Do Expiring Budgets Lead to Wasteful Year-End Spending? Evidence from Federal Procurement*

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Abstract

Many organizations have budgets that expire at the end of the fiscal year and may face incentives to rush to spend resources on low quality projects at year's end. We test these predictions using data on procurement spending by the U.S. federal government. Spending in the last week of the year is 4.9 times higher than the rest-of-the-year weekly average, and year-end information technology projects have substantially lower quality ratings. We also analyze the gains from allowing agencies to roll over unused funds into the next fiscal year.

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1 Introduction

Many organizations have budgets that expire at the end of the fiscal year. In the United States, most budget authority provided to federal government agencies for discretionary spending requires the agencies to obligate funds by the end of the fiscal year or return the funds to the Treasury; state and municipal agencies typically face similar constraints (McPherson, 2007; Jones, 2005; GAO, 2004).[1]

This "use it or lose it" feature of time-limited budget authority has the potential to result in low value spending, since the opportunity cost to organizations of spending about-to-expire funds is effectively zero.[2] Exacerbating this problem is the incentive to build up a rainy day fund over the front end of the budget cycle. Most organizations are de facto liquidity constrained, facing at the very least a high cost of acquiring mid-cycle budget authority. When future spending demands are uncertain, organizations have an incentive to hold back on marginal spending early in the budget cycle and then burn through this buffer-stock at the end of the year.

This paper examines the quantitative importance of wasteful year-end spending in the U.S. federal government and the efficiency gains from policies that could be used to address this issue. We present a simple model of the annual budget process for a single government agency with expiring budget authority. At the beginning of each year, Congress chooses a budget for the agency. In each subperiod within the year, the agency draws a parameter that determines the marginal value of expenditure and chooses a level of spending to maximize an objective with decreasing returns. We show that the combination of uncertainty and decreasing returns can lead the agency to engage in precautionary savings over the first part of the year. At the end of the year, the prospect of expiring funds leads the agency to spend all of its remaining resources even if the marginal value is below the social costs of funds (our definition of wasteful spending). As a result, there is a spike in the volume of spending and a drop-off in quality at the end of the year.

Anecdotal evidence supports these predictions. A Department of Defense employee inter-

[1] At the end of the federal fiscal year, unobligated balances cease to be available for the purpose of incurring new obligations. They sit in an expired account for 5 years in case adjustments are needed to account accurately for the cost of obligations incurred during the fiscal year for which the funds were originally appropriated. At the end of the 5 years, the funds revert to the Treasury general fund.

[2] In some settings, unspent funding may not only represent a lost opportunity but can also signal a lack of need to budget-setters, decreasing funding in future budget cycles (Laffont and Tirole, 1986; Lee and Johnson, 1998; Jones, 2005). When current spending is explicitly used as the baseline in setting the following year's budget, this signaling effect is magnified.

viewed by McPherson (2007) describes "merchants and contractors camped outside contracting offices on September 30th [the close of the fiscal year] just in case money came through to fund their contracts." At a 2006 congressional hearing, agency representatives admitted to a "use-it-or-lose-it" mentality and a "rush to obligate" at year's end (McPherson, 2007). In Canada, where the fiscal year ends on March 31, the Treasury Board President has used the term "March Madness" to describe the year-end rush-to-spend.[3]

Yet despite these accounts, there is no hard evidence on whether U.S. federal spending surges at the end of the fiscal year or whether year-end spending is lower-value than spending during the rest of the year. Reports from the Government Accountability Office in 1980 and 1985 documented that fourth quarter spending among federal agencies was somewhat higher than spending during the rest of the year. Yet a follow-up report, GAO (1998), was unable to examine quarterly agency spending patterns for 1997 because agency compliance with quarterly reporting requirements was incomplete. The report nevertheless concluded that because "substantial reforms in procurement planning and competition requirements have changed the environment . . . year-end spending is unlikely to present the same magnitude of problems and issues as before."

We address this evidentiary shortfall by examining data on procurement spending by the U.S. federal government. Federal procurement is important, accounting for about 15 percent of government expenditure, and is the category where agencies have the most discretion over the timing of spending. Our data is a near-universe of federal procurement spending from 2004 to 2009, which was recently made available to the public. These data contain contract-level information on the timing of 14.6 million purchases, totaling $2.6 trillion in government expenditure.

The data show a large spike in spending at the end of the year. If procurement spending were uniformly distributed over the year, 1.9 percent of spending would occur in each week on average. We find that 8.7 percent of spending occurs in the last week of the year, or nearly 5 times the rest-of-year weekly average. The surge in spending is broad-based, occurring in nearly all of the major government agencies. Consistent with spending on non-essential projects, year-end spending is more pronounced for maintenance and repair of buildings, furnishings and office equipment, and I.T. services and equipment.

[3] See "Treasury Board president Tony Clement calls for an end to March Madness spending," *Canada Politics Blog*, February 3, 2012.

We examine the effect on the quality of spending using a newly available dataset on the performance of 686 major information technology (I.T.) projects. Our dataset on large I.T. projects accounts for $130 billion in spending. It is also a category with a large year-end spike, with 12.3 percent of spending occurring in the last week of the year. Most importantly, our dataset provides us with a credible measure of project quality, a categorical index that combines assessments from agency chief information officers (CIOs) with data on cost and timeliness. The index is a central element in government-wide reviews that sometimes lead to project terminations.

These data show a sharp drop-off in quality at the end of the year. Projects that originate in the last week of the fiscal year have 2.2 to 5.6 times higher odds of having a lower quality score. Ordered logit and OLS regressions show that this effect is stable across a broad set of specifications. We examine and reject a number of alternative explanations for our finding.

Having confirmed predictions consistent with our model of wasteful year-end spending, we turn to policies that could be used to address this problem. A natural solution is to allow agencies to roll over unused funds into the subsequent fiscal year. We extend the model to allow for rollover and show that welfare gains crucially depend on the degree to which Congress adjusts future budget allocations to account for rolled over funds. If Congress reduces budgets one-for-one with rollover, agencies have no incentive to use this mechanism. If rolled over funds are non-salient or if Congress can at least partially commit to ignoring them, then welfare gains can be realized.

Within the U.S. federal government, the Department of Justice (DOJ) has obtained special authority to roll over unused budget authority for I.T. projects into a fund that can be used on I.T. expenditure in the following year. We show that DOJ does not have a spike in the volume of I.T. spending, with only 3.4 percent of I.T. spending occurring in the last week of the year compared to 9.3 percent for non-I.T. spending. Difference-in-differences analysis that compares I.T. and non-I.T. spending at DOJ and other agencies indicates that rollover reduces the volume of year-end spending by 9.5 percentage points, with a p-value of less than 0.1 percent. We also find that DOJ does not have a drop-off in quality at the end of the year. While the quality results are statistically significant at the 1 percent level, we caution that our DOJ evidence on quality is based on a small number of contracts.

We analyze the potential welfare gains from allowing rollover by calibrating a model to fit the spike in spending and drop-off in quality. We show that intermediate policies, such as allowing agencies to roll over funds for only a short grace period, can generate welfare gains of almost three-quarters of the full rollover value. The intuition behind this result is that even a small amount of rollover allows agencies to avoid the lowest value spending at the end of the year while maintaining sufficient precautionary balances to respond to emergency spending needs.

To the best of our knowledge, our paper is the first economic analysis of wasteful year-end spending, either in government or in a private organization. Our primary references are GAO (1985, 1998, 2004) reports and a master's thesis by McPherson (2007). Within economics, our work is most closely related to Oyer (1998), who studies how nonlinear salesperson and executive contracts lead to increased sales at the end of private sector fiscal years.[4]

The rest of the paper proceeds as follows. Section 2 presents a model of wasteful year-end spending. Section 3 examines the surge in year-end spending using a comprehensive dataset on federal procurement. Section 4 tests for a year-end drop-off in quality using data on I.T. investments. Section 5 examines the benefits of rollover. Section 6 concludes.

2 A Model of Wasteful Year-End Spending

In this section, we present a model of year-end spending. The model uses the simplest possible setup—an annual budget with two six-month subperiods—to make precise what we mean by wasteful year-end spending. In Section 3 and Section 4, we examine predictions from the model. In Section 5, we generalize the model to an infinite horizon setting with an indefinite number of subperiods to examine the welfare effects of alternative approaches to budgeting.

2.1 Model Setup

Consider an annual model of budgeting with Congress and a single government agency. At the beginning of the year, Congress chooses a budget B for the agency. Divide the year into two six-month periods, indexed by $m = 1, 2$. In each period, the agency learns about the marginal value of spending in that period and makes a spending decision accordingly.

The model has three key features. First, there are expiring budgets. Resources that are not

[4] Relatively few private sector firms have fiscal years that coincide with the federal government's, so the effects we measure are unlikely to result from this channel.

spent by the end of the year are lost to the agency and returned to the Treasury.

Second, there is uncertainty about the value of spending in future periods. This uncertainty could arise from either demand or supply factors. Shifts in military strategy or an influenza outbreak, for example, could generate an unanticipated change in demand for budget resources. On the supply side, uncertainty could be driven by variation in the price or quality of desired goods and services.[5]

Third, there are decreasing returns to spending within each period. Decreasing returns could result from short-run rigidities in the production function. For example, federal agencies with a fixed staff of contracting specialists might have less time to devote to each contract in a period with abnormally high spending. Alternatively, decreasing returns could result from a priority-based budgeting rule. During a given period, organizations might allocate resources to projects according to the surplus they provide. We first describe the agency problem and then examine the problem faced by Congress.

Agency problem. To model uncertainty and decreasing returns, assume that the amount of spending x_m in period m has a value that is given by $\alpha_m v(x_m)$, where α_m is a stochastic parameter drawn from a known distribution $F_\alpha(\cdot)$ with positive support and $v(\cdot)$ is a function that is increasing and concave.[6] Conditional on observing the first-period value-of-spending parameter α_1, the objective for the agency is

$$V(B|\alpha_1) = \max_{x_1, x_2 \geq 0} \quad \alpha_1 v(x_1) + \mathbb{E}_{\alpha_2}\left[\alpha_2 v(x_2)\right] \quad (1)$$
$$\text{s.t. } x_1 + x_2 \leq B.$$

Congress's problem. We model Congress as a unitary actor that places the same value on spending as the agency but also considers the opportunity cost of the budget it provides.[7] At the

[5] As an example of supply side uncertainty, during the 2007-2009 recession, many agencies experienced construction costs for Recovery Act projects that were below projections.

[6] Allowing for predictable shifts in the distribution of the value of spending F_α over time (e.g., due to seasonality) would not substantively change the predictions of the model. After netting out predictable changes in volume and quality of spending, the results below would hold.

[7] By modeling the agency and Congress as having the same preferences over spending, we do not consider settings where the agency places a high value on projects that the Congress views as wasteful and vice versa. We view this issue as interesting but conceptually distinct from the issue of how an agency spends its budget allocation over the year. We cannot think of a prima facie reason why the mismatch between agency and Congress's preferences should be greater at the end of the year and no reason why the rollover counterfactual we examine would interact with this type of allocative efficiency issue.

beginning of the year, it chooses a budget B for the agency to maximize the objective

$$W(B) = \max_{B \geq 0} \quad \mathbb{E}_{\alpha_1,\alpha_2}\Big[\alpha_1 v(x_1^*) + \alpha_2 v(x_2^*) - \lambda(x_1^* + x_2^*)\Big]. \tag{2}$$

In this equation, x_1^* and x_2^* represent the optimal spending choices of the agency for a given level of B, and λ represents the social cost of funds.[8,9]

2.2 Model Predictions

We now turn to predictions from the model. The agency always completely exhausts its budget by the end of the year. This occurs, in the model, because the agency has positive returns to spending and does not receive any value from returning resources to Congress. In practice, a ratchet effect (Freixas, Guesnerie and Tirole, 1985) may further increase incentives for the agency to spend its entire budget. If Congress interprets unspent resources as a signal of reduced need, then unspent funding not only produces a loss of value in the current period but may also lead to lower budgets in the future, further reducing the agency's objective.[10]

For the results below, we assume the agency has a precautionary incentive to save resources in the beginning of the year. In the consumption literature, this incentive exists if the consumption function is concave in wealth (Carroll and Kimball, 1996; Carroll, 1997). In our context, agencies have a precautionary incentive if the period 1 spending function $x_1(\alpha_1)$ is concave in α_1. In Appendix Section A, we show that this property is satisfied by many standard value of spending functions including Constant Absolute Risk Aversion (CARA), Constant Relative Risk Aversion (CRRA) with a parameter of $\gamma \geq 1$ (which includes log as a special case), and quadratic. We

[8] Our model is similar to models of life-cycle consumption (see Attanasio and Weber (2010) and Carroll (2001) for reviews), but there are two important distinctions. In life-cycle consumption models, uncertainty about future income generates uncertainty in the future budget constraint. In our model, the budget constraint is inherently certain, but there is uncertainty about the value of spending. Our parameterization of uncertainty can be viewed as the reduced form of a model in which a value of spending is specified for every good or service in every state of nature. A second distinction is that life-cycle models are designed to capture the date at which spending is consumed, and thus there is an important distinction in these models between consumption goods that are consumed immediately and durable goods that yield flow consumption over time. In contrast, we model the date that a contract is signed. Virtually all of this spending—from the purchase of office supplies to advanced weapons systems—yields value to the agency over time. The value of spending $\alpha_m v(x_m)$ can be thought of as the present discounted value of these purchases.

[9] Our setting also shares similarities with the problem of how to optimally fund and spend down a Flexible Spending Account (Cardon and Showalter, 2001).

[10] This ratchet effect could potentially have implications for optimal Congressional budget setting. We discuss this issue in Section 5.

also provide sufficient conditions for $x_1(\alpha_1)$ to be concave under any generic value of spending function.

The first result concerns the volume of spending in each period.

