# The Private Value of Innovating for the Government*

Ashish Arora † Sharon Belenzon‡ Larisa Cioaca§ Elia Ferracuti¶

July 10, 2026

**Abstract**

We quantify the private value of government R&D contracts awarded to firms. We present new evidence that R&D contracts not only finance innovation but also embed an implicit government guarantee of noncompetitive future procurement for the winning R&D contractor. We measure its private value by analyzing stock market reactions to news about R&D contract awards. Using all federal R&D contracts awarded to U.S. publicly traded firms from 1984 through 2024, we find that the average private value on an R&D contract is 24 times its maximum potential revenue. However, returns are highly skewed, with only 5.7% of firms receiving at least one top-quartile contract. Private value is linked to future production contracts, but only for noncompetitive awards to vertically integrated or large firms. These results suggest that a procurement regime bundling R&D and production contracts may enhance value for firms with production capability. We develop a conceptual framework to clarify this innovation policy lever.

**JEL Classification**: O38 – Government Policy; H57 – National Government Expenditures and Related Policies: Procurement; O31 – Innovation and Invention: Processes and Incentives

**Keywords**: government procurement, R&D contracts, private value, innovation policy, vertical integration

*We thank participants at the NBER Productivity Seminar, Strategy Science Conference, Sumantra Ghoshal Conference, International Conference on the Science of Science and Innovation (ICSSI), Workshop on Entrepreneurial Finance and Innovation (WEFI), and Entrepreneurship and Innovation Policy Seminar for their helpful comments and suggestions. We also thank Hansen Zhang for providing excellent research assistance. Ashish Arora, Sharon Belenzon, and Larisa Cioaca are grateful for the financial support received from the Alfred P. Sloan Foundation via grant G-2023-21022.

†Duke University, Fuqua School of Business and NBER; ashish.arora@duke.edu

‡Duke University, Fuqua School of Business and NBER; sharon.belenzon@duke.edu

§Tulane University, Freeman School of Business; lcioaca@tulane.edu

¶Duke University, Fuqua School of Business; elia.ferracuti@duke.edu

# 1 Introduction

Innovation drives growth (e.g., Aghion & Howitt, 1992; Romer, 1990), but market failures like knowledge spillovers lead to its underproduction (Arrow, 1962; Bloom, Schankerman, & Van Reenen, 2013; Hall, Mairesse, & Mohnen, 2010), justifying government intervention. Governments deploy various policies to incentivize innovation, but public funding for R&D remains a primary tool (Bryan & Williams, 2021). Government innovation spending falls into "push" (or supply-side) and "pull" (or demand-side) policies (Edler & Georghiou, 2007). Push spending subsidizes innovation inputs through R&D grants and tax credits. Alternatively, the government can "pull" private R&D investments by promising to buy innovative goods and services relying on R&D. The design of government procurement in general (e.g., Bosio, Djankov, Glaeser, & Shleifer, 2022) and innovation procurement more specifically (Howell, Rathje, Van Reenen, & Wong, 2021; Weyl & Tirole, 2012) is an important policy challenge. We contribute to this broad research agenda by studying one policy lever: the bundling of R&D and production contracts in federal procurement.

The government sometimes combines push and pull policies, such as when it "guarantees demand" by awarding future production contracts without competitive bidding to firms that complete government-funded R&D contracts successfully (Belenzon & Cioaca, in press). This paper examines the combined use of push and pull policies, developing a framework to explain when R&D contract winners can realize additional profits from future production contracts, even under efficient government procurement. We then study the implications of bundling R&D and production contracts for the private value of R&D contracts.

Both push and pull spending are sizable. In 2021, the federal government obligated $179.5 billion to fund R&D and $593 billion to acquire products and other services (excluding R&D). Despite this, there is limited systematic evidence on how government procurement of innovation affects corporate R&D. Importantly, R&D and production contracts are not explicitly linked in federal procurement data. Anecdotal evidence suggests that downstream government demand can pull in private investments in innovation (e.g., Edquist & Zabala-Iturriagagoitia, 2012; Levin, 1982). For example, Mowery (2012) notes:

> "*In the case of Texas Instruments, the prospect of a substantial defense procurement contract proved to be a [more] powerful incentive to develop a new approach to semicon-*

*ductor design and fabrication (the integrated circuit) than was defense R&D funding, most of which was directed to established military suppliers. Instead, the prospect of substantial sales of semiconductor components for strategic-missile guidance systems to the U.S. military operated as a sort of 'prize,' motivating Texas Instruments to develop the basic architecture for the integrated circuit.*" (p. 1713)

Other authors explore optimal procurement mechanisms (Bhattacharya, 2021; Che & Gale, 2003; Che, Iossa, & Rey, 2021; Riordan & Sappington, 1989). Belenzon and Cioaca (in press) infer the existence of the guaranteed demand mechanism from evidence that government R&D contracts increase corporate investment in upstream scientific research. To our knowledge, no study systematically quantifies the private value of government R&D contracts or the economic factors driving them. Moreover, evidence is lacking on how returns vary by procurement regime or firm production capability.

The key contribution of this paper is to estimate the private value of government R&D contracts using stock market reactions to contract awards and to link these forward-looking estimates to the obligated value of future noncompetitive production contracts (which represents future revenues). We develop a framework to understand when R&D contractors can realize additional profits from future production contracts. We model two procurement regimes (competitive bidding and guaranteed demand) and three stages (pre-R&D, R&D, and production). In the pre-R&D stage, the government selects a procurement regime: competitive bidding or guaranteed demand. In the R&D stage, R&D firms invest in developing prototypes. The firm with the best prototype wins the R&D contract. The production stage varies by the procurement regime. Under competitive bidding, specialized producers bid to manufacture the winning prototype. Under guaranteed demand, the R&D winner automatically receives the production contract and may subcontract it to a lower-cost producer. Our framework shows that guaranteed demand has no effect when R&D firms lack production capability, but can benefit both the government and firms when R&D firms possess production capabilities relevant to the project. We test these predictions in our empirical analyses.

We assume that stock prices reflect the market's expectations of a company's future profitability, including the private value of anticipated government demand embodied in R&D contracts. We assess shareholder value by analyzing stock price reactions to R&D contract awards (MacKinlay,

1997). More specifically, we analyze the stock market's response to R&D contract awards to measure the private value of these contracts.[1] If shareholders expect future compensation from lucrative government production contracts, they will revise upward their expectations about the company's value upon learning that the firm has won an R&D contract, embedding these revisions into stock prices.

This approach is conceptually straightforward but empirically challenging. Changes in a firm's stock price following a government R&D contract announcement cannot be solely attributed to the award, as other contemporaneous events may also influence them. For example, approximately half of the government R&D contract awards are associated with a negative market reaction (see the market-adjusted returns, $R_{fd}$, in Table 3). This statistic might suggest that many government R&D contracts destroy value, which is unlikely because firms would not agree to value-destroying contracts in the first place. Indeed, government contracting is generally associated with higher—not lower—profitability (e.g., Cohen & Li, 2020). To address this, we follow prior research (e.g., Chen, Wu, & Yang, 2019; Kogan et al., 2017) and impose distributional assumptions on the value implications of government R&D contracts and other events, allowing us to isolate the expected change in firm value from winning R&D contracts. We then estimate *how much* private value is attributable to guaranteed demand and *which firms* benefit. In robustness checks, we use alternative distributional and modeling assumptions to ensure our chosen design does not drive our findings.

We apply this method to a sample of 282 publicly traded U.S.-headquartered firms that received publicly reportable R&D contracts from federal agencies between April 1, 1984, and September 30, 2024. The sample includes 19,461 firm-award dates. On a typical award date, a firm receives two reportable R&D contracts and three reportable production contracts. On average, the firm's revenue from these contracts is $108 million (including $35 million in R&D contracts and $73 million in production contracts). Including options the government may exercise, the total potential revenue from these contracts is $152 million.

We document four key findings. First, the change in firm value from winning a government R&D contract is much larger than the nominal contract value, averaging 24 times the total potential

[1]Stock market responses have been widely used to measure the impact of events on firm value, such as patent grants (Kogan, Papanikolaou, Seru, & Stoffman, 2017), mergers and acquisitions (Jarrell & Poulsen, 1989), earnings (Ball & Brown, 1968), equity offerings (Asquith & Mullins Jr, 1986), and macroeconomic news (McQueen & Roley, 1993).

revenue from the R&D contract itself. We also find that private value is heavily concentrated in the tails of the distribution. At the 5th percentile, the private value represents 22% of the total potential revenue, while at the 95th percentile, it jumps to 10,086%. This suggests that the market expects substantial private value from innovating for the government, but only for a select few firms. In our sample, only 5.7% of firms receive at least one top-quartile contract by private value, and only 3.2% of firms receive more than five top-quartile contracts by private value. In robustness checks, we vary the assumptions used to estimate private values. We show that our results are robust to the inclusion of firm fixed effects. Moreover, our findings hold under alternative distributional assumptions (Cauchy rather than Normal) for the private value of government R&D contracts. We also find that our results remain consistent even when relaxing the no-anticipation assumption—the idea that the market is completely uninformed about a firm's likelihood of bidding for (and winning) an R&D contract. Further, our results are not sensitive to using longer windows over which traders incorporate information about contract awards into stock prices. Finally, we show that our results are robust to addressing the potential confounding effect of production contracts awarded contemporaneously with R&D contracts.

Second, we document that vertically integrated and large firms, namely firms with production capability, have a higher private value of government R&D contracts. At the median of their respective distributions, the private value is 781% of total potential revenue for vertically integrated firms—those that operated in at least one industry that supplied the R&D awarding agency with goods or services in the previous year—compared to 152% for non-vertically integrated firms. Similarly, the private value is 768% of total potential revenue for large firms—those with above median annual sales relative to annual sales between 1980 and 2015 in the same four-digit SIC (SIC4) industry—compared to 79% for small firms.

Next, we take advantage of two characteristics of our data to study whether the private value of R&D contracts is explained by future noncompetitive production contracts awarded to the firm. First, the federal procurement data specify the extent of competition in contract awards. Competitive procedures include sealed bids and competitive proposals, while noncompetitive procedures include sole-source contracts and follow-on contracts to previously competed contracts. Second, the market response to an event announcement is forward-looking and likely incorporates the expectation of future noncompetitive production contracts awarded to the R&D contractor. We find that

the private value of R&D contracts is meaningfully explained by *future* noncompetitive production contract obligations, a result that holds under alternative distributional assumptions. We also document that the positive relationship between the private value of R&D contracts with future noncompetitive production contracts is larger for firms with production capability (vertically integrated or large firms). These last two results align with our conceptual framework, which suggests that firms and the government benefit from guaranteed demand, but only when R&D contractors have production capability.

We make three contributions. First, we contribute to the innovation literature by showing that the private value of R&D contracts is linked to noncompetitive production contracts. This suggests that R&D contracts attract private investments, particularly for firms with in-house production capability. Our findings clarify the relationship between R&D and production and when their separation may hinder innovation—a key issue given recent shifts in government procurement. In 1980, 57% of contract dollars went to noncompetitive production contracts; by 2020, this share had fallen to 34%, signaling a move from a guaranteed-demand (bundled) regime to a competitive (unbundled) regime. Decoupling R&D from production weakens the implicit promise of future demand, thereby reducing the attraction of winning an R&D contract. Insofar as winning an R&D contract requires private investment in research, decoupling R&D from production could reduce incentives for private research (Belenzon & Cioaca, in press). We show that this association is strongest for firms with production capability (vertically integrated firms or large firms) and provide a theoretical framework to explain why.

Second, we offer insights for policymakers and managers. By analyzing the distribution of private value of R&D contracts, we identify which firms are likely to co-invest with the government in addressing societal challenges. This is critical as federal agencies' share of U.S. R&D funding has declined from 67% in 1964 to 19% in 2024 (National Center for Science and Engineering Statistics, 2026), while firms' share has risen from 31% to 75%. To mobilize private investment effectively, policymakers must understand *how* R&D contracts create private value (through guaranteed demand) and *for which firms* (vertically integrated or large firms). Our evidence that firms and the government benefit from guaranteed demand, but only when R&D contractors have production capability, has important policy implications. The shift from the guaranteed demand regime (i.e., increasing competition for production contracts) described above could weaken innovation

incentives for these firms. Moreover, antitrust initiatives have increasingly targeted large, vertically integrated firms, namely the very firms most capable of capturing the rents embedded in pull innovation programs.[2] This is particularly important given the distinct role large corporations play in the U.S. innovation ecosystem (Arora, Belenzon, Patacconi, & Suh, 2020). For managers, our findings clarify when partnering with the government on technological challenges is profitable. More broadly, understanding which firms derive significant private value from innovating for the government sheds light on the resources the private sector is likely to mobilize in addressing societal challenges.

Third, to our knowledge, we are the first to use stock market returns to estimate the private value of R&D contracts. Prior work inferred the guaranteed demand from anecdotal evidence or by linking R&D contracts with corporate investment in upstream research (Belenzon & Cioaca, in press). We introduce a flexible methodology to quantify the private monetary returns from innovating for the government that—we hope—will spur new research in this area.

This paper is structured as follows. Section 2 summarizes the institutional setting of government procurement (2.1) and reviews the related literature (2.2). Section 3 presents the conceptual framework, followed by data and methods in Section 4, results in Section 5, robustness tests in Section 6, and concluding remarks in Section 7.

# 2 Background

## 2.1 Institutional Setting

To bridge the gap between private and social returns to R&D, the government employs both push and pull innovation policies. Push policies subsidize or even directly fund R&D, while pull policies stimulate demand by procuring innovation-intensive goods and services. Government procurement can create or expand markets, increasing expected innovation profits (Cabral et al., 2006). In some cases, push and pull policies are combined—firms that complete government-funded R&D contracts may receive lucrative noncompetitive production contracts. In anticipation of such rewards, firms may proactively invest in upstream research to improve their chances of winning R&D contracts (Belenzon & Cioaca, in press). How significant is this reward? The U.S. government is the world's

[2] See, for example, the opinion article by Bork (2025) published in the *Wall Street Journal* on May 1, 2025.

largest customer, awarding contracts worth 9.6% of the country's GDP in 2019 (OECD, 2021). As already noted, it obligated $179.5 billion to R&D and $593 billion to procure goods and services (excluding R&D services) in 2021 alone. Of the R&D funding, $78 billion went to national labs and federally funded research and development centers, $50 billion to universities and non-profits (mostly via grants), and $52 billion to firms (mostly via R&D contracts).

We examine how guaranteed demand in R&D contracts influences corporate innovation. Most prior work focuses on R&D grants as funding mechanisms (e.g., Azoulay, Graff Zivin, Li, & Sampat, 2019; Howell, 2017). While R&D contracts also involve funding, their primary incentive is different. Unlike grants, which support R&D for public benefit, R&D contracts are intended to result in the eventual procurement of innovative goods and services by the federal government.[3] Grants provide financial support without strict timelines or deliverables, whereas R&D contracts require milestone-based progress and may involve performance-based payments. More importantly, R&D contracts link R&D to manufacturing by carrying the implicit promise of future production contracts.

Bundled procurement is permitted but not directly observable. The Competition in Contracting Act of 1984 allows noncompetitive contracts under certain exceptions, such as *follow-on contracts* for continued development or production (U.S. Government Accountability Office, 2014).[4] This allows agencies to bundle R&D races with production by awarding the R&D contracts competitively while granting follow-on production contracts noncompetitively. Between 1980 and 2021, $1,273 billion in R&D contracts (56% of R&D contract dollars) were awarded competitively, while $6,848 billion in production contracts (40% of production contract dollars) were awarded noncompetitively (constant 2012 dollars). This suggests bundling was widespread. However, because R&D contracts do not explicitly guarantee production contracts, measuring this implicit promise remains challenging.

Understanding which firms benefit from bundled procurement incentives is crucial for three reasons. First, R&D contracts represent a substantial public investment in innovation: $2,279 billion in R&D contracts were awarded between 1980 and 2021 (constant 2012 dollars). Over the

[3]When federal agencies seek an existing product or service, they procure it from the private market. When they need something new, they typically fund its development via R&D contracts before purchasing it through production contracts.

[4]FAR Section 6.302 limits these exceptions to circumstances when awarding follow-on contracts to any other source would likely result in (i) substantial duplication of cost that is not expected to be recovered through competition or (ii) unacceptable delays in fulfilling the agency's requirements.

same period, $17,066 billion in production contracts were awarded, some fraction of them following on from successful R&D contracts. Second, this is not just about defense contracts. Government procurement spans diverse industries. While the Department of Defense (DoD) has historically dominated, its share of total contract dollars fell from 87% in 1982 to 60% in 2021. Meanwhile, eight of the top ten product categories receiving federal contracts in 2021 were non-defense.[5] Third, recent policy changes have reduced the likelihood of bundled procurement (Belenzon & Cioaca, in press), with potentially important implications for U.S. innovation incentives.

### 2.2 Related Literature

A well-established literature examines demand-side drivers of innovation (e.g., Acemoglu & Linn, 2004; Aghion, Bergeaud, Lequien, & Melitz, 2024; Kleinknecht & Verspagen, 1990; Scherer, 1982). However, systematic evidence on how government procurement affects corporate R&D remains limited. Some studies argue that anticipated government demand stimulates private R&D investment. For example, Mowery (2012) suggests that Texas Instruments invested in developing the integrated circuit due to expected DoD demand for missile guidance systems. Similarly, Edquist and Zabala-Iturriagagoitia (2012) argue that Swedish government procurement incentivized LM Ericsson to develop the AXE telephone switch in 1992, which later captured 40% of the world market.[6]

Several studies focus on the Small Business Innovation Research (SBIR) program, which blends push and pull incentives. Wallsten (2000) finds that SBIR *grants or contracts* crowd out company-funded R&D in publicly traded small firms. In contrast, Howell (2017) finds that SBIR *grants* from the Department of Energy increase patenting, suggesting grants ease financing constraints. De Chiara and Iossa (2019) theorize that grants crowd out private R&D more than contracts, particularly for small projects. More recently, Howell et al. (2021) find that open-topic SBIR *contracts* improve patent quality and quantity, whereas conventional contracts show no significant effect. However, generalizing SBIR findings to broader procurement is problematic. First, not all SBIR

[5]The top ten categories included PSC 6505 - Drugs and biologicals (which accounted for $48 billion or 7% of all government procurement dollars), PSC R425 - Support - Professional: Engineering/Technical (4%), PSC 1510 - Aircraft, fixed wing (4%), PSC R499 - Support - Professional: Other (4%), Q201 - Medical - General Healthcare (4%), PSC 1905 - Combat ships and landing vessels (3%), PSC M1JZ - Operation of Miscellaneous Buildings (2%), PSC R408 - Support - Professional: Program Management/Support (2%), PSC D399 - IT and Telecom - Other IT and Telecom (2%), and PSC M181 - Operation of Government R&D GOCO Facilities (1%).

