract obligations that are competitively sourced has fallen precipitously over the drawdown period, from 70 percent in 2008 and 2009 to 48 percent in 2015. The rate of effective competition for ACD&P contract obligations has also dropped sharply, from 60 percent in 2009 to 34 percent in 2015. Figure 3-20 shows the breakdown of competitively sourced ACD&P contracts:

Figure 3-20: Number of Offers Received for Competed ACD&P Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

The pattern of number of offered received for competitively sourced ACD&P contract obligations has been unusual during the drawdown. Three of the four categories reached either peaks or valleys in the middle part of the drawdown period, before moving back toward prior levels in later years. Single-offer competition, which accounted for 23 percent of competitively sourced ACD&P contract obligations in 2008, fell to 13 percent by 2010, but has risen steadily since, to 29 percent in 2015. Competition with three to four offers rose from 22 percent in 2008 to 40 percent in 2013, but has declined in the last two years, to 35 percent in 2015. Competition with five or more offers, which accounted for just 6 percent of competitively sourced ACD&P contract obligations in 2008, rose to 18 percent in 2012, but fell back to 11 percent in 2014 and 2015. The only category to see a consistent trend over the period was competition with two offers, which has declined for 50 percent to 25 percent over the drawdown period.

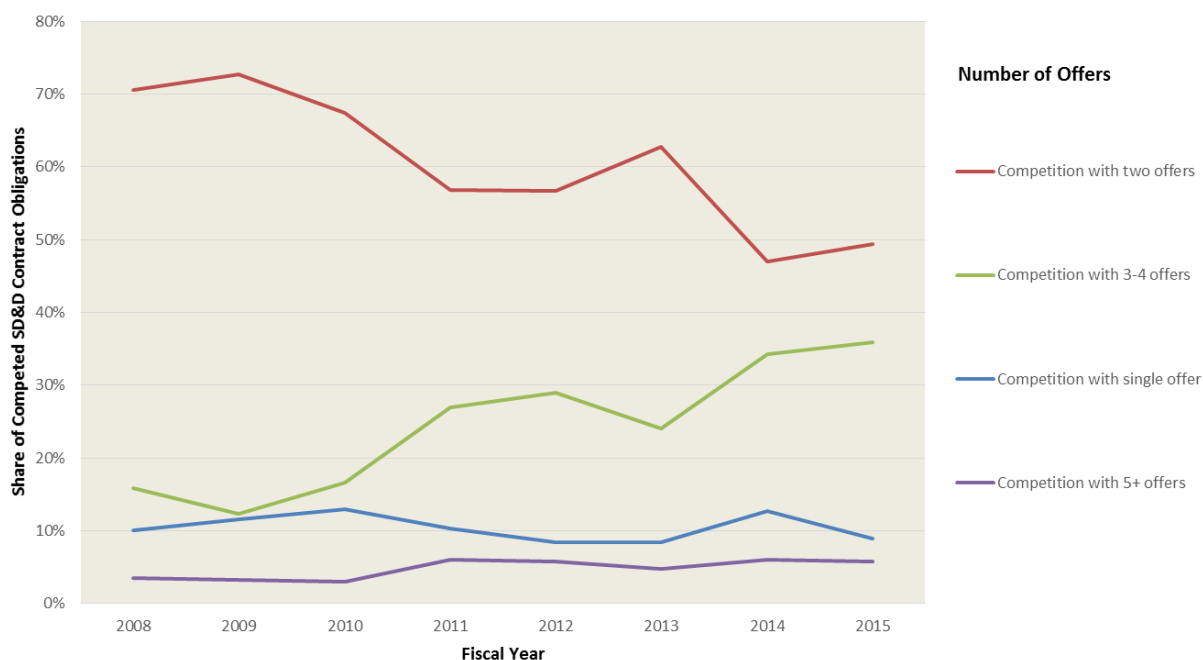
Overall, the data shows a mixed picture for ACD&P: a significant rise in single-offer competition, increases in competitions with three to four offers and five or more offers, and a halving of the share receiving only two offers.

System Development & Demonstration

More than any of the agencies, components, and stages of R&D examined in this section, SD&D shows relatively little difference between the overall rate of competition and the rate of effective competition. In the 2008–2015 period, as the overall rate of competition rose

from 46 percent to 61 percent, the rate of effective competition rose from 42 percent to 56 percent. Figure 3-21 shows the breakdown of competitively sourced SD&D contracts:

Figure 3-21: Number of Offers Received for Competed SD&D Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

Unique to SD&D, the share of competitively sourced contract obligations receiving only one offer has remained relatively low throughout the drawdown period, fluctuating between 8 percent and 13 percent. Similarly, the share receiving five or more offers is much lower than for any other agency, component, or stage of R&D examined in this section, never exceeding 6 percent in this period. For the remaining two categories, however, there is a definite increase in the number of offerors seen: as the share of competitively sourced SD&D contract obligations fell from 71 percent in 2008 to 49 percent in 2015, the share receiving three to four offers rose from 16 percent to 36 percent.