Proposition 1 (Spike in Spending). *The expected level of spending is strictly greater in period 2 than in period 1 (i.e.,* $\mathbb{E}[x_2^*] > \mathbb{E}[x_1^*]$*).*

The proof is a direct application of Jensen's inequality. Because of uncertainty and the concave period 1 spending function, the agency on average holds back some spending in the first period of the year. Because of expiring budgets, the agency then spends this entire amount in the second period. The agency can be thought of as building up a rainy-day fund or of saving more than it would in a risk-free environment due to the option value of future spending. The proofs for this proposition and the proposition that follows are presented in Appendix Section A.

The next result concerns the quality of spending in each period. Define the quality of spending in period m as the value of spending per dollar of expenditure: $q_m = \alpha_m v(x_m)/x_m$. Define expected quality as the spending-weighted expectation of quality: $\bar{q}_m = \mathbb{E}_{w(\alpha)}[q_m]$.[11]

Proposition 2 (Drop-off in Quality). *The expected quality of spending is strictly lower in period 2 than in period 1 (i.e.,* $\bar{q}_2 < \bar{q}_1$*).*

The result holds because the expected level of spending is higher in the second period and the returns to spending are concave. Thus, the average quality of spending is lower in the second period.

Finally, the model makes precise what we mean by wasteful year-end spending.

Definition 1 (Wasteful Year-end Spending). *Wasteful spending is defined as spending for which the marginal return to the agency is less than the social cost of funds (i.e.,* $\alpha_m v'(x_m^*) < \lambda$*).*

Because the agency spends all of its resources in the second period, when the agency draws a sufficiently low value of α_2, some spending will occur with a value that is below the social cost of funds. That is, agencies will engage in wasteful year-end spending.

[11]The weighted expectation is $\mathbb{E}_{w(\alpha)}[q_m] = \int q_m(\alpha)w(\alpha)dF_\alpha$ where the weight is $w(\alpha) = \frac{x(\alpha)}{\int x(\alpha)dF_\alpha}$, which is the level of spending $x(\alpha)$ normalized by $\int x(\alpha)dF_\alpha$ so it integrates to 1. We weight by the level of spending so that our measure of average quality is invariant to aggregation. This ensures that the quality measure is the same whether the agency has a single \$100 million project or two \$50 million projects with the same quality score. We similarly weight by spending in the baseline empirical analysis of the effect on quality, but also show that our results are similar when we do not weight.

To summarize, decreasing returns and uncertainty can create an incentive for organizations to build up a rainy-day fund in the first period, spending less than half of their budget on average. At the end of the year, expected spending increases, average quality drops below that of the earlier part of the year, and in some circumstances spending occurs despite having a value below the marginal cost of funds.

3 Does Spending Spike at the End of the Year?

The predictions of the model are straightforward. Spending should spike at the end of the year, and year-end spending should be of lower quality than spending during the rest of the year. Using newly available data, we test these predictions, beginning in this section with the first prediction that spending should spike at the end of the year.

For many types of government spending, there is little potential for a year-end spike. The 65 percent of U.S. federal spending that is made up of mandatory programs and interest on the debt is not subject to the timing limitations associated with annual appropriations. The 13 percent of spending that pays for compensation for federal employees is unlikely to exhibit an end-of-year surge since new hires bring ongoing costs. This leaves procurement of goods and services from the private sector as the main category of government spending in which an end-of-year spending surge could potentially occur. We therefore focus our empirical work on the procurement of goods and services, a spending category that accounted for $538 billion or 15.3 percent of federal spending in 2009 (up from $165 billion or 9.2 percent in 2000).

It is worth noting that even within procurement spending, there are categories of spending for which it would be unlikely to observe an end-of-year spike. Some types of funding, such as military construction, come with longer spending horizons to provide greater flexibility to agencies. Moreover, there are limits to what kinds of purchases can be made at year's end.

In particular, federal law provides that appropriations are available only to "meet the bona fide needs of the fiscal year for which they are appropriated." Balances remaining at the end of the year generally cannot be used to prepay for next year's needs. A classic example of an improper obligation is an order for gasoline placed 3 days before the end of the fiscal year to be delivered in monthly installments throughout the following fiscal year (GAO, 2004). That said, when there is an ongoing need and it is impossible to separate the purchase into components performed in different fiscal years, it can be appropriate to enter into a contract in one fiscal year even though a significant portion of the performance is in the subsequent fiscal year. In contrast, contracts that are readily severable generally may not cross fiscal years unless specifically authorized by statute.[12]

3.1 The Federal Procurement Data System

Falling technology costs and the government transparency movement have combined to produce an extraordinary increase in the amount of government data available on the web (Fung, Graham and Weil, 2007; The Economist, 2010). As of October 2010, Data.gov had 2,936 U.S. federal executive branch datasets available. The Federal Funding Accountability and Transparency Act of 2006 required the Office of Management and Budget (OMB) to create a public website, showing every federal award, including the name of the entity receiving the award and the amount of the award, along with other information. USAspending.gov was launched in December 2007 and now contains extensive data on federal contracts, grants, direct payments, and loans.

The data currently available on USAspending.gov include the full Federal Procurement Data System (FPDS) from 2000 to the present. FPDS is the data system that tracks all federal contracts. Every new contract awarded as well as every follow-on contracting action, such as a renewal or modification, results in an observation in FPDS. Up to 176 pieces of information are available for each contract including dollar value, a four digit code describing the product or service being purchased, the component of the agency making the purchase, the identity of the provider, the type of contract being used (fixed price, cost-type, time and materials, etc.), and the type of bidding mechanism used. While FPDS was originally created in 1978, agency reporting was incomplete for many years, and we have been told by FPDS staff that it would be difficult or impossible to assemble comprehensive data for years before 2000.[13] Moreover, while FPDS is thought to contain all government contracts from 2000 on, data quality for many fields was uneven before

[12]Over the past two decades, Congress has significantly expanded multi-year contracting authorities. For example, the General Services Administration can enter into leases for periods of up to 20 years, and agencies can contract for services from utilities for periods of up to 10 years.

[13]Indeed, we attempted to download the pre-2000 data using the FPDS web-based "atom feed". However, the aggregate level of spending and number of contracts in these data were significantly less than the amounts listed in government reports. For example, the FY 1999 Federal Procurement Reports lists that the government spent $198 billion on contracts whereas our atom feed data only covered $99 billion in spending.

the 2003 FPDS modernization. Therefore, for most of the FPDS-based analyses in this paper, we limit ourselves to data from fiscal years 2004 through 2009.[14]

Table 1 shows selected characteristics of the FPDS 2004 to 2009 sample. There were 14.6 million contracts awarded during this period, an average of 2.4 million per year. The distribution of contract size is highly skewed. Ninety-five percent of contracts were for dollar amounts below $100,000, while 78 percent of contract spending is accounted for by contracts of more than $1 million. Seventy percent of contract spending is by the Department of Defense. The Department of Energy and NASA, which rely on contractors to run large laboratories and production facilities, and the General Services Administration, which enters into government-wide contracts and contracts on behalf of other agencies, are the next largest agencies in terms of spending over this period. Twenty-nine percent of contract spending was sourced non-competitively; 20 percent was on contracts that were sourced competitively but received only a single bid; and 51 percent was on contracts that received more than one bid. Sixty-five percent of contract spending was on fixed price contracts; 30 percent was on cost-reimbursement contracts; and 6 percent was on contracts that paid on a time and materials or labor-hours basis.

3.2 The Within-Year Pattern of Government Procurement Spending

Figure 1 shows contract spending by week, pooling data from 2004 through 2009. There is a clear spike in spending at the end of the year with 16.5 percent of all spending occurring in the last month and 8.7 percent occurring in the last week of the year.[15] The bottom panel shows that when measured by the number of contracts rather than the dollar value, there is also clear evidence of an end-of-the-year spike, with 12.0 percent of spending occurring in the last month and 3.5 percent occurring in the last week.

Figure 1 also shows a spike in spending in the first week of the year, along with smaller spikes at the beginning of each quarter. Appendix Table A1 shows that these increases are predominantly due to property leases that reset on an annual basis, and service contracts with janitors and nurses

[14] FPDS excludes classified contracts. Data are made available in FPDS immediately after an award. However, during wartime, the Department of Defense is permitted a 90 day delay to minimize the potential for disclosure of mission critical information.

[15] This pattern holds in each year. Over 2004 to 2009, the fraction of spending in the last month ranges from 14.8 to 20.1 percent and the fraction of spending in the last week ranges from 6.5 to 11.5 percent.

that reset periodically.[16]

Further evidence on the year-end rush-to-spend comes from the geographic distribution of spending. A former procurement officer, stationed on the West Coast, told us that every September 30th at 9pm Pacific Time, he would receive a call from the East Coast, explaining that the fiscal year had expired in the Eastern Time zone, and asking whether he had spending needs that could be fulfilled in the remaining three hours in the Pacific Time zone's fiscal year.

Figure 2 shows year-end spending by time zone. The data is split by whether the contract is below the $100,000 threshold that generates larger oversight requirements and whether it occurred in the last day of the year or in the last week of the year excluding the last day. Consistent with this procurement officer's experience, there is a 75 percent increase in Pacific Time Zone spending on contracts of less than $100,000 in the last day of the year, and no effect in the other categories. Appendix Table A2 shows this effect is robust to a rich set of controls.

Table 2 shows that the end of the year spending surge occurs in all major government agencies. If spending were distributed uniformly throughout the year, we would expect to see 1.9 percent in the final week of the year. No agency obligates less than 3.6 percent.

Table 3 shows the percent of spending on different types of goods and services that occurs at the end of the year. The table shows some of the largest spending categories along with selected smaller categories that are very similar to the large categories. Construction-related goods and services, furnishings and office equipment, and I.T. services and equipment all have end-of-year spending rates that are significantly higher than average. These categories of spending often represent areas where there is significant flexibility about timing for performing maintenance or upgrading facilities and equipment, and which, because they represent on-going needs, have a reasonable chance of satisfying the bona fide needs requirement even if spending is obligated at the end of the year.

The categories of spending under the "Services" heading have end-of-year spending rates that are near the average. For these kinds of services it will often be difficult to meet the bona fide need requirement unless the services are inseparable from larger purchases, the services are necessary

[16]The final year of our data overlaps with the implementation of the American Recovery and Reinvestment Act (ARRA), which was signed into law on February 17, 2009. While in principle ARRA might have changed incentives to engage in wasteful year-end spending, actual year-end spending volumes in 2009 are very similar to those during the rest of our sample. Last month spending is 16.9 percent in 2009 versus 16.5 percent in the pooled 2004 to 2009 sample; last week spending is 8.7 percent in 2009 which is the same as the 8.7 percent in the pooled 2004 to 2009 sample.

to provide continuity into the beginning of the next fiscal year, or the services are covered by special multiyear contracting authorities. Thus, it is not surprising that their rate of end-of-year spending is lower than that for construction, for example. There are two categories of spending where there is very little year-end surge. The first is ongoing expenses such as fuels for which attempts to spend at the end of the year would represent a blatant violation of prohibitions against paying for the following year's expenses with current year appropriations. The second is military weapons systems for which because of long planning horizons and the flexibility provided by special appropriations authorities, one would not expect to see a concentration of spending at the end of the year.

It is the exception rather than the rule for Congress to pass annual appropriations bills before the beginning of the fiscal year. Between 2000 and 2009, the full annual appropriations process was never completed on time. Analysts have attributed some of the challenges facing federal acquisition to the tardiness of the appropriations process, since these delays introduce uncertainty and compress the time available to plan and implement a successful acquisition strategy (Acquisition Advisory Panel, 2007). In Appendix Section B we analyze the relationship between the timing of the annual appropriations acts and the within-year pattern of government contract spending. The estimates show that a delay of ten weeks—roughly the average over this time period—raises the share of spending in the last quarter of the year by 2 percentage points from a base of about 27 percent and the share of spending occurring in the last week of the year by 1 percentage point on a base of 9 percent.

Overall, the analysis in this section shows that the end-of-year spending surge is alive and well, 30 years after Congress and the GAO focused significant attention on the problem and despite reforms designed to limit it. Moreover, claims that late appropriations increase the end-of-year volume of contracting activity are accurate, suggesting that late appropriations may be exacerbating the adverse effects of having an acquisition workforce operating beyond capacity at the end of the year.

A surge in end-of-year spending does not necessarily imply bad outcomes. Agency acquisition staff can plan ahead for the possibility that extra funds will be available. Indeed, for large contracts, weeks or even months of lead-time are generally necessary. The next section of the paper therefore analyzes the relative quality of end-of-year contract spending to explore whether there are any adverse effects of the end-of-year spending surge.

4 Is End-of-Year Spending of Lower Quality?

Our model predicts that end-of-year spending will be of lower quality because agencies will spend money at the end of the year on low-value projects and because the increased volume of contracting at the end of the year will lead to less effective management of those acquisitions. As mentioned in the introduction, it has been challenging historically to study contract quality because of the limited availability of data measuring quality. In this section of the paper, we use a new dataset that includes quality information on 686 of the most important federal I.T. procurements to study whether end-of-the-year procurements are of lower quality.