[6]Industry-level studies offer mixed findings. Crespi and Guarascio (2019) find that government procurement correlates with increased patenting across 24 countries (1995-2001). Conversely, Nemet (2009) finds no evidence that demand-side policies spurred highly cited wind turbine patents in California in the 1980s.

awards signal future demand. Of the 11 participating agencies, four award only grants (Department of Energy, National Oceanic and Atmospheric Administration, National Science Foundation, Department of Agriculture), five award only R&D contracts (DoD, National Aeronautics and Space Administration, Department of Homeland Security, Department of Transportation, Environmental Protection Agency), and two award both (Health and Human Services, Education) (Small Business Administration, 2023). As discussed in Section 2.1, only R&D contracts reflect an agency's intent to procure resulting innovations. Second, SBIR is limited to small firms, which often lack the resources and capabilities to meet future government production demand, making guaranteed demand less relevant. Studies using SBIR awards are therefore less informative about the impact of bundling R&D and production contracts.

Other studies examine broader procurement. Rogerson (1989) estimates that production contracts for major aerospace projects add \$47-\$67 million in firm value (10.2%-14.6%). Lichtenberg (1988) finds that each \$1 in competitive procurement raises company-funded R&D by \$0.54. Slavtchev and Wiederhold (2016) show that shifting procurement from low-tech to high-tech industries increases private R&D by \$0.21 per dollar. In a German context, Krieger and Zipperer (2022) find that winning green government contracts increases environmentally friendly product innovation, but only for small and medium-sized firms. However, existing studies link U.S. procurement to U.S. firms only at a limited scale and do not fully test the demand-pull mechanism in this context.

Belenzon and Cioaca (in press) analyze how corporate R&D responds to the award of government R&D contracts. The authors develop a framework showing that guaranteed demand is most effective for projects that are difficult to implement under unbundled procurement. They find that government R&D contracts increase corporate investment in upstream R&D (scientific research). However, Belenzon and Cioaca (in press) do not observe how the competitive structure of procurement affects *private values*. In contrast, the present paper provides estimates of the private value of federal R&D contracts and how it varies by whether follow-on contracts are competitively awarded and whether the firm has the ability to participate in the follow-on work.

# 3 Conceptual Framework

We develop a simple conceptual framework to explain when the winner of an R&D contract can derive additional profits from future production contracts, even under efficient government procurement. The key insight is this: if the R&D winner can leverage its production capability to capture rents in the production stage, it gains more value from the R&D contract under a guaranteed demand regime than under competitive bidding.

This mechanism differs from another channel through which R&D contracts may generate future profits: firms winning R&D contracts may have an advantage in producing their own prototypes (e.g., due to tacit knowledge). Both mechanisms suggest that firms with production capability can earn additional profits if they secure the R&D contract. However, the role of guaranteed demand distinguishes them. If tacit knowledge or other advantages allow R&D winners to dominate production, they could secure government demand even without an implicit guarantee. Moreover, government contracts could be structured to capture some of the R&D winner's production surplus. In contrast, when tacit knowledge is absent, R&D winners can capture production rents via production capability only under a guaranteed demand regime.

## 3.1 Setup

We model three sequential stages, with two possible structures for the final stage:

- **Stage 1: Pre-R&D**. The government chooses payments for Stage 2 and Stage 3 to maximize expected product quality subject to budget $B$.
- **Stage 2: R&D**. R&D firms invest effort to produce proof-of-concept prototypes. The quality of the prototypes is revealed. The highest-quality prototype wins the R&D contract and receives $P_u$.[7]
- **Stage 3a: Competitive Production**. Producers, $m$ in number, bid to manufacture the winning prototype. Costs are private information, and the government holds a second-price auction, awarding the contract to the lowest-cost firm at the second-lowest bid, $\overline{C}_m$.

[7] $P_u$ denotes the contractor's expected net surplus from the R&D stage, not the government's observed contract obligation. The empirical contract-value measures do not correspond directly to $P_u$.

- **Stage 3b: Guaranteed Demand Production**. The R&D winner is awarded the production contract and receives $P_b$, with the option to subcontract it to a lower-cost producer.

**Stage 1: Pre-R&D**. The government chooses between competitive bidding and guaranteed demand. Under competitive bidding, it sets $P_u = B - \overline{C}_m$. Under guaranteed demand, it sets $P_b$ such that $P_u = B - P_b$.[8]

**Stage 2: R&D**. Two R&D firms ($i = 1, 2$) produce prototypes.[9] Prototype quality, $q_i$, depends on firm effort, $e_i$, which is unobservable and non-contractible. Quality is observable *ex post* but not contractible.[10] Under reasonable assumptions (see Online Appendix A), the probability that $q_1 > q_2$ is $\frac{e_1}{e_1 + e_2}$, where effort cost is $ge_i$ with $g > 0$. The highest-quality prototype wins the R&D contract.

**Stage 3: Production**. The government procures one unit of the product, either through competitive bidding or guaranteed demand.

There are $m$ specialized producers with manufacturing cost $C_k$ $(k = 1, 2, ..., m)$. Costs are uncertain and revealed only after investing $F$, reflecting the effort required to understand the prototype, develop a production process, and submit a bid. Producers are symmetric, and $C_k$ is independent of prior R&D involvement (i.e., we ignore tacit knowledge).

The expected profit for a producer is $\frac{1}{m}(\overline{C}_m - \underline{C}_m) - F = \frac{1}{m}\Delta_m - F$, where $\overline{C}_m$ and $\underline{C}_m$ are the expected second-lowest and lowest costs, respectively. As $m$ increases, expected profit decreases because (i) each firm's chance of winning falls, and (ii) $\Delta_m$ shrinks with $m$.[11]

[8] In Online Appendix A, we analyze the case when the government maximizes benefits minus costs, implying that optimal $P_u$ equals the government's marginal benefit from quality.

[9] Allowing more than two R&D firms does not change the conclusions.

[10] Quality is observable sufficiently well to rank prototypes *ex post* but cannot be fully specified or enforced in an *ex ante* contract. The government can therefore select the preferred prototype without being able to write a complete state-contingent contract over quality. This modeling assumption is reasonable because R&D contracts are only used when there is significant uncertainty about the methods and effort required to achieve success. Federal Acquisition Regulations specifically note: "Unlike contracts for supplies and services, most R&D contracts are directed toward objectives for which the work or methods cannot be precisely described in advance. It is difficult to judge the probabilities of success or required effort for technical approaches, some of which offer little or no early assurance of full success" (FAR § 35.002).

[11] Suppose $C_k = C - X$, where $X$ follows a uniform distribution $[-a, a]$. Then:

$$\underline{C}_m = C - a\frac{m-1}{m+1}; \quad \overline{C}_m = C - a\frac{m-3}{m+1}; \quad \frac{1}{m}\Delta_m = \frac{2a}{m(m+1)}; \quad \overline{C}_m - \overline{C}_{m+1} = \frac{4a}{(m+2)(m+1)}$$

### 3.2 Competitive Bidding

Under competitive bidding, the R&D and production contracts are independent. Firm 1's expected payoff (gross of the cost of its Stage 1 effort) is:

$$\Pi_1 = \frac{e_1}{e_1 + e_2} P_u - g e_1 + \mathbb{1}\left(\frac{1}{m+1}\Delta_{m+1} - F\right) \tag{1}$$

where $\mathbb{1} = 1$ if firm 1 has production capability and 0 otherwise. An R&D firm with production capability may enter the production stage by investing $F$. We examine *when* winning the R&D contract makes it *even more* valuable.

For simplicity, we assume $\frac{1}{m+1}\Delta_{m+1} - F = 0$, meaning the R&D firm derives little *direct* benefit from competing in Stage 3, the production stage. In Online Appendix A, we characterize the optimal R&D effort in a symmetric Nash equilibrium and show that the participation constraint is always satisfied.

The government optimally sets $P_u = B - \overline{C}_m$ because it is trying to maximize quality from a given budget $B$. It expects to pay $\overline{C}_m$ in Stage 3, leaving it with a maximum of $B - \overline{C}_m$ to incentivize R&D investment.

### 3.3 Guaranteed Demand

#### 3.3.1 R&D Firms Lack Production Capability

Under guaranteed demand, the government procures the product from the R&D winner at price $P_b$, subject to $P_b \geq \overline{C}_m$.[12] Without production capability, the R&D winner subcontracts with the lowest-cost producer, paying $\overline{C}_m$. The R&D winner's expected payoff (gross of the cost of its R&D effort) is $P_u + P_b - \overline{C}_m$.

If $P_b = \overline{C}_m$, competitive bidding and guaranteed demand yield identical outcomes—expected profit, R&D effort, and prototype quality remain unchanged. Thus, *when R&D firms lack production capability, guaranteed demand does not generate additional value for the R&D winner*, provided the government optimally sets the production price. Essentially, the R&D winner acts as an intermediary, subcontracting production on behalf of the government.

[12] The inequality represents the participation constraint for the winner of the R&D stage to fulfill the production contract.

### 3.3.2 R&D Firms Have Production Capability

Given its budget constraint, the government optimally sets $P_b = \overline{C}_m$. When the R&D winner also competes in production, it pays only $\overline{C}_{m+1}$ to the lowest-cost producer, leveraging its production capability to reduce the rents in the production stage.

Firm 1's expected payoff is:

$$\Pi_1 = \left[\frac{e_1}{e_1+e_2}(P_u + P_b - \overline{C}_{m+1}) - ge_1\right] + \left[\frac{1}{m+1}(\overline{C}_{m+1} - \underline{C}_{m+1}) - F\right] \tag{2}$$

The first term represents the expected payoff from winning the R&D contract, while the second reflects gains from production. Substituting $P_b = \overline{C}_m$ and assuming $\frac{1}{m+1}\Delta_{m+1} - F = 0$, Equation 2 simplifies to:

$$\Pi_1 = \frac{e_1}{e_1+e_2}\left[P_u + (\overline{C}_m - \overline{C}_{m+1})\right] - ge_1 \tag{3}$$

Thus, *R&D firms with production capability earn $\overline{C}_m - \overline{C}_{m+1}$ more under guaranteed demand than under competitive bidding.* The government also benefits, as guaranteed demand improves quality while adhering to the budget constraint. The government allows the R&D winner to retain some production rents to incentivize higher quality. Consequently, guaranteed demand can increase expected profits for R&D firms with production capability.

The simple intuition is that participants in Stage 3, the production stage, earn rents. Guaranteed demand, when the R&D firms have production capability, transfers some of these rents to the R&D winner, thereby also benefiting the government via higher quality innovation. When R&D firms lack production capability, guaranteed demand does not affect outcomes, as shown in Columns 1-3 of Table 1. However, when R&D firms can also have production capability, both they and the government benefit. Extensions relaxing some assumptions in this framework are discussed in Online Appendix A.

We have modeled Stage 3 as a simple second-price auction. However, the qualitative results are unchanged if the lowest cost manufacturer bargains with the government or, under guaranteed demand, with the R&D winner. If the R&D winner has production capability, it has a credible outside option, allowing it to extract better terms. In turn, it will invest more effort to win the R&D contract.

[Table 1 about here.]

### 3.4 Empirical Predictions

Our framework yields several testable predictions. First, most R&D contracts should not have high private value if production contracts are competitively bid or if the R&D firm lacks relevant production capability. *We anticipate that only a few firms are awarded R&D contracts with high private value.*

Second, high private value R&D contracts should stem from guaranteed demand, where the government commits to awarding production contracts noncompetitively to the R&D winner. *We expect the private value of R&D contracts to correlate positively with future noncompetitive production contracts.*

Third, high private value R&D contracts should be concentrated in firms with production capability (namely, vertically integrated or large firms). As shown in Table 1, *firms with production capability should have higher private R&D contract values than firms without such capability* (Column 5). More precisely, the *positive relationship between the private value of R&D contracts and future noncompetitive production contracts should hold only for firms with production capability* (Column 6).

## 4 Data and Methods

### 4.1 Data Sources

We combine data from multiple sources: (i) firm financial and R&D information from S&P's Compustat North America, CRSP U.S. Stock Databases, Web of Science, and PATSTAT; (ii) government R&D and production contracts from the Federal Procurement Data System (FPDS); and (iii) announcements of material news and events that may affect the market value of securities from S&P's Capital IQ Key Developments.

#### 4.1.1 Firm Financial and R&D Information

We start from an unbalanced panel of 7,996 publicly traded, R&D-performing U.S. firms from 1980 to 2024, based on data from Arora, Belenzon, Cioaca, Sheer, and Shvadron (2025). These firms

account for most U.S. business R&D. In 2024, their R&D expenditures totaled $674.65 billion, or 89% of the $743.02 billion in total business-funded R&D (National Center for Science and Engineering Statistics, 2026). They also received a significant share of federal procurement—$28.1 billion in R&D contracts (46% of $61.0 billion total) and $115.5 billion in production contracts (16% of $732.2 billion total) (USAspending.gov, 2026).

Firms are classified by their primary SIC4 code and the five-industry definitions from Fama and French (1993). We further categorize firms based on their vertical integration and size. We identify vertically integrated firms (*Vertically integrated*) as firms operating in at least one industry that supplied the R&D awarding agency with goods or services in the prior year, and large firms (*Large*) as firms with sales in the top half of the SIC4 industry sales distribution. We also split firms based on their scientific capabilities and technological capabilities using the distribution of scientific publications and patents within each SIC4 code.[13] Indicator variables—*High scientific capabilities*, and *High technological capabilities*—identify firms in the top half of these distributions.

#### 4.1.2 Government R&D and Production Contracts

We obtain the full set of federal contract transactions from SAM.gov (1980-2000) and USAspending.gov (2001-2024) and match over 1.7 million contract recipients to our firms and their subsidiaries.

Of the 108 million contract transactions worth $18.5 trillion, we match more than 17 million transactions totaling $6.2 trillion to 3,954 firms.[14] These include $928 billion (40%) in R&D contracts and $3.7 trillion (60%) in production contracts. Within R&D contracts, $210 billion (23%) is allocated to basic research, applied research, and experimental development, while $718 billion (77%) supports advanced development and commercialization.

The top four non-R&D services are professional support ($488 billion, category R), government building operations ($212 billion, category M), telecommunications ($318 billion, category D), and maintenance and repair ($286 billion, category J). The top four products are aerospace craft ($973 billion, group 15), guided missiles ($397 billion, group 14), ships ($363 billion, group 19), and communication and detection equipment ($344 billion, group 58).

[13] These distributions are derived from the 114,990 firm-year observations in Arora et al. (2025).

[14] All values are in constant 2017 dollars. Unmatched contracts were awarded to privately held firms, publicly held firms that did not engage in R&D or were headquartered overseas, and nonprofit organizations.

To estimate the private value of government R&D contracts, we exclude firms that did not receive such contracts from 1980 to 2024 or whose contracts were too small to be *reportable* on their award date. Since April 1, 1984, the Federal Acquisition Regulation (FAR) has required federal contracting officers to:

> *"Make information available on awards over $3 million in sufficient time for the agency concerned to announce it by 4:00 p.m. Washington, DC time on the day of award. [...] Agencies shall not release information on awards before the public release time of 4:00 p.m. Washington, DC time."* (FAR Section 5.303)

The release time changed to 5:00 p.m. (Washington, DC) on February 25, 1992. The reporting threshold increased to $3.5 million on September 28, 2006, $4 million on October 1, 2010, and $4.5 million on October 1, 2020. We focus on R&D contracts above these thresholds, as they were publicly announced after market close, whereas smaller contracts were not.[15] For each firm, we obtain daily stock data from CRSP, including price, return, market capitalization, shares outstanding, and trading volume. We also collect daily returns, including all distributions, on a value-weighted market portfolio (CRSP: vwretd). The sequential steps used to construct the final analysis sample are detailed in Appendix Table 17.[16]

With these data, we construct the measure of private value (as detailed in Section 4.2), as well as our independent and control variables (summarized in Table 2).

[Table 2 about here.]

### 4.2 Constructing the Measure of Private Value

We estimate the private value of the government's implicit promise to buy by leveraging stock price reactions to R&D contract awards. Stock prices incorporate market expectations about a firm's future, allowing us to infer the value of an event—here, an R&D contract—based on the

[15] FAR Section 5.301 has required agencies to synopsize contract awards as small as $100,000 (effective April 1, 1984) or $25,000 (for contracts likely to result in subcontracts, effective April 1, 1985) in the Commerce Business Daily (CBD). Transmission of synopses to the CBD typically occurred via first-class mail. After printing, the CBD was delivered to paid subscribers nationwide via first-class or regular mail. In practice, this meant that synopses for contracts below the $3+ million threshold reached the public several days *after* their award date. While the CBD became available online at CBDnet.gov in 1996 and contract award synopses were eventually listed on the government-wide point of electronic entry (FedBizOpps.gov starting in 2001 and SAM.gov starting in 2012), only contract awards above the $3+ million threshold had to be publicly announced after market close on the award date.

[16] Note that Appendix Table 17 reports obligated values in current $ billions.

announcement's stock price impact (see Fama, Fisher, Jensen, & Roll, 1969). We define the private value of an R&D contract as:

$$\xi_{fd} = M_{fd}\ E\left[\nu_{fd}|R_{fd}\right] \tag{4}$$

where $\xi_{fd}$ is the private value of contracts awarded to firm $f$ on day $d$. This requires two components:

1. $M_{fd}$, the firm's market value on the award date, which is observable (CRSP: $prc \times shrout \times 1,000$).

2. $E\left[\nu_{fd}|R_{fd}\right]$, the expected change in firm value due to the contract award ($\nu_{fd}$), conditional on the observed stock return ($R_{fd}$), which is unobservable.