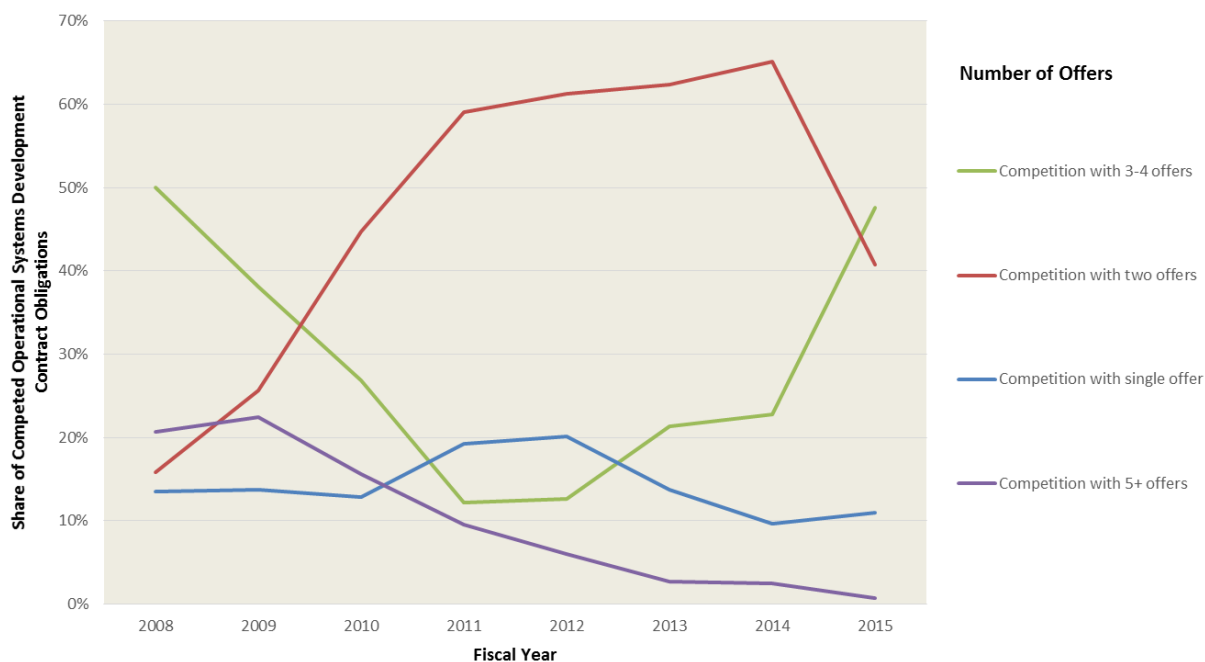
It is notable that SD&D, which saw the largest declines of any of the stages of R&D during the budget drawdown, is the only category which has seen a notable increase in the number of offers received for competitively sourced contracts.

Operational Systems Development

There has been a marked increase in both the overall rate of competition and the rate of effective competition for Operational Systems Development contract obligations. As the overall rate of competition rose from 40 percent in 2008 to 90 percent in 2015, the rate of

effective competition rose from 34 percent in 2008 to 80 percent in 2015. Figure 3-22 shows the breakdown of competitively sourced Operational Systems Development contracts:

Figure 3-22: Number of Offers Received for Competed Operational Systems Development Contract Obligations, 2008–2015



Source: FPDS; CSIS analysis.

There has been a stark decline in the number of offers received for competitively sourced Operational Systems Development contract obligations during the budget drawdown. While the share receiving only two offers has increased from 16 percent in 2008 to 41 percent in 2015, the share receiving five or more offers has declined from 21 percent to 1 percent.

Operation of Government R&D Facilities

The data shows no significant shift in the number of offers received for competitively sourced GOCO contracts during the budget drawdown.

Findings

The data is mixed on the question of whether competitively sourced federal R&D contracts have seen an increase in the number of offerors. On the one hand, many of the agencies, components, and stages of R&D have seen significant declines in the shares of R&D contracts receiving only two offers, with complimentary increases in the shares receiving either three to four offers or five or more offers. At the same time, there has been a near-universal increase in the shares receiving only one offer, in most cases to the highest levels in the period observed. Only one category, SD&D, has seen a clear increase in the number of

offers received over the course of the budget drawdown. The study team considers increasing rates of single offer competition to be a potentially troublesome sign; while it may simply be masking contracts that should be more properly classified as sole source, CSIS believes that high rates of single offer competition often signal unhealthy industrial base sectors, as well as issues with writing solicitations in a way that discourages potential bidders.

Hypothesis 7: The budget drawdown will discourage new entrants into the federal R&D contracting marketplace.