4.1 I.T. Dashboard

Our data come from the federal I.T. Dashboard (www.itdashboard.gov), which tracks the performance of the most important federal I.T. projects. The I.T. Dashboard came online in beta form in June, 2009 and provides the public with measures of the overall performance of major I.T. projects. Like the USAspending.gov data discussed earlier, the I.T. Dashboard is part of a trend toward "open government" and part of a shift in federal management philosophy toward monitoring performance trends (rather than taking static snapshots of performance) and making the trends public both for the sake of transparency and to motivate agencies to achieve high performance (Metzenbaum, 2009).[17]

Along with the availability of performance data, studying federal I.T. projects has two other advantages. The first is the ubiquity of I.T. spending. Major I.T. projects are carried out by nearly all components of the U.S. federal government. Compared to an analysis of, say, the purchase of military or medical equipment, an analysis of I.T. spending shines a much broader light on the workings of government, allowing us to test our hypotheses across agencies with a wide range of missions and organizational cultures. The second advantage is that federal I.T. spending is an

[17] The legislative foundation for the I.T. Dashboard was laid by the Clinger-Cohen Act of 1996, which established Chief Information Officers at 27 major federal agencies and called on them to "monitor the performance of the information technology programs of the agency, [and] evaluate the performance of those programs on the basis of applicable performance measurements." The E-Government Act of 2002 built upon this by requiring the public display of these data.

important and growing federal activity. Federal I.T. expenditure was $81.9 billion in 2010, and has been growing at an inflation-adjusted rate of 3.8 percent over the past 5 years.[18, 19]

Finally, it should be noted that while we are duly cautious about external validity, the widespread nature of I.T. investment across all types of organizations, including private sector ones, makes a study of I.T. purchases more broadly relevant than other categories of spending for which the federal government is the only purchaser. Not only do non-federal organizations buy similar products under similar budget structures, but they often purchase these products from the same firms that sell to U.S. federal agencies. These firms know the end-of-year budgeting game, and if they play the game at the U.S. federal level, there may be reason to believe that they operate similarly elsewhere.[20]

4.2 Data and Summary Statistics

The I.T. Dashboard displays information on major, ongoing projects at 27 of the largest agencies of the federal government. The information is gleaned from Exhibit 53 and Exhibit 300 forms that agencies are required to submit to OMB, and is available on the Dashboard website. The data we use were downloaded in March, 2010, when there were 761 projects being tracked.

For the analysis, we drop the 73 observations that are missing the quality measures, date of award, or cost variables. We also drop two enormous projects because their size would cause them to dominate all of the weighted regression results and because they are too high-profile to be indicative of normal budgeting practices.[21] This leaves us with a baseline sample of 686 projects and $130 billion in planned total spending.

Appendix Table A3 shows the year of origination of these projects and the agencies at which they occurred. Almost two-thirds of these projects (64.6 percent) and half of the spending (50.3 percent) originated in 2005 or later, although there are some ongoing projects that originated more

[18] Analytical Perspectives: Budget of the U.S. Government, 2010.

[19] These expenditure levels do not account for the social surplus from these projects. It is reasonable to think that information systems used to monitor terrorist activities, administer Social Security payments, and coordinate the health care of military veterans could have welfare impacts that far exceed their dollar costs.

[20] See Rogerson (1994) for a discussion of the incentives facing government contractors.

[21] These projects are a $45.5 billion project at the Department of Defense and a $19.5 billion project at the Department of Homeland Security. The next largest project is $3.9 billion, and the average of the remaining observations is $219 million. Because the dropped observations have above average overall ratings and are not from the last week of the year, omitting the observations works against us finding the effect predicted by our model.

than 20 years ago.[22] The projects are distributed broadly across agencies. Although the Department of Defense, Department of Transportation, and Department of Veterans Affairs have higher levels of spending, the vast majority of the agencies have at least 10 projects (21 of 27) and at least $1 billion in aggregate spending (20 of 27).

The most prominent measure tracked by the I.T. Dashboard is the overall rating of the project, which combines subindexes on cost, schedule, and performance. The cost rating subindex is based on the *absolute* percent deviation between the planned and actual cost of the project. Projects that are on average within 5 percent of the scheduled cost receive a score of 10, projects that are within 5 percent to 10 percent on average receive a score of 9, and so on down to zero. Because the symmetric treatment of under- and over-cost projects is somewhat unnatural, we also construct an alternative "cost overrun" index, which gives under-cost projects the highest scores and over-cost projects the lowest. In this index, projects that are at least 45 percent under-cost receive a score of 10, projects that are 35 percent to 45 percent under-cost receive a score of 9, and so on.

The schedule rating subindex is based on the average tardiness of the project across milestones, and takes on one of three values. Projects that are no more than 30 days overdue on average receive a score of 10, projects that are between 30 and 90 days overdue on average receive a score of 5, and projects that are more than 90 days overdue on average receive a score of 0.

The third subindex is a subjective Chief Information Officer (CIO) evaluation that is designed to reflect the CIO's "assessment of the risk of the investment's ability to accomplish its goals."[23] CIO evaluations are determined by an agency-level I.T. review process, which combines input from stakeholders such as program managers and Chief Acquisition Officers. The evaluations and supporting documentation are key inputs into the government-wide "TechStat" review process, which forms the basis for annual I.T. budget requests. There are incentives for CIOs to rank projects accurately. Contractors are likely to object to unjustifiably low scores. Issuing high scores to projects that are ultimately viewed as low quality can be a source of embarrassment.[24]

Finally, it is important to note that CIO evaluations are not mutually exclusive of the cost and

[22] We address sample selection issues in the sensitivity section below.

[23] In particular, CIOs are instructed to assess risk management (e.g., mitigation plans are in place to address risks), requirements management (e.g., investment objectives are clear and scope is controlled), contractor oversight (e.g., agency receives key reports), historical performance (e.g., no significant deviations from planned costs and schedule), human capital (e.g., qualified management and execution team), and any other factors deemed important.

[24] Of course, idiosyncratic measurement error in the dependent variable does not bias our estimates of the drop-off in quality, although it can reduce the precision of our estimates.

schedule ratings, with the CIO explicitly instructed to consider deviations from planned cost and schedule. A reason for this is that the cost and schedule subindices assess progress against current milestones, but these milestones may have been reset after being missed in the past. Thus, the CIO rating is able to account for risks associated with a project that has repeatedly missed milestones in the past even if it is currently on track. The CIO rating is based on a 1-to-5 scale, with 5 being the best.[25] In constructing the overall rating, the I.T. Dashboard converts this 1-to-5 scale to a 0-to-10 scale by subtracting 1 and multiplying by 2.5.

The overall rating is constructed by taking an average of the three subindices, with the CIO evaluation replacing the average if the CIO evaluation has a lower value.[26] The overall rating falls on a 0-to-10 scale with 10 being the best, and takes on non-integer values due to the averaging of subindices. Additional information on the indices can be found in the FAQ of the I.T. Dashboard website.

Appendix Table A4 shows summary statistics for the I.T. Dashboard sample. The average project has a planned cost of $189 million and receives an overall rating of 7.1 out of 10. The I.T. Dashboard includes information on a given project's investment phase (e.g., planning, operations and maintenance), service group (e.g., management of government resources, services for citizens), and line of business (e.g., communication, revenue collection). The bottom panel of the table shows the distribution of the sample across these project characteristics. These variables, along with agency and year fixed effects, are used as controls in the regression specifications.

To classify year-end projects, we use the date the first contract of the project was signed, creating an indicator variable for projects that originated in the last seven days of September, the end of the fiscal year. Most I.T. projects are comprised of a series of contracts that are renewed and altered as milestones are met and the nature of the project evolves. We think that using the date the first contract was signed to classify the start date of the project is the best approach; the key structure of the project is most likely determined at its onset. While future contract awards may affect the quality of the project, we observe outcomes only at the project level. We view any

[25] A rating of 5 corresponds to "low risk," 4 corresponds to "moderately low risk," 3 corresponds to "medium risk," 2 corresponds to "moderately high risk," and 1 corresponds to "high risk."

[26] The exact formula is

$$Overall\_Rating = \min\left\{\frac{2.5}{3}(CIO\_Evaluation - 1) + \frac{1}{3}Cost\_Rating + \frac{1}{3}Schedule\_Rating,\ 2.5\,(CIO\_Evaluation - 1)\right\}$$

potential measurement error from our approach as introducing downward bias in our coefficient of interest as contracts initially awarded before the last week of the year may be contaminated by modifications made in the last week of a later year, and contracts initially awarded at the rush of year's end may be rectified at a later point.

Figure 3 shows the weekly pattern of spending in the I.T. Dashboard sample. As in the broader FPDS sample, there is a spike in spending in the last week of the year. Spending and the number of projects in the last week increase to 7.2 and 8.3 times their rest-of-year weekly averages, respectively. Alternatively put, while only accounting for 1.9 percent of the days of the year, the last week accounts for 12.3 percent of spending and 14.0 percent of the number of projects. The year-end spike in spending is more pronounced in the sample of projects with a value of less than $100 million. Given the longer planning horizon for larger acquisitions, it is not surprising that we see more of a year-end spike for the smaller contracts.[27]

4.3 The Relative Quality of Year-End I.T. Contracts

Figure 4 shows the distributions of the overall rating index for last-week-of-the-year projects and projects from the rest of the year. In these histograms, the ratings on the 0 to 10 scale are binned into 5 categories with the lowest category representing overall ratings less than 2, the second lowest representing overall ratings between 2 and 4, and so on. The top figure shows the distribution weighted by planned spending, meaning that the effects should be interpreted in terms of dollars of spending. These effects are closest to the theory, which makes predictions about the average value of spending in the last period. To show that the effects are not being driven entirely by a small number of high cost projects, Panel B shows the unweighted distribution of projects for the last week and the rest of the year.

Consistent with the model, overall ratings are substantially lower at year's end. Spending in the last week of the year (Panel A) is 5.7 times more likely to have an overall rating in the bottom two categories (48.7 percent versus 8.6 percent) compared to spending during the rest of the year. Without weighting by spending, projects (Panel B) are almost twice as likely to be below the central value (10.6 percent versus 5.7 percent).

[27] As in the broader FPDS sample, the end-of-year spike in the I.T. data is a broad phenomenon, not limited to a few agencies.

To control for potentially confounding factors, we examine the effects of the last week within an ordered logit regression framework. The ordered logit model is a latent index model where higher values of the latent index are associated with higher values of the categorical variable. An advantage of the ordered logit model is that by allowing the cut points of the latent index to be endogenously determined, the model does not place any cardinal assumptions on the dependent variable.[28] In other worlds, the model allows for the range of latent index values that corresponds to an increase in the overall rating from 1 to 2 to be of a different size than the range that corresponds to an increase from 2 to 3. In particular, letting i denote observations and j denote the values of the categorical variable, the predicted probabilities from the ordered logit model are given by

$$\Pr(Overall\_Rating_i > j) = \frac{\exp(\beta_L Last\_Week_i + \beta_j + X_i'\beta_X)}{1 + \exp(\beta_L Last\_Week_i + \beta_j + X_i'\beta_X)},$$

where $Last\_Week$ is an indicator for the last week of the fiscal year, β_j is an indicator for the overall rating category, and X_i is a vector of control variables. See Greene and Hensher (2010) for a recent treatment of ordered choice models.

Table 4 presents results from maximum likelihood estimates of the ordered logit model on the I.T. dashboard sample. The estimates in the table are odds ratios. Recall that odds ratios capture the proportional change in the odds of a higher categorical value associated with a unit increase in the dependent variable, so that an odds ratio of 1/2 indicates that the odds of a higher categorical value are 50 percent lower, or reciprocally that the odds of a lower categorical variable are 2 times as great. The results in this table are weighted by inflation-adjusted spending.

The first column of the table shows the impact of a last week contract on the rating in a regression with no covariates. Columns 2 through 4 sequentially add in fixed effects for year, agency, and project characteristics. In all of the specifications, the odds ratios are well below one—ranging from 0.18 to 0.46—implying that last week spending is of significantly lower quality than spending in the rest of the year (the p-values are less than 0.01 in all specifications). The estimates imply that spending that originates in the last week of the fiscal year has 2.2 to 5.6 times higher odds of

[28] The standard ordered logit model used here does restrict the variables to have a proportional effect on the odds of a categorical outcome. We fail to reject this assumption using a Brant test that compares the standard ordered logit model with an alternative model that allows the effects to vary.

having a lower quality score.[29]

4.4 Sensitivity Analysis

This subsection explores the robustness of the basic estimates. It shows how the results vary with different treatment of large contracts, with different functional form assumptions, and when selection into the sample is taken into account.

Figure 4 showed that the finding that year-end projects are of lower quality was more pronounced in the dollar-weighted analysis than in the unweighted analysis, suggesting that a few large, poorly performing contracts could be heavily affecting the results. Columns 1 to 4 of Table 5 contain results that analyze this issue. Columns 1 and 2 split the sample at the median contract size of $62 million. Both coefficients are substantially below one, although the coefficient in column 1 is less precisely estimated. The point estimate in column 3 from an unweighted regression is quite similar to the estimate in column 1 for the smaller contracts, but with added precision from doubling the sample size by including the full sample (p-value of .02). Results in which we Winsorize the weights, assigning a weight of $1 billion to the 4 percent of projects that are larger than $1 billion, are about half way between the full sample weighted and unweighted results (p-value less than 0.01). Overall, it is clear that the pattern of lower rating for end-of-year contracts is a broad phenomenon. It is also clear that the sample contains several very large low-rated projects that were originated in the last week of the year.[30]

Column 5 of Table 5 shows results from an ordinary least squares (OLS) model in which the raw overall rating is regressed on an indicator for the contract originating in the last week of the year and on controls. The regression coefficient of -1.00 shows that I.T. spending contracted in the last week of the year receives ratings that are on average a full point lower on the 0 to 10 rating scale. This estimate confirms that the finding of lower quality year-end spending is not limited to the ordered logit functional form.

An important feature of our sample is that it reflects only active I.T. projects. Projects that have

[29]In addition to the results from the last week of the year, we have also examined spending in the last month of the year. We find this spending is of moderately lower quality than that in the first 11 months of the year. We have also examined the quality of spending in the first week of the year (which also spikes). The point estimate for the first week of the year suggests somewhat higher spending quality, but the odds ratio is not significantly different from 1.0.

[30]The stronger effect for larger contracts need not result from contract size per se, but could occur if large contracts are more complex on average. For example, if small projects are more likely to be routine "off-the-shelf" I.T. systems, then there might be less downside risk to these projects than large, unique projects originated at the end of the year.

already been completed or projects that were terminated without reaching completion are not in our sample. Unfortunately, because the I.T. Dashboard and the CIO ratings are brand new, it is not possible to acquire rating information on the major I.T. projects that are no longer ongoing.