Following Kogan et al. (2017), we estimate $E\left[\nu_{fd}|R_{fd}\right]$ in two steps. First, we identify the market's response window using stock trading volume patterns (Section 4.2.1). Second, we filter out other concurrent value-relevant events to isolate the R&D contract award's effect (Section 4.2.2). This yields $E\left[\nu_{fd}|R_{fd}\right]$, allowing us to estimate the R&D contract's private value.

### 4.2.1 When Does the Market Respond to the Announcement?

To estimate private value, we first determine *when* the market incorporates R&D contract awards into stock prices by analyzing trading volume patterns around award dates.

We examine share turnover (daily volume/shares outstanding) from three days before to three days after a reportable R&D contract award (i.e., above the FAR 5.303 threshold) and compare it to non-announcement periods. We regress share turnover on indicators for contract awards, controlling for firm-year and calendar date fixed effects. Our sample includes 282 firms that received at least one reportable R&D contract between April 1, 1984, and September 30, 2024. Results are presented in Figure 1.

[Figure 1 about here.]

The stock market responds quickly to the announcement of an R&D contract award. Share turnover rises significantly the day after a firm receives a reportable R&D contract, consistent with the FAR Section 5.303 requirement that federal contracting officers make information on reportable awards available after market close on the award date. The increase (0.02%) represents a 4.5% rise

relative to the median daily turnover rate of 0.44%. This finding is robust to adding controls for confounding announcements (see Online Appendix Table 18). Moreover, in a counterfactual analysis (see Online Appendix Figure 4), we find no turnover increase for contracts awarded before the public reporting requirement (i.e., before April 1, 1984). This pattern suggests that R&D contract awards convey information quickly absorbed by the market. Accordingly, we use a one-day window $(d+1)$ to estimate private value. We also assess robustness using an alternative three-day window, $[d+1]$ to $[d+3]$, as discussed in Section 6.2.

#### 4.2.2 Isolating the Market Response to the Announcement

Next, we isolate the stock market response to the R&D contract award from other events to calculate $E\left[\nu_{fd}|R_{fd}\right]$, the expected change in firm value due to the award, conditional on the observed stock return. We use a market-adjusted return model (Campbell, Lo, MacKinlay, & Whitelaw, 1998) to separate firms' returns into two components: (i) idiosyncratic returns, reflecting firm-specific events, and (ii) aggregate returns, reflecting events affecting all firms.[17] Online Appendix Figure 5 shows the frequency distribution of idiosyncratic returns ($R_{fd}$), which reflect responses to both government R&D contract awards ($\nu_{fd}$) and other firm-specific events ($\varepsilon_{fd}$), both unobservable. This distribution highlights the need to isolate the market response to contract awards from other events. Without this adjustment, approximately 50% of announcement days are associated with negative stock returns, suggesting that government contracts frequently destroy value—a result inconsistent with empirical evidence (e.g., Cohen & Li, 2020).[18] To address this issue, we impose distributional assumptions about the value implications of R&D awards and other events.

We assume R&D contract awards and other events are independently distributed. The private value of government R&D contracts follows a normal distribution truncated at zero ($\nu_{fd} \sim \mathcal{N}^{+}(0,\, \sigma^2_{\nu ft})$), implying contracts are value-neutral in the worst-case. Kogan et al. (2017) use the same assumption to estimate the private value of patent awards. This assumption is reasonable because most R&D contracts are "cost plus," placing the risk of cost overruns on the awarding

[17] The market-adjusted return model calculates idiosyncratic returns by subtracting market portfolio returns from each firm's stock returns. More sophisticated methods exist but require estimating the firm's stock market beta, introducing measurement error.

[18] As an example, on July 1, 1998 Texas Instruments, Inc. was awarded an R&D contract by the U.S. Air Force for "defense aircraft engineering" but experienced a negative stock market return of 3.5%. On the same day, however, Texas Instruments, Inc. also announced that they sold the semiconductor memory business to Micron, which could explain the negative stock market reaction.

agency. Note also that the variance $\sigma^2_{\nu ft}$ is assumed to be constant for all award dates $d$ in a given year, $t$, and thus is indexed by $t$. We further assume that stock market movements from other events follow a mean-zero normal distribution ($\epsilon_{fd} \sim \mathcal{N}(0, \sigma^2_{\epsilon ft})$), meaning they neither create nor destroy firm value on average, and the variance is constant for a given firm-year pair, and is thus indexed by $t$ rather than $d$. Finally, we assume that the market assigns a zero unconditional probability of firm $f$ winning R&D contracts on award date $d$, as agencies publicize contract opportunities but typically do not disclose bidding firms. If the market assigns firm $f$ a positive *ex-ante* probability of winning, our calculations may underestimate the private value of government R&D contracts.[19]

Under these assumptions, Kogan et al. (2017) show that the expected change in firm value due to a patent award—or a government R&D contract award in our case—conditional on the observed stock return is:

$$E\left[\nu_{fd} | R_{fd}\right] = \delta_{ft}\, R_{fd} + \sqrt{\delta_{ft}}\, \sigma_{\epsilon ft}\, \frac{\phi\left(-\sqrt{\delta_{ft}}\, \frac{R_{fd}}{\sigma_{\epsilon ft}}\right)}{1 - \Phi\left(-\sqrt{\delta_{ft}}\, \frac{R_{fd}}{\sigma_{\epsilon ft}}\right)} \tag{5}$$

where $\phi$ and $\Phi$ are the standard normal pdf and cdf, respectively. This function is increasing and convex in the idiosyncratic return. To compute private value based on observable stock returns, we need to estimate $\delta_{ft}$, the share of stock price variation attributable to R&D contracts, and $\sigma_{\epsilon ft}$, the standard deviation of returns from other firm-specific events. We follow Kogan et al. (2017) and assume that $\delta$ is constant across firms and over time, as separately estimating a parameter for each firm-time pair is infeasible given the limited number of award dates per firm.

We estimate $\delta$ as $= 1 - e^{-\gamma}$, where $\gamma$ is recovered from the regression:

$$ln(R_{fd+1})^2 = \gamma I_{fd} + \boldsymbol{Z}'_{fd}\boldsymbol{c} + \upsilon_{fd} \tag{6}$$

where $R_{fd+1}$ is the idiosyncratic return for firm $f$ on the trading day after the award, $I_{fd}$ is 1 if firm $f$ won a reportable R&D contract on day $d$, and $\boldsymbol{Z}$ is a vector of controls including: $P_{fd}$, indicating if firm $f$ received a reportable production contract on day $d$; $A_{fd}$, indicating other material announcements on day $d$; and firm-year and calendar day fixed effects.[20] In this specification,

[19] The reader may find these assumptions too stringent or unreasonable. We assess the robustness of our findings to different distributional assumptions and report our findings in Section 6.2.

[20] Material announcements are identified using S&P Capital IQ's Key Developments, which tracks 165 event types. We focus on 14 types likely to affect stock prices: bankruptcies, dividends, earnings, executive changes, fixed income, financing, guidance, index, lawsuits, mergers and acquisitions, private placements, ratings, and stock splits.

$v_{fd}$ is an *iid* error term, and $\gamma$ describes how volatility in stock returns changes on R&D contract announcement dates. Our estimate produces $\hat{\gamma} = 0.038$, yielding $\hat{\delta} = 1 - e^{-\hat{\gamma}} \approx 0.037$.

To estimate $\sigma_{\epsilon ft}$, we first calculate firm $f$'s conditional return variance in year $t$ as realized mean idiosyncratic squared returns ($\sigma^2_{ft}$). Then, we use the fraction of trading days with R&D contract announcements to isolate variance from other events.[21]

### 4.3 Econometric Framework

The unit of observation is a firm-award date, not an individual contract.[22]. To examine the *guaranteed demand* mechanism—the idea that R&D contracts carry an implicit promise from the government to procure the resulting goods and services from the successful R&D contractor in the future—we estimate the relationship between the private value of R&D contracts and subsequent production contract obligations using the regression:

$$\ln(Private\ value)_{fd} = \alpha_0 + \alpha_1 \ln(Obligations\ in\ future\ procurement)_{fd} + \boldsymbol{Z}'_{fd}\boldsymbol{\omega} + \boldsymbol{\tau} + \epsilon_{fd} \quad (7)$$

where $Private\ value_{fd}$ is the estimated private value of R&D contracts awarded to firm $f$ on award date $d$, inferred from stock market reactions. This value incorporates expectations of future procurement. $Obligations\ in\ future\ procurement_{fd}$ are the dollars obligated in future production contracts awarded to firm $f$ over the subsequent 3, 5, or 10 years. The vector $\boldsymbol{Z}$ controls for firm market value, obligated contract value, and contract option value at award date $d$. All monetary values are adjusted to constant 2017 dollars (in millions) using the GDP Implicit Price Deflator (Office of Management and Budget, 2023). For variables measured in millions of dollars, we add \$1 before taking natural logarithms. The vector $\boldsymbol{\tau}$ represents year fixed effects. We do not include firm fixed effects because 31% of our sample firms have only one R&D award date, an additional 31% have fewer than five award dates, indicating limited within-firm variation for the majority of our sample. However, as discussed in the previous section, we assume that the variance is constant for a given firm-year pair. Thus, without firm fixed effects, our results might reflect cross-firm

[21] The formula is $\sigma^2_{\epsilon ft} = 3\,\sigma^2_{ft}\left(1 + 3\,m_{ft}\left(e^{\hat{\gamma}} - 1\right)\right)^{-1}$, where $m_{ft}$ is the fraction of trading days with R&D contract announcements in year $t$ (Kogan et al., 2017).

[22] A firm-award date may include multiple R&D transactions and contemporaneous production transactions. We therefore refer to the estimated outcome as the value associated with an R&D award date

differences, such as differences in exposure to market volatility, rather than the impact of R&D contract announcements. For this reason, in robustness checks, we add firm fixed effects to the vector of controls. Finally, we cluster standard errors at the year level to account for potential serial correlation in private value across R&D contracts awarded in a given year.[23]

This is a descriptive analysis. The specification is unusual in using outcomes that will be realized in the future to "predict" a current outcome. It is, however, consistent with stock market valuations being forward-looking. Our primary coefficient of interest, $\alpha_1$, captures the relationship between R&D contract value and future procurement.[24] If R&D contracts serve as a signal of future government demand, we expect $\hat{\alpha_1} > 0$. When disaggregating future production contract obligations into *competitive* and *noncompetitive* awards, we anticipate the positive relationship to be driven by noncompetitive procurement. We further test whether this effect holds for firms with production capabilities (vertically integrated or large firms) but not for firms without such capabilities (non-integrated or small firms), as predicted by our framework. Finally, we examine how this relationship varies by awarding agency, industry, scientific capabilities, and technological capabilities.

# 5 Estimation Results

## 5.1 The Private Value of R&D Contracts

We apply the parameters estimated in Sections 4.2.1 and 4.2.2 to Equation 4 to calculate the private value of R&D contracts. Between April 1, 1984, and September 30, 2024, firms in our sample received reportable R&D contracts on 19,461 trading days (see Appendix Table 17 for details on the sequential steps used to construct the final analysis sample.).

The 282 firms in our analysis sample are not heavily reliant on government procurement. Between 1980 and 2024, they earned an average of 14% of their sales from the federal government,

[23] Our findings are robust to clustering standard errors at the firm level.

[24] As discussed in Arora, Belenzon, Ferracuti, and Nagar (2024), the estimated contract value using the observed stock market return as in Kogan et al. (2017) is a noisy estimate of the true contract value, and the measurement error arises from two sources: the inherent noise in the relationship between the contract's value and market return, and the bias introduced by the estimation procedure. Furthermore, the estimation error is such that the mean of the estimated value distribution matches the mean of the true value distribution, but the estimated value distribution is more compressed than the true value distribution. The same issues extend to our estimation procedure. In particular, the measurement error is negatively correlated with the true contract value. In turn, this implies a downward bias in the estimated coefficient of future procurement, $\hat{\alpha_1}$, a conservative bias.

including both R&D and production contracts. However, this average is pulled up by a handful of major government contractors. Excluding the 19 firms that derived 50% or more of their 1980-2024 sales from federal sources (e.g., SAIC, Lockheed Martin, General Dynamics), the average falls to just 10% among the remaining 263 firms.

Table 3 reports descriptive statistics for this variable and other key regressors. On average, the private value of an R&D contract is $675 million, with values ranging from $10 million (5th percentile) to $2,187 million (95th percentile). To better understand these estimates, we compare them to two benchmarks: the contract value obligated on the award date (on average, $108 million) and the total potential revenue from the contract, including base and option values (on average, $152 million). Panel C of Table 3 shows that the private value of government R&D contracts is substantial, averaging 24 times the total potential revenue from the contracts themselves. The distribution of normalized private value is concentrated in the tails, as illustrated in Panel B of Figure 2. At the 5th percentile, private value is 22% of total potential revenue, while at the 95th percentile, it is 10,086%. Only 16 firms (5.7%) receive at least one top-quartile contract, and only 3.2% of firms in our sample receive more than five top-quartile contracts.

[Table 3 about here.]

We further divide the sample into two periods with roughly comparable numbers of firm–award observations: 1984–2008 (9,504 observations) and 2009–2024 (9,957 observations). As reported in Table 4, the average normalized private value of R&D contracts increases over time, rising from 22 times total revenue in the earlier period to 26 times in the later one. This upward shift is also evident in the right tail of the distribution: the 90th-percentile private value grows from 53 times total revenue in the first period to 63 times in the second.

[Figure 2 about here.]

[Table 4 about here.]

### 5.2 Private Value of R&D Contracts and Production Capability

Our framework suggests that firm production capability is a key factor in determining the private value of R&D contracts. The hypothesized mechanism is the future entry into production for the

resulting innovation. Firms with production capability relevant to the focal innovation are better able to enter production. Our descriptive evidence using vertical integration and firm size as proxies for production capability is consistent with this logic.[25] As shown in Table 5, the median private value of R&D contracts is substantially higher for vertically integrated firms (781%) than for non-integrated firms (152%). Similarly, the median private value of R&D contracts is substantially higher for large firms (768%) than for small firms (79%).[26]

[Table 5 about here.]

### 5.3 Private Value of R&D Contracts and Other Firm Characteristics

We examine additional heterogeneity in the estimated private value of R&D contracts in Table 6. While we do not have clear theoretical predictions for these differences, they offer additional insight into the private value of government R&D contracts.

First, we observe variation by industry (Panels A-E). At the median, the private value is 880% of total potential revenue in manufacturing, 620% in high-tech, 382% in consumer, and 64% in healthcare industries.

Second, firm scientific and technological capabilities are associated with differences in private value (Panels F-I). The private value is higher for firms with high scientific capabilities (782%) than for those with low scientific capabilities (99%). High (low) scientific capabilities are defined as firms having an annual flow of scientific publications above (below) the industry median. Similarly, the private value is higher for firms with high technological capabilities (802%) than for those with low technological capabilities (124%), with high (low) technological capabilities defined as an annual patent flow above (below) the SIC4 industry median.

[Table 6 about here.]

[25] A firm is vertically integrated if it operated in at least one industry that supplied the focal R&D-awarding agency with goods or services in the prior year. A firm is large if it has above-median annual sales relative to other firms in the same SIC4 industry.

[26] The reader may be concerned that the private value of R&D contracts awarded to vertically integrated (large) firms is larger because these firms have more volatile stock prices. We find the opposite: the stock price volatility of vertically integrated (large) firms is *smaller* than the stock price volatility of non-vertically integrated (small) firms. If so, the value of their R&D contracts is being underestimated.

## 5.4 The Relationship Between Private Value of R&D Contracts and Future Production Contracts

Table 7 offers descriptive evidence on the relationship between the private value of R&D contracts and the *future production contracts* obligated to the recipient firm within five years of the focal R&D contract.[27] This analysis examines whether the forward-looking private value of R&D contracts is associated with future production obligations, consistent with the guaranteed demand mechanism. Panel A shows that above-median *Private values* of R&D contracts are associated with above-median *Obligated value of future production, 5 years*. This relationship is stronger for noncompetitive future production contracts (Panel C) than for competitive future production contracts (Panel B).

[Table 7 about here.]

Table 8 studies the same relationship between the private value of R&D contracts and future production obligations in a multivariate analysis. Columns 1-3 progressively add controls for market value on the award date, the obligated value, and the options value of the focal contract. The results indicate that private value is positively correlated with future production obligations ($p < 0.001$). At sample means, the coefficient in Column 3 suggests that a one standard deviation increase in *Obligated value of future production, 5 years* is associated with a 6% increase in private value.[28]

Next, we assess whether this association is driven by noncompetitive production contracts, as expected under the *guaranteed demand* mechanism. Column 4 separates future production into noncompetitive and competitive contracts, showing that private value is positively correlated with noncompetitive production contracts but not with competitive ones. At sample means, the coefficient on noncompetitive procurement suggests that a one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a 7% increase in private value.[29] Results are similar when replacing noncompetitive obligations with their share of total

[27] We calculated *Obligated value of future production, 5 years* as the total dollar amount of contractual obligations made by all federal agencies to the focal firm for non-R&D services and products in the five years following the focal R&D contract.

[28] Average *Private value* is $675.08 million, while average *Obligated value of future production, 5 years* is $63,816.58 million. A one standard deviation increase in *Obligated value of future production, 5 years* is associated with a $61,000.23 * 0.061 ($675.08 + $0.000001)/($63,816.58 + $0.000001) = $39.36 million increase in *Private value*.

[29] Average *Private value* is $675.08 million, while average *Obligated value of future noncompetitive production, 5 years* is $44,655.42 million. A one standard deviation increase in *Obligated value of future noncompetitive production,*

future production obligations (Column 5, $p < 0.001$). Additional robustness checks (untabulated) confirm these findings using three-year and ten-year time horizons.

Firms often develop innovative goods and services for both government and private markets. Thus, an alternative explanation for our correlational results is that the private value of R&D contracts reflects firms' ability to leverage government R&D in private markets. This would indicate a funding effect (akin to grants) rather than a guaranteed demand effect. However, Online Appendix Table 20 shows that the private value of R&D contracts is positively related to future government demand but negatively related to future private demand, suggesting that this positive association does not reflect contracting firms' ability to leverage government R&D in private markets.

Overall, our findings indicate that R&D contracts carry an implicit promise from the government to procure the goods and services resulting from the R&D effort from the winning R&D contractor without competition.

[Table 8 about here.]

