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# Does Government Spending Crowd Out R&D Investment? Evidence from Government-Dependent Firms and Their Peers

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## Abstract

We provide evidence that managerial incentives to manipulate real activities can influence the effectiveness of fiscal policy. Increases in federal spending lead government-dependent firms to expand research and development (R&D) investment whereas industry-peer firms contract. The net result is a reduction in industry-level R&D investment. We find evidence of a novel mechanism for the crowding out of peer-firm investment: peer-firm managers respond to falling relative performance by cutting R&D to manage current earnings upward. We show that these differential responses manifest in firm value. These findings are robust to endogeneity and selection concerns as well as a battery of alternative explanations.

## I. Introduction

Government spending represents a significant portion of the United States' gross domestic product (GDP), averaging over 37% between 1970–2017 and now accounts for over 50% of GDP growth (Davidson (2018)). While government spending can plausibly impact firms throughout the economy, its effect will be especially pronounced in government suppliers. The U.S. federal government is the single largest customer in the world with annual spending in excess of half a trillion

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dollars on goods and services. As a result, many firms in the economy are dependent on the government spending as a major source of sales revenue.[1] For example, Booz Allen Hamilton Holding Corporations 2018 annual report states that "Our business, prospects, financial condition, or operating results could be materially harmed… by… budgetary constraints, including Congressionally mandated automatic spending cuts, affecting U.S. government spending generally, or specific agencies in particular, and changes in available funding."

The last half century has also seen total research and development (R&D) spending in the United States grow significantly, currently amounting to approximately $US500 billion per year. While government spending impacts R&D expenditures through the direct federal funding of small, private new ventures (Howell (2017)), it can also *indirectly* influence private R&D expenditures of large, publicly traded firms. Specifically, since R&D increases with size and sales (e.g. Klette and Griliches (2000)), if higher government spending results in higher earnings for firms dependent on government spending as a major source of revenue, then government spending may also increase private R&D spending through this sales channel.[2] In this paper, we analyze the relation between government spending and private R&D expenditures through this channel.

We take a new approach to studying the impact of government spending on private investment by examining the heterogeneous responses in the R&D expenditures of three distinct types of firms to government spending (discussed in detail in Section III and the Supplementary Material). First, we study government-dependent (GD) firms that rely on government spending as a major source of sales revenue, making them particularly sensitive to changes in federal spending. Second, we consider the nondependent industry peers of the GD firms, or those operating in the same industries as GD firms and producing similar products and services, but specialize in providing their products and services to the private sector. These firms may be indirectly impacted by changes in government spending. Finally, we also consider nonpeer firms that operate in industries with no GD firms. We briefly discuss our predictions regarding these groups in the following and in more detail in Section II.

First, we predict that as a result of their higher profitability, GD firms will increase R&D spending in response to government spending increases (e.g., Brown et al. (2009)). Second, we predict that increases in government spending will lead peers of GD firms to decrease R&D investment, whereas nonpeers will remain unaffected. As opposed to traditional hypothesized mechanisms of public spending

[1]For example, 70% of Lockheed Martin's $53.8 billion in sales came from the U.S. Government in 2018. However, this dependence is not isolated to traditional defense industry firms: Amazon has expanded sales of consumer goods through procurement contracts to the federal government and was vying with Microsoft for a $10 billion Joint Enterprise Defense Infrastructure contract with its Amazon Web Services segment. Further, Humana Inc. ($5.5bn, or 81% of their plan premiums and service revenue), General Electric ($3.2bn in government sales), Deloitte LLP ($1.9bn in government sales), and FedEx Corp. ($1.0bn in government sales) were all among the top 100 contractors to the federal government in 2018.

[2]Further, as a result of a lack of collateral (compared to capital investment), higher information asymmetries due to the technical R&D process, and a desire for firms to protect intellectual property, R&D is primarily funded through internal cash flow (Brown, Fazzari, and Petersen (2009)).

reducing private investment (see David, Hall, and Toole (2000) for a comprehensive review), we propose a relative-performance channel as a novel mechanism to explain this response that has been previously overlooked. Briefly, relative performance evaluation provides managers with both explicit (i.e., compensation contracts) and implicit (career or reputation concerns) incentives to avoid declines in performance relative to industry peers (e.g., see Gibbons and Murphy (1990), Holmstrom (1979), (1999), and Zwiebel (1995)). Additionally, research shows that firms vary R&D to meet earning targets (e.g., Bushee (1998), Dechow and Sloan (1991)). Therefore, when an increase in government spending results in an increase in GD firm earnings and profitability (and therefore a decrease in the relative performance of peer firms), we expect managers of peer firms to adjust short-term earnings up by cutting R&D expenditure.[3] In contrast, we do not expect nonpeers to respond to changes in government spending because their performance is not benchmarked against GD firms.

Following the recent literature to identify large customers of operating firms (e.g., Dhaliwal, Judd, and Shaikh (2016), Ellis, Fee, and Thomas (2012), Harford, Schonlau, and Stanfield (2019), and Hertzel, Li, Officer, and Rodgers (2008)), we find evidence consistent with our predictions: following increases in government spending, GD firms increase investment in R&D, whereas their industry-peers contract and nonpeers do not significantly respond. Although we observe a positive impact on GD firm investment in R&D, we also find that, on net, government spending reduces (i.e., “crowds out”) industry-level investment in R&D due to the reduction in R&D of the industry peers of GD firms. We also present analysis suggesting these effects have significant differential value impacts on these firms. Therefore, we present evidence consistent with both sides of the existing literature examining the relation between government spending and private R&D.

In a series of tests motivated by the literature, we find evidence consistent with relative performance evaluation acting as the primary mechanism explaining industry-peer contraction.[4] Consistent with our prediction, we show that peer firms experience a relative decline in sales but not earnings. We also find that the R&D reductions for industry peers are concentrated in firms where earnings management is most likely: i) firms with CEOs whose pay is most sensitive to industry performance (i.e., stronger relative performance evaluation); ii) firms with CEOs with greater career concerns (i.e., younger CEOs); iii) firms in more competitive industries (Aggarwal and Samwick (1999)); iv) years when government spending increases, rather than declines; and v) in firms belonging to industries with lower unionization (Bova (2013)). In the Supplementary Material, we do not observe a similar reduction in capital expenditures (which does not impact relative earnings); we obtain evidence that peer firms manage earnings through other discretionary

[3]Despite involving temporary adjustments to R&D and other discretionary expenses to manage short-term earnings, previous studies document real earnings management can have significant long-term value and other real effects (e.g., see Stein (1989), Bereskin, Hsu, and Rotenberg (2018)).

[4]Several papers studying real earnings management, including Baber, Fairfield, and Haggard (1991), Bens, Nagar, and Wong (2002), Bens, Nagar, Skinner, and Wong (2003), Bereskin et al. (2018), Bushee (1998), Cohen, Dey, and Lys (2008), Cohen and Zarowin (2010), Dechow and Sloan (1991), Edmans, Fang, and Lewellen (2017), Graham, Harvey, and Rajgopal (2005), Roychowdhury (2006), and Stein (1988), (1989).

expenses (i.e., advertising and selling, general, and administrative expense (SG&A)) in response to variation in government spending; and we find that the likelihood that peer-firms cut R&D increases *only* if an increase in government spending is also associated with a decline in the relative performance of peers compared to the prior year (Bushee (1998)).

We explore and rule out several plausible alternative explanations for the negative response of peer-firms (and the positive response of GD firms) to variation in government spending in Section IV.D. Specifically, we do not find that macro-level considerations (i.e., price/interest rate/tax channel and the counter-cyclicality of government spending), competitive effects or peers responding to a negative shock (i.e., losing government contract bids), a displacement of funding in the presence of positive technology spillovers, political uncertainty, or political contributions are driving our results. We conclude that "crowding out," in our context, is not driven by these effects, but rather by the incentives of industry-peer managers to match the earnings of GD firms.

We also take several steps to mitigate the potential endogeneity of government spending to private investment. First, we study the value effects of unexpected budget-shocks on GD firms and their peers by utilizing key dates related to the U.S. government's credit rating downgrade and the Budget Control Act in 2011. We estimate that the cumulative abnormal return to GD firms is between $-1.7\%$ and $-3.6\%$ across these events, consistent with budget shocks causally impacting GD firms. Furthermore, these events impacted the value of peers that are more likely to manage earnings positively. Together, these tests suggest government spending significantly (and causally) impacts GD and peer firm value. Second, we introduce a variable representing split control in Congress to identify exogenous changes in government spending. Split control of Congress can influence the speed, direction, and magnitude of changes in spending but is plausibly exogenous to differential private investment by government-dependent firms and satisfies a variety of weak instrument tests (discussed in detail in Section V.B and the Supplementary Material). Taken together, these results document evidence that our findings are not driven by the endogeneity of government spending.

Finally, we perform a series of robustness tests to mitigate concerns regarding the comparability of our groups of firms (GD, peers, and nonpeers) and the potential endogeneity of firms choosing to be GD (i.e., "selection" effects) as discussed in Section V.C. Specifically, we perform our analysis using propensity-matched samples, we compare the effects of corporate vs. government customers, we study whether changes in government spending predict government dependence, and we perform our analysis in a subsample of firms that have ever listed the government as an important customer. In all of these tests, we do not find evidence that our results are driven by the selection of firms into government-dependence.

Our paper is related to the literature addressing the question of whether government spending crowds out private R&D investment. The extant literature documents mixed findings, some document significant positive spillovers to private R&D (e.g., Howell (2017), Levy and Terleckyj (1983), and Link (1982)), whereas others report the crowding out of private investment on the average firm or industry (e.g., Carmichael (1981), Wallsten (2000), and Cohen, Coval, and Malloy (2011)).

We document the heterogenous effects of government-spending impacts on firm R&D investment by examining the impact of fiscal policy on three types of firms (GD, peer, and nonpeer firms) and contribute to this literature by showing that in addition to the direct funding effect of small, private new ventures documented by Howell (2017), government spending can indirectly increase the R&D of GD firms through a sales/earnings channel. However, we also document that government spending reduces R&D spending in GD industries due to reductions in R&D spending by peers of GD firms consistent with papers such as Cohen et al. (2011). Finally, we offer a novel, and previously undocumented, mechanism through which government spending can deter private R&D and crowd out industry level investment: peer firms cut R&D expenses to manage short-term earnings when faced with a decline in relative earnings. We therefore provide the first evidence for the role of R&D's impact on earnings, combined with industrial relative performance evaluation and managerial incentives in understanding the mechanisms behind fiscal crowding out.[5] We also contribute to the literature on relative performance evaluation (discussed in Section II) by providing some of the first evidence that relative performance evaluation alters managerial behavior.

## II. Hypothesis Development

We now develop hypotheses for the heterogeneous impact of government spending on the R&D investment of different types of firms. Specifically, we focus on three types of firms that we expect to respond differently to changes in government spending: GD firms, peer-firms, and nonpeers. To this end, we also propose a mechanism to explain the heterogeneous impact across firm type.

GD firms respond to changes in government spending because variation in the spending impacts the expected value of current and future government contracts. Increases in government spending increases the probability and size of future contracts as well as the values of current contracts, since most government contracts have built-in options to purchase additional units.[6] Therefore, we expect the R&D investment of GD firms to increase when government spending increases.

[5]Broadly speaking, our paper related to the growing literature on the influence that government and politics can have on economic outcomes and corporate behavior (e.g., Belo, Gala, and Li (2013), Cohen and Malloy (2016), Dinc and Gupta (2011), Duchin and Sosyura (2012), Goldman (2018), Julio and Yook (2012), Liu and Ngo (2014), and Pastor and Veronesi (2012)). Our paper is also related to the literature on the impact of government spending on private (capital) investment and output (key references include Ramey and Shapiro (1998), Edelberg, Eichenbaum, and Fisher (1999), Blanchard and Perotti (2002), Burnside, Eichenbaum, and Fisher (2004), Cohen et al. (2011), and Kim and Nguyen (2020)).