Ideally, one would want a sample of all major I.T. projects that originated in a particular period in time. The bias introduced by the way in which our sample was constructed most likely leads us to underestimate the end-of-year effect. In particular, very bad contracts begun in the last week of the year are likely to be canceled and would not appear in our data set. Similarly, very well executed contracts from earlier in the year are likely to be completed ahead of schedule and also not appear in our data set. Thus, our estimates likely understate the gap in quality that we would find if we could compare all contracts from the last week of the year with all contracts from the rest of the year.

To explore the extent of bias that a selection mechanism like the one just described might introduce into our estimates, we assembled a dataset of all 3,859 major I.T. projects that originated between 2002 and 2010. We were able to assemble this dataset using the annual Exhibit 53 reports that allow OMB to track I.T. projects across the major federal agencies. These data show that more recently originated projects are significantly more likely to be in our sample. Our sample contains 85 percent of the total spending on projects that originated in 2007 or later and only 28 percent of the spending on projects that originated before this date.

A simple way to assess whether there is selection is to estimate the model on samples split into earlier and later years. A difference in the coefficient of interest across samples, given the assumption that there is no time trend in the effect, would be indicative of selection bias. Given this assumption, however, we can estimate the parameter of interest exactly by using the date of project origination to identify a selection correction term. Column 6 implements this strategy, showing estimates from a Heckman selection model in which the year of origination is excluded from the second stage. The results show a larger effect than the corresponding OLS estimate, but the lack of precision means that we cannot rule out that the effects are the same.[31] The negative coefficient on the selection term, although statistically indistinguishable from zero, suggests that lower quality projects are, on net, more likely to remain in the sample over time.

[31] Consistent with this finding, OLS estimates on a sample split in 2007 show a larger point estimate in the later years, but we cannot reject the hypothesis that the coefficients are the same.

4.5 Alternative Mechanisms

The results from the I.T. Dashboard show that, consistent with the predictions of our model, year-end spending is of lower quality than spending obligated earlier in the year. In our discussion of the model, we posited two potential channels for this effect: agencies may save low priority projects for the end of the year and undertake them only if they have no better uses for the funds, and the high volume of contracting activity at the end of the year might result in less management attention per project.

There are, however, other mechanisms that could lead to a drop-off in quality—and have different implications for the counterfactual of allowing agencies to roll over unused funds into the subsequent year. One such mechanism is *procrastination*.[32] If the contracting officers who do a worse job of planning, writing, or managing contracts are also inclined to procrastinate, then we may see a surge of low quality contracts at the end of the year because that is when the least effective acquisition professionals get their contracts out the door. This mechanism has different policy implications because allowing agencies to roll over funds would not necessarily improve outcomes: the least effective acquisition professionals would simply issue their contracts at a different time of year.

To evaluate the importance of this mechanism, we estimate regression specifications that control for contracting office fixed effects, allowing us to compare the relative performance of projects procured by the same acquisition professionals at different points in time. In particular, we worked to obtain data on the contracting office for each contract and merged this information with the I.T. Dashboard dataset.[33] The data on contracting offices is incomplete, but does allow us to identify the contracting offices for 38 percent of the spending ($48 billion out of $125 billion) and 41 percent (275 of 671) of the projects in our data. Importantly, most of the spending (82 percent) and projects (84 percent) occur at contracting offices that are involved with more than one project, allowing us to use variation within contracting offices.

Columns 1 and 2 of Table A8 show the results of this analysis. We show coefficients from linear regressions because the maximum likelihood estimates of the ordered logit model with a large

[32] We thank Steve Kelman for suggesting this mechanism.

[33] Contracting offices are composed of a small number of contracting specialists, technical assistants, and program managers. As of 2010, there were 35,048 contracting series employees (GS-1102) in the Federal Government (Federal Acquisition Institute, 2011) and 8,829 unique contracting offices, an average of 4.0 contracting professionals per office.

number of fixed effects does not reliably converge. The drop-off in quality is similar in magnitude to the baseline estimate of -1.00. While the weighted estimate is imprecise, the unweighted specification is statistically distinguishable from zero at the 2 percent level. Therefore, the evidence does not suggest that our results stem from worse contracting offices disproportionally writing year-end contracts.

Another mechanism that could lead to a drop-off in quality is *priority-based contracting*. Suppose agencies (i) fund a fixed set of projects and (ii) undertake projects in priority order, starting with the highest quality. This mechanism will naturally lead to declining average quality over the course of the year. However, this mechanism will not, by itself, generate an increase in the volume of spending at year's end. But, if we make the additional assumption that agencies undertake a large number of low priority projects, we can generate a spike in spending at the end of the year. In this model, agencies always undertake the same set of projects and there is no welfare loss from wasteful year-end spending.

Because agencies undertake a fixed set of projects, a key prediction of this priority-based model is that allowing rollover does not affect the volume of year-end spending. As we discuss in more detail in Section 5, the Department of Justice (DOJ) has obtained special authority to roll over unused budget authority for I.T. projects into a fund that can be used on I.T. expenditure in the following year. We show that DOJ does not have an economically significant spike in the volume of I.T. spending, with only 3.4 percent of I.T. spending occurring in the last week of the year compared to 9.3 percent for non-I.T. spending. We also conduct difference-in-differences analysis that compares I.T. and non-I.T. spending at DOJ and other agencies and show that rollover reduces the volume of year-end spending by 9.5 percentage points. This effect is estimated using thousands of contracts and has a p-value of less than 0.1 percent.

Additional evidence against this alternative model comes from examining the second moment of the volume and quality data. In our model of wasteful year-end spending, value-of-spending shocks, α, accumulate throughout the year such that there should be significantly more variation (i.e., a larger second moment) in the volume and the quality of spending at the end of the year. This higher variance occurs because sometimes agencies receive several low value-of-spending shocks over the course of the year, resulting in substantial remaining budget authority at the end of the year and a high volume of low quality spending. At other times, agencies accumulate several high value-of-spending shocks so that they have little money left to spend at the end of the year and therefore engage in a low volume of high quality spending.[34] In the priority-based model, variation in the deterministic list of projects might create some variation in within-year spending patterns but there is no a priori reason why there should be relatively more variation in spending volumes or spending quality at the end of the year.

Appendix Table A9 investigates these two predictions. Columns 1 and 2 show the standard deviation of weekly spending volumes in the last week and the rest-of-the-year in the full FPDS data. This analysis is conducted using a dataset in which the observations are annual percentages of spending by agency and by week. Column 1 shows the standard deviations in the raw data, and column 2 shows the standard deviations after partialling out agency and year fixed effects.[35] The table shows that there is significantly more variation at the end of the year, with 50 percent higher standard deviations across both specifications.

Columns 3 and 4 examine the standard deviation of the overall ratings of project quality in the I.T. Dashboard data. This analysis is conducted using the project-level data and is weighted by spending on each project so that the standard deviations can by interpreted as the variation per dollar of expenditure. Column 3 shows the standard deviations in the raw data and column 4 shows standard deviations after partialling out agency, year, and product characteristic fixed effects. The table shows that the variation in project quality at the end of the year is higher in both specifications.

The increased variation in volume and quality at the end of the year is inconsistent with the priority-based model. At the same time, the increased variation is crucial to the welfare gains from rollover because it implies there are states of the world where the value of spending is well below the social cost of funds and would be avoided if the agency could roll over these funds into the subsequent year. Thus, this evidence not only distinguishes between these models but shows they are different on exactly the dimension that generates the conflicting welfare predictions.

A final mechanism that could explain the year-end drop-off in quality but would have different policy implications is *reverse causality*. If CIOs give a project a low overall rating not because

[34] We have confirmed these predictions in simulations of the calibrated model.

[35] Let y_{ijt} denote the percentage of spending at agency i in year j and week t. Columns 1 show the standard deviation of y_{ijt} for week $t = 52$ and week $t < 52$. To construct the estimates in column 2, we run the regression $y_{ijt} = \delta_i + \delta_j + \epsilon_{ijt}$ where δ_i and δ_j and agency and year fixed effects, construct the residuals $\epsilon_{ijt} = y_{ijt} - \delta_i - \delta_j$, and then show the standard deviation of ϵ_{ijt} for week $t = 52$ and week $t < 52$.

it is low quality but because the CIO recalls it being originated in the end-of-year rush then our finding would be spurious and a policy response would not be justified.[36]

To evaluate this issue, we examine whether the drop-off in quality is relatively stronger for CIOs who have had a longer tenure at their agency and for whom the timing of project origination is likely to be more salient. If the drop-off is stronger for CIOs who were present for the start of the project, then we might be worried about this reverse casualty channel. To conduct this analysis, we obtained CIO biographical statements and used the information in these statements to split the sample into projects for which the CIO has a tenure of more than 3 years at the agency (357 of 671 projects) and projects for which the CIO has a tenure of 3 years or less (235 of 671 projects).[37] Columns 3 and 4 of Table A8 show odds ratios from ordered logit regressions on the longer and shorter tenure samples. The odds ratios are significantly below 1 and similar across both samples, suggesting that reverse causality is unlikely to be a concern.

4.6 Why Are Year-End Contracts of Lower Quality?

To further explore the mechanism behind poor end-of-year contracts, we examine the subcomponents of the overall rating to see which subindices are responsible for the result. Appendix Table A5 repeats our main ordered logit analysis with each subindex as the dependent variable. The results show clearly that it is the evaluation by the agency CIO that is responsible for the main finding. Neither the cost rating nor the schedule rating has an odds ratio that is significantly different from 1. The CIO evaluation shows that the odds of having a higher rating are one-sixth as high for last-week-of-the-year contracts. The coefficient in the CIO regression is insensitive to adding the cost rating and scheduling rating into the regression, suggesting that it is information in the CIO rating that is not incorporated in the other ratings that is responsible for the result.

This finding is not all that surprising. As previously mentioned, the I.T. Dashboard explicitly places more faith in the CIO's assessment than in the other components by allowing the CIO assessment to override the other components if it is lower than the other components. Moreover, the ability to reset milestone targets makes it difficult to assess the cost and schedule ratings. But while not surprising, the fact that it is the CIO evaluation that is driving the result means that

[36]We thank Nick Bloom for alerting us to the possibility of this mechanism.

[37]Biographical statements, at the time of writing, were available at https://cio.gov/about/members/. We were unable to classify CIO tenure for 79 of the projects.

we cannot learn much about the mechanism from the subindices, since the CIO evaluation is a comprehensive measure of the I.T. project's performance.

Another way to explore possible mechanisms is to examine whether other observable features of end-of-year contracts are different from those earlier in the year. Specifically, we examine whether features that policymakers often define as high risk—such as lack of competitive bidding or use of cost-reimbursement rather than fixed cost pricing—are more prevalent in end-of-year contracts. For this analysis, we return to the FPDS sample of all contracts from 2004 to 2009. To facilitate the analysis, we aggregate the 14.6 million observations up to the level of the covariates. We then estimate linear probability models with indicators for contract characteristics (e.g., a non-competitively sourced indicator) as the dependent variable on an indicator for last week of the fiscal year and controls. The regressions are weighted by total spending in each cell.

Columns 1 and 2 of Appendix Table A6 examine shifts in the degree of competitive sourcing at the end of the year. The use of non-competitive contracts shows little change. However, contracts that are competitively sourced are significantly more likely to receive only one bid, perhaps because the end-of-year rush leaves less time to allow bidding to take place. The estimates indicate that there is almost a 10 percent increase in contracts receiving only a single bid—a 1.7 percentage point increase on a base of 20 percent. On net, then, there is a modest increase in "risky" non-competitive and one-bid contracts at the end of the year.

Columns 3 and 4 investigate the type of contract used. Because of their open-ended financial risk, contracts that provide for cost reimbursement rather than specifying a fixed price often require the contracting officer to obtain extra layers of approval—approval that may be difficult to obtain during the end-of-the-year crunch. Column 3 shows that cost-reimbursement contracts are 3.2 percentage points less likely at the end of the year, conditional on detailed controls for the product or service purchased. The use of time and material or labor hours (T&M/LH), which also provide cost-based reimbursement, increases by 0.4 percentage points at the end of the year. T&M/LH contracts are often used when a contracting officer doesn't have time to specify the exact requirements of a contract.

Overall, the analysis in this section provides some evidence on the causes of lower performance at the end of the year. The shift in contract type and the rise in competitively sourced contracts that receive only one bid is consistent with a mechanism in which contracting officers face substantial time pressure at the end of the year, obtaining fewer bids for each contract and choosing to use less time-intensive contract vehicles when they have sufficient discretion. The evidence does not allow us to assess the relative importance of this mechanism compared to other potential explanations, such as that agencies save lower priority projects for the end of the year and undertake them only if funds permit.

5 Allowing for Rollover

The existence of wasteful year-end spending raises the question of whether anything can be done to reduce it. Reducing uncertainty would be helpful but is infeasible in practice for many organizations due to the inherent unpredictability of some types of shocks. A natural way to increase efficiency would be to allow organizations to roll over budget authority across years. Under such a system, budgeting would still occur on an annual basis, but rather than expiring at year's end, unused funds would be added to the newly granted budget authority in the next year.

The idea that budget authority should last for longer than one year is not new. Article 1, Section 8 of the U.S. Constitution gave Congress the power of taxation to fund 17 categories of expenditure. For one of these categories, "To raise and support armies", the Framers placed a time limit on budget authority, specifying that "no appropriation of money to that use shall be for longer term than two years." For all other categories, no limit was specified, suggesting that periods longer than two years were potentially desirable in a broad range of circumstances.