### 5.5 Variation by Production Capability

As discussed in our conceptual framework, firms with production capability may be better positioned to benefit from guaranteed demand. Therefore, we expect a strong relationship between the private value of R&D contracts and future production contracts for firms with production capability and not for firms without such capability.

Empirically, we interact the indicator variable *Vertically integrated* with our measures of future production, and report the OLS estimation in Table 9. We find that the relationship between private value and future production is larger for vertically integrated firms, with non-integrated firms showing a very weak association. The difference is driven by noncompetitive production contracts and does not apply to competitive production contracts.

Similarly, we interact the indicator variable *Large* with our measures of future production, and report the OLS estimation in Table 10. We find that the relationship between private value and future production is larger for large firms. This result is driven by noncompetitive production contracts and does not apply to competitive production contracts. Similar results hold when we

*5 years* is associated with a \$48,548.61 * 0.073 (\$675.08 + \$0.000001)/(\$44,655.42 + \$0.000001) = \$53.58 million increase in *Private value*.

define *Large* by comparing a firm's sales to those of firms in the same three-digit SIC (SIC3) industry and year.

[Table 9 about here.]

[Table 10 about here.]

The evidence of a positive link between the private value of R&D contracts and subsequent noncompetitive production contracts and the evidence that this association is stronger for firms with relevant production capability point to the *guaranteed demand* mechanism (Section 3). Under this regime, winning an R&D award comes with an implicit commitment by the government to buy the resulting output—so firms with in-house production capability directly capture the rents and favorable terms that follow R&D success.

Alternative explanations fall short. *Tacit knowledge* or other types of production cost advantage for the R&D winner would make future production contracts more lucrative. However, in this case, the R&D winner would not require a noncompetitive award. Its advantage would suffice for it to capture rents from production contracts. Put otherwise, even without guaranteed demand, the R&D winner would enter the bidding for a competitive contract. Likewise, *contractual monopoly power*—securing exclusive supply rights and negotiating favorable production terms—should benefit any firm that wins R&D contracts, including nonintegrated or smaller firms that could subcontract production. Yet the results show that the private R&D contract value-future production contract relationship is confined to vertically integrated or large firms. Only guaranteed demand predicts both the noncompetitive results and the firm-capability interactions we observe.

# 6 Robustness Tests

## 6.1 Firm Fixed Effects

As discussed in Section 4.3, we do not include firm fixed effects in our main analyses because our sample features limited within-firm variation for the majority of firms. This empirical choice may raise the concern that our main results reflect cross-firm differences in exposure to market volatility rather than the impact of R&D contract announcements. For this reason, we re-estimate

the relationship between the private value of R&D contracts and future production contracts with the inclusion of firm fixed effects.[30]

Table 11 shows that our main findings remain unchanged. The coefficient on *Obligated value of future production, 5 years* remains positive and significant, though somewhat attenuated (0.017 in Column 1 vs. 0.061 in Column 3 of Table 8). Similar reductions appear when we disaggregate by contracting regime (competitive vs. noncompetitive) or include interactions with vertical integration and firm size. These shifts likely reflect both the smaller number of firms included in the sample because of singleton observations (195 firms vs. 282) and the lower within-firm variation in vertical integration and size because these firm characteristics are persistent.[31] On the other hand, note also that coefficient estimates are likely downward biased, implying that the true strength of association is yet larger. Overall, the robustness of the main patterns reinforces the idea that the observed relationships are not driven by time-invariant firm characteristics.

[Table 11 about here.]

## 6.2 Alternative Assumptions

Our estimates of the private value of the government's implicit promise to buy—and the resulting economic inferences—rely on several assumptions. Here, we assess the sensitivity of our findings to changes in these assumptions. In summary, our inference is robust to assumptions about the distributional characteristics of the firm's stock return components, the extent to which the market anticipates R&D contracts, and how quickly the market incorporates new information in stock prices.

### 6.2.1 Alternative Distributional Assumptions

As discussed in Section 4.2.2, isolating the market response to R&D contract awards from other (largely unobservable) events requires distributional assumptions about the value implications of government R&D awards and other events. In our main estimations, we assume the private value

[30] Recall, as shown in Equation 6, that we estimate the share of stock price variation attributable to R&D contracts ($\delta$) using firm-year fixed effects, and compute the estimated value using firm-year specific variation in returns.

[31] Within-firm variation in private value, future production, vertical integration and firm size are 23%, 27%, 64% and 55% of the sample variation, respectively.

of government R&D contracts follows a normal distribution truncated at zero, while the value implication of other events is normally distributed, with the two being independent.

We test the robustness of our findings by assuming the R&D contract award-related component of firms' stock returns follows the positive part of a Cauchy distribution centered at zero, while the component related to other events follows a Cauchy distribution centered at zero. The Cauchy distribution, with heavy tails, may better describe the private value of government R&D contracts (with a thick left tail and a few contracts being extremely valuable) but requires stronger assumptions to estimate the model parameters, as in Kogan et al. (2017).

We first assess whether the frequency distribution of private value changes meaningfully under the Cauchy assumptions. As shown in Figure 3, the Cauchy distribution results in a heavier-tailed frequency distribution (Panel A). The average private value increases from 24 times total potential revenue to 92 times, while the median value rises from 7 times to 29 times (see Panel A of Online Appendix Table 19). These statistics suggest that our main estimates of private value are conservative and may represent a lower bound of the true private value of government R&D contracts.

Next, we re-estimate our main regression to assess whether our inference about the guaranteed demand in government R&D contracts holds. The results in Table 12 are reassuring: the private value of R&D contracts remains strongly correlated with future noncompetitive production contracts ($p < 0.001$). The magnitude is similar to our main estimation. At the sample means, the coefficient on noncompetitive production in Column 1 indicates that a one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a 5% increase in private value.[32]

[Figure 3 about here.]

### 6.2.2 Non-Zero Probability of Winning

In our main estimations, we assume the market is uninformed about a firm's likelihood of bidding for (and winning) an R&D contract (no-anticipation assumption). This assumption biases our

[32] Average *Private value* is $2,484.12 million, while average *Obligated value of future noncompetitive production, 5 years* is $44,655.42 million. A one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a $44,655.42 * 0.053 ($2,484.12 + $0.000001)/($44,655.42 + $0.000001) = $131.66 million increase in *Private value*.

estimates of private value downward. If the stock market anticipates a firm is likely to bid and win, some of the contract's private value is reflected in stock prices before the award announcement. While we deem our assumption conservative, we relax it in this section to allow for the possibility that investors assess how many firms have the technical capabilities to bid on each contract. This is plausible because, in major acquisition programs, R&D often occurs in stages. Firms successful in earlier stages can bid on later ones, allowing investors to update their probability assessments.

To incorporate this possibility, we model the ex-ante probability of winning, $\pi$, as decreasing with the number of bidders (more bidders mean higher competition) and increasing with the number of R&D contracts a firm won in the previous year (more past contract awards indicate a higher probability of success). We calculate:

$$\pi_{fd} = \frac{1}{\#\ of\ bidders_{fd}} \times \frac{Past\ awards_{fd}}{1 + max(Past\ awards)} \tag{8}$$

where $\#\ of\ bidders_{fd}$ is the average number of bidders on the reportable R&D contracts awarded to firm $f$ on day $d$, and $Past\ awards_{fd}$ is the number of R&D contracts won by firm $f$ in the 365 days before day $d$, normalized by 1 + the maximum number of R&D contracts won by any firm in same period. This variable captures the notion that the market is less surprised when a "serial winner" (e.g., Lockheed Martin, the largest contractor in our data) wins another contract.

Panel B in Figure 3 compares the baseline (no anticipation) and alternative (some anticipation) distributions. As expected, when the market assigns positive *ex-ante* probabilities of winning, the estimated private value of R&D contracts increases (on average, from 24 to 48 times total potential revenue; at the median, from 7 to 11 times; see Panel B of Online Appendix Table 19).

The results from re-estimating our main regression are shown in Table 12. Relaxing the no-anticipation assumption does not change our inference about the existence and magnitude of the implicit promise of guaranteed demand in government R&D contracts. At the sample means, the coefficient on noncompetitive procurement in Column 2 indicates that a one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a larger 12.7% increase in private value (compared to 7% in the main estimation).[33]

[33] Average *Private value* is $1,565.37 million, while average *Obligated value of future noncompetitive production, 5 years* is $44,655.42 million. A one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a $48,548.61 * 0.127 ($1,565.37 + $0.000001)/($44,655.42 + $0.000001) = $216.13 million increase in *Private value*.

### 6.2.3 3-Day Estimation Window

To estimate the private value of R&D contracts, we need to identify the period over which traders incorporate information about contract awards into stock prices. As discussed in Section 4.2.1, we expect this impounding to occur quickly, by the end of the trading day following the award announcement ($[d+1]$). Nonetheless, we assess the robustness of our inference by re-estimating the private value of R&D contracts using a 3-day window after the award date ($[d+1, d+3]$), assuming traders incorporate information over a longer period.

Panel C in Figure 3 compares the baseline (1-day window) and alternative (3-day window) distributions. We find that the estimated private value of R&D contracts increases (on average, from 24 to 40 times total potential revenue; at the median, from 7 times to 12 times; see Panel C of Online Appendix Table 19).

As before, we present the results from re-estimating our main regression in Table 12. Our inference about the existence and magnitude of the implicit value of guaranteed demand in government R&D contracts remains robust when extending the estimation window from 1 to 3 days. At the sample means, the coefficient on noncompetitive procurement in Column 3 indicates that a one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a 8.7% increase in private value (compared to 7% in the main estimation).[34]

## 6.3 Confounding Effect of Production Contracts

Our data show that firms often receive both R&D and production contracts on the same date: of the 19,461 R&D contract award days in our sample, only 6,484 do not feature a production contract award. This creates interpretational challenges. If production contracts also carry an implicit promise of future business with the government (Belenzon & Cioaca, in press), our estimates may overstate the private value of government R&D contracts and spuriously relate it to the obligated value of future production contracts. Moreover, winning both R&D and production contracts may be indicative of the production capability of the firm. The R&D contract value, therefore, might be correlated with future production obligation because it is indicative of production capability,

[34] Average *Private value* is \$1,143.56 million, while average *Obligated value of future noncompetitive production, 5 years* is \$47,524.22 million. A one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a \$49,619.01 * 0.087 (\$1,143.56 + \$0.000001)/(\$47,524.22+ \$0.000001) = \$103.88 million increase in *Private value*.

not because of guaranteed demand.

We address these interpretational challenges in two ways. First, we add an indicator variable equal to 1 if a reportable production contract was awarded on the same date as a focal R&D contract, and 0 otherwise. Including this control slightly reduces the coefficient estimate on future noncompetitive production, from 0.073 (Column 4 of Table 8) to 0.070 (Column 4 of Table 12). At sample means, a one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* corresponds to a 7% increase in private value, almost the same as in the main estimation.[35] Thus, production contracts also carrying an implicit promise of future business with the government does not seem to fully explain our findings. Second, we re-estimate our main results on the 6,484 R&D contract award days that do not feature a production contract award, both without (Online Appendix Table 21) and with (Online Appendix Table 22) firm fixed effects. We continue to find that there exists a positive association between the private value of R&D contracts and the obligated value of future noncompetitive production contracts, and that this association is larger for vertically integrated or large firms. Thus, award days with both R&D and production contracts being indicative of production capabilities for the firm also does not seem to fully explain our findings.

[Table 12 about here.]

### 6.4 Variation by Awarding Agency

The Department of Defense dominates both R&D and production contracting in terms of total contract value and contract volume. This raises the possibility that our results may be driven solely by defense procurement. To explore this possibility, we identify the top five agencies by the number of "reportable" R&D contracts awarded to our sample firms during 1980-2024: Department of Defense (DoD), National Aeronautics and Space Administration (NASA), Department of Transportation (DoT), Department of Health and Human Services (HHS), and Department of Energy (DoE), with all other agencies combined in the residual category. We then divide the obligated value of future production into contracts from these agencies versus others, reporting OLS estimation results using

[35] Average *Private value* is $675.08 million, while average *Obligated value of future noncompetitive production, 5 years* is $39,194.01 million. A one standard deviation increase in *Obligated value of future noncompetitive production, 5 years* is associated with a $48,548.61 * 0.070 ($675.08 + $0.000001)/($44,655.42 + $0.000001) = $51.38 million increase in *Private value*.

a 5-year future period in Table 13.

We find that the estimated private value is positively related to the obligated value of future production contracts from four of the top five agencies (Columns 1-3 and 5), with HHS and DoE as the exceptions (Columns 4 and 5). In Table 14, similar results hold when we restrict attention to R&D contracts from each top agency individually. The relationship between the private value of R&D contracts and future production contracts from the *same* agency remains positive and significant. We conclude that our findings are not driven solely by DoD R&D contracts but extend to other agencies as well.

[Table 13 about here.]

[Table 14 about here.]

### 6.5 Variation by Other Firm Characteristics

We explore whether the relationship between the private value of R&D contracts and future production contracts varies based on other firm characteristics.

First, we examine whether industries differ in the strength of the implicit promise to buy products resulting from R&D. Firms are classified into primary industries based on their SIC4 classification from Compustat and the five industry definitions from Fama and French (1993). We interact industry indicator variables with measures of future production contracts and report OLS results in Table 15.

[Table 15 about here.]

We find that the positive and significant relationship between private value and future production holds for most industries (Columns 1-3), with health being the only exception. The lack of a positive relationship for health firms is consistent with our earlier results for HHS. Again, the stock market's response to R&D awards reflects the private value of future *noncompetitive* production contract obligations (Columns 4-6), especially for manufacturing and high-tech firms.

Next, we explore whether the relationship between private value and future production contracts varies with firm capabilities, specifically scientific and technological capabilities. We measure a firm's scientific capabilities by its annual publication output relative to other firms in the same

SIC4 industry between 1980 and 2024. The indicator *High scientific capabilities* equals 1 for firm-years with above-median publications and 0 otherwise. Similarly, *High technological capabilities* equals 1 if a firm's annual patent flow exceeds the industry median. We interact these indicators with measures of future production contracts and report OLS results in Table 16.

High scientific capabilities positively moderate the relationship between private value and future noncompetitive production (Columns 2 and 5, p-values $< 0.001$). High technological capabilities also strengthen this relationship (Columns 4 and 5, p-values $< 0.05$). In contrast, neither type of capability meaningfully moderates the relationship between private value and future competitive production.

[Table 16 about here.]

## 7 Conclusion

This paper examines how government procurement of innovative products and services can leverage private resources to address societal technological challenges. We estimate the private value of R&D contracts using stock market responses to contract award announcements. Since R&D contracts often carry the promise of future noncompetitive production contracts for successful contractors, their private value can exceed R&D profits alone. Our approach allows us, for the first time, to systematically measure the distribution of the government's implicit promise to buy innovative products across firms.

We find that R&D contracts offer significant private value—approximately 24 times the potential revenue from the R&D contracts. However, these returns are unevenly distributed, with vertically integrated firms and large firms, which possess both scientific and manufacturing capacity, benefiting more from noncompetitive government demand. This highlights the strategic advantage of integrated firms that can leverage both R&D and manufacturing capabilities to capture future government contracts. Moreover, the disproportionate benefits for firms with production capability, alongside trends of large firms getting larger and more dominant in their markets (Autor, Dorn, Katz, Patterson, & Van Reenen, 2020; De Loecker, Eeckhout, & Unger, 2020), suggest that specialized and smaller firms may not be able to capitalize fully on government procurement opportunities.

Our results have implications for the U.S. innovation ecosystem. Recent government policies

decoupling production from R&D contracts may reduce large firms' incentives to invest in R&D directed at public missions. These effects may be further exacerbated by antitrust policy targeting large, integrated firms. Future research should explore the conditions under which the private value of R&D contracts increases with a firm's manufacturing capacity.

By quantifying the private value of federal procurement, this paper provides some empirical foundation for ongoing academic and policy discussions about the appropriate balance between publicly funded "push" (university-based science) and demand-side "pull" (procurement-based) instruments within the broader U.S. innovation ecosystem (e.g., Babina, He, Howell, Perlman, & Staudt, 2023; Fleming, Greene, Li, Marx, & Yao, 2019; Lerner & Stern, 2020).

Our results suggest that reducing public funding for university-based research in favor of expanded competitive procurement programs is unlikely to succeed, unless procurement programs are targeted to vertically integrated, large firms. Because competitive production awards dissipate private rents, they fail to generate meaningful incentives for most firms—particularly small and mid-sized contractors—to undertake ambitious, mission-oriented technological innovation. Rather than reallocating innovative capacity, such policy proposals risk significantly contracting America's overall innovation pipeline. Moreover, the pronounced concentration of rents among a few large incumbents underscores a policy tension: increased antitrust scrutiny may unintentionally weaken the very firms uniquely positioned to address critical government-led technological missions.

## References


Acemoglu, D., & Linn, J. (2004). Market size in innovation: Theory and evidence from the pharmaceutical industry. *The Quarterly Journal of Economics*, *119*(3), 1049–1090.

Aghion, P., Bergeaud, A., Lequien, M., & Melitz, M. J. (2024). The heterogeneous impact of market size on innovation: Evidence from French firm-level exports. *The Review of Economics and Statistics*, *106*(3), 608–626. doi: 10.1162/rest_a_01199

Aghion, P., & Howitt, P. (1992). A model of growth through creative destruction. *Econometrica*, *60*(2), 323–351. Retrieved 2024-10-26, from http://www.jstor.org/stable/2951599

Arora, A., Belenzon, S., Cioaca, L., Sheer, L., & Shvadron, D. (2025). *Discern 2.1: Duke innovation & scientific enterprises research network.* (Unpublished dataset)

Arora, A., Belenzon, S., Ferracuti, E., & Nagar, J. P. (2024). *Revisiting the private value of scientific inventions* (Tech. Rep.). National Bureau of Economic Research.

Arora, A., Belenzon, S., Patacconi, A., & Suh, J. (2020). The changing structure of American innovation: Some cautionary remarks for economic growth. *Innovation Policy and the Economy*, *20*(1), 39–93.

Arrow, K. J. (1962). The economic implications of learning by doing. *The Review of Economic Studies*, *29*(3), 155–173.

Asquith, P., & Mullins Jr, D. W. (1986). Equity issues and offering dilution. *Journal of Financial Economics*, *15*(1-2), 61–89.