[6]The exact details of government procurement contracts are not publicly available, however, in cases where a losing bidder makes a protest, details of the original request for quotation (RFQ) are released (e.g., see Cohen and Malloy (2016), Canayaz, Cornaggia, and Cornaggia (2019)). Two recent cases highlight the typical structure of a government procurement contract. First is a request from the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) for acquisition and grant management services. The RFQ asked for a blanket purchase agreement for a base-year and four 1-year options for acquisition and grant management services. See: http://www.gao.gov/products/D09839#mt=e-report. Second, the Defense Logistics Agency issued a RFQ for the delivery of 74,274 track pads with an option to purchase 74,274 additional units. See: http://www.gao.gov/products/D09736#mt=e-report.

Higher government spending may increase private R&D for GD firms by increasing GD firm sales and improving profitability. Financing frictions restrict R&D investment more than other forms of investment (e.g., see Brown et al. (2009), Hall (1992), (2002), and Himmelberg and Petersen (1994)). These frictions can restrict R&D investment due to a lack of collateral and higher information asymmetries, protecting intellectual property. As such, the least-cost form of finance for R&D is internal cash flow (Brown et al. (2009)). Higher government spending will result in higher cash flows and profit for dependent firms, thus making it possible to fund R&D projects internally. This discussion leads us to our first hypothesis:

*Hypothesis 1.* Government-dependent firms increase R&D investment in response to an increase in government spending.

A key prediction from agency theory is that there are benefits from explicitly evaluating managers through compensation contracts on the basis of relative performance when firms face common business risks (i.e., within the same industry). In these situations, relative performance evaluation (RPE) can provide incentives while insulating managers from common uncertainty (Holmstrom (1979)).[7] However, although RPE in compensation contracts offers benefits in the form of risk-sharing when firms face common shocks, it can also entail costs. RPE can generate perverse incentives for managers to match the performance of peers by, for example, colluding, sabotaging the measured performance of peers, or manipulating one's own measured performance (Gibbons and Murphy (1990)). There is sufficient empirical evidence to suggest that relative performance is an important consideration when designing CEO compensation contracts. For example, Bettis, Bizjak, Coles, and Kalpathy (2018) show that about half of the compensation contracts they examine contained explicit provisions for relative performance evaluation. Other papers finding evidence of RPE include Gibbons and Murphy (1990), Hall and Liebman (1998), Albuquerque (2009), Lewellen (2015), Gong, Li, and Shin (2011), and De Angelis and Grinstein (2020).[8]

Implicit incentives outside current salary in the form of reputation or career concerns can also induce perverse incentives. Although early theoretical work focused on showing that career concerns can induce additional effort (e.g., Fama (1980), Gibbons and Murphy (1992), Holmstrom (1999), and Lazear and Shaw (2007)), recent studies show that career concerns may incentivize individuals to choose actions that are welfare decreasing (e.g., Seimsen (2008)). More generally, in the presence of common-industry risk, several models (e.g., Scharfstein and Stein (1990), Zwiebel (1995), and Prendergast and Stole (1996)) show that reputation concerns lead managers to adjust their behavior to influence how the market infers managerial ability based on relative performance. Empirically, Chevalier and Ellison (1999) and Hong, Kubik, and Solomon (2000) show that herding behavior is stronger in analysts with greater career concerns. Further, Chevalier and Ellison (1997) show that reputation concerns lead fund managers to take excessive risk when behind the industry benchmark in the last quarter prior to relative evaluation occurs.

[7]See Prendergast (1999) for a review of the provision of incentives in a firm.
[8]See Edmans, Gabaix, and Jenter (2017) for a review of the RPE literature.

The previous discussion suggests that relative performance evaluation provides both explicit and implicit incentives for managers to match the industry standard. This type of managerial myopia is common (Graham et al. (2005)), can impact firm R&D investment and be detrimental to long-term firm value and performance (Stein (1989)), and has been documented in previous research (e.g., Bereskin et al. (2018), Bushee (1998), Dechow and Sloan (1991), Edmans et al. (2017), and Graham et al. (2005)).

An increase in government spending improves the earnings and sales growth of GD firms relative to their industry peers due to the persistence of being GD. Because managers tend to vary R&D in an attempt to meet earnings benchmarks (e.g., Bushee (1998), Dechow and Sloan (1991)) and peer firm managers are evaluated on a relative basis against GD firms, managers have strong incentives to take actions to avoid a decline in relative performance by cutting R&D expenditures. Therefore, we propose a novel channel through which government spending can crowd out the private investment of peers: real earnings management. Furthermore, because the managers of nonpeers are not evaluated against the performance of GD firms, we expect that nonpeers will not vary R&D significantly when government spending changes. This discussion is summarized in our second hypothesis:

*Hypothesis 2.* Peers of government-dependent firms reduce R&D when government spending increases due to an earnings management channel, whereas nonpeer R&D spending will not vary with changes in government spending.

The predicted positive relation between GD firm R&D investment and government spending and the negative relation between industry peer R&D investment and government spending could be the result of other mechanisms. Therefore, we also consider a number of plausible alternative hypotheses (e.g., macroeconomic or competitive effects) that might explain a reduction in peer-firm R&D. A detailed discussion of these alternatives and associated tests are in Section IV.D. However, note that any theory offered to explain a reduction in peer-firm investment in response to rising government expenditure must also *simultaneously* predict that nonpeers do not adjust R&D significantly.

## III. Background and Data

This section provides are brief discussion of the U.S. federal government budget process and the data used in this paper. The Supplementary Material contains a more detailed discussion of the budget process and, in particular, of why our approach to measuring federal spending related to R&D is superior to alternative measures.

### A. Government Budget Process

The federal budget for the U.S. government is incredibly large; the 2015 Budget for example, was almost $4 trillion.[9] Spending is divided into two broad

[9]The President's Budget proposal totaled $3.9 trillion (see: https://www.gpo.gov/fdsys/pkg/BUDGET-2015-BUD/pdf/BUDGET-2015-BUD.pdf), whereas the final budget totaled $3.7 trillion (see: https://www.cbo.gov/publication/51110).

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types. The first component (the focus of this paper) is referred to as discretionary spending. This type of spending comprised approximately 30% of the total budget in 2015 and is negotiated annually, requiring Congress to provide spending authority (i.e., funding) in appropriations acts each year. Failure to appropriate funds before the end of the fiscal year implies the cessation of funding, which occurred in 2013 and 2018, resulting in the partial shutdown of U.S. government functions. The discretionary budget authority (DBA) sets the maximum available funds for discretionary programs in the following fiscal year. Therefore, it represents expected aggregate (discretionary) federal expenditure levels (i.e., outlays) because the distribution and actual level of spending is yet to be determined when Congress approves a certain level of funding.

There is no overall R&D budget and no special treatment of R&D within most agency budgets. Rather, R&D expenditures are folded into regular budget items of more than two dozen federal departments and independent agencies (Hourian (2015)). However, almost all federal R&D spending comes from the discretionary component of the budget and R&D spending as a percentage of the discretionary budget is remarkably stable, especially during our sample period (1990–2013). We argue that DBA, relative to traditional measures (discussed in further detail in the Supplementary Material), suffers less from simultaneity problems. While DBA captures both the direct (i.e., R&D grants) and indirect (i.e., improved performance leading to increased R&D spending) time varying impacts of government spending on private R&D, the indirect impacts should be the most material in our analysis given the large, publicly traded nature of our sample of GD firms.

The budget calendar and timing of when managers first learn about the size of the Budget Authority for the coming fiscal year is important to our empirical setting. The formal budget process begins when the President is generally required to transmit a budget proposal to Congress for consideration by early February of the prior year.[10] The House then begins consideration of annual appropriations bills to approve a discretionary budget authority by June 30. Therefore, in a typical year, the budget authority for year $t$ is known to managers in year $t-1$. We therefore examine how the DBA for year $t$ (established in $t-1$) influences firm R&D decisions in year $t$. We discuss the budget calendar and timing of the Budget Authority in further detail in the Supplementary Material.

We argue that when the DBA is announced peers know whether, in the next year, they are more or less likely to underperform GD firms. This is because, as we will show in the following, when DBA increases, peers know they are not likely to become a GD firm but that the profits of GD firms are going to increase leading to a fall in their relative performance. Thus, they can immediately start planning to cut R&D and other discretionary expenses.

## B. Data

To perform our analysis, we require an accurate classification of GD firms and non-GD firms (peers) within a given industry. Therefore, we exploit the statutory

[10]This deadline is extended if there is a change in the administration to allow sufficient time for the new administration to develop a budget policy. In these years, the timeline for transmitting the President's proposal to Congress is typically extended to April or May; however, there is no specific date that is set by law.

requirement mandating firms to report the identity of customers representing more than 10% of total firm sales to identify and create a database of firms that identify the federal government as a major customer from the Compustat segments file from 1990–2013.

We begin with classifications of customer type reported in Compustat and later manually check each observation to ensure government, private firm, market, and geographic region customers are correctly identified as such. Because being a GD firm is highly persistent, we also restrict the sample of firms reporting actual sales to the government. By focusing on these firms, we rely on within-firm variation in sales to the government (as a fraction of total sales) to identify the impact of government spending on R&D for dependent firms. After aggregating the data at the firm-year level and restricting the sample to firms with reported R&D, we obtain a sample of 47,806 firm-year observations, of which 4,847 correspond to firm-years where we have data on firm level sales to the federal government (representing approximately 11% of possible firm-years in our sample). In this sample, the average sales to the government as a fraction of total firm sales is approximately 24%.[11]

We define the variable GOVSALES (HIGOVSALES) as the lagged fraction of firm sales generated from federal government purchases (as an indicator equal to 1 when the proportion of sales that the U.S. federal government is responsible for is greater than the median of GD firms, and 0 otherwise). We define the indicator PEERGOVIND as equal to 1 for all firm years in the same 4-digit SIC as a GD firm but not reporting the federal government as a major customer, and 0 otherwise.[12] Nonpeers are firms operating in 4-digit SIC industries with no GD firms.

Motivated by the discussion of the budget process in the previous Section III.A and the Supplementary Material, our focus in this paper is on the entire discretionary component of federal spending. In particular, we measure expected changes in government spending by examining the variation in Discretionary Budget Authority (DBA) year-to-year obtained from the Office of Management and Budget (http://www.whitehouse.gov/omb/budget/historical-tables/). We define DBA as the total discretionary budget authority (in constant 2009 trillions of dollars). In a typical year, the budget authority for year $t$ is known to managers in year $t-1$. We therefore examine how the DBA for year $t$ (established in $t-1$) influences firm R&D decisions in year $t$. We provide a detailed description of this timing in the Supplementary Material.

We obtain firm-level accounting and market variables from the Compustat and CRSP databases, which are then matched to our existing sample of GD firms. We define R&D as total research and development expenditure scaled

[11]For the full sample, of a potential 118,823 observations, 12,788 correspond to years where we have data on firm sales to the government. The average sales to the government as a fraction of firm sales is approximately 23%. Thus, R&D firms are not particularly different from firms with missing R&D when it comes to voluntarily reporting the level of sales to the government. We present the industry distribution of firms that report the government as a major customer in Table A.1 of the Supplementary Material.

[12]The results of the paper are robust throughout to our definition of industry peer. The results are similar but slightly weaker when we define industry-peer on the basis of 3-digit SIC. This is expected because a broadening of the industry classification weakens the competitive effects between these peer firms and GD firms.

by assets.[13] We include (lagged, i.e., year $t$ - 1) control variables commonly found in the literature and defined in the Supplementary Material, where we also present figures plotting DBA over time. Table 1 presents summary statistics for the full sample of firms. The mean (median) value for DBA is $0.92 ($0.84) trillion 2009 dollars with a standard deviation of approximately $0.22 trillion. The mean R&D ratio for the full sample is 7.77%.

# IV. Results

## A. Government Spending and the R&D Investment of GD Firms

The first implication of our motivating discussion for Hypothesis 1 is that GD firm performance (i.e., sales growth and earnings) will improve relative to industry peers and nonindustry peers following increases in DBA. This improved GD firm performance as a result of government spending increases will lead GD firms to fund increases in R&D investment.