More recently, Jones (2005) has argued for extending the U.S. federal government's obligation period from 12 to 24 months, and McPherson (2007) has recommended that agencies be allowed to carry over unused budget authority for one-time or emergency use for an additional year. The federal government of Canada has adopted a version of rollover, allowing agencies to carry over up to 5 percent of their budget authority across years. In response to concerns over wasteful year-end spending, Oklahoma and Washington also allow their agencies to roll over their budget authority to some extent.[38] Finally, within the U.S. federal government, the Department of Justice (DOJ) has obtained special authority to transfer unused budget authority to an account that can be used for capital and other similar expenditure in future years.[39]

[38]See McPherson (2007) for an in-depth discussion.

[39]See Public Law 102-140: 28 U.S.C. 527. The special authority is also discussed in a May 18, 2006 Senate hearing

5.1 Extending the Model

To allow for rollover, we extend the model to an infinite horizon setting. At the beginning of each year, denoted $y = 1, 2, 3, \ldots$, Congress decides on a budget B_y for the agency. In each month, $m = 1, 2, \ldots M$, the agency learns about the value of spending in that period $\alpha_{y,m}$ and chooses a spending level $x_{y,m}$ accordingly. Indexes update like a standard calendar: The index $\{y, m\}$ is followed by $\{y, m+1\}$ if $m < M$ and $\{y+1, 1\}$ if $m = M$.

Agency's problem. It is easiest to present the agency problem in recursive form. Let $V_m(A_{y,m})$ be the month-specific, present value to the agency from entering a period $\{y, m\}$ with $A_{y,m}$ assets. Let β denote the monthly discount factor. The agency's problem is to choose a level of spending to maximize the value of current period spending plus the discounted expected value of next period's value function:

$$V_m(A_{y,m}) = \max_{A_{y,m} \geq x_{y,m} \geq 0} \quad \alpha_{y,m} v(x_{y,m}) + \beta \mathbb{E}_{y,m} \left[V_{m+1}(A_{y,m+1}) \right].$$

In periods before the end of the year, next period's assets are current assets minus spending. At the end of the year, next period's assets are a new budget allocation plus a function $g(A_{y,M} - x_{y,M})$ of remaining assets.

$$A_{y,m+1} = \begin{cases} A_{y,m} - x_{y,m} & \text{if } m < M \\ B_{y+1} + g(A_{y,M} - x_{y,M}) & \text{if } m = M \end{cases}$$

The no-rollover case is given by $g(A_{y,M} - x_{y,M}) = 0$; full rollover is given by $g(A_{y,M} - x_{y,M}) = A_{y,M} - x_{y,M}$

Congress's problem. As before, Congress places the same value on spending as the agency but also considers the opportunity cost of funds. Let $\tilde{A}_y \equiv g(A_{y-1,M} - x_{y-1,M})$ indicate the resources that the agency rolls over from year $y-1$ to year y. The recursive form of Congress's problem is

$$W(\tilde{A}_y) = \max_{B_y \geq 0} \quad \mathbb{E}_y \Big[\sum_{m=1}^{M} \beta^{m-1} \alpha_m v(x^*_{y,m}) + \beta^M W(\tilde{A}_{y+1}) - \lambda \sum_{m=1}^{M} \beta^{m-1} x^*_{y,m} \Big],$$

entitled, "Unobligated Balanced: Freeing Up Funds, Setting Priorities and Untying Agency Hands."

where next year's rolled over amount is given by

$$\tilde{A}_{y+1} = g(\tilde{A}_y + B_y - \sum_{m=1}^{M} x^*_{y,m})$$

and $x^*_{y,m}$ is the agency's choice for optimal spending, which is affected by the budget B_y.

5.2 Congressional Commitment

The benefit of rollover depends on the degree to which Congress can refrain from raiding the agency's rolled over funds. Suppose full rollover is permitted by law: $g(A_{y,M} - x_{y,M}) = A_{y,M} - x_{y,M}$. Consider the case in which Congress cannot commit to a budget rule.

Proposition 3 (No Commitment)**.** *If Congress cannot commit to a budget rule, the agency will never roll over any budget authority, and allowing rollover will not produce an efficiency gain.*

To see this, notice that at the beginning of each year, Congress's problem yields an optimal level of assets for the agency that equates the expected marginal value of spending to the social cost of funds. It follows that if the agency rolls over an additional dollar, it is optimal for Congress to reduce the agency's budget allocation to fully offset this amount. Since the agency values spending, it will be better off spending all of its resources by year's end and not rolling over any budget authority. The formal proof for this proposition, and the proposition below, can be found in Appendix Section A.

Now suppose that Congress can commit to a budget rule $B^*_y = \Gamma(A_{y-1,M} - x_{y-1,M})$ that could depend on the amount of rolled over funds.

Proposition 4 (Full Commitment)**.** *If Congress can commit to a budget rule, it is optimal for Congress to provide a constant budget that does not depend on the level of rolled over resources (i.e., $B^*_y = \bar{B}$), and welfare will be higher than in the no-rollover scenario.*

Because Congress places the same value on spending as the agency, it wants to avoid distorting the agency's inter-temporal spending decisions. It does this by making future budgets unconditional on the amount of rolled over funds.[40] Agency spending does not spike at the end of the

[40]This result shares intuition with results on optimal unemployment insurance in the presence of hidden savings (Abdulkadiroglu, Kuruscu and Sahin, 2002; Kocherlakota, 2004). In these papers, hidden savings weakens the link between optimal unemployment benefits and the length of time unemployed. Here, if Congress can commit to a budget rule, it is similarly optimal for future budget allocations to be unconditional on the amount of rolled over funds.

year, and there is no year-end drop-off in quality. The only difference between full commitment and the first-best is that agencies cannot borrow.

This result also implies that it is never optimal for the budget office to offer to share savings with an agency, for example by allowing agencies to keep 50 percent of unused funds and then applying the remaining 50 percent to deficit reduction. So long as the portion of unused funds retained by the agency is below 100 percent, agencies will have an incentive to do some spending with a value below the social cost of funds.[41]

Finally, the model does not exhibit a ratchet effect phenomenon (Freixas, Guesnerie and Tirole, 1985), in which the pattern of spending over the year provides an informative signal to Congress on the social value of spending at the agency. This is because the pattern of spending is only indicative of the *relative* magnitude of the value of spending shocks $\alpha_{y,m}$ compared to their expected value $\mathbb{E}[\alpha_{y,m}]$ and does not in general provide information on their absolute magnitude, which is what determines Congress's budget allocation.[42,43]

5.3 Empirical Evidence

To explore whether allowing rollover gives rise to the type of beneficial effects that are predicted by the full commitment equilibrium, we examine procurement data from the Department of Justice. In 1992, the Department of Justice (DOJ) obtained special authority to roll over up to 4 percent of annual revenue into a fund that could be used for up to five years on I.T. and related projects.[44] DOJ has been using this authority, rolling over \$1.8 billion during the 1994 to 2006 period (Senate, 2006), yet may be worried about commitment. In a recent report, Senator Tom Coburn criticized

[41]There are institutional factors that help Congress commit to allowing rollover. Congress and agencies play a repeated game. If Congress raids an agency's rolled over resources in one year, the agency may play a trigger strategy, never rolling over funds in the future. If multiple agencies were permitted rollover, Congress might be concerned about its reputation, and refrain from raiding an agency's rainy-day fund to avoid discouraging other agencies from rolling over their resources.

[42]To see this, consider a setting with two periods, no rollover, and a spike in spending at the end of the year. Based on this pattern of spending, Congress is able to infer that the agency received a below average draw for α in the first period of the year. The pattern of spending, however, cannot be used to determine the average value of spending, which is what determines Congress's budget allocation.

[43]There are a number of extensions to the model that would be interesting to consider. For instance, what is the effect of asymmetric information between Congress and the agency or of a principle-agent setup where moral hazard by the agency is a central concern.

[44]In particular, the law allows the transfer of unobligated balances into the "capital account of the Working Capital Fund to be available for the department-wide acquisition of capital equipment, development and implementation of law enforcement or litigation related automated data processing systems, and for the improvement and implementation of the Department's financial management and payroll/personnel systems." (Public Law 102-140, 28 USC 527) See: http://www.justice.gov/jmd/costreim/wcf-website-update.pdf.

the agency for its behavior, stating, "Every year the Department ends the year with billions of unspent dollars. But instead of returning this unneeded and unspent money to the taxpayers, the DOJ rolls it over year to year" (Coburn, 2008).

To examine the effects of rollover, we return to the data on the volume and quality of contract spending analyzed in Sections 3 and 4. Table 6 presents difference-in-differences estimates of the effect of the DOJ rollover authority on the volume of year-end spending. Rows compare the fraction of spending that occurs in the last week of the year at DOJ and at other agencies; columns compare I.T. and non-I.T. projects. The first row shows that at other agencies, 8.5 percent of non-I.T. spending occurs in the last week of the fiscal year; for I.T. projects, 12.1 percent of spending occurs in the last week of the year. At DOJ, the fraction of non-I.T. spending that occurs in the last week of the year is 9.3 percent, similar to the government-wide average. Whereas at other agencies the fraction of I.T. spending that occurs in the last week of the year is above the fraction of non-I.T. spending, at DOJ it is significantly lower. At DOJ, only 3.4 percent of I.T. spending occurs in the last week of the year, much closer to the 1.9 percent that would result from constant expenditure over the year. The difference-in-differences estimate is a decline of 9.5 percentage points, with a p-value of less than 0.1 percent.

Because DOJ has relatively little end-of-year I.T. spending, there is less data to look at the effects on quality. Table 7 shows difference-in-differences estimates of the effect on overall ratings using the I.T. Dashboard data. At other agencies, last-week I.T. projects have overall ratings that are 1.9 points lower than rest-of-year projects on average. DOJ has 15 I.T. projects in the Dashboard with only 1 occurring in the last week of the year. This project has the highest overall rating of all the projects undertaken by DOJ and is 1.6 points higher than the average. While one should be cautious in interpreting a result that comes from a single observation, a difference-in-differences estimate shows how unlikely it is that the one end-of-year DOJ I.T. project would be of such high quality if there were no effect of rollover—the DOJ rollover variable has a p-value that is below .01. Appendix Table A10 show the result is robust across a broad set of regression specifications.

In sum, the DOJ data provide empirical support for beneficial effects of rollover. Allowing for the rollover of I.T. funds leads to a substantial decrease in the volume of year-end I.T. spending at DOJ relative to other agencies, and also seems to lead to an increase in project quality.

5.4 Calibrating the Welfare Gains

The results in the previous section—that permitting rollover eliminates the spike in spending and the associated decline in quality—gives an indication of the potential welfare gains from permitting rollover. But the theoretical model suggests that a deeper assessment is needed. In particular, rollover should improve the quality of spending over the front part of the year as well. For instance, in the beginning of the year, agencies with a high value of spending can tap into funds rolled over from the previous period. Moreover, the gains from permitting rollover depend on how Congress reacts to rolled-over funds. To study these types of effects and to consider more generally the welfare gains from alternative rollover policies, we calibrate the infinite horizon model to fit the spike in spending and the drop-off in quality at the end of the year.

The model is characterized by a parameter that determines the curvature of the value of spending function and a parameter that determines the distribution of spending shocks. We calibrate these parameters such that simulated data from the model has the same spike in spending and drop-off in quality that we observed in the federal procurement data. In our baseline calibration, we specify a CRRA $v(x) = \frac{x^{1-\gamma}}{1-\gamma}$ value of spending function with curvature parameter γ and a log normal $\ln \alpha \sim N(0, \sigma)$ distribution of spending shocks with standard deviation σ. We set the number of months per year to $M = 12$ and the monthly discount factor to $\beta = 0.996$.[45] We normalize the social cost of funds to $\lambda = 1$. While the specific quantitative results are dependent on the chosen functional form, we show in the appendix that results are quite similar with a CARA spending function. Full details on the calibration can be found in Appendix Section C.

As a first step, we assess the welfare gains from rollover by comparing the non-rollover status quo to three alternative scenarios. In the first scenario, we allow rollover, but reduce the agency's budget authority to produce the same expected value of spending as in the no-rollover regime. This can be thought of as an estimate of the compensating variation from allowing rollover. Appendix Table A13 shows that Congress could allow rollover, reduce the agency's budget by 13 percent, and the value of spending would be identical to the status quo.

The second scenario examines the welfare gain from rollover when Congress can re-optimize the budget it provides to the agency. In our simulations Congress chooses to reduce the agency's

[45] This monthly discount factor implies an annual discount factor of $0.95 = 0.996^{12}$.

budget allocation by an amount that turns out to be similar to the reduction in the compensating variation scenario because agencies on average enter the year with rolled-over funds, so Congress does not need to provide as much funding to ensure that the agency can take advantage of high α periods. Moreover, this effect outweighs the greater willingness of Congress to provide funds in a rollover environment given that agencies will not squander them on projects with a value below the social cost of funds. The welfare gains in this Congressional reoptimization scenario are slightly higher than those in the compensating variation scenario.

The third scenario examines the welfare gains from the first-best level of spending, defined as the level of spending that equates the marginal social value of spending to the marginal social cost of funds in each period. Compared to rollover, which effectively allows agencies to save, the first-best effectively allows agencies both to save and to borrow. The welfare gains from this counterfactual are approximately 19 percent, but are an upper bound because, in the real world, agencies can acquire extra resources in extenuating circumstances through mid-year supplemental appropriations from Congress, a channel we do not model in our rollover scenario.

Whether these welfare gains can be achieved depends on Congress's ability to commit to future budgets. While Congress cannot completely tie its own hands, it can design policies to increase the likelihood of commitment. For example, Congress could specify that rolled-over amounts are not reported in standard budget tables, increasing the cost of obtaining this information. Our analysis shows that small commitment probabilities can achieve relatively large welfare gains. We conduct a counterfactual analysis where with probability π Congress commits and agencies are able to roll over the full amount of unspent resources into the next year, and with probability $1 - \pi$ Congress reneges and unspent resources are taken from the agency and valued in the welfare function at the social cost of funds. Panel A of Appendix Figure A3 shows that a 25 percent commitment probability leads to welfare gains of more than half the full rollover value, as agencies prefer to roll over their funds than engage in flat-of-the-curve spending at the end of the year.