Autor, D., Dorn, D., Katz, L. F., Patterson, C., & Van Reenen, J. (2020). The fall of the labor share and the rise of superstar firms. *The Quarterly Journal of Economics*, *135*(2), 645-709. doi: 10.1093/qje/qjaa004

Azoulay, P., Graff Zivin, J. S., Li, D., & Sampat, B. N. (2019). Public R&D investments and private-sector patenting: Evidence from NIH funding rules. *The Review of Economic Studies*, *86*(1), 117–152.

Babina, T., He, A. X., Howell, S. T., Perlman, E. R., & Staudt, J. (2023). Cutting the innovation engine: How federal funding shocks affect university patenting, entrepreneurship, and publications. *The Quarterly Journal of Economics*, *138*(2), 895–954. doi: 10.1093/qje/qjac046

Ball, R., & Brown, P. (1968). An empirical evaluation of accounting income numbers. *Journal of Accounting Research*, *6*(2), 159–178.

Belenzon, S., & Cioaca, L. C. (in press). Guaranteed demand and corporate R&D. *Management Science*.

Bhattacharya, V. (2021). An empirical model of R&D procurement contests: An analysis of the DOD SBIR program. *Econometrica*, *89*(5), 2189–2224.

Bloom, N., Schankerman, M., & Van Reenen, J. (2013). Identifying technology spillovers and product market rivalry. *Econometrica*, *81*(4), 1347–1393.

Bork, R. H. (2025, May 1). Say goodbye to the antitrust consumer welfare standard. *The Wall Street Journal*. Retrieved from https://www.wsj.com/opinion/say-goodbye-to-the-antitrust-consumer-welfare-standard-0510be30?reflink=desktopwebshare_permalink

Bosio, E., Djankov, S., Glaeser, E., & Shleifer, A. (2022). Public procurement in law and practice. *American Economic Review*, *112*(4), 1091–1117.

Bryan, K. A., & Williams, H. L. (2021). Innovation: market failures and public policies. In *Handbook of industrial organization* (Vol. 5, pp. 281–388). Elsevier.

Cabral, L., Cozzi, G., Denicolo, V., Zanza, M., Spagnolo, G., et al. (2006). Procuring innovation. In *Handbook of Procurement.* Cambridge University Press.

Campbell, J. Y., Lo, A. W., MacKinlay, A. C., & Whitelaw, R. F. (1998). The econometrics of financial markets. *Macroeconomic Dynamics*, *2*(4), 559–562.

Che, Y.-K., & Gale, I. (2003). Optimal design of research contests. *American Economic Review*, *93*(3), 646–671.

Che, Y.-K., Iossa, E., & Rey, P. (2021). Prizes versus contracts as incentives for innovation. *The Review of Economic Studies*, *88*(5), 2149–2178.

Chen, M. A., Wu, Q., & Yang, B. (2019). How valuable is FinTech innovation? *The Review of Financial Studies*, *32*(5), 2062–2106.

Cohen, D. A., & Li, B. (2020). Customer-base concentration, investment, and profitability: The U.S. government as a major customer. *The Accounting Review*, *95*(1), 101–131.

Crespi, F., & Guarascio, D. (2019). The demand-pull effect of public procurement on innovation and industrial renewal. *Industrial and Corporate Change*, *28*(4), 793–815.

De Chiara, A., & Iossa, E. (2019). Public procurement as a demand-side policy: Project competition and innovation incentives. *CEPR Discussion Paper*(No. DP13664).

De Loecker, J., Eeckhout, J., & Unger, G. (2020). The rise of market power and the macroeconomic implications. *The Quarterly Journal of Economics*, *135*(2), 561-644. Retrieved from https://doi.org/10.1093/qje/qjz041 doi: 10.1093/qje/qjz041

Edler, J., & Georghiou, L. (2007). Public procurement and innovation: Resurrecting the demand side. *Research Policy*, *36*(7), 949–963.

Edquist, C., & Zabala-Iturriagagoitia, J. M. (2012). Public procurement for innovation as mission-oriented innovation policy. *Research Policy*, *41*(10), 1757–1769.

Fama, E. F., Fisher, L., Jensen, M. C., & Roll, R. (1969). The adjustment of stock prices to new information. *International Economic Review*, *10*(1), 1–21.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, *33*(1), 3–56.

Fleming, L., Greene, H., Li, G., Marx, M., & Yao, D. (2019). Government-funded research increasingly fuels innovation. *Science*, *364*(6446), 1139-1141. doi: 10.1126/science.aaw2373

Hall, B. H., Mairesse, J., & Mohnen, P. (2010). Measuring the returns to r&d. In *Handbook of the economics of innovation* (Vol. 2, pp. 1033–1082). Elsevier.

Howell, S. T. (2017). Financing innovation: Evidence from R&D grants. *American Economic Review*, *107*(4), 1136–1164.

Howell, S. T., Rathje, J., Van Reenen, J., & Wong, J. (2021). *Opening up military innovation: Causal effects of "bottom-up" reforms to U.S. defense research* (NBER Working Paper No. 28700). Retrieved from https://www.nber.org/papers/w28700

Jarrell, G. A., & Poulsen, A. B. (1989). The returns to acquiring firms in tender offers: Evidence from three decades. *Financial Management*, *18*(3), 12–19.

Kleinknecht, A., & Verspagen, B. (1990). Demand and innovation: Schmookler re-examined. *Research Policy*, *19*(4), 387–394.

Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. (2017). Technological innovation, resource allocation, and growth. *The Quarterly Journal of Economics*, *132*(2), 665–712.

Krieger, B., & Zipperer, V. (2022). Does green public procurement trigger environmental innovations? *Research Policy*, *51*(6), 104516.

Lerner, J., & Stern, S. (Eds.). (2020). *Innovation policy and the economy, volume 20.* University of Chicago Press.

Levin, R. C. (1982). The semiconductor industry. In *Government and technical progress.* Pergamon Press.

Lichtenberg, F. R. (1988). The private R and D investment response to federal design and technical competitions. *American Economic Review*, *78*(3), 550–559.

MacKinlay, A. C. (1997). Event studies in economics and finance. *Journal of Economic Literature*, *35*(1), 13–39.

McQueen, G., & Roley, V. V. (1993). Stock prices, news, and business conditions. *The Review of Financial Studies*, *6*(3), 683–707.

Mowery, D. C. (2012). Defense-related R&D as a model for "Grand Challenges" technology policies. *Research Policy*, *41*(10), 1703–1715.

National Center for Science and Engineering Statistics. (2026). *National Patterns of R&D Resources: 2023–24 Data Update.* (NSF 26-313. Alexandria, VA: National Science Foundation. Retrieved March 4, 2026 from https://ncses.nsf.gov/data-collections/national-patterns/2023-2024.)

Nemet, G. F. (2009). Demand-pull, technology-push, and government-led incentives for non-incremental technical change. *Research Policy*, *38*(5), 700–709.

OECD. (2021). *Government at a glance 2021.* Retrieved from https://www.oecd-ilibrary.org/governance/government-at-a-glance-2021_1c258f55-en (Accessed March 21, 2024) doi: 10.1787/1c258f55-en

Office of Management and Budget. (2023). *Table 10.1—Gross Domestic Product and Deflators Used in the Historical Tables: 1940–2028.* (Retrieved from https://www.whitehouse.gov/omb/budget/historical-tables/. Accessed May 11, 2023.)

Riordan, M. H., & Sappington, D. E. (1989). Second sourcing. *The RAND Journal of Economics*, *20*(1), 41–58.

Rogerson, W. P. (1989). Profit regulation of defense contractors and prizes for innovation. *Journal of Political Economy*, *97*(6), 1284–1305.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, *98*(5, Part 2), S71–S102.

Scherer, F. M. (1982). Demand-pull and technological invention: Schmookler revisted. *The Journal of Industrial Economics*, *30*(3), 225–237.

Slavtchev, V., & Wiederhold, S. (2016). Does the technological content of government demand matter for private R&D? Evidence from U.S. states. *American Economic Journal: Macroeconomics*, *8*(2), 45–84.

Small Business Administration. (2023). *Contracts versus grants.* https://www.sbir.gov/tutorials/program-basics/tutorial-6. (Accessed August 30, 2023)

U.S. Government Accountability Office. (2014). *Noncompetitive contracts based on urgency need additional oversight* (Tech. Rep. No. GAO-14-304). Retrieved from https://www.gao.gov/assets/670/661983.pdf

USAspending.gov. (2026). *Advanced search.* Retrieved from https://www.usaspending.gov/search

Wallsten, S. J. (2000). The effects of government-industry R&D programs on private R&D: The case of the Small Business Innovation Research program. *The RAND Journal of Economics*, *31*(1), 82–100.

Weyl, E. G., & Tirole, J. (2012, 11). Market power screens willingness-to-pay. *The Quarterly Journal of Economics*, *127*(4), 1971-2003. Retrieved from https://doi.org/10.1093/qje/qjs032 doi: 10.1093/qje/qjs032

# ONLINE APPENDIX

## Appendix A Extensions to the Conceptual Framework

In this section, we explain some of the assumptions made in our conceptual framework and discuss what happens when we relax them.

### A.1 Assumptions About Quality

Prototype quality is $q_i = r_i + \nu_i$, where $r_i$ is the research effort and $\nu_i$ is a stochastic term. Research effort is not observable, while its cost is $g\exp(r_i)$, where $g > 0$. For analytical convenience, we assume $\nu_i$ has a type I extreme value distribution with parameters $\mu = 0$ and $\beta = 1$, so that $Pr[q_1 > q_2] = \dfrac{\exp(r_1)}{\exp(r_1) + \exp(r_2)}$. Using the notation $exp(r_i) = e_i$, we can write $Pr[q_1 > q_2] = \dfrac{e_1}{e_1 + e_2}$.

### A.2 Participation Constraint

When firm 1's expected payoff is $\Pi_1 = \frac{e_1}{e_1+e_2}P_u - ge_1$, the optimal R&D effort is given by the first-order condition:

$$\frac{e_2}{(e_1 + e_2)^2}P_u - g = 0 \tag{9}$$

At a symmetric Nash Equilibrium, $e_1 = e_2 = e = \dfrac{P_u}{4g}$. The participation constraint, $\Pi_i \geq 0$, is always satisfied because the firm's equilibrium expected payoff is $\frac{1}{2}(P_u) - \frac{1}{4}P_u > 0$.

### A.3 R&D Winner Has a Production Advantage

Suppose the R&D winner has a production advantage. For example, production may require some tacit knowledge that the R&D winner has, such that the R&D winner can extract some payment from the other producers without having to enter the production stage itself. This incentive mechanism does not require guaranteed demand. Indeed, guaranteed demand is a substitute for any production advantage enjoyed by the R&D winner.

### A.4 Entering the Production Stage Is Costly for the R&D Winner

Suppose $\frac{1}{m+1}(\overline{C}_{m+1} - \underline{C}_{m+1}) - F < 0$. Note that $\overline{C}_m - \overline{C}_{m+1} > \frac{1}{m}\Delta_m$ for $m > 2$. This implies that there is a range of $F$ such that even if $\frac{1}{m}\Delta_m < F$ so that expected production profits are negative, an R&D winner would profitably enter production because the additional rents extracted, represented by $\overline{C}_m - \overline{C}_{m+1}$, may still be greater than the production losses.

### A.5 Government Maximizes Net Payoff

Suppose the government's payoff from getting a prototype of quality $q$ is $V(q, B) = \alpha_0 + \alpha_1 q - B$, where $\alpha_1 > 0$ and $B$ is the government's expenditure. The government's payoff is $W = \mathrm{E}_q\, V(q) - B$. If the quality of the prototype developed by firm $i$, $q_i$, is related to the firm's effort by the relation $q_i = \ln(e_i) + \nu_i$, where $\nu_i$ has a type I extreme value distribution with parameters $\mu = 0, \beta = 1$, then the government's objective function can be written as $W = A + \alpha_1 \ln(e_1 + e_2) - B$.

At a symmetric Nash Equilibrium, $e_1 = e_2 = e = \frac{P_u}{4g}$.[36] The government optimally sets $P_u = \alpha_1$, so that total expenditure without guaranteed demand is simply $B = \alpha_1 + \overline{C}_m$. As before, guaranteed demand offers no additional incentive benefit unless R&D firms have production capability. Different from the fixed budget case, the government reduces the R&D net surplus to $P_u - (\overline{C}_m - \overline{C}_{m+1})$.

[36] As noted, the participation constraint of the firm is always satisfied because the firm's equilibrium expected payoff is $\frac{1}{2}(P_u) - \frac{1}{4}P_u > 0$.

# Appendix B Additional Figures and Tables

[Table 17 about here.]

[Figure 4 about here.]

[Table 18 about here.]

[Figure 5 about here.]

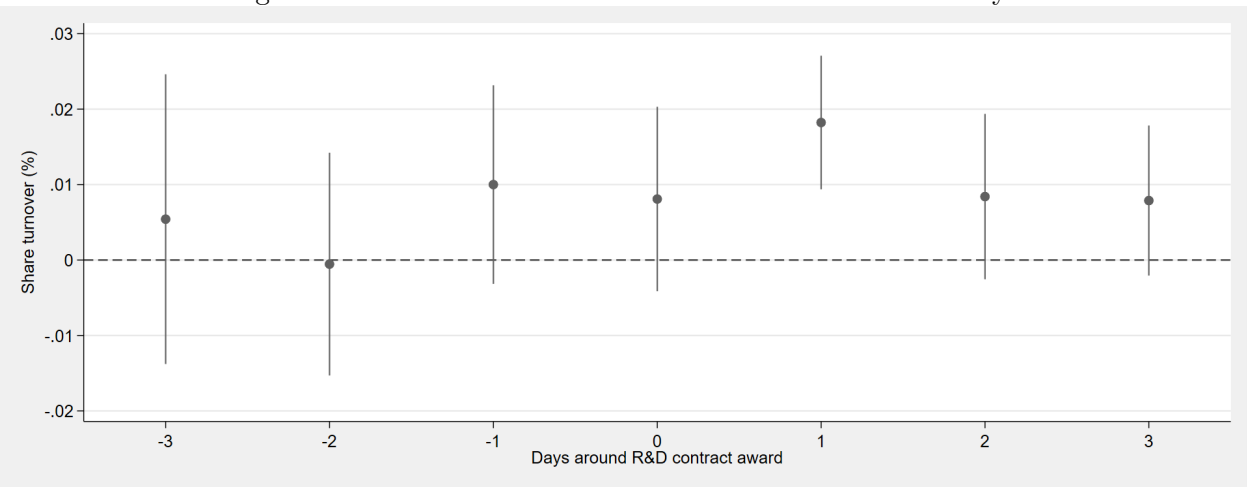
[Table 19 about here.]

[Table 20 about here.]

[Table 21 about here.]

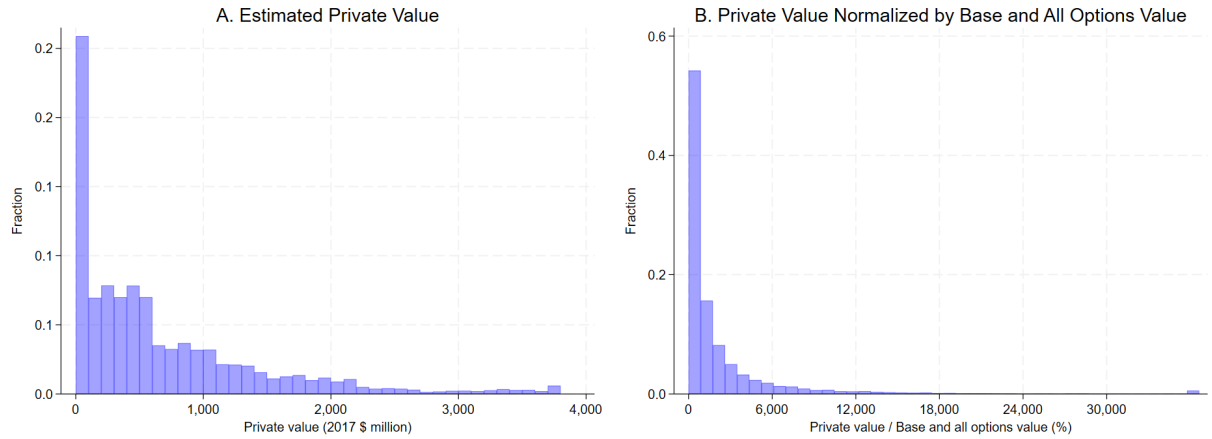
[Table 22 about here.]