We test this implication directly in Table 2 by regressing the relation between the interaction of GOVSALES (models 1 and 3) or HIGOVSALES (models 2 and 4) and DBA on sales growth (models 1 and 2) and earnings (models 3 and 4).

TABLE 1

Summary Statistics

Table 1 reports summary statistics. R&D is research and development investment expenditure scaled by total assets; DBA is the total discretionary budget authority (in constant 2009 trillion dollars); GOV is an indicator equal to 1 if the federal government is a major customer, and 0 otherwise; GOVSALES is the ratio of firm sales sold to the federal government as a fraction of total sales (for firms with the federal government as a major customer), and 0 otherwise; HIGOVSALES is an indicator equal to 1 if GOVSALES is above median, and 0 otherwise; CASHHOLD is the stock of cash as a percentage of total assets; CASHFLOW is cash flow from operations as a percentage of total assets; SIZE is the natural logarithm of the market value of equity; MB is the market to book ratio; LEV is long-term debt plus short term debt as a percentage of market value; CAPEX is capital expenditure scaled by total assets; SALESGROWTH is the annual proportional change in total sales; EARNINGS is net income scaled by total assets; AGE is firm age in years; INFLATION is the annual inflation rate based on the consumer price index; GROWTH is the annual growth in real gross domestic product; 10YRTB is the 10-year constant maturity Treasury bond rate; and URATE is the unemployment rate. The number of observations used is $N$ = 47,806 and correspond to the sample used in the estimation of our main model (Table 3).

| | Mean | Std. Dev. | P25 | P50 | P75 |
|---|---|---|---|---|---|
| R&D | 7.77 | 12.25 | 0.31 | 3.31 | 10.44 |
| DBA | 0.92 | 0.22 | 0.73 | 0.84 | 1.09 |
| GOV | 0.09 | 0.29 | 0.00 | 0.00 | 0.00 |
| HIGOVSALES | 0.03 | 0.16 | 0.00 | 0.00 | 0.00 |
| GOVSALES | 2.16 | 11.56 | 0.00 | 0.00 | 0.00 |
| SALES | 20.36 | 46.34 | 0.06 | 0.72 | 13.47 |
| EARNINGS | 0.05 | 14.63 | −2.88 | 3.75 | 7.17 |
| CASHHOLD | 15.20 | 16.97 | 2.83 | 9.10 | 21.42 |
| CASHFLOW | 2.43 | 84.87 | 0.36 | 7.71 | 14.02 |
| SIZE | 5.57 | 2.06 | 4.06 | 5.49 | 6.98 |
| MB | 3.65 | 31.43 | 1.31 | 2.10 | 3.61 |
| LEV | 49.94 | 72.90 | 0.70 | 21.06 | 65.72 |
| CAPEX | 4.87 | 5.03 | 1.63 | 3.45 | 6.41 |
| SALESGROWTH | 0.20 | 0.77 | −0.02 | 0.09 | 0.23 |
| AGE | 14.65 | 10.90 | 6.00 | 11.00 | 20.00 |
| INFLATION | 2.59 | 1.07 | 1.70 | 2.60 | 3.34 |
| GROWTH | 2.64 | 1.77 | 1.68 | 2.73 | 4.33 |
| 10YRTB | 4.88 | 1.62 | 3.89 | 4.67 | 5.86 |
| URATE | 5.99 | 1.56 | 4.90 | 5.60 | 7.30 |

[13]We scale by assets to avoid a mechanical relation between firm sales to government and our measure of R&D.

TABLE 2

Budget Cycles and Corporate Performance

Table 2 reports regression results for firm sales growth and earnings. The independent variables of interest include: GOVSALES is the ratio of firm sales sold to the federal government as a fraction of total sales (for firms with the federal government as a major customer), and 0 otherwise; HIGOVSALES is an indicator equal to 1 if GOVSALES is above the median (for firms with the federal government as a major customer), and 0 otherwise; and DBA is the total discretionary budget authority (in constant 2009 dollars). Control variables include: CASHHOLD is the stock of cash as a percentage of total assets; CASHFLOW is cash flow from operations as a percentage of total assets; SIZE is the natural logarithm of the market value of equity; MB is the market to book ratio; LEV is long-term debt plus short term debt as a percentage of market value; AGE is firm age in years; INFLATION is the annual inflation rate based on the consumer price index; GROWTH is the annual growth in real gross domestic product; 10YRTB is the 10-year constant maturity Treasury bond rate; and URATE is the unemployment rate. Robust *t*-statistics (with standard errors double clustered by firm and year) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

| | Sales Growth | | Earnings | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| $GOVSALES_{t-1} \times DBA_t$ | 0.204** | | 4.157* | |
| | (2.24) | | (1.81) | |
| $GOVSALES_{t-1}$ | −0.280*** | | −2.938 | |
| | (−3.08) | | (−1.39) | |
| $HIGOVSALES_{t-1} \times DBA_t$ | | 0.131* | | 3.739*** |
| | | (2.01) | | (2.91) |
| $HIGOVSALES_{t-1}$ | | −0.161** | | −2.773* |
| | | (−2.46) | | (−2.05) |
| $PEERGOVIND \times DBA_t$ | | | | |
| PEERGOVIND | | | | |
| $CASHHOLD_{t-1}$ | 0.003*** | 0.003*** | 0.022* | 0.021* |
| | (5.66) | (6.02) | (1.82) | (1.76) |
| $SIZE_{t-1}$ | 0.025*** | 0.026*** | 2.558*** | 2.523*** |
| | (3.88) | (4.06) | (5.98) | (5.95) |
| $MB_{t-1}$ | −0.000** | −0.000** | −0.000 | −0.000 |
| | (−2.24) | (−2.25) | (−0.76) | (−0.84) |
| $LEV_{t-1}$ | 0.002** | 0.002** | 0.006 | 0.007 |
| | (2.35) | (2.35) | (1.33) | (1.41) |
| $AGE_{t-1}$ | −0.004*** | −0.004*** | −0.125*** | −0.126*** |
| | (−3.59) | (−3.47) | (−4.01) | (−4.20) |
| No. of obs. | 61,117 | 61,117 | 98,244 | 98,244 |
| $R^2$ | 0.264 | 0.262 | 0.499 | 0.496 |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |

We include a series of controls from the literature as well as firm and year fixed effects and double cluster standard errors by firm and year. Due to the inclusion of year fixed effects, the coefficient on DBA is subsumed.

We find evidence consistent with the positive relation between GD firm accounting performance/profitability and government spending in Table 2. Specifically, we document a positive and significant relation between government spending and GD firm performance for both measures of government dependence. To economically interpret these findings, we consider the size of year-on-year changes in DBA (conditional on increases). For a standard deviation increase in DBA (0.073), the coefficient estimate of 4.2 from column 2 of Table 2 and the mean GOVSALES of 2.16 (Table 1) imply an increase in ROA by about 0.6 percentage points (or 16% relative to the sample median ROA).

Having established the positive impact that government spending has on GD firm performance, we now formally test Hypothesis 1 and establish an empirical relation between government spending and firm-level R&D investment for GD firms relative to their peers and nonpeers. Our baseline model is:

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(1) $$\text{R\&D}_{it} = \beta_0 + \beta_1 \text{DBA}_t \times \text{GOVSALES}_{it-1} + \beta_2 \text{GOVSALES}_{it-1} + \beta_{Controls}\, Controls_{it-1} + \theta_i + \theta_t + \varepsilon_{it}.$$

where $\varepsilon_{it}$ is the error term, and $\theta_i$ and $\theta_t$ represent firm and year fixed effects to account for unobserved firm heterogeneity and allow us to estimate the within-firm impact of changes in DBA and sales to the government on firm investment in R&D and to account for common time trends, such as the impact of the financial crisis, respectively. Importantly, including firm fixed effects allows us to study abnormal changes in R&D spending, by studying within-firm effects of changes in DBA. We double cluster standard errors at the firm and year level.[14] We also reestimate equation (1) replacing GOVSALES with our HIGOVSALES indicator.

Models 1 and 2 in Table 3 report our baseline specifications including year and firm fixed effects. Due to the inclusion of year fixed effects in these models, the level effect of DBA is subsumed. Models 3 and 4 control for firm characteristics, firm-fixed effects, time-varying macroeconomic variables, and a linear time trend (rather than year fixed-effects).

We find support for Hypothesis 1 in Table 3. Specifically, we observe a positive and significant relation between DBA and R&D for GD firms (relative to peers and nonpeers). The point estimate on GOVSALES × DBA in model 1 suggests that an 0.07 increase in DBA leads to an increase in R&D by 0.80 for the average dependent firm (i.e., when evaluated at the mean GOVSALES of 2.16). Compared to the median R&D ratio, this translates to an economically significant increase of approximately 24%. These results show that increases in government spending are associated with economically large increases in R&D for GD firms and are consistent with Hypothesis 1, as well as recent evidence showing the positive effects of government grants on firm investment and revenues (Howell (2017)).

## B. Peer-Firm R&D, Government Spending, and Crowding Out

Table 4 tests the motivation and predictions of Hypothesis 2 and reports the effects of DBA changes on the relative profitability and R&D investment for industry peers and firms unrelated to GD firms. The analysis reported in Panel A is related to the results in Table 2 and demonstrate that peer-firm performance declines relative to GD firms when DBA increases; a necessary condition to provide peer firm managers with the incentive to reduce investment in R&D. Contrary to the improvement seen in GD firm performance in Table 2, we find that the sales growth of industry peers declines relative to other firms following increases in DBA. However, although the sales growth of industry peers is significantly lower than all other firms (model 1), there is not a significant difference between the earnings of peers and other firms (model 2). This result is consistent with industry peers reducing R&D spending to match the improved earnings of GD firms when GD

[14]In unreported tests, all of the results remain if we replace firm-fixed effects with 2-digit industry fixed-effects. Our results are robust to alternative clustering, namely by industry (2- or 4-didgit SIC) and year.

TABLE 3

**Budget Cycles and Corporate Investment**

Table 3 reports regression results for firm R&D. The independent variables of interest include the following: GOVSALES is the ratio of firm sales sold to the federal government as a fraction of total sales (for firms with the federal government as a major customer), and 0 otherwise; HIGOVSALES is an indicator equal to 1 if GOVSALES is above median (for firms with the federal government as a major customer), and 0 otherwise; DBA is the total discretionary budget authority (in constant 2009 dollars); and PEERGOVIND is an indicator equal to 1 if the firm does not have the federal government as a major customer but operates in an industry (4-digit SIC) with at least one firm that has the federal government as a major customer, and 0 otherwise. Control variables include the following: CASHHOLD is the stock of cash as a percentage of total assets; CASHFLOW is cash flow from operations as a percentage of total assets; SIZE is the natural logarithm of the market value of equity; MB is the market to book ratio; LEV is long-term debt plus short term debt as a percentage of market value; AGE is firm age in years; INFLATION is the annual inflation rate based on the consumer price index; GROWTH is the annual growth in real gross domestic product; 10YRTB is the 10-year constant maturity Treasury bond rate; and URATE is the unemployment rate. Robust *t*-statistics (with standard errors double clustered by firm and year) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $GOVSALES_{t-1} \times DBA_t$ | 5.254** | | 4.678** | |
| | (2.16) | | (2.35) | |
| $GOVSALES_{t-1}$ | −5.038** | | −4.536** | |
| | (−2.62) | | (−2.67) | |
| $HIGOVSALES_{t-1} \times DBA_t$ | | 3.418** | | 3.704** |
| | | (2.51) | | (2.55) |
| $HIGOVSALES_{t-1}$ | | −3.391*** | | −3.535*** |
| | | (−2.92) | | (−2.96) |
| $CASHHOLD_{t-1}$ | 0.008 | 0.008 | 0.010 | 0.011 |
| | (0.93) | (0.93) | (1.16) | (1.17) |
| $CASHFLOW_{t-1}$ | −0.007 | −0.007 | −0.007 | −0.007 |
| | (−1.06) | (−1.06) | (−1.06) | (−1.06) |
| $SIZE_{t-1}$ | −1.363*** | −1.363*** | −1.333*** | −1.333*** |
| | (−4.18) | (−4.18) | (−4.17) | (−4.17) |
| $MB_{t-1}$ | 0.007 | 0.007 | 0.007 | 0.007 |
| | (1.46) | (1.46) | (1.41) | (1.41) |
| $LEV_{t-1}$ | −0.000 | −0.000 | −0.000 | −0.000 |
| | (−1.65) | (−1.65) | (−1.62) | (−1.62) |
| $AGE_{t-1}$ | 0.036** | 0.036** | 0.026* | 0.026* |
| | (2.75) | (2.76) | (1.78) | (1.79) |
| $DBA_t$ | | | −3.124*** | −3.124*** |
| | | | (−4.51) | (−4.51) |
| $INFLATION_{t-1}$ | | | 0.066 | 0.066 |
| | | | (0.80) | (0.80) |
| $GROWTH_{t-1}$ | | | −0.030 | −0.030 |
| | | | (−0.62) | (−0.62) |
| $URATE_{t-1}$ | | | −0.022 | −0.023 |
| | | | (−0.36) | (−0.38) |
| $10YRTB_{t-1}$ | | | −0.238* | −0.238* |
| | | | (−1.74) | (−1.75) |
| TIMETREND | | | 0.090* | 0.090* |
| | | | (1.82) | (1.82) |
| No. of obs. | 47,806 | 47,806 | 47,806 | 47,806 |
| $R^2$ | 0.809 | 0.809 | 0.808 | 0.808 |
| Year FE | Yes | Yes | No | No |
| Firm FE | Yes | Yes | Yes | Yes |