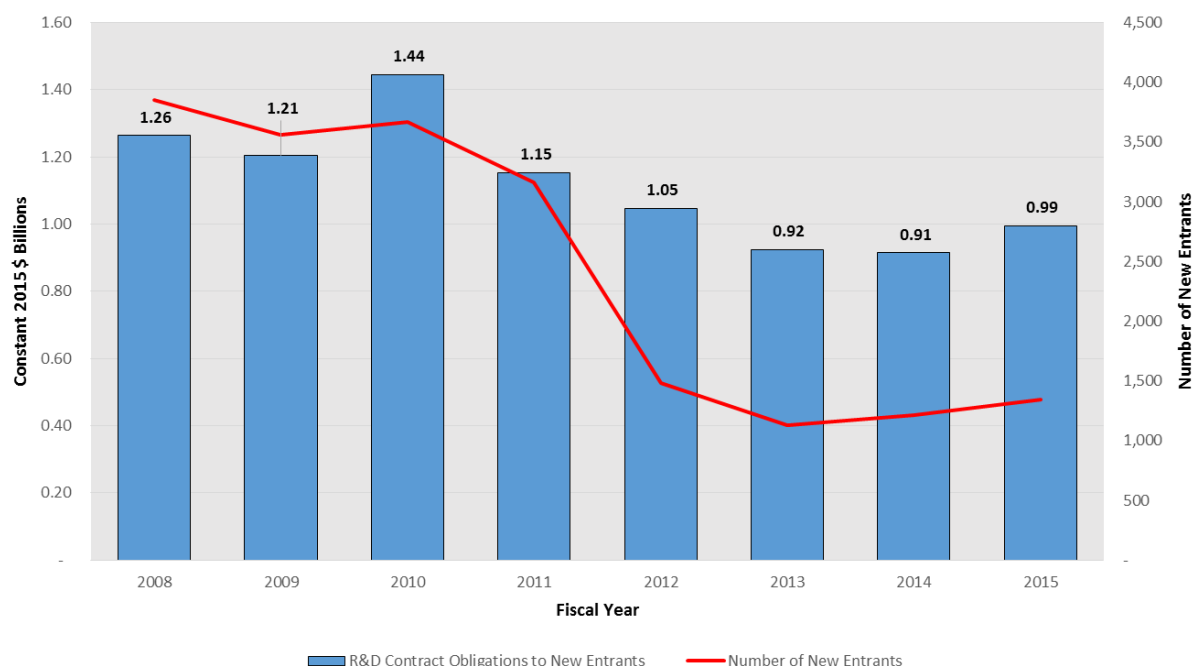
The logic underpinning Hypothesis 7 is straightforward: with the federal R&D contracting market declining precipitously during the budget drawdown, it makes sense that the market would become a less attractive target for companies to enter. If true for federal R&D contracting, this would be particularly worrisome, since enticing new, innovative firms to enter the federal R&D marketplace is critical to bringing emerging technologies and methods into the federal government.

For this analysis, CSIS has leaned upon the decade-plus of work it has done to classify the parent vendors for contracts within FPDS, to track changes in those parent vendors, and to classify those parent vendors by their size. FPDS itself does not robustly or reliably classify contracts by parent vendor; rather, the main vendor identifier in FPDS is the Dun & Bradstreet (DUNS) number. Aside from being a private, proprietary classification system, the main limitation of using DUNS numbers is that each number corresponds to only a particular business unit or location, and a single parent vendor may have dozens or even hundreds of associated DUNS numbers. See the methodology section in Appendix I for more details on how CSIS classifies contracts by parent vendor.

To perform this analysis, CSIS looked at the universe of federal R&D contracts in each fiscal year, identified the vendors in each year that were receiving R&D contract obligations for the first time, and tracked the total obligations going to such “new entrants” in each year. If the hypothesis were true, CSIS would expect to see significant declines in the number of new entrants over the drawdown period, as well as the contract obligations going to those new entrants.

Figure 3-23 shows the trends for new entrants into the overall federal R&D contracting marketplace since 2008:

Figure 3-23: Number of New Entrants and Contract Obligations to New Entrants in the Federal R&D Marketplace, 2008–2015



Source: FPDS; CSIS analysis.

The data shows that, while the number of new entrants into the overall federal R&D marketplace has declined in line with the prediction made by Hypothesis 7 during the budget drawdown, the decline in the dollars going to new entrants has been significantly more modest. In 2008, there were approximately 3,900 new entrants into the federal R&D marketplace, and that level was relatively stable until 2011, when it declined from 3,700 to 3,200. The number of new entrants declined by more than half in 2012, to fewer than 1,500, and fell to a low of just over 1,100 by 2013. The number of new entrants has rebounded slightly, to over 1,300 in 2015, but for the 2008–2015 period overall, new entrants into the federal R&D marketplace have declined by nearly two-thirds.

Over that same 2008–2015 period, however, federal R&D contract obligations to new entrants, which accounted for approximately 2 percent of overall federal R&D contract obligations in each year, have only declined by 21 percent. 2015 saw moderate growth in contract obligations from 2014, which saw the lowest level of obligations in the period examined, but even looking at the change from 2008 to the floor in 2014, contract obligations only declined by 28 percent. Either way, the decline in contract obligations to new entrants was notably less steep than the 38 percent decline in overall federal R&D contract obligations between 2008 and 2015.

To better understand the drivers behind this trend, the study broke down the data on new entrants further, looking at differences between different sizes of vendors, using the same categorization methodology as in Hypothesis 4, with one key difference: separating out

vendors that are “Always Small” in a particular year, meaning that they are classified as small by the government for all contract obligations in that year, from vendors that are “Sometimes Small,” meaning that they received some contracts for which they were not classified as small.

By number of new entrants, both Always Small vendors (-70 percent), which have accounted for around three-fifths of all new entrants throughout the period, and Sometimes Small vendors (-78 percent) declined more steeply than overall federal R&D new entrants between 2008 and 2015, while the number of new entrants that are Medium vendors (-24 percent) has declined much less steeply. The number of Medium new entrants actually dropped by nearly two-thirds between 2011 and 2013, but has rebounded significantly since.

By contract obligations, the trend looks similar—both Always Small vendors (-47 percent) and Sometimes Small vendors (-77 percent) declined far more steeply than overall federal R&D contract obligations to new entrants between 2008 and 2015. Obligations to Medium new entrants more than doubled over that period, though as with the number of new entrants, there was a sharp drop in obligations in the early part of the 2010s before a sharp recent rebound, in this case back to prior levels.