Figure 1: Share Turnover Around R&D Contract Award Days



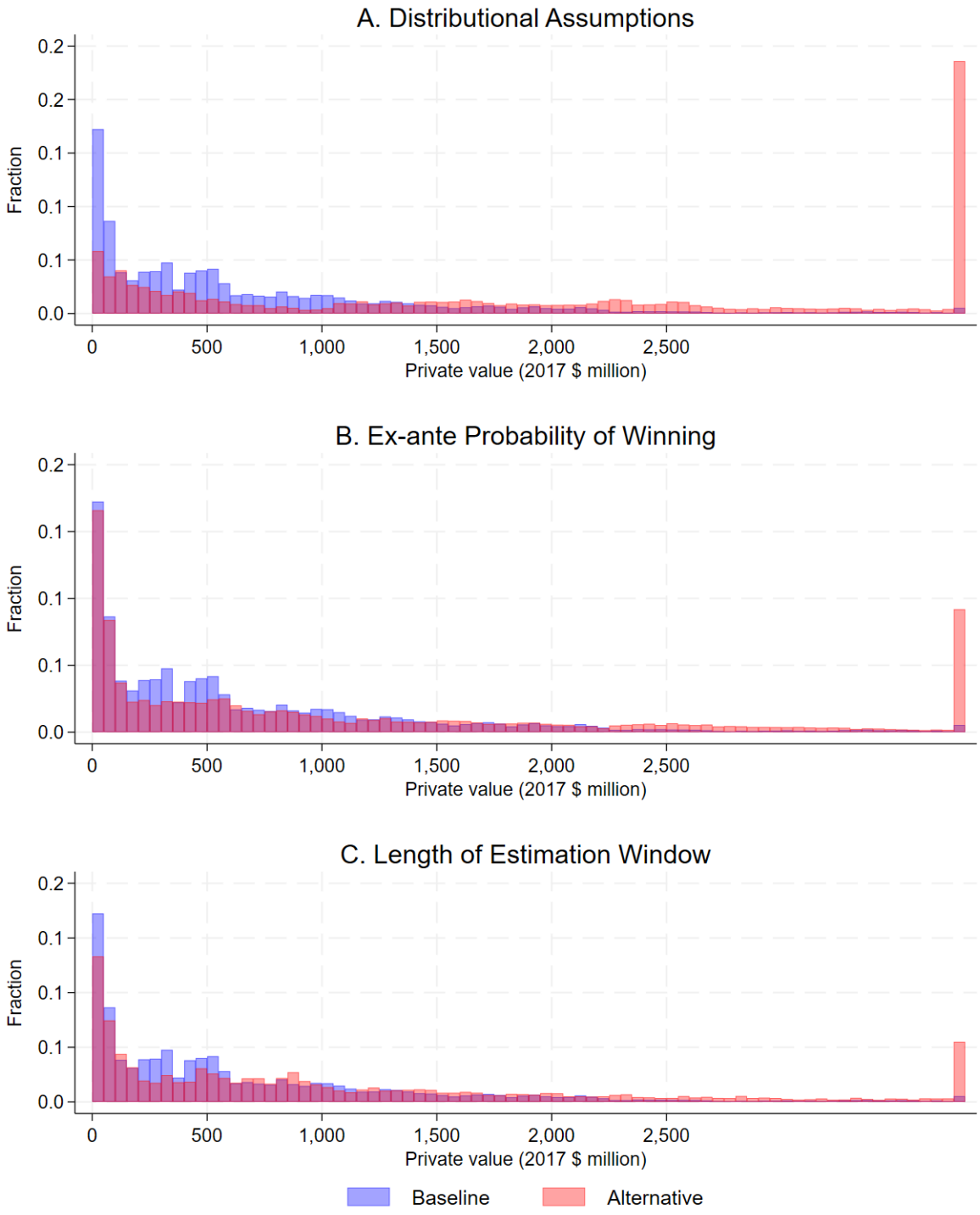

This figure presents the share turnover around R&D contract award days. Share turnover $h$ is the ratio of daily volume (CRSP: vol, in units) to shares outstanding (CRSP: shrout, converted to units). The median daily share turnover for R&D contractors is 0.44%. We report the coefficient estimates $b_l$, $l = -3, -2, ..., 2, 3$ and 95% confidence intervals for the following specification: $h_{fd} = a + \sum_l b_l I_{fd+l} + \boldsymbol{Z}'_{fd}\boldsymbol{c} + \epsilon_{fd}$, where the indicator variable $I$ takes the value one if firm $f$ is awarded an R&D contract on date $d$ and zero otherwise. The vector of controls $\boldsymbol{Z}_{fd}$ includes firm x year and calendar date fixed effects. Standard errors are clustered by year.

Figure 2: Frequency Distribution of Private Value of R&D Contracts



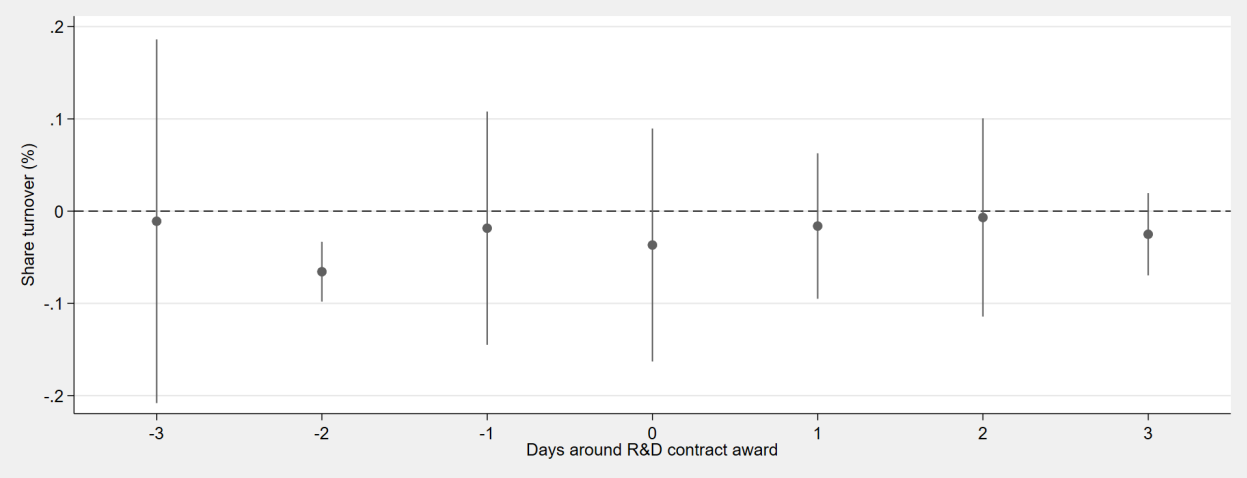

This figure presents the frequency distribution of *Private value* of R&D contracts as estimated (Panel A) and normalized by the *Base and all options value* of the contract (Panel B). These distributions have been winsorized at their respective 99.5th percentile for expositional clarity.

Figure 3: Comparisons of Frequency Distributions



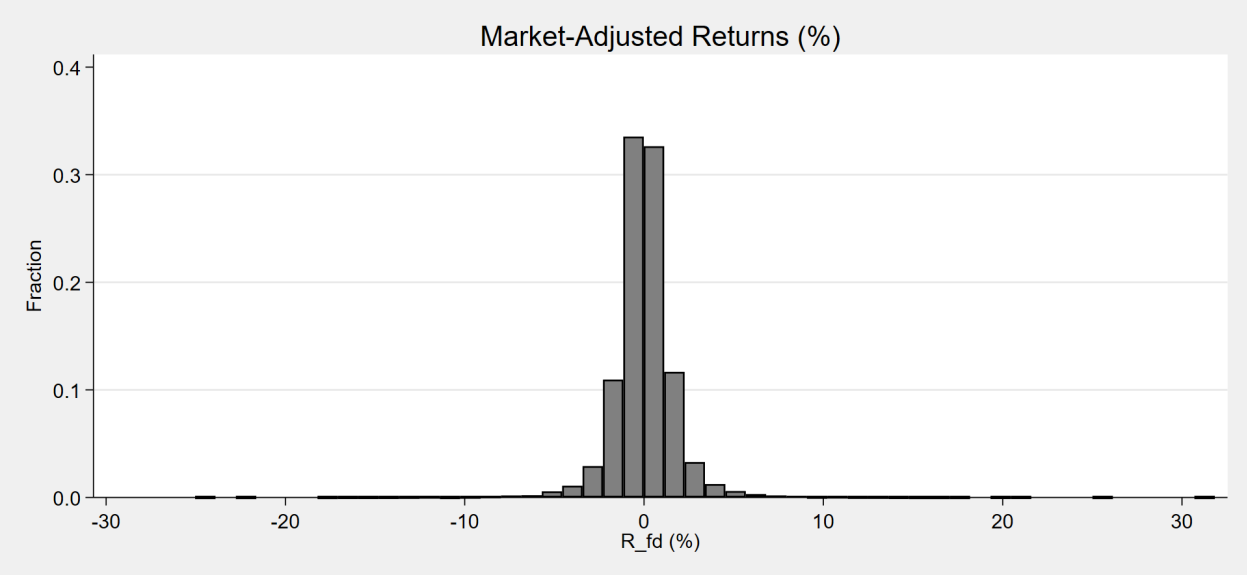

This figure presents comparisons of frequency distributions for *Private value* estimated using alternative distributional assumptions (Panel A), ex-ante probabilities of winning (Panel B), and lengths of the estimation window (Panel C). For expositional clarity, these distributions have been winsorized at the 99.5th percentile of the baseline distribution.

Figure 4: Share Turnover Around R&D Contracts Awarded Before the Public Reporting Requirement




This figure presents the share turnover around R&D contracts awarded before the public reporting requirement was put in place (i.e., awarded from October 1, 1979, to March 31, 1984).

Figure 5: Frequency Distribution of Idiosyncratic Returns




This figure presents the frequency distribution of idiosyncratic (market-adjusted) returns.

Table 1: Procurement Regimes and Empirical Predictions

| (1) Capability | (2) Competitive bidding | (3) Guaranteed demand | (4) Proxy | (5) Private value | (6) Relationship with future production |
|---|---|---|---|---|---|
| R&D firms lack production capability | $P_b = \bar{C}_m$ R&D winner payoff=$P_u$ | $P_b = \bar{C}_m$ R&D winner payoff=$P_u$ | Specialized, small firms | Smaller | No relationship |
| R&D firms have production capability | $P_b = \bar{C}_m$ R&D winner payoff=$P_u$ | $P_b = \bar{C}_m$ R&D winner payoff $= P_u + (\bar{C}_m - \bar{C}_{m+1})$ | Vertically integrated, large firms | Larger | Positive relationship |

*Notes:* This table compares gross payoffs under competitive bidding (Column 2) and guaranteed demand (Column 3) for firms with and without production capability. It also presents testable empirical predictions using firm vertical integration and size as proxies for production capability (Columns 5 and 6).

Table 2: Independent and Control Variables

| Variable name | Variable description |
|---|---|
| **A. Independent variables** | |
| Obligated value of future production, 3/5/10 years | Production contracts obligated to the firm during the 3/5/10 years following the focal award |
| Obligated value of future noncompetitive production, 3/5/10 years | Production contracts obligated to the firm without competition during the 3/5/10 years following the focal award |
| Obligated value of future competitive production, 3/5/10 years | Production contracts obligated to the firm with competition during the 3/5/10 years following the focal award |
| Share noncompetitive in future production, 3/5/10 years | Share obtained by dividing the value of production contracts obligated to the firm without competition during the 3/5/10 years following the focal award by the total value of production contracts obligated to the firm during the 3/5/10 years following the focal award |
| **B. Control variables** | |
| Market value | Market value of the firm on the focal award date |
| Obligated value of focal contract | Value the U.S. government promised to spend, either immediately or in the future, on the focal award |
| Options value of focal contract | Value of (any) options the U.S. government may choose to exercise, in the future, on the focal award |

*Notes:* This table summarizes the main independent and control variables used in the econometric analyses.

Table 3: Descriptive Statistics for Main Variables

| | (1) | (2) | (3) | (4) | (5) | (6) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| | | | | Distribution | | | | |
| | Obs. | Mean | Std. dev. | 5th | 10th | 50th | 90th | 95th |
| **A. Contract private value** | | | | | | | | |
| $R_{fd}$(%) | 19,461 | 0.03 | 1.80 | -2.33 | -1.61 | -0.01 | 1.70 | 2.48 |
| $E[\nu_{fd}\|R_{fd}]$(%) | 19,461 | 1.68 | 0.96 | 0.52 | 0.63 | 1.47 | 3.11 | 3.54 |
| Private value (2017 $ million) | 19,461 | 675.08 | 778.95 | 10.10 | 24.90 | 431.02 | 1,728.83 | 2,187.50 |
| **B. Other contract characteristics** | | | | | | | | |
| Obligated value (2017 $ million) | 19,461 | 108.40 | 294.46 | 4.80 | 6.00 | 35.14 | 240.68 | 424.47 |
| Base and all options value (2017 $ million) | 19,461 | 152.60 | 776.91 | 4.92 | 6.30 | 39.80 | 312.40 | 570.99 |
| Obligated value of future prod. (3 years, 2017 $ million) | 19,461 | 38,573.87 | 36,057.85 | 211.21 | 968.99 | 29,903.28 | 94,212.83 | 112,835.33 |
| Obligated value of future prod. (5 years, 2017 $ million) | 19,461 | 63,816.58 | 61,000.23 | 327.98 | 1,301.52 | 48,894.96 | 159,668.41 | 187,171.11 |
| Obligated value of future prod. (10 years, 2017 $ million) | 19,461 | 124,611.13 | 125,064.68 | 539.18 | 1,971.94 | 94,219.12 | 330,909.94 | 403,802.48 |
| # reportable R&D transactions | 19,461 | 1.41 | 0.96 | 1.00 | 1.00 | 1.00 | 2.00 | 3.00 |
| # reportable prod. transactions | 19,461 | 2.16 | 3.00 | 0.00 | 0.00 | 1.00 | 5.00 | 8.00 |
| **C. Comparisons** | | | | | | | | |
| Private value / Obligated value (%) | 19,461 | 2,617.66 | 5,811.91 | 27.38 | 66.33 | 844.71 | 6,384.07 | 10,692.38 |
| Private value / Base and all options value (%) | 19,461 | 2,420.57 | 5,561.41 | 22.18 | 54.42 | 732.08 | 5,852.03 | 10,086.16 |

*Notes:* This table presents descriptive statistics for the main variables used in the econometric analyses. The sample includes 19,461 firm-days when at least one reportable R&D contract was awarded to a sample firm. Panel A reports the distribution of the market-adjusted returns $R_{fd}$ on the trading day following the contract award date; the filtered components of returns $E[\nu_{fd}|R_{fd}]$; and, the estimated private value of R&D contracts, deflated to 2017 (million) dollars using the GDP chained price index (Office of Management and Budget, 2023). Panel B reports the distribution of other contract characteristics. Panel C reports the distribution of the estimated private value of R&D contracts normalized by the obligated values (and base and all options values, respectively) of R&D contracts.

Table 4: Descriptive Statistics by Period

| | (1) | (2) | (3) | (4) | (5) | (6) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| | | | | Distribution | | | | |
| | Obs. | Mean | Std. dev. | 5th | 10th | 50th | 90th | 95th |
| **A. Years 1984-2008** | | | | | | | | |
| Private value (2017 $ million) | 9,504 | 512.77 | 592.31 | 6.60 | 17.51 | 331.65 | 1,335.18 | 1,667.20 |
| Private value / Base and all options value (%) | 9,504 | 2,220.90 | 5,370.39 | 12.16 | 30.04 | 644.66 | 5,324.38 | 9,417.65 |
| **B. Years 2009-2024** | | | | | | | | |
| Private value (2017 $ million) | 9,957 | 830.01 | 895.53 | 17.07 | 36.51 | 517.83 | 2,080.62 | 2,681.88 |
| Private value / Base and all options value (%) | 9,957 | 2,611.16 | 5,731.59 | 53.84 | 102.25 | 822.12 | 6,333.82 | 11,019.14 |

*Notes:* This table presents descriptive statistics for R&D contracts by period.

Table 5: Descriptive Statistics by Firm Vertical Integration and Size

| | (1) | (2) | (3) | (4) | (5) | (6) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| | | | | Distribution | | | | |
| | Obs. | Mean | Std. dev. | 5th | 10th | 50th | 90th | 95th |
| **A. Vertically integrated firms** | | | | | | | | |
| Private value (2017 $ million) | 18,569 | 700 | 783 | 14 | 31 | 454 | 1,754 | 2,209 |
| Private value / Base and all options value (%) | 18,569 | 2,487 | 5,603 | 25 | 62 | 781 | 6,003 | 10,184 |
| **B. Non-integrated firms** | | | | | | | | |
| Private value (2017 $ million) | 892 | 152 | 450 | 2 | 3 | 25 | 324 | 807 |
| Private value / Base and all options value (%) | 892 | 1,037 | 4,382 | 6 | 14 | 152 | 1,269 | 3,522 |
| **C. Large firms** | | | | | | | | |
| Private value (2017 $ million) | 18,996 | 691 | 781 | 15 | 30 | 446 | 1,745 | 2,205 |
| Private value / Base and all options value (%) | 18,996 | 2,476 | 5,617 | 25 | 60 | 768 | 5,956 | 10,184 |
| **D. Small firms** | | | | | | | | |
| Private value (2017 $ million) | 465 | 12 | 15 | 1 | 2 | 7 | 27 | 57 |
| Private value / Base and all options value (%) | 465 | 142 | 202 | 5 | 9 | 79 | 320 | 548 |

*Notes:* This table presents descriptive statistics for R&D contracts by firm vertical integration and size. Vertically integrated firms operated in at least one SIC4 industry that supplied the focal R&D-awarding agency with goods or services in the prior year. Large firms had above-median annual sales (compared to other publicly traded firms operating in the same SIC4 industry).

Table 6: Descriptive Statistics by Other Firm Characteristics

| | (1) | (2) | (3) | (4) | (5) | (6) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| | | | | Distribution | | | | |
| | Obs. | Mean | Std. dev. | 5th | 10th | 50th | 90th | 95th |
| **A. Consumer firms** | | | | | | | | |
| Private value (2017 $ million) | 371 | 89 | 67 | 9 | 19 | 82 | 179 | 209 |
| Private value / Base and all options value (%) | 371 | 807 | 975 | 21 | 35 | 382 | 2,257 | 2,754 |
| **B. Manufacturing firms** | | | | | | | | |
| Private value (2017 $ million) | 11,067 | 933 | 904 | 14 | 30 | 694 | 2,122 | 2,772 |
| Private value / Base and all options value (%) | 11,067 | 3,053 | 6,794 | 23 | 59 | 880 | 7,531 | 12,974 |
| **C. High-tech firms** | | | | | | | | |
| Private value (2017 $ million) | 7,607 | 357 | 361 | 11 | 25 | 271 | 918 | 1,092 |
| Private value / Base and all options value (%) | 7,607 | 1,631 | 3,175 | 27 | 60 | 620 | 4,004 | 6,677 |
| **D. Health firms** | | | | | | | | |
| Private value (2017 $ million) | 256 | 147 | 298 | 1 | 1 | 7 | 635 | 854 |
| Private value / Base and all options value (%) | 256 | 1,023 | 3,089 | 5 | 8 | 64 | 2,479 | 6,250 |
| **E. Other firms** | | | | | | | | |
| Private value (2017 $ million) | 160 | 192 | 152 | 2 | 9 | 199 | 387 | 454 |
| Private value / Base and all options value (%) | 160 | 2,188 | 2,597 | 11 | 57 | 1,256 | 5,604 | 7,361 |
| **F. Firms with high scientific capabilities** | | | | | | | | |
| Private value (2017 $ million) | 18,815 | 698 | 783 | 15 | 31 | 452 | 1,750 | 2,207 |
| Private value / Base and all options value (%) | 18,815 | 2,496 | 5,639 | 25 | 61 | 782 | 6,008 | 10,246 |
| **G. Firms with low scientific capabilities** | | | | | | | | |
| Private value (2017 $ million) | 646 | 22 | 43 | 1 | 2 | 13 | 53 | 61 |
| Private value / Base and all options value (%) | 646 | 217 | 745 | 6 | 10 | 99 | 505 | 715 |
| **H. Firms with high technological capabilities** | | | | | | | | |
| Private value (2017 $ million) | 18,407 | 709 | 786 | 18 | 34 | 458 | 1,763 | 2,225 |
| Private value / Base and all options value (%) | 18,407 | 2,536 | 5,691 | 28 | 65 | 802 | 6,113 | 10,378 |
| **I. Firms with low technological capabilities** | | | | | | | | |
| Private value (2017 $ million) | 1,054 | 80 | 163 | 1 | 2 | 16 | 481 | 542 |
| Private value / Base and all options value (%) | 1,054 | 412 | 1,092 | 6 | 10 | 124 | 850 | 1,573 |

*Notes:* This table presents descriptive statistics for R&D contracts by industry (Panels A-E), firm scientific capabilities (Panels F and G), and firm technological capabilities (Panels H and I).