firms' relative performance improves as a result of changes in government spending.[15] We directly test Hypothesis 2 and ensure nonpeer firms are not driving the negative relation between DBA and R&D among non-GD firms in Panel B. We use

[15]As reported in Table A.16 of the Supplementary Material, we complement this analysis by examining how firm value (market-to-book) varies with our continuous proxy for the expected level of federal spending, DBA. We find that, despite having similar accounting earnings, market-to-book ratios fall significantly for peer firms in response to increases in government spending, consistent with the findings of Stein (1989) and Edmans et al. (2017).

TABLE 4

**Budget Cycles, Corporate Performance, and R&D Investment for Peer and Nonpeer Firms**

Panel A of Table 4 reports regression results for firm earnings and sales growth similar to Table 2. Panel B presents regression results for firm R&D similar to Table 3. The independent variables of interest include the following: PEERGOVIND is an indicator equal to 1 if the firm does not have the federal government as a major customer but operates in an industry (4-digit SIC) with at least one firm that has the federal government as a major customer, and 0 otherwise; PEERSALES is the maximum of the ratio of firm sales sold to the federal government as a fraction of total sales (for firms with the federal government as a major customer) within a given 4-digit SIC industry if the firm does not have the federal government as a major customer, and 0 otherwise; and DBA is the total discretionary budget authority (in constant 2009 dollars). Control variables include: CASHHOLD is the stock of cash as a percentage of total assets; CASHFLOW is cash flow from operations as a percentage of total assets; SIZE is the natural logarithm of the market value of equity; MB is the market to book ratio; LEV is long-term debt plus short term debt as a percentage of market value; AGE is firm age in years. INFLATION is the annual inflation rate based on the consumer price index; GROWTH is the annual growth in real gross domestic product; 10YRTB is the 10-year constant maturity Treasury bond rate; and URATE is the unemployment rate. Robust *t*-statistics (with standard errors double clustered by firm and year) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

*Panel A. Peer Performance*

| | Sales Growth | Earnings | Earnings if R&D Not Cut |
|---|---|---|---|
| | 1 | 2 | 3 |
| PEERGOVIND × $DBA_t$ | −0.063* | 1.165 | −0.348 |
| | (−2.03) | (1.39) | (−1.36) |
| PEERGOVIND | 0.078** | −1.177 | 0.270 |
| | (2.73) | (−1.48) | (1.25) |
| $CASHHOLD_{t-1}$ | 0.003*** | 0.021* | 0.001 |
| | (6.02) | (1.76) | (0.47) |
| $SIZE_{t-1}$ | 0.026*** | 2.531*** | 2.200*** |
| | (4.15) | (5.95) | −6.4 |
| $MB_{t-1}$ | −0.000** | −0.000 | −0.000 |
| | (−2.25) | (−0.85) | (−1.01) |
| $LEV_{t-1}$ | 0.002** | 0.007 | 0.002 |
| | (2.36) | (1.41) | (0.92) |
| $AGE_{t-1}$ | −0.004*** | −0.127*** | −0.007 |
| | (−3.45) | (−4.28) | (−1.18) |
| PEERGOVIND × $DBA_t$(column 2) – PEERGOVIND × $DBA_t$(column 3) | | 1.513* | |
| Test diff. | | 1.73 | |
| No. of obs. | 61,117 | 98,244 | 98,244 |
| $R^2$ | 0.262 | 0.496 | 0.466 |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |

*Panel B. Peer R&D*

| | Full Sample | Non-Government Dependent Firms | Full Sample | Non-Government Dependent Firms | Peer Firms | Nonpeer Firms |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| PEERGOVIND × $DBA_t$ | −0.849** | −0.801* | | | | |
| | (−2.18) | (−1.97) | | | | |
| PEERGOVIND | 0.798** | 0.810** | | | | |
| | (2.22) | (2.26) | | | | |
| PEERSALES × $DBA_t$ | | | −1.069** | −1.039** | | |
| | | | (−2.45) | (−2.22) | | |
| PEERSALES | | | 1.042** | 1.091** | | |
| | | | (2.60) | (2.61) | | |
| $DBA_t$ | | | | | −4.322*** | −0.660 |
| | | | | | (−5.12) | (−1.35) |
| $CASHHOLD_{t-1}$ | 0.009 | 0.008 | 0.009 | 0.008 | 0.009 | 0.025*** |
| | (1.02) | (0.89) | (1.02) | (0.89) | (0.93) | (2.95) |
| $CASHFLOW_{t-1}$ | −0.007 | −0.006 | −0.007 | −0.006 | −0.004 | −0.067*** |
| | (−1.06) | (−1.05) | (−1.06) | (−1.05) | (−1.06) | (−4.00) |
| $SIZE_{t-1}$ | −1.364*** | −1.359*** | −1.364*** | −1.359*** | −1.767*** | −0.441*** |
| | (−4.20) | (−4.33) | (−4.20) | (−4.33) | (−4.27) | (−3.47) |
| $MB_{t-1}$ | 0.007 | 0.006 | 0.007 | 0.006 | 0.006 | −0.031 |
| | (1.45) | (1.42) | (1.45) | (1.41) | (1.32) | (−0.74) |

*(continued on next page)*

TABLE 4 (continued)

Budget Cycles, Corporate Performance, and R&D Investment for Peer and Nonpeer Firms

*Panel B. Peer R&D (continued)*

| | Full Sample | Non-Government Dependent Firms | Full Sample | Non-Government Dependent Firms | Peer Firms | Nonpeer Firms |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| $LEV_{t-1}$ | −0.000 | −0.000 | −0.000 | −0.000 | −0.000 | 0.000 |
| | (−1.64) | (−1.62) | (−1.64) | (−1.62) | (−1.54) | (0.42) |
| $AGE_{t-1}$ | 0.037*** | 0.036** | 0.038*** | 0.037** | 0.110** | 0.026** |
| | (2.87) | (2.39) | (2.91) | (2.44) | (2.54) | (2.13) |
| $INFLATION_{t-1}$ | | | | | 0.088 | 0.032 |
| | | | | | (0.69) | (0.75) |
| $GROWTH_{t-1}$ | | | | | −0.035 | −0.010 |
| | | | | | (−0.54) | (−0.26) |
| $10YRTB_{t-1}$ | | | | | −0.049 | −0.026 |
| | | | | | (−0.58) | (−1.01) |
| $URATE_{t-1}$ | | | | | −0.546** | −0.052 |
| | | | | | (−2.70) | (−1.16) |
| No. of obs. | 47,806 | 43,371 | 47,816 | 43,371 | 22,063 | 19,675 |
| $R^2$ | 0.809 | 0.814 | 0.809 | 0.814 | 0.805 | 0.839 |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | No | No |

the same empirical specification as equation (1); however, we replace our indicator for GD firms with PEERGOVIND.

Consistent with the previous discussion and the predictions of Hypothesis 2, we find that *DBA* is associated with a significant reduction in R&D investment by peer firms (i.e., crowds out peer firm investment). We find that industry peers of GD firms reduce investment in R&D significantly relative to all other firms (i.e., GD as well as nonpeers) following increases in DBA (Table 4, Panel B, model 1). In model 2, we find that this effect holds when GD firms are excluded from the sample: peers of GD firms reduce R&D significantly more that nonpeers, in response to increases in DBA. We continue to find evidence in support of a reduction in peer-firm R&D investment when we use an alternative measure of peer firms[16] (models 3 and 4) or split the sample of non-GD firms into peers (model 5) and nonpeers (model 6) and examine how R&D varies with DBA. As indicated by model 5, peer firms unconditionally and significantly cut R&D spending when DBA increases. In model 6, by contrast, nonpeers do not vary R&D significantly. The point estimate from model 4 implies that an increase in DBA of 0.07 leads to a reduction in R&D by 0.3 (or approximately 9.1% relative to the sample median). This reduction in R&D represents half the 0.6 percentage point gain in ROA that GD firms experience for the same DBA increase.

To further analyze the relation between DBA and peer earnings if they had not cut R&D, we subtract the amount of R&D that is cut from reported earnings and present these results in model 3 (Panel A) of Table 4. We find that the coefficient is negative but still insignificant. However, the difference in the coefficient on

[16]That is, for each peer firm (i.e., when the indicator PEERGOVIND equals 1) we define PEERSALES as the maximum of the ratio of firm sales sold to the federal government as a fraction of total sales within the 4-digit SIC industry that the peer-firm operates. This variable measures the degree of government dependence of the most dependent firm in the industry and assigns it to the peer-firms.

TABLE 5

Budget Cycles and Industry R&D Investment

Table 5 reports regression results for industry (4-digit SIC) R&D. The independent variables of interest include: GOVIND is an indicator equal to 1 if the industry (4-digit SIC) has at least one firm that has the federal government as a major customer, and 0 otherwise; HIGOVSALESIND is an indicator equal to 1 if the industry has above median dependence on the government (above median proportion of sales to government according to 1997 Input-Output tables form the Bureau of Labor Studies), and 0 otherwise; the un-interacted version of HIGOVSALESIND is spanned by industry fixed effects and is thus not reported; and DBA is the total discretionary budget authority (in constant 2009 dollars). Control variables (not reported) include: ICASHHOLD is the value-weighted industry mean stock of cash as a percentage of total assets; ICASHFLOW is the value-weighted industry mean cash flow from operations as a percentage of total assets; ISIZE is the value-weighted industry mean of the natural logarithm of the market value of equity; IMB is the value-weighted industry mean market to book ratio; ILEV is the value-weighted industry mean long-term debt plus short term debt as a percentage of market value; and IAGE is the value-weighted industry mean firm age in years. Robust *t*-statistics (with standard errors clustered by industry) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

| | Value Weighted Mean | Industry R&D Investment |
|---|---|---|
| | 1 | 2 |
| GOVIND × $DBA_t$ | −1.079** | |
| | (−2.18) | |
| GOVIND | 0.907** | |
| | (2.03) | |
| $HIGOVSALESIND_{t-1}$ × $DBA_t$ | | −2.686** |
| | | (−2.44) |
| No. of obs. | 6,680 | 6,680 |
| $R^2$ | 0.636 | 0.637 |
| Controls | Yes | Yes |
| Year FE | Yes | Yes |
| Industry FE | Yes | Yes |

PEERGOVIND × $DBA_t$ between models 2 and 3 is positive (1.513) and significant implying that peer firm actions significantly alter the bottom line. Based on an increase in DBA of 0.07, as before, this difference of 1.513 can be interpreted as peer firm earnings being 0.11 percentage points lower (or 2.8% relative to the sample median ROA) if peer firms had not cut R&D.