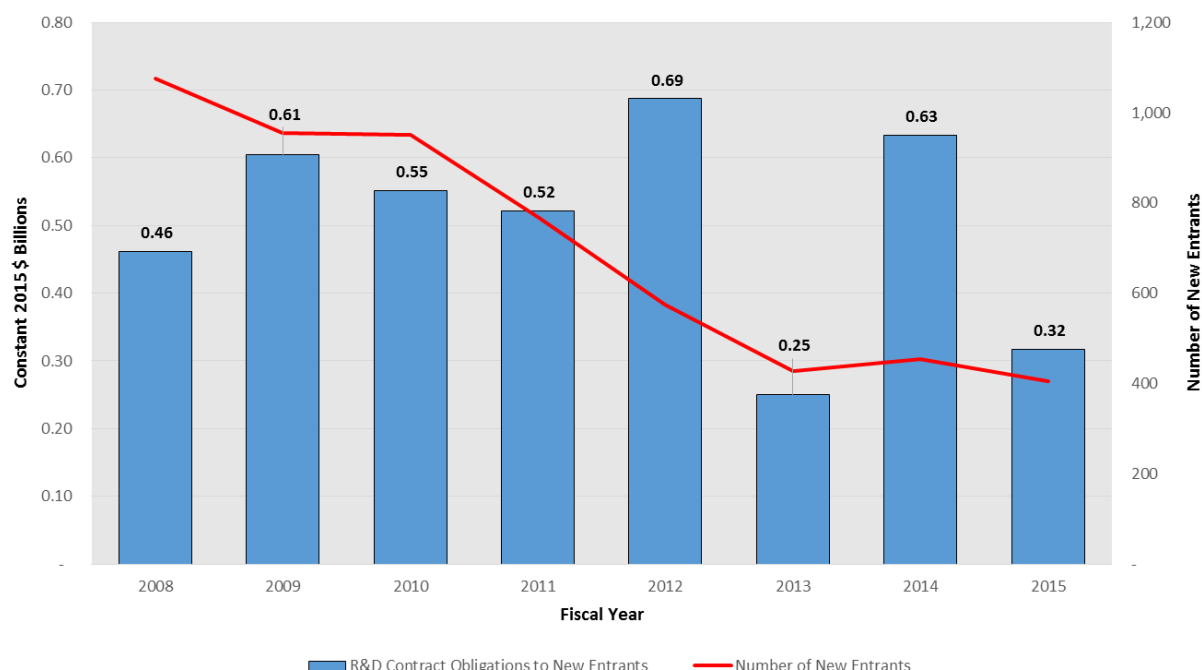
For overall federal R&D contracts, then, the data strongly supports the hypothesis in terms of number of new entrants, and strongly contradicts the hypothesis in terms of contract obligations going to new entrants. Small vendors, both those that do all their contracting as small businesses and those that are only small for some contracts, seemed to have been disproportionately affected in both respects, though the Always Small vendors declined less steeply than the Sometimes Small vendors in terms of contract obligations.

The sections that follow will examine the trends for new entrants into the federal R&D marketplace, broken down by R&D customer.

Department of Defense

Since 2008, new entrants have accounted for between 1 percent and 2 percent of total DoD R&D contract obligations. Figure 3-24 shows the trends for new entrants into the DoD R&D contracting marketplace since 2008:

Figure 3-24: Number of New Entrants and Contract Obligations to New Entrants in the DoD R&D Marketplace, 2008–2015



Source: FPDS; CSIS analysis.

As with overall federal R&D, there is a clear trend showing declining numbers of new entrants into the DoD R&D contracting marketplace over the course of the budget drawdown. Since 2008, the number of new entrants in each year has declined consistently, from nearly 1,100 in 2008 to just over 400 in 2015, a decline of over three-fifths. Over that same period, contract obligations to new entrants have declined by only 31 percent, compared to 53 percent for DoD R&D overall since 2008. That trend masks significant year-to-year volatility, however; between 2012 and 2013, for example, in the period where the impact of sequestration is most directly seen, obligations declined by 64 percent, before returning to near previous levels in 2014, and dropping by half in 2015.