We also use the model to examine the effect of two intermediate policies. The first is to allow agencies to roll over funding for a time-limited grace period.[46] Such a grace period would not simply result in a spike in spending at the new deadline. Because next year's budget authority

[46]We thank Dan Feenberg for suggesting this counterfactual.

would provide a de facto rainy day fund, even a few months of rollover would allow agencies to draw down their previous year's savings over a longer time period while using next year's allotment to insure against large spending needs.[47] We find that a one-month grace period achieves 41 percent of the welfare gains from full rollover; a two-month grace period achieves 66 percent; and a four-month grace period 90 percent (see Panel B of Appendix Figure A3).

The second alternative is for Congress to provide more funding on a multi-year basis. While the full implications of less frequent fiscal policy are outside the scope of this paper, one benefit of multi-year budgeting is that it reduces the frequency of wasteful year-end spending. In our calibrated model, we find that two-year budget cycles achieve 70 percent of the gains from full rollover and three-year budget cycles achieve 90 percent (see Panel C of Appendix Figure A3).

The results are subject to a number of caveats. We assume that agencies—and their employees—do not have self-control problems. If agencies are prone to procrastinate, for example, then a year-end deadline may force agencies to get languishing projects out the door, providing a benefit that could offset some of the cost of lower quality spending.

Another assumption we make is that agencies cannot achieve the equivalent of rollover today by purchasing fungible goods or "parking" funds in contracts that can be repurposed at the end of the year. The empirical analysis showed relatively little year-end spending in the most fungible categories—such as fuels, lubricants, oils and waxes—and we would not see a drop-off in quality if funds were used in this manner. To the extent some funding is already rolled over through such methods, the benefits of legally permitting rollover would be reduced.

6 Conclusion

Our model of an organization facing a fixed period in which it must spend its budget resources made three predictions. We have confirmed all three using data on U.S. federal contracting. First, there is a surge of spending at the end of the year. Second, end-of-year spending is of lower quality. Third, permitting the rollover of spending into subsequent periods eliminates the end-of-year spending surge and appears to lead to higher quality.

[47] Because Congress rarely passes a budget on schedule and agencies are operating under continuing resolutions, this partial rollover period often will have expired by the time that a new budget is determined. In this case, Congress would have no incentive to take this rolled-over amount into consideration.

Our welfare simulations suggest that most of the inefficiency from wasteful year-end spending could be eliminated with relatively modest changes to budget procedures—for example, by allowing agencies to roll over unused funds into the next fiscal year for use during a four-month grace period.

In evaluating possible policy reforms, one should not lose sight of the potential benefits of one-year budget periods. Shorter appropriations cycles may produce benefits from greater Congressional control over executive branch operations. The use-it-or-lose it feature of appropriated funds may push projects out the door that would otherwise languish due to bureaucratic delays. And there may be institutional barriers to achieving the full benefits illustrated in the welfare simulations. For example, unless the rollover balances stay with the same part of the organization that managed to save them, agency subcomponents will still have an incentive to use up the entirety of their allocations.

While a full assessment of potential policy reforms is beyond the scope of this paper, two things are clear. First, the conventional wisdom expressed in GAO (1998) that the federal end-of-year spending problem was largely solved with the budget process reforms of the early 1980s is wrong. There remains a large surge in spending in the last week of the year. Second, this spending surge has real consequences. Our finding that year-end I.T. spending is of lower quality demonstrates for the first time that the end-of-year spending surge does in fact result in lower quality spending.

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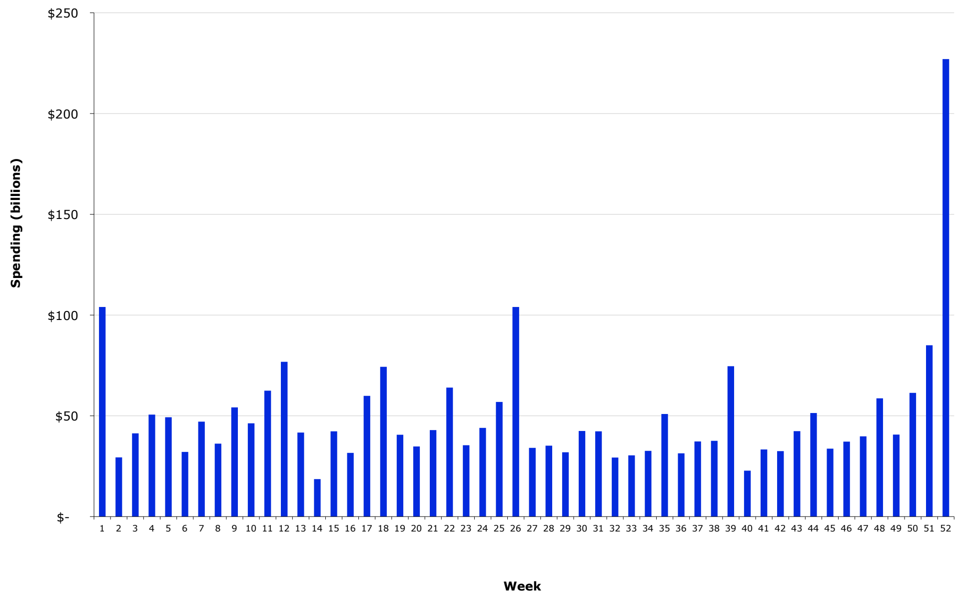
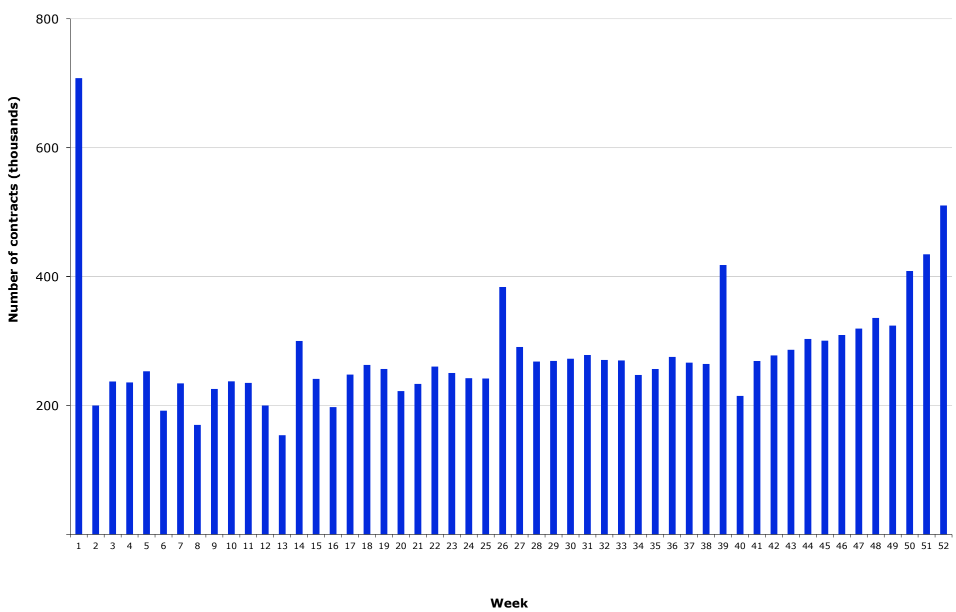
Figure 1: Federal Contracting by Week, Pooled 2004 to 2009 FPDS



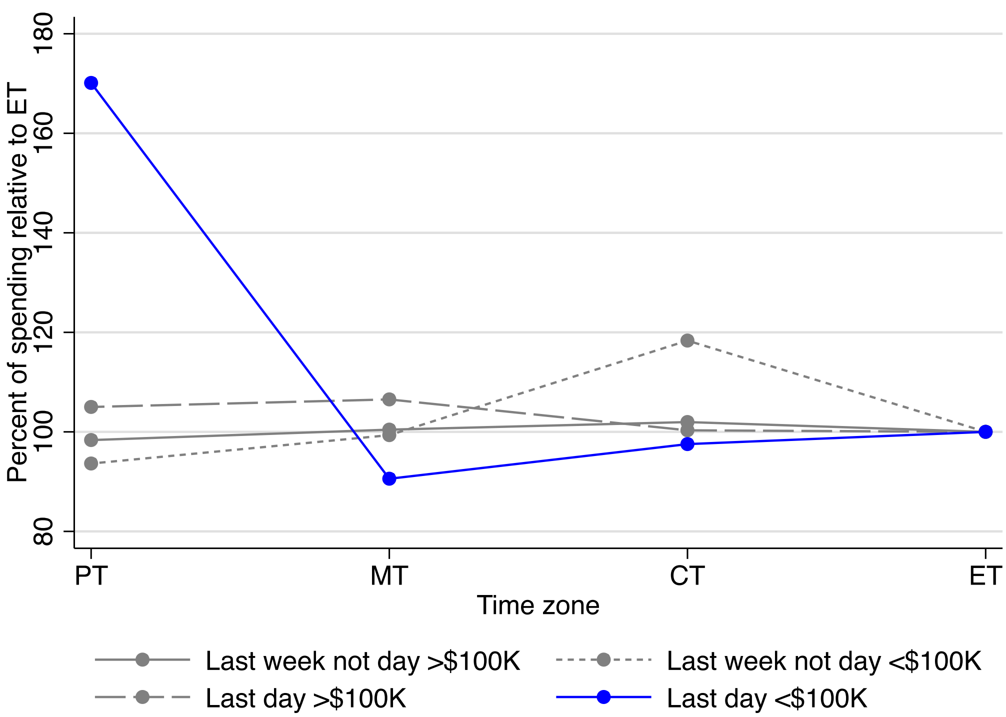
(a) Spending



(b) Number of Contracts

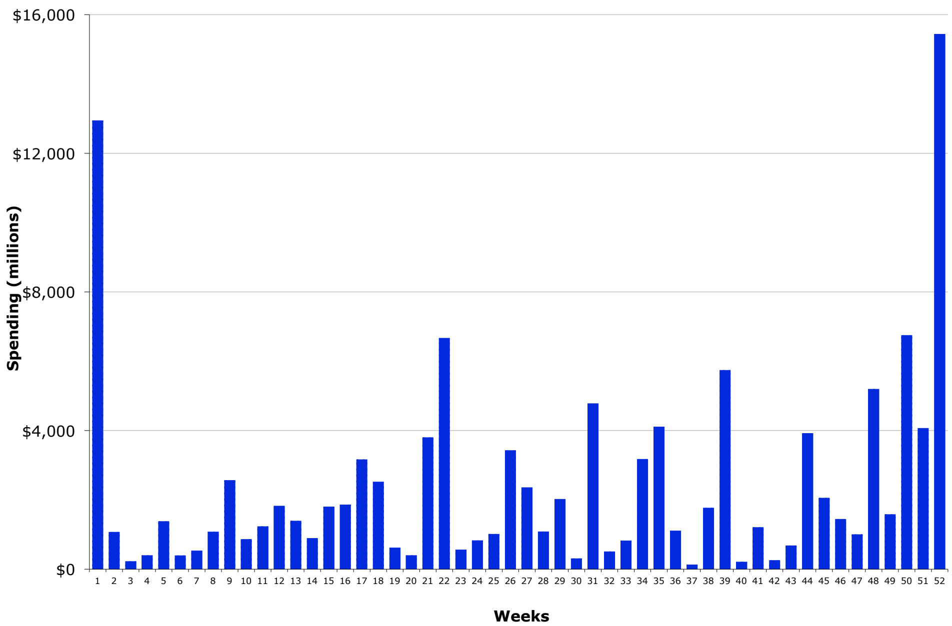
Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Total spending and number of contracts by week of the federal fiscal year. Spending values inflation-adjusted to 2009 dollars using the CPI-U.

Figure 2: Year-End Spending by Time Zone

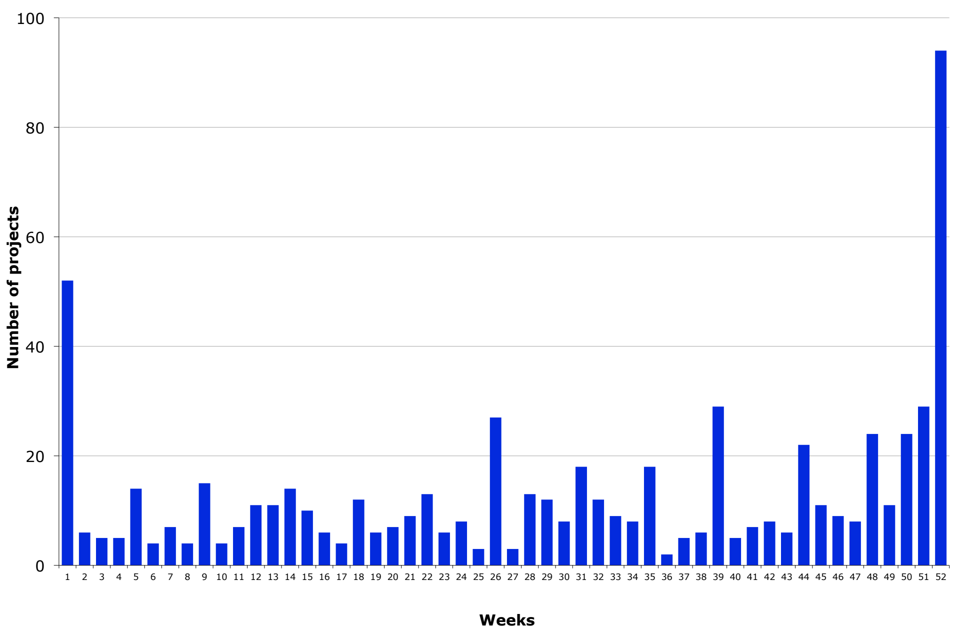


Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov
Note: Figure shows percent of annual spending by time zone in the last day and last week excluding the last day of the fiscal year and by contract size. The x-axis shows time zones displayed from west (PT) to east (ET) for the contiguous U.S. The y-axis shows the percent of year-end spending in that time zone relative to the percent of year-end spending in ET to normalize for different levels of spending by time period and contract size. Spending values inflation-adjusted to 2009 dollars using the CPI-U.