The results of Tables 3 and 4 are consistent with Hypothesis 2 and with results in the existing economics literature showing that government spending crowds out private investment (i.e., Cohen et al. (2011)). We contribute to the literature by finding that only firms that compete directly with GD firms contract investment in R&D, consistent with our hypothesis.

In Table 5, we test whether the heterogeneous effects predicted by Hypotheses 1 and 2 lead to a net-negative (and therefore crowding out) impact of government spending on industry investment in R&D. For each industry, we calculate value-weighted industry mean values for our variables of interest and run regressions of industry R&D. In model 1, we define GOVIND as an indicator equal to 1 if there is at least one GD firm operating in the 4-digit SIC industry and 0 otherwise and include this variable along with its interaction with DBA into the model. In model 2, we replace GOVIND with HIGOVSALESIND, which is an indicator that is equal to 1 if the industry has at least one GD firm operating in it and the industry has an above-the-median proportion of sales to the government, and 0 otherwise. We calculate this variable using data from input-output tables for the year 1997 sourced from the Bureau of Labor Statistics. Models 1–2 include both industry and year fixed effects and standard errors double clustered by industry and year. Consistent with an aggregate (industry-level) crowding-out effect, we find evidence that the net-impact of government spending on industry-level investment on R&D is negative. From model 1, an increase in DBA of 0.07 reduces aggregate industry investment by about 2% relative to the mean. Our results are qualitatively similar if we use equal weighted industry mean or industry median values.

The findings of Tables 2–4 contribute to the literature by documenting that government spending can positively impact the performance and therefore R&D expenditures of large, public GD firms, similar to the positive impact documented by Howell (2017) of directly funded R&D on private new ventures. However, government spending has a negative impact on the industries that they operate in overall (e.g., consistent with Cohen et al. (2011)). Hypothesis 2 predicts that the heterogeneous pattern of R&D responses is due to relative performance mechanism. That is, because government spending leads to a fall in the performance of peer firms relative to GD firms, managers of peer firms are incentivized to cut R&D expenditures to improve short-term earnings. We present evidence in favor of this mechanism in the following section and then consider potential alternative explanations for the heterogeneous effects previously documented.

## C. Relative Performance Channel

We provide empirical support for the relative performance channel acting as a crowding-out mechanism (as predicted in Hypothesis 2) through several tests.

First, we study whether peer firms manage other discretionary expenses in response to changes in DBA. Consistent with Roychowdhury (2006), we show in Table 6 that peer firms manage their advertising and SG&A expenses in response to changes in DBA. As with R&D, peer firms reduce advertising and SG&A expenses relative to government-dependent firms, nonpeers, and unconditionally.

Second, we examine whether the R&D investment of peer firms is more sensitive to variation in DBA when managers have greater incentives to match

TABLE 6

Incentives to Cut Other Discretionary Expenses

Table 6 reports regression results for alternate discretionary expenses used in previous studies on real earnings management (e.g., Roychowdhury (2006)). The dependent variable in columns 1 and 2 is ADEVERTISING_EXPENSES (advertising expenses scaled by total assets), and the dependent variable in columns 3 and 4 is SG&A_EXPENSES (SG&A expenses scaled by total assets). The independent variables of interest include: PEERGOVIND is an indicator equal to 1 if the firm does not have the federal government as a major customer but operates in an industry (4-digit SIC) with at least one firm that has the federal government as a major customer, and 0 otherwise; and DBA is the total discretionary budget authority (in constant 2009 dollars). Control variables (not reported) are similar to models 1–2 of Table 2. Robust $t$-statistics (with standard errors double clustered by firm and year) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

| | Advertising_Expenses | | SG&A_Expenses | |
|---|---|---|---|---|
| | Full Sample | Peer Firms | Full Sample | Peer Firms |
| | 1 | 2 | 3 | 4 |
| PEERGOVIND × $DBA_t$ | −0.618* | | −3.810*** | |
| | (−1.84) | | (−3.49) | |
| PEERGOVIND | 0.684** | | 3.461*** | |
| | (2.08) | | (3.69) | |
| $DBA_t$ | | −1.525*** | | −5.345*** |
| | | (−2.93) | | (−3.54) |
| No. of obs. | 19,906 | 6,807 | 55,597 | 20,743 |
| $R^2$ | 0.855 | 0.867 | 0.826 | 0.842 |
| Controls | Yes | Yes | Yes | Yes |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | No | Yes | No |

TABLE 7

Peer R&D Investment and Management Incentives to Manage Earnings

Table 7 reports regression results for subsample R&D regressions. The independent variable of interest is PEERGOVIND which is an indicator equal to 1 if the firm does *not* have the federal government as a major customer but operates in an industry (4-digit SIC) with at least one firm that has the federal government as a major customer, and 0 otherwise; and DBA is the total discretionary budget authority (in constant 2009 dollars). CEO_PAY_SENSITIVITY_TO_INDUSTRY_ROA is calculated by regressing total CEO pay on industry ROA and retaining the coefficient estimate for each CEO in the ExecuComp database during our sample period (Gibbons and Murphy (1990), Hall and Liebman (1998)). We use median firm ROA in each 4-digit SIC industry-year as industry ROA. CEO_AGE is the age of the CEO in a given firm-year. We create three subsamples by terciles for each variable. High refers to the upper tercile, Med refers to the middle tercile, and Low refers to the lower tercile. Control variables (not reported) include: CASHHOLD is the stock of cash as a percentage of total assets; CASHFLOW is cash flow from operations as a percentage of total assets; SIZE is the natural logarithm of market value of equity; MB is the market to book ratio; LEV is long-term debt plus short-term debt as a percentage of market value; and AGE is firm age in years. Test "diff. H-L" reports the *Z*-statistic for the test of equality of PEERGOVIND × DBA coefficients between high and low subsamples (see Clogg et al. (1995)). Robust *t*-statistics (with standard errors that are double clustered by firm and year) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

| | R&D Regression by: | | | | | |
|---|---|---|---|---|---|---|
| | CEO_PAY_SENSITIVITY_TO_INDUSTRY_ROA | | | CEO_AGE | | |
| | Low | Med | High | Low | Med | High |
| | 1 | 2 | 3 | 4 | 5 | 6 |
| PEERGOVIND × DBA $_t$ | 0.521<br>(0.67) | 0.125<br>(0.15) | −2.906***<br>(−3.62) | −1.176<br>(−1.59) | 0.281<br>(0.43) | 0.377<br>(0.86) |
| High-low<br>Test diff. H-L | | −3.43***<br>−3.07 | | | 1.55**<br>1.81 | |
| PEERGOVIND | −0.425<br>(−0.60) | −0.230<br>(−0.29) | 2.949***<br>(3.82) | 1.384*<br>(1.88) | −0.354<br>(−0.59) | −0.325<br>(−0.77) |
| No. of obs. | 3,861 | 4,209 | 4,129 | 5,583 | 4,657 | 4,970 |
| $R^2$ | 0.887 | 0.844 | 0.821 | 0.823 | 0.893 | 0.863 |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

the earnings of GD firms in Table 7. Managers who have compensation packages more tightly linked to industry conditions (i.e., relative performance evaluation or industry benchmarking) have stronger incentives to match the earnings of GD firms. Models 1–3 show the following: i) The coefficient estimate on PEERGOVIND × DBA is monotonically decreasing across subsamples as CEO pay becomes increasingly sensitive to industry ROA;[17] ii) the peer firm effect is concentrated in firms with CEOs whose pay is the most sensitive to industry performance; and iii) the difference in the coefficient on PEERGOVIND × DBA between the high and low sensitivity samples is statistically significant (see Clogg, Petkova, and Haritou (1995)).

Because younger CEOs are considered to have greater career or reputation concerns (Chevalier and Ellison (1999), Gibbons and Murphy (1992), Hong et al. (2000), and Hu, Kale, Pagani, and Subramanian (2011)), we examine the influence of career concerns by splitting our sample into terciles based on CEO age and reestimating our main peer-firm regression in models 4—6. Although the coefficient estimate on PEERGOVIND × DBA is not significant across all three samples, it is most negative for the youngest CEOs (i.e., those with the highest career concerns) and monotonically increasing across subsamples as CEOs become older.

[17]We regress total CEO pay on industry ROA and retain the coefficient estimate for each CEO in the ExecuComp database during our sample period (Gibbons and Murphy (1990), Hall and Liebman (1998)). We use median firm ROA in each 4-digit SIC industry-year as industry ROA.

Importantly, the difference between the coefficient estimate in the high and low age subsamples is statistically significant.

To provide further support for the real earnings management channel prediction of Hypothesis 2, we also report cross-sectional tests based on industry and macroeconomic characteristics in Table 8. First, because firm performance is benchmarked within industry, we expect that managers in more competitive industries will have stronger incentives to engage in real earnings management (Aggarwal and Samwick (1999)). The results in models 1 and 2 of Table 8 show that the reduction in R&D by peer firms is concentrated in high competition industries with an above the median value for the 4-digit SIC Herfindahl–Hirschman Index (HHI).

Second, the more analysts following a given industry may incentivize firms to care more about meeting relative earnings, the more that peer firms will care about meeting relative earnings. Therefore, we examine differences according to the number of analysts covering the industry in Table 8, columns 3 and 4, and find that the peer firm effect is indeed concentrated in industries more with more analysts. Third, financing through equity markets may increase the emphasis on relative performance targets. We find that our results are concentrated in firms in industries with a higher reliance on equity (proxied by the inverse of the industry median leverage ratio) in columns 5 and 6.

Fourth, firms belonging to industries with higher unionization are incentivized to supply conservative accounting numbers (Leung, Li, and Rui (2010)) and to realize bad news (Bova (2013)) to increase bargaining power relative to unions. Alternatively, unions may prevent cuts to R&D-related unionized labor. Therefore, earnings management is more costly for highly unionized industries and we are less likely to observe a reduction in R&D to boost current earnings in an attempt to match or beat GD firms in our setting. Doing so can result in greater wage demands from unionized labor. Consistent with the above, we find that the observed peer effects are concentrated in industries with below the median unionization in models 7 and 8.[18]

Finally, peer firms have incentives to cut R&D when DBA is increasing but not increase R&D (and thus reduce earnings) when DBA is falling. In models 9 and 10, we find that the reduction in R&D by peer firms in response to variation in DBA only exists for years when DBA increases and is insignificant (and in fact positive) for years when DBA decreases. Further, we find that the differences in the coefficient estimates across all of the previous subsample tests are statistically significant.

In the results reported in the Supplementary Material, we provide further support to real earnings management acting as a crowding-out mechanism. First we use tests motivated by Bushee (1998) and document that peer firms with worse performance relative to GD firms reduce R&D expenditures more following an increase in DBA in Table A.3. Further in Table A.3, we find that an increase in DBA is associated with an increase in the likelihood of a cut in R&D only if there is also a deterioration of performance of peer firms relative to GD firms, consistent with

[18]We obtain this data from the Union Membership and Coverage Database maintained by Barry Hirsch and David Macpherson and available from www.unionstats.com. In Table A.2 of the Supplementary Material we show that cuts to other discretionary spending (i.e., advertising and SG&A) are also concentrated nonunionized industries.