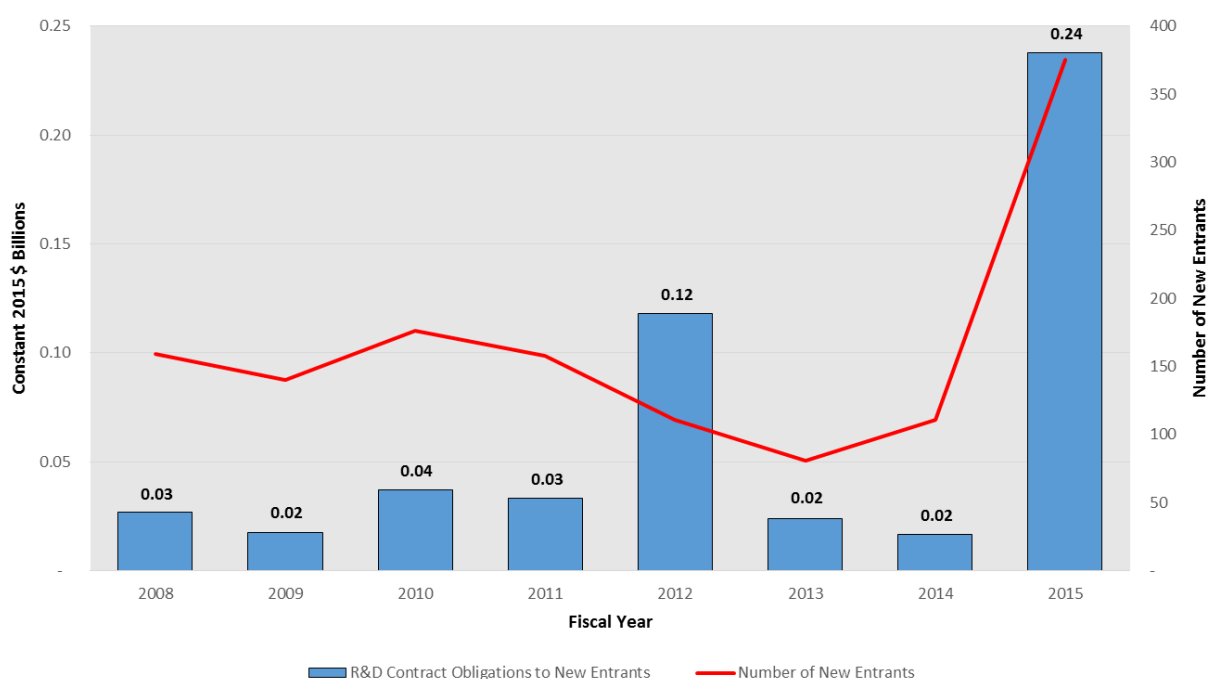
Looking deeper into the data by size of vendor, the trends for DoD R&D new entrants by number of entrants are notably different than for overall federal R&D. Always Small vendors (-60 percent) and Medium vendors (-53 percent) declined slightly less steeply than overall DoD R&D new entrants, while Sometimes Small vendors (-78 percent) declined notably more steeply. By contract obligations, however, the trends look somewhat similar to overall federal R&D: contract obligations to Medium vendors (-33 percent) declined roughly in parallel to overall DoD R&D new entrants, while Always Small vendors (-45 percent) declined more steeply, and Somewhat Small vendors (-73 percent) declined at over twice the rate of overall DoD R&D new entrants.

Overall, the data for DoD R&D new entrants strongly supports the hypothesis in terms of numbers of new entrants, while the data on contract obligations to new entrants is more ambiguous.

NASA

Since 2008, new entrants have accounted for 1 percent or less of NASA R&D contract obligations in every year except 2015, when they accounted for 3 percent. Figure 3-25 shows the trends for new entrants into the DoD R&D contracting marketplace since 2008:

Figure 3-25: Number of New Entrants and Contract Obligations to New Entrants in the NASA R&D Marketplace, 2008–2015



Source: FPDS; CSIS analysis.

NASA's R&D marketplace is an outlier both in number of new entrants and in contract obligations to new entrants. The number of new entrants declined by over half between 2010 and 2013, but rose to a new high in 2015, more than the double the highest level in the prior years. Similarly, contract obligations to new entrants had been reasonably consistent, aside from a one-year spike in 2012, until 2015, when obligations increased almost 15-fold over 2014 levels.

Looking at the data by size of vendor, the unusually high number of new entrants in 2015 is due to a surge in Medium vendors, which rose over 22-fold from 2014 levels. The number of Sometimes Small new entrant vendors more than doubled, while the number of Always Small vendors increased by just under 20 percent. The contract obligations going to Medium new entrant vendors increased from just over \$1 million to nearly \$170 million between 2014 and

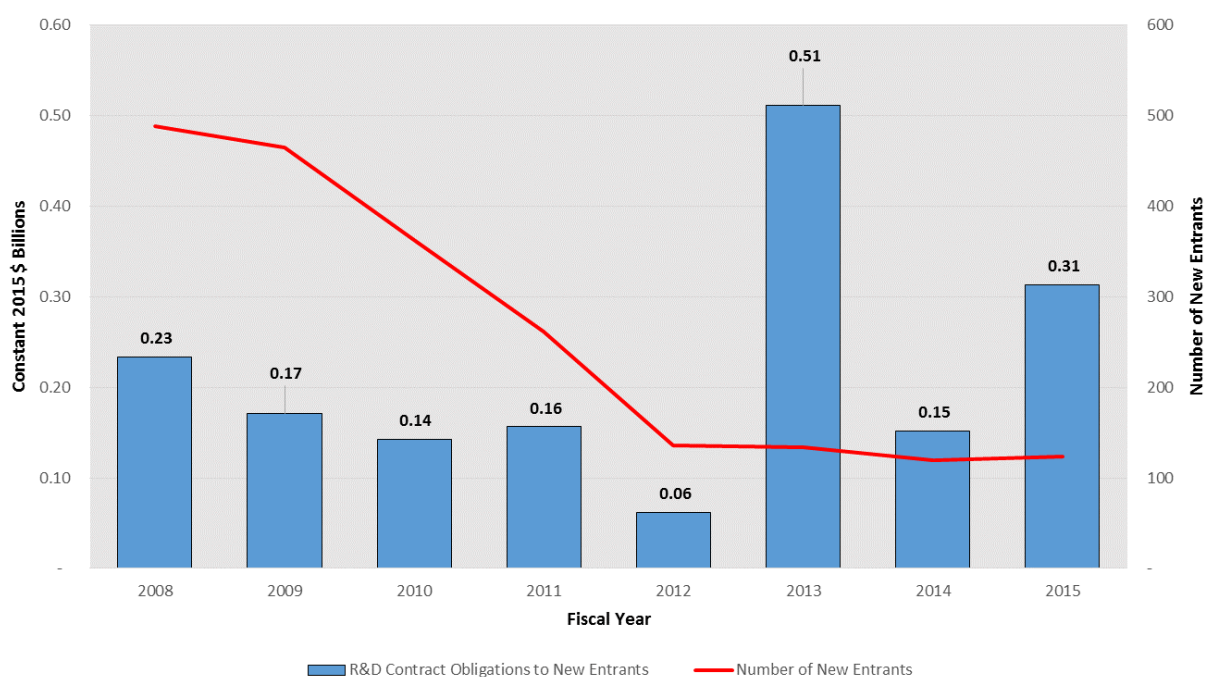
2015, while Always Small (fourfold increase) and Sometimes Small (14-fold increase) also saw major growth.