Figure 3: I.T. Contracting by Week



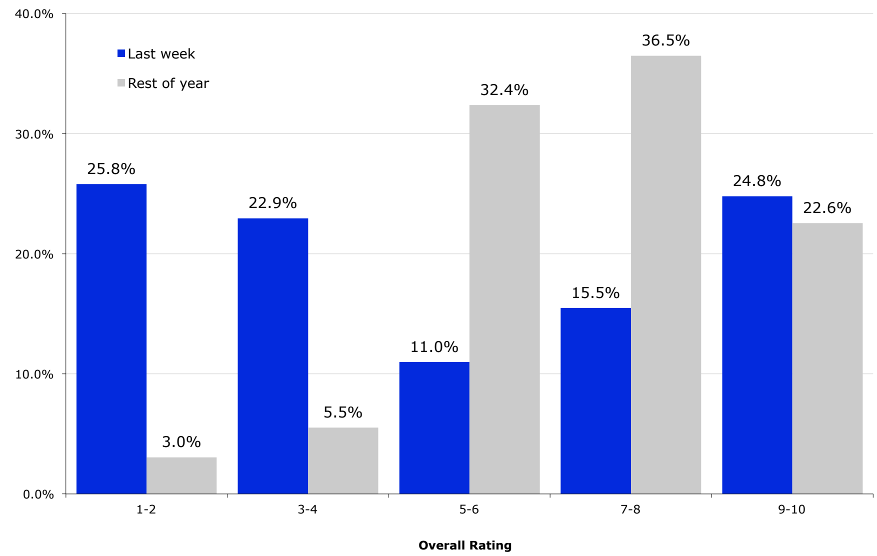
(a) Spending



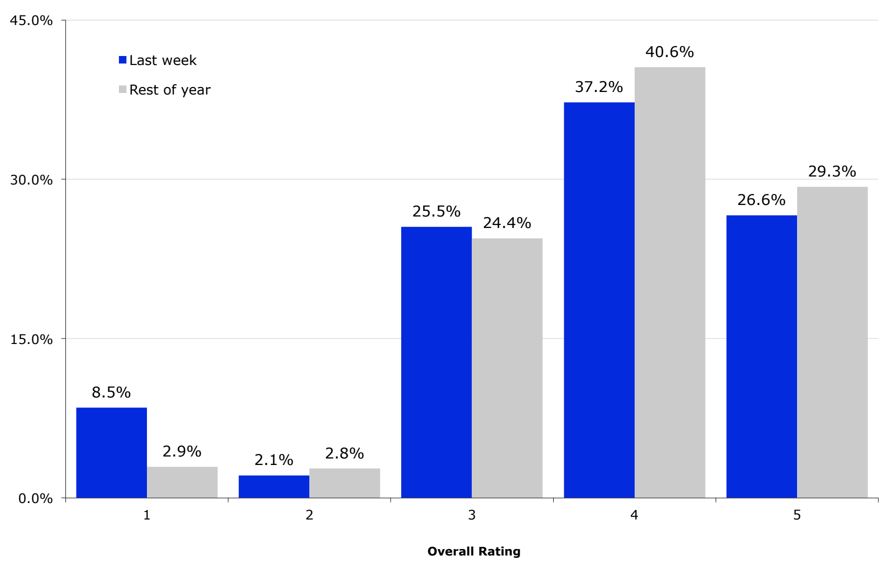
(b) Number of Projects

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov.
Note: Total spending and number of I.T projects by week of the federal fiscal year. Spending values inflation-adjusted to 2009 dollars using the CPI-U.

Figure 4: Year-End and Rest-of-Year Overall Ratings



(a) Spending



(b) Number of projects

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov.
Note: Overall rating histograms for I.T. projects originating in the last week and rest of the year. To construct this figure, ratings are binned into 5 categories with the lowest category representing overall ratings less than 2, the second lowest representing overall ratings between 2 and 4, and so on. See text for details on the overall rating index. Panel A weights projects by inflation-adjusted spending. Panel B shows unweighted values.

Table 1: Summary Statistics: Federal Contracting, Pooled 2004 to 2009 FPDS

	Spending		Contracts	
	Billions	Percent	Count	Percent
Totals	$2,597	100.0%	14,568,153	100.0%
Year				
2004	$304	11.7%	1,413,320	9.7%
2005	$355	13.7%	1,857,959	12.8%
2006	$405	15.6%	2,719,482	18.7%
2007	$452	17.4%	2,977,431	20.4%
2008	$542	20.9%	3,292,059	22.6%
2009	$538	20.7%	2,307,902	15.8%
Contract size				
Less than $100K	$166	6.4%	13,844,183	95.0%
$100K to $1M	$398	15.3%	625,973	4.3%
At least $1M	$2,033	78.3%	97,997	0.7%
Agency				
Agriculture	$25	1.0%	241,626	1.7%
Commerce	$13	0.5%	112,756	0.8%
Defense	$1,824	70.2%	3,536,530	24.3%
Education	$8	0.3%	12,806	0.1%
Energy	$142	5.5%	37,756	0.3%
Environmental Protection Agency	$8	0.3%	62,713	0.4%
General Services Administration	$82	3.2%	4,830,748	33.2%
Health and Human Services	$76	2.9%	249,907	1.7%
Homeland Security	$74	2.8%	255,461	1.8%
Housing and Urban Development	$6	0.2%	15,666	0.1%
Interior	$25	1.0%	377,743	2.6%
Justice	$33	1.3%	420,379	2.9%
Labor	$13	0.5%	41,229	0.3%
National Aeronautics and Space Administration	$83	3.2%	81,211	0.6%
National Science Foundation	$2	0.1%	4,201	0.0%
Other	$37	1.4%	179,283	1.2%
Small Business Administration	< $1	< 0.1%	3,361	< 0.1%
State	$34	1.3%	239,019	1.6%
Transportation	$21	0.8%	57,235	0.4%
Treasury	$25	1.0%	177,662	1.2%
Veterans Affairs	$67	2.6%	3,630,856	24.9%
Competition type				
Non-competitive	$745	28.7%	3,553,453	24.4%
Competitive with one bid	$521	20.0%	3,883,273	26.7%
Competitive with more than one bid	$1,332	51.3%	7,131,422	49.0%
Contract type				
Fixed price	$1,675	64.5%	14,167,104	97.2%
Cost-reimbursement	$780	30.0%	151,356	1.0%
Time and materials/labor hours	$142	5.5%	249,693	1.7%

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Contract spending inflation-adjusted to 2009 dollars using the CPI-U.

Table 2: Year-End Contract Spending by Agency, Pooled 2004 to 2009 FPDS

	Spending (billions)	Percent of spending	
		Last month	Last week
Agriculture	$24.8	17.0%	6.2%
Commerce	$13.4	21.4%	5.6%
Defense	$1,820.0	16.0%	8.6%
Education	$8.2	18.6%	11.2%
Energy	$142.0	6.6%	4.0%
Environmental Protection Agency	$8.1	22.3%	10.4%
General Services Administration	$82.0	12.9%	7.0%
Health and Human Services	$76.4	25.5%	12.2%
Homeland Security	$73.6	22.7%	9.4%
Housing and Urban Development	$5.7	18.5%	11.7%
Interior	$25.3	23.2%	7.6%
Justice	$32.6	17.9%	9.4%
Labor	$12.7	12.9%	5.9%
National Aeronautics and Space Administration	$82.7	16.9%	11.0%
National Science Foundation	$2.0	27.7%	11.5%
Small Business Administration	$.4	31.9%	16.3%
State	$33.5	34.9%	20.4%
Transportation	$20.5	17.6%	3.6%
Treasury	$24.9	15.3%	9.6%
Veterans Affairs	$66.9	18.2%	9.5%
Other	$37.4	28.6%	18.9%
Total	$2,600.0	16.5%	8.7%

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Contract spending inflation-adjusted to 2009 dollars using the CPI-U.

Table 3: Year-End Contract Spending By Selected Product or Service Code, Pooled 2004 to 2009 FPDS

	Spending (billions)	Percent of spending	
		Last month	Last week
Construction-related			
Construction of structures and facilities	$136.0	40.9%	28.6%
Maintenance, repair, or alteration of real property	$72.5	34.8%	20.1%
Architect and engineering services	$32.8	26.1%	13.8%
Installation of equipment	$4.0	33.9%	20.4%
Prefabricated structures and scaffolding	$3.7	34.9%	18.4%
Furnishings and office equipment			
Furniture	$8.0	37.3%	18.4%
Office supplies and devices	$4.0	24.9%	16.6%
Household and commercial furnishings and appliances	$1.2	37.8%	20.7%
Office machines, text processing systems and equipment	$1.1	33.5%	17.0%
I.T. services and equipment			
Automatic data processing and telecom. services	$145.0	21.0%	12.3%
Automatic data processing equipment	$53.7	29.2%	14.9%
Services			
Professional, admin, and management support services	$336.0	19.1%	9.9%
Research and development	$309.0	11.3%	5.3%
Utilities and housekeeping services	$73.7	15.6%	9.1%
Ongoing			
Fuels, lubricants, oils and waxes	$72.7	13.2%	0.7%
Medical services	$68.8	4.9%	1.7%
Chemicals and chemical products	$6.2	3.3%	1.3%
Tires and tubes	$1.0	8.7%	2.7%
Toiletries	$0.3	12.2%	3.0%
Military weapons systems			
Aircraft and airframe structural components	$141.0	5.7%	2.9%
Ships, small craft, pontoons, and floating docks	$48.5	7.5%	2.1%
Guided missiles	$38.0	8.1%	3.5%
Other	$1,111.6	13.6%	6.8%
Total	$2,600.0	16.5%	8.7%

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Contract spending in the last month and week of the fiscal year by selected 2-digit product or service code, inflation-adjusted to 2009 dollars using the CPI-U. Categories jointly account for 57.2 percent of total spending.

Table 4: Ordered Logit Regressions of Overall Rating on Last Week and Controls

	Odds ratio of higher overall rating			
	(1)	(2)	(3)	(4)
Last week	0.26	0.46	0.30	0.18
	(0.07)	(0.14)	(0.10)	(0.07)
Year FE		X	X	X
Agency FE			X	X
Project characteristics FE				X
N	671	671	671	671

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov.
Note: Odds ratios from ordered logit regressions. Coefficient of 1 indicates no effect. Overall rating is a quality index that combines that CIO evaluation, cost rating, and scheduling rating subindices (see text for details). It takes values from 0 to 10, with 10 being the best. Project characteristics are fixed effects for investment phase, service group and line of business (see Table A4). Observations weighted by inflation-adjusted spending. Standard errors in parentheses.

Table 5: Sensitivity Analysis of the Effect on Overall Ratings

	Odds ratio of higher overall rating from ordered logit				Coefficients from linear model	
	Contracts < $62M	Contracts ≥ $62M	Unweighted	Winsorized weights	OLS	Heckman selection model
	(1)	(2)	(3)	(4)	(5)	(6)
Last week	0.60	0.18	0.56	0.37	-1.00	-1.57
	(0.23)	(0.11)	(0.14)	(0.12)	(0.39)	(0.64)
Year FE	X	X	X	X	X	
Agency FE	X	X	X	X	X	X
Project characteristics	X	X	X	X	X	X
Weighted by spending	X	X		X	X	X
λ						-0.87
						(0.85)
R-squared					0.69	
N	335	336	671	671	671	3,803

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov and 2003 to 2010. Exhibit 53 reports, available at http://www.whitehouse.gov/omb/e-gov/docs/.
Note: Columns 1 to 4 show odds ratios from ordered logit regressions. Coefficient of 1 indicates no effect. Columns 1 and 2 split the sample at the median value. Column 3 shows odds ratios from an unweighted regression. Column 4 Winsorizes the spending weight at $1 billion (96th percentile). Columns 5 and 6 show regression coefficients from linear regressions. Column 5 reports coefficients from a simple OLS regression. Column 6 reports coefficient from a Heckman selection model with a linear second stage. In this regression, the sample is all major I.T. projects recorded in the Exhibit 53 reports. The excluded variable in this selection model is the year of project origination. The parameter λ is the implied coefficient on the inverse Mill's ratio selection term. Overall rating is a quality index that combines that CIO evaluation, cost rating, and scheduling rating subindices (see text for details). It takes values from 0 to 10, with 10 being the best. Project characteristics are fixed effects for investment phase, service group, and line of business (see Table A4).). Observations weighted by inflation-adjusted spending unless otherwise mentioned. Robust standard errors in parentheses.

Table 6: Difference-in-Differences of Last Week Spending on Justice and I.T.

	Non-I.T.	I.T.	Difference	Difference-in-differences
Other agencies	0.0850 (0.0001) [N = 5,844,732]	0.1205 (0.0006) [N = 310,554]	-0.0355 (0.0007)	
Justice	0.0931 (0.0006) [N = 250,576]	0.0335 (0.0045) [N = 1,566]	0.0596 (0.0051)	-0.0951 (0.0058)

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Table shows fraction of spending in the last week of the year at the Department of Justice and other agencies on non-I.T. and I.T. contracts. Robust standard errors in parentheses, calculated using the corresponding regressions specifications.

Table 7: Difference-in-Differences of Overall Rating on Justice and Last Week

	Last week	Rest-of-year	Difference	Difference-in-differences
Other agencies	4.730 (0.394) [N=94]	6.644 (0.096) [N=577]	-1.914 (1.096)	
Justice	8.333 [N=1]	6.705 (0.355) [N=14]	1.628 (0.482)	3.542 (1.186)

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov.
Note: Table shows the overall rating of I.T. projects at the Department of Justice and other agencies in the last week and rest of the year. Robust standard errors in parentheses, calculated using the corresponding regressions specifications.