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## TABLE 8

## Cross-Sectional Tests of Peer R&D Investment

Table 8 reports regression results for subsample R&D regressions. The independent variable of interest is PEERGOVIND which is an indicator equal to 1 if the firm does *not* have the federal government as a major customer but operates in an industry (4-digit SIC) with at least one firm that has the federal government as a major customer, and 0 otherwise; and DBA is the total discretionary budget authority (in constant 2009 dollars). INDUSTRY_COMPETITION is measured by the Herfindahl–Hirschman Index; High and low refer to below and above median HHI values respectively. INDUSTRY_ANALYST_FOLLOWING is the total number of analysts following a given industry; and high and low refer to above and below median respectively. INDUSTRY_RELIANCE_ON_EQUITY is the industry median value of the inverse of the leverage ratio; and high and low refer to above and below median respectively. INDUSTRY_UNIONIZATION is industry level unionization calculated using data from the Union Membership and Coverage Database; and high and low refer to above and below median respectively. ΔDBA is the change in DBA from the previous year; Positive refers to an increase from the previous year and Negative refers to a decrease from the previous year. Control variables (not reported) include: CASHHOLD is the stock of cash as a percentage of total assets; CASHFLOW is cash flow from operations as a percentage of total assets; SIZE is the natural logarithm of the market value of equity; MB is the market to book ratio; LEV is long-term debt plus short term debt as a percentage of market value; and AGE is firm age in years. Test "diff. H-L" reports the *Z*-statistic for the test of equality of PEERGOVIND × DBA coefficients between high and low subsamples (see Clogg et al. (1995)). Robust *t*-statistics (with standard errors that are double clustered by firm and year) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

| | R&D Regression by | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | INDUSTRY_COMPETITION | | INDUSTRY_ANALYST_FOLLOWING | | INDUSTRY_RELIANCE_ON_EQUITY | | INDUSTRY_UNIONIZATION | | ΔDBA | |
| | High | Low | High | Low | High | Low | High | Low | Positive | Negative |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| PEERGOVIND × $DBA_t$ | −1.128** | −0.058 | −1.420*** | −0.238 | −1.033** | −0.201 | −0.319 | −4.808*** | −0.709** | 0.213 |
| | (−2.12) | (−0.14) | (−2.79) | (−0.74) | (−2.40) | (−0.92) | (−0.37) | (−4.29) | (−2.20) | (0.37) |
| High-low | −1.07*** | | −1.18*** | | −0.83*** | | 3.92*** | | −0.92* | |
| Test diff. H-L | −2.24 | | −2.78 | | −2.44 | | 2.77 | | −1.40 | |
| PEERGOVIND | 1.076** | 0.136 | 1.226*** | 0.281 | 0.905** | 0.278 | 2.400*** | 5.862*** | 0.746** | −0.045 |
| | (2.11) | (0.38) | (2.58) | (0.95) | (2.29) | (1.40) | (2.87) | (5.50) | (2.74) | (−0.09) |
| No. of obs. | 23,230 | 24,307 | 21,466 | 22,007 | 36,265 | 10,337 | 31,270 | 16,695 | 26,282 | 19,975 |
| $R^2$ | 0.806 | 0.810 | 0.810 | 0.837 | 0.797 | 0.864 | 0.346 | 0.464 | 0.845 | 0.846 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

other evidence documenting relative performance evaluation (e.g., Albuquerque (2009), Gong et al. (2011), De Angelis and Grinstein (2020)).[19] Second, in Table A.4 we show that peer firms, but not GD firms, also vary discretionary accruals in response to DBA. Thus, peer firms appear to manage earnings on multiple dimensions.[20] Fourth, in Table A.5 we show that the cut in R&D is not permanent and does not last more than two periods which is consistent with R&D cuts being associated with earnings management rather than in response to a negative economic shock like losing a government contract.

Additionally, unlike R&D, capital expenditure (CAPEX) is not expensed, and thus can only indirectly affect net income. Thus, it is unlikely that peer firms will adjust CAPEX (relative to other firms) in response to DBA if the earnings management channel is driving our R&D results. We do not find evidence that discretionary spending significantly impacts GD firm capital expenditures relative to peer firms and nonpeers, nor does it impact the capital investment of peers relative to GD firms and nonpeers in Table A.6 of the Supplementary Material. In Table A.7 we document that our results are primarily centered in firms with higher costs of using accruals to improve earnings and lower costs of real earnings management (Zang (2012)). Finally, we follow Kothari, Mizik, and Roychowdhury (2016) and find that peer firm R&D becomes less persistent (i.e., peer firms are cutting R&D) following increases in DBA in Table A.8.

Overall, the results in this section provide strong evidence in support of Hypothesis 2 that the relative performance channel explains the reduction in peer firm R&D.

## D. Alternative Channels

In this section, we discuss and rule out several alternative mechanisms for the crowding out of peer-firm R&D. In considering the following possible explanations, it is important to note that any theory offered to explain the reduction in peer-firm investment in response to rising government expenditure must also simultaneously explain the fact that GD firms increase R&D as well as the fact that nonpeers do not adjust R&D significantly. The tests conducted in this section are reported in the Supplementary Material to conserve space.

### 1. Macroeconomic Channel

First, standard macroeconomic channels cannot explain our results. For example, the interest rate (and tax) channel predicts the average firm contracts investment and does not make predictions about heterogeneous responses across firm type nor heterogeneous impacts across investment type (i.e., CAPEX vs. R&D). Likewise, counter-cyclicality in government spending is not consistent with our findings.

[19]Further, it does not appear that peer firms cut R&D if relative performance is low, but DBA is not increasing. Thus, it appears that government contracts (proxied by DBA) are special in our setting. As we will discuss later (see Table A.23 in the Supplementary Material), DBA increases lead to higher sales for GD firms but do *not* increase the likelihood of peers becoming GD firms, which drives a decline in relative performance.

[20]The literature suggests firms using real versus accrual based earnings management depends on the relative cost of each method (see, e.g., Badertscher (2011); Cohen et al. (2008), Cohen and Zarowin (2010), and Zang (2012)).

This alternative predicts that increased U.S. government spending during recessions creates a differential impact on R&D spending between GD firms and all other firms. This explanation, however, cannot account for the important fact that nonpeers, which do not compete directly with GD firms, do not change R&D significantly. Further, it also cannot account for the lack of response in capital expenditure investment reported in Table A.6 of the Supplementary Material nor the robustness of the baseline regression to the inclusion of industry-year fixed effects. In addition, our results are robust to propensity score matching (discussed in the following), reducing the likelihood that differences in R&D investment are driven by differences between observable characteristics of GD firms, their peers, or nonpeers. Finally, we also deal explicitly with the simultaneity of government spending in our subsequent analysis and find that our results are robust to endogeneity.

### 2. Microeconomic Negative Shock Channel

A second potential alternative mechanism for the crowding-out effect is a rational response from peer firms to reduce R&D spending. This response could be the result of increased competition in the industry for a limited number of R&D projects, higher R&D input prices induced by an increase in direct government R&D spending, or firms that have recently lost a bid for a new contract rationally reducing spending. We find this explanation unlikely for several reasons. First, this explanation suggests that the crowding-out should be strongest in concentrated industries where peers have more to gain from adjusting R&D expenditures. However, we find the opposite to be the case in Table 8. In addition, we decompose our peer firm effect (i.e., PEERGOVIND) into peers that are "always peers" and those that are "switching peers," where switching peers can switch to and from being GD firms or to and from being nonpeers in Table A.9 of the Supplementary Material. Presumably, firms that never switch status to GD are less likely to be competing for government contracts. Further, if the reduction in R&D for the average peer is due to firms that reduce R&D spending in response to losing contracts, we would expect our results to be concentrated in the switching peers group. Contrary to this alternative, we find that "always peers" and "switching peers" respond similarly to increases in DBA (i.e., cut R&D), though the magnitude is much larger for "always" peer firms.

Further, Bloom, Schankerman, and Van Reenen (2013) and Krieger (2021) find evidence that the competitive effects of increases in R&D on peers (consistent with the alternative explanation) are small and dwarfed by information effects. These previous empirical findings would predict a positive spillover on industry peers and therefore a positive, rather than negative relationship between DBA and R&D spending for peers of government dependent firms. Therefore, this explanation would bias us against finding a negative response by peers. In addition, if peers reduced investment due to losing a government contract or another negative economic shock, we would expect they would reduce capital expenditures as well as R&D. As discussed in Section IV.C, we do not find evidence that DBA is significantly related to capital expenditures for GD firms or their peers.

Alternatively, our results could be driven by a labor-market channel similar to Kim and Nguyen (2018). Specifically, peers could face a negative employment shock due to the improved performance of GD firms causing a shift in employment within the industry leading peers to reduce R&D spending. In addition, if the reduction in peer R&D is the result of losing or challenging a bid for a government contract, then we would expect peer employment to decrease (Canayaz et al. (2019)). As reported in Table A.10 in the Supplementary Material, we do not find evidence consistent with this mechanism that employment increases at GD firms or declines at their peers in response to increases in government spending. Therefore, it is unlikely that a labor-market mechanism is driving our results.

Finally, the negative shock channel may impact peer firm investment indirectly via an increase in the cost and availability of external finance for peer firms. We rule out this possibility in the following ways. First, in subsample tests split based on median cash holdings, we do not find a significant difference between the R&D investments of peer firms with more internal slack (i.e., those that are less reliant on external finance) in Table A.11 in the Supplementary Material. Second, we match firms to the Dealscan database and find that the cost, amount, and covenant strictness of syndicated bank loans for peer firms do not vary with DBA in Table A.12.

### 3. Other Alternative Channels

A third possible mechanism explaining the reduction in peer-firm R&D is the possibility that peers experience positive industry R&D spillovers from the increase in investment by GD firms. This alternative channel is partially mitigated by our use of firm fixed effects. Further, as discussed in Bloom et al. (2013) and Krieger (2021), information spillovers should result in a positive relation between R&D and DBA for peer firms. Additionally, our results remain unchanged when we include state fixed-effects, and we do not find a significant difference between high-innovation states (based on a 2013 Bloomberg state innovation ranking) and low-innovation states where spillovers are less likely (Audretsch and Feldman (1996), Jaffe (1986)) in Table A.13 in the Supplementary Material.[21]

Fourth, peer firms may reduce investment due to higher political uncertainty. The political uncertainty channel appears unlikely given that it implies that the firms with more exposure to the political process (GD firms) would respond even more negatively than their peers, contrary to our results (Julio and Yook, 2012). Further, recent evidence from Atanassov, Julio, and Leng (2019) suggests that unlike capital investment (where we observe no effect), R&D may *increase* with political uncertainty, which is inconsistent with the observed peer-firm contraction. Finally, inferences remain unchanged when we include an election indicator or the Baker, Bloom, and Davis (2016) political uncertainty index as controls in Table A.14 in the Supplementary Material.

Fifth, because political contributions predict government contracts (e.g., see Brogaard, Denes, and Duchin (2021)), the differential effects on R&D between GD firms and their peers might be driven by an omitted 'political contributions' variable. However, it is unclear why a lack of political contributions by peers and nonpeers would cause peers to reduce R&D following increases in government spending but leave nonpeers' R&D unaffected. Additionally, using political contributions data from Brogaard et al., we do not find that political contributions in the

[21] Rankings are obtained from Bloomberg's 2013 U.S. State Innovation Index. We note that this analysis does not preclude any positive spillovers to geographic peers occurring, such as the sales spillovers of geographically close firms found by Goldman (2018).

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previous year predict our government-dependence variables, vary with DBA, or vary between peers and nonpeers.[22] Finally, we do not find that political contributions significantly predict R&D expenditures for GD, peer, or nonpeer firms, either alone or interacted with DBA in Table A.15 in the Supplementary Material.

Taken together, we consider peer firms as those operating in the same industries as GD firms, producing similar products and services however appear to (in the short-term) specialize in providing their products and services to private sector. However, the relative performance between peers and GD firms matters to peers because of industry benchmarking and variation in DBA (i.e., size of government contracts to GD firms) significantly impacts relative performance.

## V. Identification, Selection, and Causality

In this section, we discuss our identification strategy to make causal inferences regarding the relation between DBA and firm R&D independent of the potentially endogenous nature of DBA to firm investment and the selection of firms into government dependence. We provide additional discussion of our robustness tests in the Supplementary Material.