Overall, the data for NASA R&D new entrants does not provide support for the hypothesis, but neither does it directly contradict the hypothesis, as the data from 2015 could be the result of a one-year anomaly.

HHS

Since 2008, the share of HHS contract obligations going to new entrants has been significantly higher than for federal R&D overall or for the two other agencies examined in this section. The share going to new entrants has fluctuated greatly over the period, falling from 8 percent in 2008 to 2 percent in 2012, spiking to a high of 15 percent in 2013, falling back to 5 percent in 2014, and rising again to 12 percent in 2015. Figure 3-26 shows the trends for new entrants into the DoD R&D contracting marketplace since 2008:

Figure 3-26: Number of New Entrants and Contract Obligations to New Entrants in the HHS R&D Marketplace, 2008–2015



Source: FPDS; CSIS analysis.

The number of new entrants into the HHS R&D contracting marketplace declined steadily from 2008–2012, falling from 490 to 136, but has been largely steady in the years since. Similarly, HHS R&D contract obligations to new entrants declined by 73 percent between 2008 and 2012, but have fluctuated wildly since, increasing over eightfold between 2012 and 2013, falling by more than 70 percent in 2014, and then doubling in 2015. For the period as a whole, HHS R&D contract obligations to new entrants increased by 34 percent.

Looking at the data by size of vendor, the number of both Always Small and Sometimes Small new entrants fell roughly in parallel to overall HHS R&D new entrants since 2008, while Medium new entrants were relatively preserved, though still with a sharp decline (-60 percent.) For contract obligations, Always Small new entrants (-39 percent) saw sharp declines, while obligations to Sometimes Small new entrants virtually disappeared (-95 percent.) HHS R&D contract obligations to Medium new entrants increased by 327 percent between 2008 and 2015, though that figure masks significant year-to-year volatility within the period.

Overall, the data on HHS R&D shows moderate support for the hypothesis with regards to number of new entrants, but does not support the hypothesis with regards to contract obligations to new entrants.

Findings

Of the seven hypotheses examined, this is the only one where the data provides consistent support, even if only for some elements. Federal R&D overall, DoD, and HHS all show a clear and consistent decline in the number of new entrants over the course of the budget drawdown, with those declines most heavily concentrated among vendors that are either Always Small or Sometimes Small. By contract obligations, however, there is no concrete evidence to support the hypothesis; not only did R&D contract obligations to new entrants not decline to nearly the same degree as the number of new entrants, but they are also declined more slowly than overall R&D contract obligations.

This seeming contradiction, with the number of new entrants dropping steeply but obligations to new entrants being relatively preserved, tells an interesting story about how the federal R&D contracting marketplace has changed during the budget drawdown. The data indicates that most of the potential new entrants being driven away from the federal R&D marketplace are those small enough that they can only perform relatively small contracts. Larger vendors capable of performing contracts of various sizes have fared relatively better, indicating the value of that flexibility. It is also notable that Always Small vendors consistently did better than Sometimes Small vendors, which points to the value of small business set-asides as a way to smooth the way for new entrants into federal contracting.

This change in the federal R&D marketplace is nonetheless worrisome, because if the market is discouraging small R&D firms from becoming federal contractors, then many of the innovative, start-up vendors that the government, and particularly DoD, are trying to entice into the federal contracting marketplace are likely to be pushed away by those same factors. More study is needed on this issue to determine whether there is a way to mitigate this trend going forward.

Additionally, the harsher declines in both number of Sometimes Small new entrants and contract obligations to Sometimes Small new entrants may indicate that firms growing out of the small business classification have faced particular difficulties during the budget drawdown.

Final Thoughts

The data highlighted in this report clearly shows that, while federal R&D contract obligations have declined dramatically overall, this decline has not been consistent across the major R&D contracting agencies and their major components, or across the different stages of R&D. Moreover, with very narrow exceptions, only one of the predictions made by the study team regarding the effect of the downturn on federal R&D contracting, based on the conventional wisdom, has been borne out by the data.

While federal contract obligations overall have declined precipitously during the current budget drawdown, the impact has fallen more harshly on the federal R&D contracting portfolio. NASA represents a notable exception to this trend. Furthermore, the contrast between NASA and DoD was particularly stark, as while NASA was able to grow its R&D contracting portfolio by finding savings in its services contracts, DoD services contracts were actually relatively preserved during the budget drawdown, at the expense of its R&D contracting portfolio.

For DoD, the key finding from this data is the existence of a six-year trough the development pipeline for major weapons systems. The Air Force looks likely to buck that trend in the coming years as spending for the Long Range Strike Bomber program ramps up. However, the Navy's continued delay of development timelines for programs like the Ohio-replacement ballistic submarine due to budget constraints, and the Army's continued uncertainty about future missions, requirements, and resources, indicate that the overall trough is likely to continue into the foreseeable future.