Table 7: Cross Tabulation of Private Value of R&D Contracts and Future Production

| | (1) | (2) |
|---|---|---|
| | Obligated value of future production, 5 years | |
| Private value of R&D contracts | Below median | Above median |
| **A. All future production contracts** | | |
| Below median | 38% | 12% |
| Above median | 12% | **38%** |
| **B. Only competitive future production contracts** | | |
| Below median | 35% | 15% |
| Above median | 15% | **35%** |
| **C. Only noncompetitive future production contracts** | | |
| Below median | 39% | 11% |
| Above median | 11% | **39%** |

*Notes:* This table provides a cross-tabulation between the private value of R&D contracts and the value of future production contracts awarded to the recipient firm during the five years following the focal R&D contract. The unit of analysis is a firm-award date (N=19,461). Percentages show the relative frequency of each cell.

Table 8: Private Value and Future Production

| Dependent variable: | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | ln($1+Private value) | | | | |
| | Baseline | Control for obligated value | Control for options value | Split future production by regime | Use share noncompeted |
| ln($1+Obligated value of future production, 5 years) | 0.071 | 0.061 | 0.061 | | 0.142 |
| | (0.008) | (0.008) | (0.008) | | (0.009) |
| ln($1+Obligated value of future noncompetitive prod., 5 years) | | | | 0.073 | |
| | | | | (0.006) | |
| ln($1+Obligated value of future competitive prod., 5 years) | | | | -0.012 | |
| | | | | (0.006) | |
| Share noncompetitive in future prod. (5 years) | | | | | 0.560 |
| | | | | | (0.042) |
| ln($1+Options value of focal contract) | | | 0.002 | 0.002 | 0.001 |
| | | | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | | 0.080 | 0.077 | 0.073 | 0.037 |
| | | (0.006) | (0.006) | (0.006) | (0.005) |
| ln($1+Market value) | 0.986 | 0.967 | 0.967 | 0.938 | 0.858 |
| | (0.012) | (0.010) | (0.010) | (0.009) | (0.010) |
| Firm FE | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 675.08 | 675.08 | 675.08 | 675.08 | 678.02 |
| Firms | 282 | 282 | 282 | 282 | 255 |
| Observations | 19,461 | 19,461 | 19,461 | 19,461 | 19,360 |
| Adjusted R-squared | 0.943 | 0.946 | 0.946 | 0.948 | 0.957 |

*Notes:* This table presents OLS estimates of the relationship between the private value of R&D contracts and the future production contracts obligated to the firm during the five-year period following the focal award. Standard errors (in parentheses) are clustered by year.

Table 9: Variation by Firm Vertical Integration (Relative to R&D Awarding Agency)

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | Future = 3 years | Future = 5 years | Future = 10 years | Future = 3 years | Future = 5 years | Future = 10 years |
| ln($1+Obligated value of future production) | -0.006 | -0.005 | -0.005 | | | |
| | (0.004) | (0.004) | (0.004) | | | |
| × *Vertically integrated* | 0.115 | 0.115 | 0.112 | | | |
| | (0.015) | (0.015) | (0.014) | | | |
| ln($1+Obligated value of future noncompetitive prod.) | | | | -0.010 | -0.008 | -0.013 |
| | | | | (0.004) | (0.005) | (0.005) |
| × *Vertically integrated* | | | | 0.138 | 0.138 | 0.145 |
| | | | | (0.011) | (0.011) | (0.011) |
| ln($1+Obligated value of future competitive prod.) | | | | 0.008 | 0.007 | 0.014 |
| | | | | (0.005) | (0.006) | (0.005) |
| × *Vertically integrated* | | | | -0.029 | -0.031 | -0.045 |
| | | | | (0.009) | (0.011) | (0.011) |
| Vertically integrated | -0.691 | -0.735 | -0.759 | -0.481 | -0.511 | -0.498 |
| | (0.120) | (0.129) | (0.129) | (0.095) | (0.103) | (0.102) |
| ln($1+Options value of focal contract) | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.059 | 0.058 | 0.058 | 0.053 | 0.052 | 0.052 |
| | (0.008) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| ln($1+Market value) | 0.936 | 0.935 | 0.936 | 0.895 | 0.895 | 0.894 |
| | (0.014) | (0.014) | (0.013) | (0.014) | (0.014) | (0.013) |
| Firm FE | No | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 |
| Firms | 282 | 282 | 282 | 282 | 282 | 282 |
| Observations | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 |
| Adjusted R-squared | 0.951 | 0.951 | 0.951 | 0.954 | 0.954 | 0.954 |

*Notes:* This table presents OLS estimates of the relationship between private value and future production obligations by firm vertical integration. *Vertically integrated* is an indicator variable equal to 1 if the recipient firm operated in one or more SIC4 industries that supplied the focal R&D agency with goods and services in the previous year and 0 otherwise. Standard errors (in parentheses) are clustered by year.

Table 10: Variation by Firm Size

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | Future = 3 years | Future = 5 years | Future = 10 years | Future = 3 years | Future = 5 years | Future = 10 years |
| ln($1+Obligated value of future production) | -0.030 | -0.032 | -0.030 | | | |
| | (0.004) | (0.005) | (0.005) | | | |
| × *Large* | 0.100 | 0.107 | 0.105 | | | |
| | (0.009) | (0.009) | (0.008) | | | |
| ln($1+Obligated value of future noncompetitive prod.) | | | | -0.008 | -0.002 | 0.002 |
| | | | | (0.008) | (0.007) | (0.008) |
| × *Large* | | | | 0.086 | 0.084 | 0.077 |
| | | | | (0.010) | (0.010) | (0.011) |
| ln($1+Obligated value of future competitive prod.) | | | | -0.018 | -0.025 | -0.025 |
| | | | | (0.006) | (0.005) | (0.006) |
| × *Large* | | | | 0.010 | 0.016 | 0.018 |
| | | | | (0.010) | (0.010) | (0.010) |
| Large | -0.561 | -0.656 | -0.717 | -0.361 | -0.435 | -0.484 |
| | (0.075) | (0.076) | (0.073) | (0.061) | (0.061) | (0.064) |
| ln($1+Options value of focal contract) | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.075 | 0.073 | 0.072 | 0.070 | 0.068 | 0.068 |
| | (0.006) | (0.007) | (0.006) | (0.006) | (0.006) | (0.006) |
| ln($1+Market value) | 0.968 | 0.963 | 0.961 | 0.937 | 0.933 | 0.932 |
| | (0.011) | (0.011) | (0.011) | (0.010) | (0.010) | (0.010) |
| Firm FE | No | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 |
| Firms | 282 | 282 | 282 | 282 | 282 | 282 |
| Observations | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 |
| Adjusted R-squared | 0.948 | 0.948 | 0.949 | 0.950 | 0.950 | 0.950 |

*Notes:* This table presents OLS estimates of the relationship between private value and future production obligations by firm size. *Large* is an indicator variable equal to 1 if the recipient firm has above-median annual sales (compared to annual sales between 1980 and 2024 of other firms operating in the same SIC4 industry) and 0 otherwise. Standard errors (in parentheses) are clustered by year.

Table 11: Robustness Checks: Adding Firm Fixed Effects

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | Baseline | Baseline by regime | Vertical integration baseline | Vertical integration by regime | Firm size baseline | Firm size by regime |
| ln($1+Obligated value of future production) | 0.017 | | 0.017 | | -0.022 | |
| | (0.009) | | (0.007) | | (0.012) | |
| × *Vertically integrated* | | | 0.001 | | | |
| | | | (0.007) | | | |
| × *Large* | | | | | 0.041 | |
| | | | | | (0.013) | |
| ln($1+Obligated value of future noncompetitive prod.) | | 0.031 | | 0.015 | | 0.015 |
| | | (0.009) | | (0.007) | | (0.010) |
| × *Vertically integrated* | | | | 0.026 | | |
| | | | | (0.009) | | |
| × *Large* | | | | | | 0.017 |
| | | | | | | (0.012) |
| ln($1+Obligated value of future competitive prod.) | | -0.008 | | 0.010 | | -0.034 |
| | | (0.007) | | (0.006) | | (0.008) |
| × *Vertically integrated* | | | | -0.024 | | |
| | | | | (0.007) | | |
| × *Large* | | | | | | 0.026 |
| | | | | | | (0.009) |
| Vertically integrated | | | 0.067 | 0.082 | | |
| | | | (0.058) | (0.049) | | |
| Large | | | | | -0.163 | -0.115 |
| | | | | | (0.113) | (0.095) |
| ln($1+Options value of focal contract) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| ln($1+Obligated value of focal contract) | -0.002 | -0.002 | -0.002 | -0.001 | -0.002 | -0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| ln($1+Market value) | 0.903 | 0.901 | 0.903 | 0.898 | 0.901 | 0.898 |
| | (0.018) | (0.018) | (0.018) | (0.018) | (0.019) | (0.019) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 677.85 | 677.85 | 677.85 | 677.85 | 677.85 | 677.85 |
| Firms | 195 | 195 | 195 | 195 | 195 | 195 |
| Observations | 19,374 | 19,374 | 19,374 | 19,374 | 19,374 | 19,374 |
| Adjusted R-squared | 0.983 | 0.983 | 0.983 | 0.983 | 0.983 | 0.983 |

*Notes:* This table presents OLS estimates of the relationship between the private value of R&D contracts and future production contracts while adding firm fixed effects. Standard errors (in parentheses) are clustered by year.

Table 12: Robustness Checks: Using Alternative Distributional Assumptions

| Dependent variable: | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | ln($1+Private value) | | | |
| | Cauchy distributions | Non-zero probability of winning | 3-day window | Control for production contracts |
| ln($1+Obligated value of future noncompetitive prod., 5 years) | 0.053 | 0.127 | 0.087 | 0.070 |
| | (0.004) | (0.009) | (0.007) | (0.006) |
| ln($1+Obligated value of future competitive prod., 5 years) | 0.002 | -0.022 | 0.002 | -0.015 |
| | (0.004) | (0.009) | (0.007) | (0.006) |
| Reportable production contract | | | | 0.143 |
| | | | | (0.013) |
| ln($1+Options value of focal contract) | 0.001 | 0.006 | 0.001 | 0.001 |
| | (0.000) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.050 | 0.116 | 0.083 | 0.048 |
| | (0.004) | (0.010) | (0.007) | (0.006) |
| ln($1+Market value) | 0.994 | 0.963 | 0.947 | 0.937 |
| | (0.005) | (0.015) | (0.011) | (0.009) |
| Firm FE | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes |
| Mean DV | 2,484.12 | 1,565.37 | 1,143.56 | 675.08 |
| Firms | 282 | 282 | 282 | 282 |
| Observations | 19,461 | 19,461 | 19,461 | 19,461 |
| Adjusted R-squared | 0.978 | 0.877 | 0.942 | 0.949 |

*Notes:* This table presents OLS estimates of the relationship between the private value estimated using alternative assumptions and the obligated value of future production contracts awarded to the firm during the five years following the focal award. *Reportable production contract* is an indicator variable equal to 1 if a reportable production contract was awarded on the same date as a focal R&D contract, and 0 otherwise. Standard errors (in parentheses) are clustered by year.

Table 13: Variation by Agency (Top Five)

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | DoD | NASA | DoT | HHS | DoE | Top five |
| ln($1+Obligated value of future DoD prod., 5 years) | 0.042 | | | | | |
| | (0.005) | | | | | |
| ln($1+Obligated value of future non-DoD prod., 5 years) | 0.005 | | | | | |
| | (0.007) | | | | | |
| ln($1+Obligated value of future NASA prod., 5 years) | | 0.023 | | | | |
| | | (0.003) | | | | |
| ln($1+Obligated value of future non-NASA prod., 5 years) | | 0.036 | | | | |
| | | (0.007) | | | | |
| ln($1+Obligated value of future DoT prod., 5 years) | | | 0.011 | | | |
| | | | (0.003) | | | |
| ln($1+Obligated value of future non-DoT prod., 5 years) | | | 0.048 | | | |
| | | | (0.007) | | | |
| ln($1+Obligated value of future HHS prod., 5 years) | | | | -0.003 | | |
| | | | | (0.002) | | |
| ln($1+Obligated value of future non-HHS prod., 5 years) | | | | 0.051 | | |
| | | | | (0.006) | | |
| ln($1+Obligated value of future DoE prod., 5 years) | | | | | 0.004 | |
| | | | | | (0.003) | |
| ln($1+Obligated value of future non-DoE prod., 5 years) | | | | | 0.051 | |
| | | | | | (0.006) | |
| ln($1+Obligated value of future top five agency prod., 5 years) | | | | | | 0.072 |
| | | | | | | (0.007) |
| ln($1+Obligated value of future other agency prod., 5 years) | | | | | | -0.011 |
| | | | | | | (0.004) |
| ln($1+Options value of focal contract) | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.081 | 0.071 | 0.075 | 0.081 | 0.078 | 0.076 |
| | (0.006) | (0.007) | (0.006) | (0.006) | (0.006) | (0.007) |
| ln($1+Market value) | 0.973 | 0.963 | 0.958 | 0.974 | 0.966 | 0.968 |
| | (0.010) | (0.010) | (0.011) | (0.010) | (0.012) | (0.010) |
| Firm FE | No | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 | 675.12 |
| Firms | 282 | 282 | 282 | 282 | 282 | 282 |
| Observations | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 | 19,460 |
| Adjusted R-squared | 0.946 | 0.949 | 0.947 | 0.946 | 0.946 | 0.947 |

*Notes:* This table presents OLS estimates of the relationship between private value and future production from the top five agencies that award reportable R&D contracts. The top five agencies are DoD, NASA, DoT, HHS, and DoE. Standard errors (in parentheses) are clustered by year.

Table 14: Future Production Contracts From the Same Agency

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | DoD subsample | NASA subsample | DoT subsample | HHS subsample | DoE subsample | Top five subsample |
| ln($1+Obligated value of future DoD prod., 5 years) | 0.073 | | | | | |
| | (0.011) | | | | | |
| ln($1+Obligated value of future NASA prod., 5 years) | | 0.025 | | | | |
| | | (0.010) | | | | |
| ln($1+Obligated value of future DoT prod., 5 years) | | | 0.062 | | | |
| | | | (0.023) | | | |
| ln($1+Obligated value of future HHS prod., 5 years) | | | | 0.009 | | |
| | | | | (0.005) | | |
| ln($1+Obligated value of future DoE prod., 5 years) | | | | | 0.034 | |
| | | | | | (0.017) | |
| ln($1+Obligated value of future top five agency prod., 5 years) | | | | | | 0.091 |
| | | | | | | (0.041) |
| ln($1+Options value of focal contract) | 0.002 | 0.001 | -0.002 | 0.005 | 0.009 | -0.003 |
| | (0.000) | (0.002) | (0.002) | (0.003) | (0.010) | (0.006) |
| ln($1+Obligated value of focal contract) | 0.063 | 0.111 | 0.071 | 0.144 | 0.071 | 0.055 |
| | (0.007) | (0.012) | (0.016) | (0.021) | (0.035) | (0.035) |
| ln($1+Market value) | 0.968 | 1.017 | 1.052 | 0.830 | 0.855 | 0.895 |
| | (0.015) | (0.019) | (0.053) | (0.012) | (0.041) | (0.040) |
| Firm FE | No | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 690.61 | 743.00 | 531.26 | 239.95 | 208.72 | 250.69 |
| Firms | 222 | 42 | 14 | 59 | 15 | 32 |
| Observations | 15,840 | 2,428 | 366 | 409 | 104 | 295 |
| Adjusted R-squared | 0.947 | 0.952 | 0.955 | 0.965 | 0.964 | 0.944 |

*Notes:* This table presents OLS estimates of the relationship between private value and future production from the same agency that awarded the largest R&D contract on the focal award date. Standard errors (in parentheses) are robust to heteroskedasticity.