### A. Exogenous Budget Shocks and Firm Value

Because the budget authority determines the size of the pie but not how funds are actually spent, DBA is unlikely to be contaminated by firm R&D and performance. Regardless, we perform several tests to control for the potential endogeneity of DBA. First, we utilize a quasi-natural experiment to disentangle the potentially endogenous relationship between the value of GD firms and their peers and government spending. These events provide a plausibly exogenous and surprising shock to the U.S. government's expected discretionary spending and therefore expected sales of GD firms and their peers. Specifically, we utilize three dates in 2011 regarding the downgrade of the U.S. government's debt rating (Apr. 18th, July 16th, and Aug. 5th). In addition, the U.S. Congress passed the Budget Control Act (BCA) to significantly reduce the growth of government expenditures on Aug. 2nd, 2011. The importance and plausible exogeneity of these event dates are discussed in detail in the Supplementary Material.

We predict that these events will increase the probability of future fiscal tightening, increase the risk of sales for GD firms, and thus reduce the value of GD firms. This provides causal evidence that changes in government spending impact the value of GD firms and evidence against reverse-causality driving our previous results. We perform short-window event tests examining cumulative abnormal stock returns of all firms around the 12-day window of all event dates (defined as the sum of the difference between the daily return of the firm and the value-weighted market across the 3 days surrounding each event) using a standard ordinary least squares (OLS) regression methodology (Brown and Warner (1980)). We include controls common in the literature and used in equation (1) as well as industry fixed effects and present the results in models 1–2 (Panel A) of Table 9.

[22]Data limitations results in a shorter sample from 2001 to 2010. We thank Matthew Denes for providing this data.

TABLE 9

Market Reaction to Expected Budget Tightening

Table 9 reports empirical results from models examining firm values on key event dates. Panel A tests the abnormal return reaction for all firms and presents the relationship between firms with the U.S. government as a significant customer. Models 1–2 present results from the estimation of ordinary least squares (OLS) models; and models 3–4 present the results from the estimation of Sefcik and Thompson (1986) models. The dependent variable in the OLS models is the cumulative abnormal return (CAR) over the 3-day window surrounding each event day combined for all event days. Robust $t$-statistics (with standard errors double clustered by firm and year) in parentheses. The dependent variable in the Sefcik–Thompson models is the factor portfolio's daily return with coefficient estimates computed as per the procedure described in Section IV and the Supplementary Material. All other controls (not reported) are as defined in Table 3. The events are Apr. 18th, 2011, the day that S&P issued a negative outlook on the U.S. government's credit rating, July 18th, 2011, the day Egan-Jones downgraded U.S. government debt, Aug. 2nd, 2011, the day an agreement on the increase of the U.S. debt ceiling was reached by Congress, and Aug. 5th, 2011, the day S&P downgraded U.S. government debt. Panel B presents abnormal returns regression results to the combined events tested in Panel A (models 1–2). Model 1 restricts the sample to firms where PEERGOVIND is 1 and where R&D is nonmissing. Model 2 restricts the sample to firms that do not have the federal government as a major customer and where R&D is nonmissing. HIRD is an indicator equal to 1 if the firm has above the median R&D, and 0 otherwise. Control variables (not reported) are the same as those in Panel A. OLS standard errors are robust to heteroscedasticity and within-firm correlation. Sefcik–Thompson standard errors are robust to heteroscedasticity and cross-sectional correlation between firms with shared event days. Industry fixed effects (FE) are defined at the 2-digit SIC level. Adjusted $R^2$ is suppressed for the Sefcik–Thompson multiple equation models. No. of obs. denotes the number of firm-event observations for OLS models and the number of trading days used in estimation for Sefcik–Thompson models. Robust $t$-statistics in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

*Panel A. GD Firm Estimates*

| | OLS | | Sefcik–Thomson | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| $GOVSALES_{t-1}$ | −0.046** | | −0.006*** | |
| | (−2.36) | | (−4.53) | |
| $HIGOVSALES_{t-1}$ | | −0.025*** | | −0.003*** |
| | | (−2.97) | | (−5.06) |
| Controls | Yes | Yes | Yes | Yes |
| Industry effects | Yes | Yes | Yes | Yes |
| No. of obs. | 3737 | 3744 | 210 | 210 |
| $R^2$ | 0.147 | 0.147 | N/A | N/A |

*Panel B. Abnormal Returns of Government-Dependent Peers with High R&D Expenditures*

| | 1 | 2 |
|---|---|---|
| PEERGOVIND × $HIRD_{t-1}$ | | 0.021* |
| | | (1.91) |
| PEERGOVIND | | −0.007 |
| | | (−0.88) |
| $HIRD_{t-1}$ | 0.026*** | 0.003 |
| | (2.98) | (0.27) |
| Controls | Yes | Yes |
| Industry effects | Yes | Yes |
| No. of obs. | 1045 | 1684 |
| $R^2$ | 0.099 | 0.104 |

We find support for our prediction that the increased probability of a reduction in government spending significantly reduces the value of GD firms.

To mitigate downward bias in standard errors due to shared event days, we also present daily abnormal return factor portfolio estimates on event indicators using the seemingly unrelated regression (SUR) methodology similar to Sefcik and Thompson (1986) in models 3–4.[23] We again document evidence that GD firms significantly declined in value around these events. Economically, the total effect of the four events

[23]This procedure also provides a falsification test, comparing the abnormal returns of GD firms on the event day to the abnormal returns in the 12 months surrounding the events. For brevity, each individual regression's estimated coefficients of the constant, the value-weighted market return, and the $R^2$ are suppressed in these models.

in the SUR framework is equal to an abnormal return of −1.7% for the average GD firm, and for a highly GD firm the reaction is approximately −3.6%.[24]

In Panel B of Table 9, we test the abnormal returns of peer firms with high R&D expenses (i.e., those most able to manage earnings by changing R&D) around these events on a subsample of peers in model 1 and a subsample of non-GD firms in model 2. We document that the peers that were most able to manage earnings upward by cutting R&D experienced positive abnormal returns in response to a reduction in expected spending (and thus reduced expected future real earnings management). The event analysis allows us to isolate the market reaction to a cut in government spending on GD firm and peer firm value. To further document the negative relation between government spending and peer firm value, we document a significant negative relation between government spending and the market-to-book ratios of peer firms (see Table A.17 in the Supplementary Material). In addition, we do not observe a reversal of this relation in the subsequent 2 years. These results demonstrate the important impact that changes in R&D spending (even short term) can have on long-term firm value. We also find that R&D investment significantly declined for GD firms following the BCA of 2011 using a difference-in-differences setting in Table A.18. This result provides additional support for the causal relationship between shocks to government spending and the R&D investment of GD firms.

## B. Instrumenting for Discretionary Budget Authority

In addition to the event-study analysis in Table 9, we also perform instrumental variable analysis to ensure that our previous results are not driven by the potential endogeneity of DBA to firm investment, value, and performance. We use the balance of power in Congress as an instrument that correlates with the level of government spending, but is plausibly exogenous to private sector R&D. We motivate the instruments briefly in the following and in further detail in the Supplementary Material.

A balance of power in Congress (i.e., more veto players) substantially slows the budget process and is usually associated with more compromise on spending levels and spending changes are less expected (Tsebelis (1995), (2002)). The slowed budget process has been highlighted in recent years by Congress failing to appropriate funds in a timely fashion resulting in the partial shutdown of governmental functions in 2013, a near shutdown in 2015, and another shutdown in 2018. Although government spending may be influenced by the expected changes in firm R&D, we argue it is unlikely that expected R&D similarly determines a balance of power in Congress (i.e., each House controlled by a different party) at the national level. Although several papers study the endogenous nature of political cycles and economic outcomes, these papers also assume a single policymaker (i.e., no split control of congress) in the interest of simplicity/tractability (Alesina, Roubini, and Cohen (1997), Pastor and Veronesi (2019)). The difficulty in modeling the effects of economic outcomes on multiple policymakers provides some

[24]We obtain this estimate by multiplying the coefficient estimate for the average daily abnormal portfolio return of $GOVSALES_{t\text{-}1}$ by the number of days in the four event windows evaluated at the mean proportion of sales to the government (−0.006 x 12 x 0.24 = −1.7). We present analysis of individual event day windows in Table A.16 of the Supplementary Material.

justification for the use of split Congress as an instrument of government spending that is plausibly exogenous to firm investment. While several papers study the impact of political polarization and policy uncertainty on firm investment (e.g., Azzimonti (2018), Duquerroy (2019)), our methodology and robustness tests discussed in the following alleviate concerns that the instrument violates the exclusion criteria.

We propose a variable capturing the congressional balance of power to instrument for the budget authority. Specifically, SPLIT_CONTINUOUS is defined as the proportion of Democrats in the Senate (including the Vice President in cases where the ratio is exactly 50%, because the Vice President acts as a tiebreaker) minus 0.5, multiplied by the ratio of Republicans in the House minus 0.5, scaled by the maximum (0.25). This variable generates a higher value when the Senate or House is strongly controlled by Democrats and the other chamber is controlled by Republicans and a smaller number based on the degree of a split between and within the chambers of Congress. In the Supplementary Material (Table A.22), we also report results for three additional instruments that capture the split between and within chambers of Congress.

We must instrument for both DBA and its interaction with our government-dependence variables; therefore, we require two instruments. Because we cannot estimate the fitted value of DBA (i.e., DBAHAT) and interact it with the government-dependence variables (Wooldridge ((2002), p.236)), we follow Wooldridge's recommendation to perform a 3-stage procedure. First we estimate DBAHAT by regressing DBA on the instrument (SPLIT_CONTINUOUS) and all exogenous control variables and firm fixed effects. Next we use SPLIT_CONTINUOUS and the interaction of DBAHAT with a government-dependence variable as instruments for DBA and DBA interacted with the same government-dependence variable in a standard 2-stage least squares (2SLS) setting.

We include the controls used in models 3 and 4 of Table 3 as well as a linear time trend because we cannot include year fixed effects. Because the second and third stages are at the firm level, the analysis will overstate the power of the first and second stages but will not impact the estimation of DBAHAT. Therefore, to ensure that our results are not impacted by this correlation and thus subject to a weak-instrument problem, we cluster by firm and by year in the reported first stage. Additionally, we utilize the Kleibergen and Paap (2006) weak-instrument test (see model 1 of Table A.21 in the Supplementary Material), allowing for clustering to account for cross-sectional correlation in the first and second stages, and conclude that the instrument is valid.

We report the results of these regressions in Panels A and B of Table 10. Panel A reports results using GOVSALES, whereas Panel B reports results using HIGOVSALES. In both panels, we report our first stage regressions in model 1. We find that SPLIT_CONTINUOUS is significantly and negatively related to DBA in both panels (consistent with anecdotal evidence). In the second stage, as reported in models 2–3, we find that SPLIT_CONTINUOUS continues to be negative and significantly related to DBA, whereas GOVSALES interacted with DBAHAT is positive and significantly related to the interaction of GOVSALES and DBA.