Looking at the industrial base that supports federal R&D contracting, the most dramatic change was the sharp decline in the share of R&D contract obligations going to large prime vendors within DoD, largely as a result of the aforementioned six-year trough in DoD's developmental pipeline for major weapons systems. Over that same period, there has been a marked surge in the share of R&D contracts going to small vendors within DoD, as the result of obligations to small vendors declining far more slowly than to other vendor size categories. This can be seen as a victory for policies that promote small business participation—in an extremely challenging environment, small vendors have managed to largely hold their ground, even as the bigger players were facing sharp declines.

The data regarding small vendors is not all positive, however. There has been a particularly sharp decline in the number of new small vendors entering the federal R&D marketplace in each year over the course of the budget drawdown. Interestingly, those vendors who were classified as small businesses for all of their contracts fared better than those for whom only some of their contracts fell under small business rules. The data also shows that, while contract obligations to new entrants who were "Sometimes Small" fell roughly in line with the declining numbers of new entrants, contract obligations to "Always Small" new entrants were actually preserved relative to the overall federal R&D marketplace. While more research is needed to make any definitive conclusions, this data may indicate that firms growing out of the small-business classification have faced particular difficulties during the budget drawdown.

Appendix: Methodology

For nearly a decade, the Defense-Industrial Initiatives Group (DIIIG) has issued a series of analytical reports on federal contract spending for national security across the government. These reports are built on FPDS data, presently downloaded in bulk from USAspending.gov. DIIIG now maintains its own database of federal spending, including years 1990–2014, that is a combination of data download from FPDS and legacy DD350 data. For this report, however, the study team primarily relied on FY2000–2015. Data before FY 2000 require mixing sources and incurs notable limitations.

The biggest change for past readers of these reports is that the category of the largest defense vendors has been reduced to the “Big 5.” In past years, BAE Systems, and then United Technologies, have held the role as the sixth company. However, merger and acquisition activity described in section 4.2 will soon change the vendor in the sixth spot yet again. This lack of stability defeats the point of tracking the largest vendors as a separate category, and so, going forward, CSIS will focus on the five largest defense vendors: Lockheed Martin, Boeing, General Dynamics, Raytheon, and Northrop Grumman.

Inherent Restrictions of FPDS

Since the analysis presented in this report relies almost exclusively on FPDS data, it incurs four notable restrictions.

First, contracts awarded as part of overseas contingency operations are not separately classified in FPDS. As a result, we do not distinguish between contracts funded by base budgets and those funded by supplemental appropriations.

Second, FPDS includes only prime contracts, and the separate subcontract database (Federal Subaward Reporting System, FSRS) has historically been radically incomplete; only in the last few years have the subcontract data started to approach required levels of quality and comprehensiveness. Therefore, only prime contract data are included in this report.

Third, reporting regulations require that only unclassified contracts be included in FPDS. We interpret this to mean that few, if any, classified contracts are in the database. For DoD, this omits a substantial amount of total contract spending, perhaps as much as 10 percent. Such omissions are probably most noticeable in R&D contracts.

Finally, classifications of contracts differ between FPDS and individual vendors. For example, some contracts that a vendor may consider as services are labeled as products in FPDS and vice versa. This may cause some discrepancies between vendors’ reports and those of the federal government.

Constant Dollars and Fiscal Years

All dollar amounts in this data analysis section are reported as constant FY 2015 dollars unless specifically noted otherwise. Dollar amounts for all years are deflated by the implicit GDP deflator calculated by the U.S. Bureau of Economic Analysis, with FY2015 as the base year, allowing the CSIS team to more accurately compare and analyze changes in spending across time. Similarly, all compound annual growth values and percentage growth comparisons are based on constant dollars and thus adjusted for inflation.

Due to the native format of FPDS and the ease of comparison with government databases, all references to years conform to the federal fiscal year. FY2015, the most recent complete year in the database, spans from October 1, 2014, to September 30, 2015.

Data Reliability Notes and Download Dates

Any analysis based on FPDS information is naturally limited by the quality of the underlying data. Several Government Accountability Office (GAO) studies have highlighted the problems of FPDS (for example, William T. Woods's 2003 report "Reliability of Federal Procurement Data," and Katherine V. Schinas's 2005 report "Improvements Needed for the Federal Procurement Data System—Next Generation").

In addition, FPDS data from past years are continuously updated over time. While FY2007 was long closed, over \$100 billion worth of entries for that year were modified in 2010. This explains any discrepancies between the data presented in this report and those in previous editions. The study team changes over prior-year data when a significant change in topline spending is observed in the updates. Tracking these changes does reduce ease of comparison to past years, but the revisions also enable the report to use the best available data and monitor for abuse of updates.

Despite its flaws, the FPDS is the only comprehensive data source of government contracting activity, and it is more than adequate for any analysis focused on trends and order-of-magnitude comparisons. To be transparent about weaknesses in the data, this report consistently describes data that could not be classified due to missing entries or contradictory information as "unlabeled" rather than including it in an "other" category.

The 2015 data used in this report were downloaded in February 2016.

Detailed Methods

The sections below are specific to only selected graphs or tables that posed additional technical challenges.