Table 15: Variation by Industry

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | Future = 3 years | Future = 5 years | Future = 10 years | Future = 3 years | Future = 5 years | Future = 10 years |
| ln($1+Obligated value of future production) | 0.007 | 0.009 | 0.011 | | | |
| | (0.014) | (0.013) | (0.012) | | | |
| × *Consumer* | 0.057 | 0.055 | 0.055 | | | |
| | (0.011) | (0.010) | (0.009) | | | |
| × *Manufacturing* | 0.080 | 0.076 | 0.071 | | | |
| | (0.010) | (0.009) | (0.008) | | | |
| × *HiTech* | 0.079 | 0.075 | 0.071 | | | |
| | (0.010) | (0.009) | (0.008) | | | |
| × *Health* | -0.040 | -0.033 | -0.030 | | | |
| | (0.015) | (0.013) | (0.012) | | | |
| ln($1+Obligated value of future noncompetitive prod.) | | | | -0.035 | -0.047 | -0.017 |
| | | | | (0.059) | (0.053) | (0.059) |
| × *Consumer* | | | | 0.035 | 0.003 | -0.083 |
| | | | | (0.069) | (0.068) | (0.079) |
| × *Manufacturing* | | | | 0.134 | 0.145 | 0.123 |
| | | | | (0.060) | (0.055) | (0.063) |
| × *HiTech* | | | | 0.150 | 0.165 | 0.134 |
| | | | | (0.056) | (0.051) | (0.056) |
| × *Health* | | | | 0.011 | 0.029 | -0.009 |
| | | | | (0.059) | (0.053) | (0.060) |
| ln($1+Obligated value of future competitive prod.) | | | | 0.038 | 0.053 | 0.028 |
| | | | | (0.058) | (0.052) | (0.058) |
| × *Consumer* | | | | 0.026 | 0.050 | 0.122 |
| | | | | (0.067) | (0.064) | (0.075) |
| × *Manufacturing* | | | | -0.043 | -0.060 | -0.046 |
| | | | | (0.059) | (0.054) | (0.062) |
| × *HiTech* | | | | -0.060 | -0.080 | -0.057 |
| | | | | (0.054) | (0.050) | (0.055) |
| × *Health* | | | | -0.050 | -0.069 | -0.031 |
| | | | | (0.057) | (0.051) | (0.057) |
| ln($1+Options value of focal contract) | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.001 |
| | (0.001) | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.061 | 0.061 | 0.062 | 0.053 | 0.054 | 0.054 |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| ln($1+Market value) | 0.951 | 0.951 | 0.953 | 0.912 | 0.913 | 0.910 |
| | (0.013) | (0.012) | (0.012) | (0.013) | (0.012) | (0.013) |
| Firm FE | No | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 |
| Firms | 282 | 282 | 282 | 282 | 282 | 282 |
| Observations | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 |
| Adjusted R-squared | 0.951 | 0.951 | 0.951 | 0.954 | 0.954 | 0.954 |

*Notes:* This table presents OLS estimates of the relationship between private value and future production, conditional on firms' primary industries (defined according to Fama and French (1993)). The excluded industry is *Other*. Standard errors (in parentheses) are clustered by year.

Table 16: Variation by Firm Scientific and Technological Capabilities

| Dependent variable: | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | ln($1+Private value) | | | | |
| | Scientific capabilities | Competitive/ noncompetitive production | Technological capabilities | Competitive/ noncompetitive production | Both scientific and technological capabilities |
| ln($1+Obligated value of future production, 5 years) | -0.020 | | -0.001 | | |
| | (0.010) | | (0.013) | | |
| × *High scientific capabilities* | 0.095 | | | | |
| | (0.013) | | | | |
| × *High technological capabilities* | | | 0.079 | | |
| | | | (0.016) | | |
| ln($1+Obligated value of future noncompetitive prod., 5 years) | | -0.017 | | 0.015 | -0.030 |
| | | (0.008) | | (0.015) | (0.006) |
| × *High scientific capabilities* | | 0.106 | | | 0.079 |
| | | (0.010) | | | (0.015) |
| × *High technological capabilities* | | | | 0.071 | 0.044 |
| | | | | (0.020) | (0.018) |
| ln($1+Obligated value of future competitive prod., 5 years) | | -0.004 | | -0.009 | -0.014 |
| | | (0.008) | | (0.006) | (0.011) |
| × *High scientific capabilities* | | -0.011 | | | -0.003 |
| | | (0.008) | | | (0.010) |
| × *High technological capabilities* | | | | -0.002 | 0.007 |
| | | | | (0.011) | (0.012) |
| High scientific capabilities | -0.431 | -0.246 | | | -0.177 |
| | (0.106) | (0.092) | | | (0.089) |
| High technological capabilities | | | -0.465 | -0.293 | -0.229 |
| | | | (0.098) | (0.083) | (0.077) |
| ln($1+Options value of focal contract) | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.072 | 0.067 | 0.071 | 0.067 | 0.064 |
| | (0.007) | (0.006) | (0.007) | (0.007) | (0.006) |
| ln($1+Market value) | 0.949 | 0.917 | 0.955 | 0.926 | 0.914 |
| | (0.009) | (0.008) | (0.011) | (0.011) | (0.009) |
| Firm FE | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 675.08 | 675.08 | 675.08 | 675.08 | 675.08 |
| Firms | 282 | 282 | 282 | 282 | 282 |
| Observations | 19,461 | 19,461 | 19,461 | 19,461 | 19,461 |
| Adjusted R-squared | 0.949 | 0.951 | 0.949 | 0.950 | 0.952 |

*Notes:* This table presents OLS estimates of the relationship between private value and future production, conditional on firm scientific and technological capabilities. *High scientific capabilities* is an indicator equal to 1 if the firm's annual publications count is above median (compared to annual publications between 1980 and 2024 of other firms operating in the same SIC4 industry) and 0 otherwise. *High technological capabilities* is an indicator equal to 1 if the firm's annual patent count is above median (compared to annual patents between 1980 and 2024 of other firms operating in the same SIC4 industry) and 0 otherwise. Standard errors (in parentheses) are clustered by year.

Table 17: Sample Construction

| Step | Description | Firms remaining | Firm-award dates | Obligated value of R&D contracts | Obligated value of production contracts |
|---|---|---|---|---|---|
| 1 | Raw dataset | 7,996 | | | |
| 2 | Drop non-contractors | 3,760 | 1,134,725 | $752.50 | $4,538.47 |
| 3 | Drop deobligations | 3,738 | 1,068,720 | $757.99 | $4,602.66 |
| 4 | Keep only reportable contracts | 886 | 83,739 | $713.19 | $4,193.81 |
| 5 | Keep only reportable R&D contracts | 320 | 21,133 | $673.39 | $1,529.01 |
| 6 | Keep only reportable R&D contracts awarded during April 1, 1984-Sept. 30, 2024 | 314 | 20,547 | $654.26 | $1,460.64 |
| 7 | Drop missing stock returns | 282 | 19,461 | $525.59 | $1,159.00 |
| 8 | Final analysis sample | 282 | 19,461 | $525.59 | $1,159.00 |

*Notes:* This table documents the sequential steps used to construct the final analysis sample. Starting from the DISCERN 2.1 dataset of publicly traded, R&D-performing U.S. firms from 1980 to 2024 (Arora et al., 2025), we report the number of firms, firm-award dates, and obligated value of R&D and production contracts (in current $ billions) remaining after each restriction or cleaning procedure.

Table 18: Share Turnover Around R&D Contract Award Dates

| Dependent variable: | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Share turnover, $h_{fd}$ | | | |
| | Baseline | Any confounders | Specific confounders | Production contracts |
| $I_{fd-4}$ | 0.020 | 0.020 | 0.021 | 0.021 |
| | (0.008) | (0.008) | (0.009) | (0.009) |
| $I_{fd-3}$ | 0.007 | 0.007 | 0.007 | 0.007 |
| | (0.010) | (0.010) | (0.009) | (0.009) |
| $I_{fd-2}$ | 0.001 | 0.000 | 0.000 | 0.000 |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| $I_{fd-1}$ | 0.011 | 0.012 | 0.010 | 0.010 |
| | (0.007) | (0.006) | (0.007) | (0.007) |
| $I_{fd}$ | 0.009 | 0.010 | 0.010 | 0.010 |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| $I_{fd+1}$ | 0.021 | 0.020 | 0.020 | 0.020 |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| $I_{fd+2}$ | 0.010 | 0.010 | 0.010 | 0.009 |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| $I_{fd+3}$ | 0.009 | 0.009 | 0.008 | 0.008 |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| $I_{fd+4}$ | 0.006 | 0.006 | 0.006 | 0.005 |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| Any confounding announcement | | 0.171 | | |
| | | (0.006) | | |
| Alliance announcement | | | 0.061 | 0.061 |
| | | | (0.010) | (0.010) |
| Bankruptcy announcement | | | 0.574 | 0.574 |
| | | | (0.451) | (0.451) |
| Dividend announcement | | | 0.003 | 0.003 |
| | | | (0.004) | (0.004) |
| Earnings announcement | | | 0.532 | 0.532 |
| | | | (0.022) | (0.022) |
| Executive change announcement | | | 0.027 | 0.027 |
| | | | (0.008) | (0.008) |
| Fixed income announcement | | | 0.190 | 0.190 |
| | | | (0.028) | (0.028) |
| Financing announcement | | | 0.042 | 0.041 |
| | | | (0.024) | (0.024) |
| Guidance announcement | | | 0.234 | 0.234 |
| | | | (0.028) | (0.028) |
| Index announcement | | | 0.318 | 0.318 |
| | | | (0.045) | (0.045) |
| Lawsuit announcement | | | 0.091 | 0.091 |
| | | | (0.012) | (0.012) |
| M&A announcement | | | 0.120 | 0.120 |
| | | | (0.013) | (0.013) |
| Private placement announcement | | | 0.118 | 0.118 |
| | | | (0.024) | (0.024) |
| Rating announcement | | | 0.403 | 0.403 |
| | | | (0.048) | (0.048) |
| Stock split announcement | | | 0.268 | 0.268 |
| | | | (0.066) | (0.066) |
| Any production contract award | | | | 0.002 |
| | | | | (0.003) |
| Firm x year FE | Yes | Yes | Yes | Yes |
| Calendar date FE | Yes | Yes | Yes | Yes |
| Mean DV | 1.05 | 1.05 | 1.05 | 1.05 |
| Firms | 283 | 283 | 283 | 283 |
| Observations | 1,671,152 | 1,671,152 | 1,671,152 | 1,671,152 |
| Adjusted R-squared | 0.541 | 0.543 | 0.546 | 0.546 |

*Notes:* This table presents the estimation results for the relationship between share turnover and indicator variables taking the value 1 if the focal firm received a reportable R&D contract on the focal date, and 0 otherwise. Standard errors (in parentheses) are clustered by year.

Table 19: Private Value of R&D Contracts Using Alternative Assumptions

| | (1) | (2) | (3) | (4) | (5) | (6) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| | | | | Distribution | | | | |
| | Obs. | Mean | Std. dev. | 5th | 10th | 50th | 90th | 95th |
| **A. Cauchy Distributions** | | | | | | | | |
| Private value (2017 $ million) | 19,461 | 2,484 | 2,640 | 40 | 109 | 1,767 | 6,225 | 7,624 |
| Private value / Obligated value (%) | 19,461 | 9,978 | 22,192 | 118 | 282 | 3,426 | 23,607 | 40,165 |
| Private value / Base and all options value (%) | 19,461 | 9,230 | 21,464 | 96 | 230 | 2,942 | 21,466 | 37,388 |
| **B. Non-Zero Probability of Winning** | | | | | | | | |
| Private value (2017 $ million) | 19,461 | 1,565 | 2,974 | 10 | 26 | 616 | 3,522 | 5,931 |
| Private value / Obligated value (%) | 19,461 | 5,268 | 14,624 | 29 | 74 | 1,310 | 12,236 | 22,290 |
| Private value / Base and all options value (%) | 19,461 | 4,816 | 13,591 | 24 | 62 | 1,132 | 11,264 | 20,411 |
| **C. Three-Day Estimation Window** | | | | | | | | |
| Private value (2017 $ million) | 19,461 | 1,144 | 1,337 | 12 | 35 | 703 | 2,947 | 3,852 |
| Private value / Obligated value (%) | 19,461 | 4,358 | 9,664 | 35 | 92 | 1,402 | 10,681 | 17,799 |
| Private value / Base and all options value (%) | 19,461 | 4,029 | 9,233 | 29 | 76 | 1,205 | 9,871 | 16,795 |

*Notes:* This table presents descriptive statistics for the re-estimated private value of R&D contracts. Panel A reflects the assumption of Cauchy distributions. Panel B reflects the assumption that the ex-ante probability of winning decreases in the number of bidders and increases in the number of R&D contracts won by the focal firm in the previous year. Panel C uses a 3-day window following the award date, $[t+1, t+3]$, to estimate the private value.

Table 20: Private Value of R&D Contracts and Future Demand

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | Future = 3 years | Future = 5 years | Future = 10 years | Future = 3 years | Future = 5 years | Future = 10 years |
| ln($1+Obligated value of future govt. demand) | 0.162 | 0.161 | 0.153 | | | |
| | (0.015) | (0.015) | (0.013) | | | |
| ln($1+Value of future private demand) | -0.065 | -0.069 | -0.086 | -0.066 | -0.066 | -0.078 |
| | (0.015) | (0.015) | (0.014) | (0.014) | (0.014) | (0.013) |
| ln($1+Obligated value of future noncompetitive prod.) | | | | 0.073 | 0.076 | 0.074 |
| | | | | (0.008) | (0.008) | (0.009) |
| ln($1+Obligated value of future competitive prod.) | | | | -0.008 | -0.007 | -0.002 |
| | | | | (0.007) | (0.007) | (0.007) |
| ln($1+Options value of focal contract) | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.039 | 0.039 | 0.039 | 0.068 | 0.067 | 0.064 |
| | (0.007) | (0.007) | (0.006) | (0.006) | (0.006) | (0.006) |
| ln($1+Market value) | 0.956 | 0.958 | 0.977 | 0.991 | 0.986 | 0.994 |
| | (0.015) | (0.014) | (0.012) | (0.016) | (0.016) | (0.014) |
| Firm FE | No | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 637.62 | 621.26 | 612.66 | 637.62 | 621.26 | 612.66 |
| Firms | 272 | 271 | 271 | 272 | 271 | 271 |
| Observations | 17,923 | 17,765 | 17,550 | 17,923 | 17,765 | 17,550 |
| Adjusted R-squared | 0.955 | 0.954 | 0.954 | 0.947 | 0.946 | 0.947 |

*Notes:* This table presents OLS estimation results for the relationship between the estimated private value of R&D contracts and future demand. Future government demand is the sum of R&D and production contracts awarded to the firm during the 3/5/10-year period following the focal award. Future private demand is sales minus future government demand. Standard errors (in parentheses) are clustered by year.

Table 21: Robustness Checks: Using R&D-Only Award Dates

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | Baseline | Baseline by regime | Vertical integration baseline | Vertical integration by regime | Firm size baseline | Firm size by regime |
| ln($1+Obligated value of future production) | 0.046 | | -0.003 | | -0.027 | |
| | (0.006) | | (0.005) | | (0.004) | |
| × *Vertically integrated* | | | 0.097 | | | |
| | | | (0.011) | | | |
| × *Large* | | | | | 0.084 | |
| | | | | | (0.007) | |
| ln($1+Obligated value of future noncompetitive prod.) | | 0.044 | | -0.010 | | -0.006 |
| | | (0.005) | | (0.005) | | (0.006) |
| × *Vertically integrated* | | | | 0.110 | | |
| | | | | (0.011) | | |
| × *Large* | | | | | | 0.058 |
| | | | | | | (0.008) |
| ln($1+Obligated value of future competitive prod.) | | 0.001 | | 0.007 | | -0.020 |
| | | (0.005) | | (0.006) | | (0.005) |
| × *Vertically integrated* | | | | -0.017 | | |
| | | | | (0.010) | | |
| × *Large* | | | | | | 0.025 |
| | | | | | | (0.009) |
| Vertically integrated | | | -0.540 | -0.376 | | |
| | | | (0.093) | (0.077) | | |
| Large | | | | | -0.416 | -0.276 |
| | | | | | (0.069) | (0.057) |
| ln($1+Options value of focal contract) | -0.002 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | 0.075 | 0.071 | 0.061 | 0.051 | 0.073 | 0.069 |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.008) | (0.008) |
| ln($1+Market value) | 0.938 | 0.927 | 0.903 | 0.883 | 0.931 | 0.919 |
| | (0.008) | (0.008) | (0.010) | (0.012) | (0.009) | (0.009) |
| Firm FE | No | No | No | No | No | No |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 428.36 | 428.36 | 428.36 | 428.36 | 428.36 | 428.36 |
| Firms | 275 | 275 | 275 | 275 | 275 | 275 |
| Observations | 6,477 | 6,477 | 6,477 | 6,477 | 6,477 | 6,477 |
| Adjusted R-squared | 0.940 | 0.941 | 0.946 | 0.948 | 0.943 | 0.943 |

*Notes:* This table presents OLS estimates of the relationship between the private value of R&D contracts and future production contracts after excluding firm-award dates when reportable production contracts are also awarded. Standard errors (in parentheses) are clustered by year.

Table 22: Robustness Checks: Using R&D-Only Award Dates and Adding Firm Fixed Effects

| Dependent variable: | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ln($1+Private value) | | | | | |
| | Baseline | Baseline by regime | Vertical integration baseline | Vertical integration by regime | Firm size baseline | Firm size by regime |
| ln($1+Obligated value of future production) | 0.012 | | 0.013 | | -0.028 | |
| | (0.006) | | (0.006) | | (0.011) | |
| × *Vertically integrated* | | | -0.002 | | | |
| | | | (0.007) | | | |
| × *Large* | | | | | 0.043 | |
| | | | | | (0.011) | |
| ln($1+Obligated value of future noncompetitive prod.) | | 0.022 | | 0.009 | | 0.005 |
| | | (0.007) | | (0.007) | | (0.008) |
| × *Vertically integrated* | | | | 0.029 | | |
| | | | | (0.008) | | |
| × *Large* | | | | | | 0.019 |
| | | | | | | (0.009) |
| ln($1+Obligated value of future competitive prod.) | | -0.008 | | 0.011 | | -0.037 |
| | | (0.005) | | (0.005) | | (0.008) |
| × *Vertically integrated* | | | | -0.027 | | |
| | | | | (0.006) | | |
| × *Large* | | | | | | 0.030 |
| | | | | | | (0.009) |
| Vertically integrated | | | 0.059 | 0.059 | | |
| | | | (0.047) | (0.034) | | |
| Large | | | | | -0.112 | -0.069 |
| | | | | | (0.096) | (0.082) |
| ln($1+Options value of focal contract) | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| ln($1+Obligated value of focal contract) | -0.010 | -0.010 | -0.010 | -0.010 | -0.010 | -0.010 |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.004) |
| ln($1+Market value) | 0.895 | 0.894 | 0.895 | 0.889 | 0.888 | 0.886 |
| | (0.020) | (0.020) | (0.020) | (0.020) | (0.021) | (0.021) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mean DV | 433.39 | 433.39 | 433.39 | 433.39 | 433.39 | 433.39 |
| Firms | 188 | 188 | 188 | 188 | 188 | 188 |
| Observations | 6,390 | 6,390 | 6,390 | 6,390 | 6,390 | 6,390 |
| Adjusted R-squared | 0.984 | 0.984 | 0.984 | 0.984 | 0.984 | 0.984 |

*Notes:* This table presents OLS estimates of the relationship between the private value of R&D contracts and future production contracts after (1) excluding firm-award dates when reportable production contracts are also awarded and (2) adding firm fixed effects. Standard errors (in parentheses) are clustered by year.