Political polarization may impact firm investment. Specifically, Azzimonti (2018) finds that higher polarization, likely correlated with our previously

## TABLE 10

### Budget Cycles and Corporate R&D Investment: Instrumental Variable Results

Table 10 reports regression from a 3-stage procedure following Wooldridge (2002) in estimating results for firm R&D. Following Wooldridge, model 1 instruments for DBA as a first stage of the procedure. In Panel A, the independent variable of interest is GOVSALES and is defined as the ratio of firm sales sold to the federal government as a fraction of total sales (for firms with the federal government as a major customer), and 0 otherwise. In Panel B, the independent variable of interest is HIGOVSALES and is an indicator equal to 1 if GOVSALES is above the median (for firms with the federal government as a major customer), and 0 otherwise. In both panels, SPLIT_CONTINUOUS is an instrumental variable defined as the proportion of Democrats in the Senate (including the Vice President in cases where the ratio is exactly 50%, because the Vice President acts as a tiebreaker) minus 0.5, multiplied by the ratio of Republicans in the House minus 0.5, scaled by the maximum (0.25). Control variables (not reported) include: CASHHOLD is the stock of cash as a percentage of total assets; CASHFLOW is cash flow from operations as a percentage of total assets; SIZE is the natural logarithm of the market value of equity; MB is the market to book ratio; LEV is long-term debt plus short term debt as a percentage of market value; and AGE is firm age in years, firm fixed-effects, macroeconomic controls (as defined in Table 3). A linear time trend is also included due to the lack of year fixed effects (which cannot be included because DBA varies by year). Model 1 in Panel A presents the first stage of the procedure, regressing SPLIT_CONTINUOUS and all controls on DBA. DBAHAT is the predicted total discretionary budget authority (in constant 2009 dollars) from the first stage regression. Models 2–3 present the second stage of the procedure, regressing SPLIT _CONTINUOUS and GOVSALES × DBAHAT on DBA (model 2) and GOVSALES × DBA (model 3). Model 4 presents the third stage of the procedure, regressing the fitted values from model 2 (DBAHAT2) and model 3 ([GOVSALES × DBA]HAT) along with all control variables on R&D investment. Therefore, as recommended by Wooldridge, SPLIT_CONTINUOUS and GOVSALES × DBAHAT, along with all controls, act as instruments for the potentially endogenous DBA and GOVSALES × DBA. Panel B reports the procedure for Panel A, replacing GOVSALES with HIGOVSALES. Robust *t*-statistics (with standard errors double clustered by firm and year) in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% levels.

*Panel A. Government Sales*

| First Stage | | Second Stage | | | Third Stage | |
|---|---|---|---|---|---|---|
| | $DBA_t$ | | $DBA_t$ | $GOVSALES_{t-1} \times DBA_t$ | | R&D |
| | 1 | | 2 | 3 | | 4 |
| $SPLIT\_CONTINUOUS_t$ | −0.409*** | $SPLIT\_CONTINUOUS_t$ | −0.409*** | 0.000 | $[GOVSALES_{t-1} \times DBA_t]HAT$ | 5.901* |
| | (−4.02) | | (−4.02) | (0.16) | | (1.95) |
| $GOVSALES_{t-1}$ | −0.005 | $GOVSALES_{t-1} \times DBAHAT_t$ | −0.017 | 0.997*** | $DBAHAT2_t$ | −0.414 |
| | (−0.45) | | (−0.75) | (16.35) | | (−0.25) |
| | | $GOVSALES_{t-1}$ | 0.005 | 0.345*** | $GOVSALES_{t-1}$ | −5.447** |
| | | | (0.22) | (11.06) | | (−2.28) |
| No. of obs. | 47,806 | No. of obs. | 47,806 | 47,806 | No. of obs. | 47,806 |
| $R^2$ | 0.931 | $R^2$ | 0.931 | 0.996 | $R^2$ | 0.808 |
| Controls | Yes | Controls | Yes | Yes | Controls | Yes |
| Macroeconomic controls | Yes | Macroeconomic controls | Yes | Yes | Macroeconomic controls | Yes |
| Time trend | Yes | Time trend | Yes | Yes | Time trend | Yes |
| Firm FE | Yes | Firm FE | Yes | Yes | Firm FE | Yes |
| Year FE | No | Year FE | No | No | Year FE | No |

*(continued on next page)*

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TABLE 10 (continued)

**Budget Cycles and Corporate R&D Investment: Instrumental Variable Results**

*Panel B. High Government Sales*

| First Stage | | Second Stage | | | Third Stage | |
|---|---|---|---|---|---|---|
| | $DBA_t$ | | $DBA_t$ | $HIGOVSALES_{t-1} \times DBA_t$ | | R&D |
| | 1 | | 2 | 3 | | 4 |
| $SPLIT\_CONTINUOUS_t$ | −0.409*** | $SPLIT\_CONTINUOUS_t$ | −0.409*** | 0.000 | $[HIGOVSALES_{t-1} \times DBA_t]HAT$ | 3.883** |
| | (−4.02) | | (−4.02) | (0.07) | | (2.32) |
| $HIGOVSALES_{t-1}$ | −0.003 | $HIGOVSALES_{t-1} \times DBAHAT_t$ | −0.011 | 1.005*** | $DBAHAT2_t$ | −0.386 |
| | (−0.53) | | (−0.93) | (16.33) | | (−0.23) |
| | | $HIGOVSALES_{t-1}$ | 0.003 | 0.340*** | $HIGOVSALES_{t-1}$ | −3.714** |
| | | | (0.33) | (10.79) | | (−2.65) |
| No. of obs. | 47,806 | No. of obs. | 47,806 | 47,806 | No. of obs. | 47,806 |
| $R^2$ | 0.931 | $R^2$ | 0.931 | 0.996 | $R^2$ | 0.808 |
| Controls | Yes | Controls | Yes | Yes | Controls | Yes |
| Macroeconomic controls | Yes | Macroeconomic controls | Yes | Yes | Macroeconomic controls | Yes |
| Time trend | Yes | Time trend | Yes | Yes | Time trend | Yes |
| Firm FE | Yes | Firm FE | Yes | Yes | Firm FE | Yes |
| Year FE | No | Year FE | No | No | Year FE | No |

discussed instrument, reduces aggregate private investment. Conversely, Duquerroy (2019) finds evidence that a unified government (control of executive and legislative branches) reduces firm investment. Our evidence does not suggest that these mechanisms are impacting our results for several reasons. First, the heterogeneous effect of DBA on the R&D investment of GD firms, their peers, and nonpeers suggests the opposite to the findings of these papers. We show that higher polarization in Congress is related to a reduction in investment in GD firms, consistent with Azzimonti, but inconsistent with Duqerroy. However, we find the opposite reaction for peers (inconsistent with Azzimonti, but consistent with Duquerroy) and no reaction by nonpeers (inconsistent with both papers). Finally, including DBAHAT uninteracted explicitly controls for any potential aggregate mechanism, leaving [GOVSALES$_{t-1}$ × DBA$_t$]HAT unaffected.

Although the instrument plausibly fulfills the relevance condition and exclusion criteria from the previous discussion and analysis, we perform additional tests to ensure the validity of our instruments in the Supplementary Material. Briefly, we do not find that our instrument is correlated with leading economic indicators (Table A.19) and we do not find significant differences in analyst forecasts for firms in government-dependent industries prior to the 2010 U.S. Congressional Election, which elected a split Congress (Table A.20). Finally, we find similar evidence when we use an indicator for split control of Congress or a continuous variable that captures how close and document evidence that the instrument is valid.

We report the 3-stage regressions results in model 4 of Table 10 (Panels A and B). We find that the instrumented measure of discretionary budget authority interacted with the GD measure is positive and significantly related to R&D for both of our measures of GD firms. This analysis provides consistent results with the event-study analysis documented in Table 9 and the difference-in-differences analysis in Table A in the Supplementary Material.18. Taken together, these results provide further evidence that the observed positive relation between R&D and DBA for GD firms is not driven by the reverse causality concerns previously discussed.

## C. Selection into Government Dependence

In this section, we directly address the possibility that selection bias may explain our findings in a number of tests reported in the Supplementary Material. Specifically, we perform several tests to ensure our results are not driven by the characteristics determining the selection of firms into government dependence, but rather through our hypothesized mechanism. First, we find that an increase in DBA increases the degree, but not likelihood, of government dependence Likewise, we find that cutting R&D negatively impacts the degree, but not the likelihood, of government independence (Table A.23). Thus, changes in DBA or R&D cuts are unlikely to predict future government dependence. The persistence in government dependence is discussed in greater detail in the Supplementary Material.

Second, our results remain unchanged when we reestimate model 2 of Table 3 on a subsample of firms who have *ever* listed the government as a major customer. This analysis accounts for latent characteristics that may cause firms to select into selling to the government by only considering firms that have at some stage "selected" to be GD (Table A.24).

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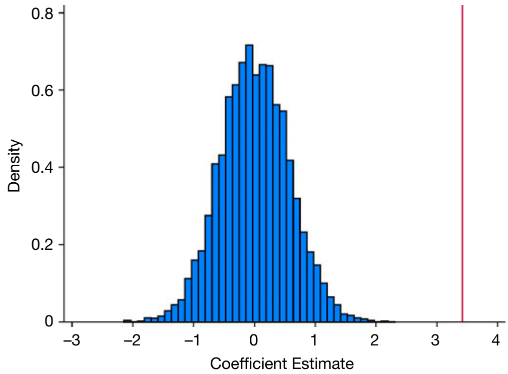
FIGURE 1

Budget Cycles and Corporate R&D Investment: Monte Carlo Counterfactual Analysis

Figure 1 presents a histogram of the results of 10,000 Monte Carlo simulations, designed to analyze whether the relation between R&D expenditure and federal spending for government-dependent firms as reported in Table 3 was due to unmodeled relations in the data. The simulations repeat the methodology from equation (1) in model 2 of the table. For each simulation, 2,416 firm-years (the number of actual government-dependent firm years with their proportion of sales to government customers above the median in the sample) were chosen at random. The figure shows a histogram of the estimated coefficient on the explanatory variable HIGOVSALES × DBA for the simulations. The actual coefficient estimate from Table 3, model 2 (3.418) is plotted as a vertical line for reference. None of the estimated HIGOVSALES × DBA simulation coefficients were greater than the actual estimated coefficient using the real sample of government-dependent firms.




Third, the results are robust to performing a propensity-score match for each GD firm and its 5 peer and 5 nonpeer nearest-neighbors with common support and matched within year on all control characteristics from Table 3 (Rosenbaum and Rubin (1983)) in Table A.25 in the Supplementary Material. Fourth, we do not find evidence that firms with corporate (as opposed to government) customers nor their peers exhibit significant empirical relations between government spending and R&D investment (Table A.26). This reduces the likelihood that the characteristics leading firms to have large customers, rather than our hypothesized mechanisms are driving our results. Finally, we do not find evidence that this relation is being driven by firm size, which is predictive of reporting the government as a major customer (Table A.27).

Finally, Figure 1 presents a histogram of the results of 10,000 Monte Carlo simulations, randomly choosing 2,416 firm-years as highly GD and reestimating model 2 of Table 2 for each simulation. We plot the estimated coefficient on the interaction between HIGHGOVSALES and DBA from Table 2 (3.418) as a red vertical line for comparison. As indicated in the figure, the actual estimated coefficient in Table 2 is greater than all 10,000 simulated coefficients. Our results are therefore not driven by random differences between GD and nondependent firms.

Taken together, the results presented in this section and in the Supplementary Material reduce concerns that our previous estimates of the relation between government spending and firm investment and performance are driven by the endogeneity of DBA. Finally, we perform a series of additional robustness tests reported in the Supplementary Material and observe that our results are: i) not driven by the financial crisis (Table A.28); ii) hold when we use disaggregated industry DBA (Table A.29); and iii) robust to excluding financials and utilities (Table A.30).

# VI. Conclusion

The literature reports mixed evidence on the impact of government spending on private R&D investment, with several studies documenting significant positive spillovers to private R&D (e.g., Howell (2017)), whereas others report the crowding out of private investment (e.g., Cohen et al. (2011)). Exploiting a statutory requirement mandating firms to report large and important customers, we reconcile these mixed findings by identifying groups of firms likely to respond differently to variation in government spending. Consistent with our predictions, an interesting picture emerges: firms reliant on a the government as a major source of revenue increase R&D investment when expected government spending increases, whereas peer firms reduce investment, which leads to a net reduction in R&D investment at the industry level. Further, nonpeers do not adjust R&D significantly to changes in government spending.

After testing multiple alternative mechanisms, we find evidence consistent with a novel, previously unstudied mechanism to explain the reduction of peer-firm and the crowding out of industry investment in R&D: peer firms cut R&D to manage short-term earnings when faced with falling relative performance. Our findings highlight the importance of a firm's accounting and managerial incentives in determining the impact of government spending on private sector investment and in understanding the determinants of investment policy.

# Supplementary Material

To view supplementary material for this article, please visit http://doi.org/10.1017/S0022109020000927.

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