Competition

The study team followed DoD methodology and calculated competition by using two fields: extent of competition, which is preferred for contract awards; and fair opportunity, which is

preferred for task and delivery orders under most indefinite delivery vehicles (IDVs). In the vast majority of cases, competitive status is classified for the entire contract duration. Thus, if a contract had a duration of three years and was competed in the first year, it qualifies as competed for the entire duration. This also extends to single-award indefinite delivery contracts, which are classified based on whether the original vehicle was competed rather than consistently treated as only receiving an offer from the single awardee. However, for some other vehicles, such as multiple-award IDVs, the number of offers is instead tracked separately for each task order.

To better evaluate the rate of “effective competition,” the study team categorizes competitively awarded contracts by the number of offers received. CSIS defines effective competition as a competitively sourced contract awarded after receiving two or more offers. CSIS focuses on the number of offers for competed contracts because it reveals information about the request for proposals. A solicitation that only has a single respondent indicates some combination of three factors: thinness in the underlying market; a failure to notify or give adequate response time to potential competitors; or a contract that is unappealing to vendors.

The focus on the number of offers also has a basis in the regulation known as the Single Offer rule (DFARS 215.371), which addresses competitive acquisitions in which only one offer is received. This rule was rewritten in 2012 to add a policy section that shifts emphasis away from an analysis of whether the circumstances described at FAR 15.403-1 (c)(1)(ii) (determining adequate price competition) are present, to whether statutory requirements for obtaining certified cost or pricing data are met and if the price is fair and reasonable. The revised rule also emphasizes the need to extend the period of solicitation when only one offer is received, to see whether a longer response period can elicit additional bids. Essentially, the new standard suggests that if you cannot get two bidders, you must evaluate whether proceeding with one bid can be done while protecting the interests of the government.

Vendor Categorization

Small, Medium, and Large Vendors

To analyze the breakdown of competitors in the market into small, medium, and large vendors, the CSIS team assigned each vendor in the database to one of these size categories. Any organization designated as small by the FPDS database—according to the criteria established by the federal government—was categorized as such unless the vendor was a known subsidiary of a larger entity. Due to varying standards across sectors, an organization may meet the criteria for being a small business in certain contract actions and not in others. The study team did not override these inconsistent entries when calculating the distribution of value by vendor size.

Vendors with annual revenue of more than \$3 billion, including from nonfederal sources, are classified as large. This classification is based on the vendor’s most recent revenue figure at time of classification. For vendors that have gone out of business or been acquired, this date may be well before 2014. A joint venture between two or more organizations is treated as a

single separate entity, and organizations with a large parent are also defined as large. Due to their system integrator role and consistent market share, the study team placed the five largest defense contractors (Lockheed Martin, Boeing, Raytheon, Northrop Grumman, and General Dynamics) into a separate category called “Big 5 defense vendors.” Any vendor assigned a unique identifier by FPDS but is neither small nor large is classified as “medium.”

To identify large vendors, the study team investigated any vendor with total obligations of \$500 million in a single year or \$2 billion over the study period. Determining revenues is the most labor-intensive part of the process and involves the use of vendor websites, news articles, various databases, and public financial documents. When taken together, all of this work explains the increase in the market share of large vendors versus some older editions of this report. While large vendors are, on rare occasions, reassigned into the middle tier, the vast majority of investigations either maintain the status quo or identify small or medium vendors that should be classified as large.

Handling of Subsidiaries and Mergers and Acquisitions

To better analyze the defense industrial base, the study team made significant efforts to consolidate data related to subsidiaries and newly acquired vendors with their parent vendors. This consolidation results in, among other things, a parent vendor appearing once on CSIS’s top 20 lists rather than being divided between multiple entries. The assignment of subsidiaries and mergers to parent vendor is done on an annual basis, and a merger must be completed by the end of March in order to be consolidated for the fiscal year in question. This enabled the study team to more accurately analyze the defense industrial base, the number of players in it, and the players’ level of activity.

Over the past seven years, the study team has applied a systematic approach to vendor rollups. FPDS uses hundreds of thousands of nine-digit DUNS (Data Universal Numbering System) codes from Dun and Bradstreet to identify service providers. A salutary benefit of this standardization is that FPDS now provides parent vendor codes. These parent codes track the current ownership of vendors but are not backward looking. Thus, a merger that happened in 2010 would not affect parent assignments in 2000. This prevents the study team from adopting these assignments in their entirety. The study team investigates vendors that receive \$250 million of total contract revenue or more than \$1 billion in obligations between 2000 and 2014, no matter how much they receive in any individual year. We have reinforced these manual DUNS number assignments with automated assignments based on vendor names. Qualifying for an automated assignment by name requires three criteria: 1) a standardized vendor name that matches with the name of a parent vendor; 2) that the name has been matched to the parent vendor by the CSIS or the Parent DUNS number field; and 3) there are no alternative CSIS assignments with that vendor name. This process is not immune to error, but it reduces the risk that a DUNS code is considered large in one year but overlooked in another. As an error-checking mechanism, the study team investigated contradictions by comparing our assignments to those made by Parent DUNS numbers for every DUNS number with \$500 million in annual obligations or \$2 billion in total obligations.

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Gregory Sanders is the deputy director for research with the Defense-Industrial Initiatives Group at CSIS, where he manages a team that analyzes U.S. defense acquisition issues. Utilizing data visualization and other methods, his research focuses on extrapolating trends within government contracting. This requires innovative management of millions of unique data from a variety of databases—most notably the Federal Procurement Database System, and extensive cross-referencing of multiple budget data sources. Mr. Sanders holds an M.A. in international studies from the University of Denver and a B.A. in government and politics, as well as a B.S. in computer science, from the University of Maryland.

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