APPENDIX FOR ONLINE PUBLICATION ONLY

A Proofs

A.1 Proposition 1

Let $x_1(\alpha_1)$ denote the agency's period 1 spending conditional on shock α_1. We first show that $x_1(\mathbb{E}[\alpha_1]) = B/2$. Recall that α_1 and α_2 are drawn from the same distribution and that the value-of-spending function, $v(x)$, is increasing and concave. Because $v(\cdot)$ is increasing, the constraint $x_1 + x_2 \leq B$ will bind with equality. Substituting this constraint into the first period objective, the first-order condition for the agency becomes $\alpha_1 v'(x_1) - \mathbb{E}[\alpha_2]v'(B - x_1) = 0$. Substituting $\mathbb{E}[\alpha_1]$ for α_1 yields $\mathbb{E}[\alpha_1]v'(x_1) - \mathbb{E}[\alpha_2]v'(B - x_1) = 0$. Because $\mathbb{E}[\alpha_1] = \mathbb{E}[\alpha_2]$, this implies $v'(x_1) - v'(B - x_1) = 0$ and therefore $x_1(\mathbb{E}[\alpha_1]) = B/2$.

Suppose that $x_1(\alpha_1)$ is concave. Given this assumption, Jensen's inequality implies that $\mathbb{E}[x_1(\alpha_1)] < x_1(\mathbb{E}[\alpha_1]) = B/2$. Because $\mathbb{E}[x_1] < B/2$ and $\mathbb{E}[x_2] = B - \mathbb{E}[x_1] > B/2$, it follows that $\mathbb{E}[x_2] > \mathbb{E}[x_1]$.

Below we show that $x_1(\alpha_1)$ is concave when the value of spending function, $v(x)$, is Constant Absolute Risk Aversion (CARA), Constant Relative Risk Aversion (CRRA) with a parameter of $\gamma \geq 1$ (which includes log as a special case), and quadratic. We provide sufficient conditions for $x_1(\alpha_1)$ to be concave under any generic value of spending function.

The CARA value of spending function is defined by $v(x) = -\exp(-rx)$ with $r > 0$. For a given α_1, the first order condition for period 1 spending is $\alpha_1 r \exp(-rx_1) = \mathbb{E}[\alpha_2] r \exp(-r(B - x_1))$, yielding the period 1 spending function $x_1(\alpha_1) = \frac{B}{2} + \frac{\ln(\alpha_1/\mathbb{E}[\alpha_2])}{2r}$. Differentiation shows that $x_1'(\alpha_1) = \frac{1}{2\alpha_1 r} > 0$ and $x_1''(\alpha_1) = -\frac{1}{2\alpha_1^2 r} < 0$, and therefore that $x_1(\alpha_1)$ is concave.

The CRRA value of spending function is defined by $v(x) = \frac{x^{1-\gamma}}{1-\gamma}$ with $\gamma > 0$. For a given α_1, the first order condition for period 1 spending is $\alpha_1 x_1^{-\gamma} = \mathbb{E}[\alpha_2](B - x_1)^{-\gamma}$ and yields the period 1 spending function $x_1(\alpha_1) = \frac{B}{(\mathbb{E}[\alpha_2]/\alpha_1)^{1/\gamma}+1}$. The first derivative is positive: $x_1'(\alpha_1) = \frac{B(\mathbb{E}[\alpha_2]/\alpha_1)^{1/\gamma}}{\alpha_1\gamma\left((\mathbb{E}[\alpha_2]/\alpha_1)^{1/\gamma}+1\right)^2} > 0$. The second derivative is $x_1''(\alpha_1) = -\frac{B(\mathbb{E}[\alpha_2]/\alpha_1)^{1/\gamma}\left(\gamma(\mathbb{E}[\alpha_2]/\alpha_1)^{1/\gamma} - (\mathbb{E}[\alpha_2]/\alpha_1)^{1/\gamma} + \gamma + 1\right)}{\alpha_1^2\gamma^2\left((\mathbb{E}[\alpha_2]/\alpha_1)^{1/\gamma}+1\right)^3}$ and is negative if and only if $1 + \gamma + \gamma\left(\mathbb{E}[\alpha_2]/\alpha_1\right)^{1/\gamma} > \left(\mathbb{E}[\alpha_2]/\alpha_1\right)^{1/\gamma}$. A sufficient condition for this to hold is $\gamma > 1$.

When $\gamma = 1$, the CRRA value of spending function reduces to a log value of spending function $v(x) = \ln(x)$. In this case, the first order condition is $\frac{\alpha_1}{x_1} = \frac{\mathbb{E}[\alpha_2]}{B - x_1}$, and the period 1 spending function is $x_1(\alpha_1) = B\frac{\alpha_1}{\mathbb{E}[\alpha_2]+\alpha_1}$. Since $x_1'(\alpha_1) = \frac{B\mathbb{E}[\alpha_2]}{(\mathbb{E}[\alpha_2]+\alpha_1)^2} > 0$ and $x_1''(\alpha_1) = -\frac{2B\mathbb{E}[\alpha_2]}{(\mathbb{E}[\alpha_2]+\alpha_1)^3} < 0$, the spending function is also concave.

The quadratic value of spending function is defined by $v(x) = x - bx^2$ with $0 < b < \frac{1}{2B}$ so that the value is increasing and concave over the feasible range of spending, $x_1 \in [0, B]$. The first order condition is $\alpha_1(1 - bx_1) = \mathbb{E}[\alpha_2](1 - 2b(B - x_1))$ and yields the period 1 spending function $x_1(\alpha_1) = \frac{\alpha_1 + \mathbb{E}[\alpha_2](2bB-1)}{2b(\alpha_1+\mathbb{E}[\alpha_2])}$. Let us assume that the support of α_1 is bounded such the agency never finds it optimal to be at a corner solution in the first period. The first derivative is $x_1(\alpha_1) = \frac{\mathbb{E}[\alpha_2](1-bB)}{b(\alpha_1+\mathbb{E}[\alpha_2])^2} > 0$, which is positive because $0 < b < \frac{1}{2B}$. The second derivative is $x_1''(\alpha_1) = \frac{-\mathbb{E}[\alpha_2](1-bB)}{b(\alpha_1+\mathbb{E}[\alpha_2])^3} < 0$, which is negative due to the same condition. Therefore, we have shown that $x_1(\alpha_1)$ is increasing and concave.

In the general case with an arbitrary concave value of spending function $v(x)$, the first order condition is $\alpha_1 v'(x_1) = \mathbb{E}[\alpha_2]v'(B-x_1)$. By the Implicit Function Theorem, $x_1'(\alpha_1) = \frac{-v'(x_1)}{\alpha_1 v''(x_1)+\mathbb{E}[\alpha_2]v''(B-x_1)} > 0$. Differentiating yields

$$x_1''(\alpha_1) = \frac{v'(x_1)v''(x_1) + v'(x_1)v''(x_1) - v'(x_1)^2 \frac{\alpha_1 v'''(x_1) - \mathbb{E}[\alpha_2]v'''(B-x_1)}{\alpha_1 v''(x_1) + \mathbb{E}[\alpha_2]v''(B-x_1)}}{\Big(\alpha_1 v''(x_1) + \mathbb{E}[\alpha_2]v''(B-x_1)\Big)^2}$$

which is negative if

$$-2\frac{v''(x_1)}{v'(x_1)} > -\frac{\alpha_1 v'''(x_1) - \mathbb{E}[\alpha_2]v'''(B-x_1)}{\alpha_1 v''(x_1) + \mathbb{E}[\alpha_2]v''(B-x_1)}.$$

The left hand side is twice the coefficient of absolute risk aversion and is strictly greater than zero. The condition trivially holds if $v'''(x) = 0$ and more generally holds if $v'''(x)$ is small relative to the level of absolute risk aversion.

A.2 Proposition 2

We first show that spending-weighted average quality, $\mathbb{E}_{w(\alpha)}[q_m]$, can be alternatively expressed as the unweighted expected value of spending divided by the unweighted expected level of spending, $\mathbb{E}[\alpha_m v(x_m)]/\mathbb{E}[x_m]$. In particular, the spending-weighted expectation of quality is given by $\mathbb{E}_{w(\alpha)}[q_m] = \int q_m(\alpha)w(\alpha)dF_\alpha$ where quality is $q_m(\alpha) = \frac{\alpha_m v(x_m)}{x_m}$ and the weight is $w(\alpha) = \frac{x(\alpha)}{\int x(\alpha)dF_\alpha}$. Plugging in for quality and the weight yields

$$\begin{aligned}\int q_m(\alpha)w(\alpha)dF_\alpha &= \int \frac{\alpha_m v(x_m)}{x_m} \cdot \frac{x_m(\alpha_m)}{\int x_m(\alpha_m)dF_\alpha} dF_\alpha \\ &= \left(\int \alpha_m v(x_m)dF_\alpha\right)\left(\frac{1}{\int x_m(\alpha_m)dF_\alpha}\right) \\ &= \frac{\mathbb{E}[\alpha_m v(x_m)]}{\mathbb{E}[x_m]}\end{aligned}$$

where the expectation in the bottom line is taken over the distribution of α_m.

To show that there is a drop-off in average quality, first suppose, contrary to the fact, that the agency does not know its period 1 value of spending parameter α_1 when it makes its period 1 spending decision x_1. If this is the case, then $x_1 = x_2 = B/2$ with expected quality in both periods equal to $\frac{\bar{\alpha}v(B/2)}{B/2}$.

Now suppose that α_1 is observed prior to the period 1 spending decision as specified in the model. We will show that observing α_1 (i) increases total quality on average across both periods and (ii) decreases quality on average in period 2. Since total quality equals quality in period 1 plus quality in period 2, this implies that observing α_1 increases period 1 quality. A rise in period 1 quality and drop-off in period 2 quality, relative to the case where quality is equal, implies that quality in period 1 is higher than quality in period 2.

We first show that total quality on average strictly increases when α_1 is observed. To see this, rewrite the period 1 objective for the agency as

$$V(\alpha_1, \theta) = \max_{x_1} \quad \theta(\alpha_1 - \mathbb{E}[\alpha_1])v(x_1) + \mathbb{E}[\alpha_1]v(x_1) + \bar{\alpha}v(B-x_1).$$

The parameter θ takes on values on the closed unit interval $\theta \in [0,1]$ and allows us to smoothly interpolate between the objective function where the agency does not observe α_1 (which is captured by $\theta = 0$) and the objective where the agency observes α_1 (which is captured by $\theta = 1$). From the envelope theorem, we know $\frac{\partial V}{\partial \theta} = (\alpha_1 - \mathbb{E}[\alpha_1])v(x_1(\alpha))$. Assuming the standard conditions that permit the interchange of integration and differentiation, $\frac{\partial}{\partial \theta}\mathbb{E}_{\alpha_1}[V(\alpha_1, \theta)] = \mathbb{E}_{\alpha_1}[(\alpha_1 - \bar{\alpha})v(x_1(\alpha_1))]$. By the concavity of $v(\cdot)$ and Jensen's inequality, we know that $\mathbb{E}_{\alpha_1}[(\alpha_1 - \mathbb{E}[\alpha_1])v(x_1(\alpha_1))] > 0$ and therefore $\frac{\partial}{\partial \theta}\mathbb{E}_{\alpha_1}[V(\alpha_1, \theta)] > 0$ or that total quality over both periods is higher on average when α_1 is observed.

We next show that observing α_1 leads to a strict decrease in average period 2 quality. To see this, notice that observing α_1 has two effects on period 2 spending $x_2(\alpha_1) = B - x_1(\alpha_1)$. First, from Proposition 1 we know that the average level of spending increases: $\mathbb{E}[x_2(\alpha_1)] > B/2$. Second, we know that for any non-degenerate distribution, observing α_1 leads to a mean preserving spread in spending around $\mathbb{E}[x_2(\alpha_1)]$. Because of the concavity of $v(\cdot)$, increasing the average level of period 2 spending reduces the average quality of period 2 spending: $\frac{\mathbb{E}_{\alpha_2}\left[\alpha_2 v(\mathbb{E}_{\alpha_1}[x_2(\alpha_1)])\right]}{\mathbb{E}_{\alpha_1}[x_2(\alpha_1)]} < \frac{\mathbb{E}[\alpha_t v(B/2)]}{\mathbb{E}[B/2]}$. By the concavity of $v(\cdot)$ and second-order stochastic dominance, a mean-preserving spread in $x_2(\alpha_1)$ around $\mathbb{E}[x_2(\alpha_1)]$ leads to a further drop in average period 2 quality: $\frac{\mathbb{E}_{\alpha_2}[\alpha_2 v(x_2(\alpha_1))]}{\mathbb{E}_{\alpha_1}[x_2(\alpha_1)]} < \frac{\mathbb{E}_{\alpha_2}\left[\alpha_2 v(\mathbb{E}_{\alpha_1}[x_2(\alpha_1)])\right]}{\mathbb{E}_{\alpha_1}[x_2(\alpha_1)]}$.

So we have shown that observing α_1 leads to an increase in total quality over both periods and a drop in period 2 quality relative to the case where quality is equal on average in both periods. This implies that period 1 quality increases relative to the case where quality is equal on average in both periods. It then follows that average quality is higher in period 1 than in period 2 or $\bar{q}_1 > \bar{q}_2$.

A.3 Proposition 3

Assume full rollover is permitted by law, and Congress cannot commit to a budget rule. Let $\tilde{A}_y \equiv A_{y-1,M} - x_{y-1,M}$ indicate the budget authority rolled over by the agency. Consider the budget setting problem for Congress:

$$W(\tilde{A}_y) = \max_{B_y \geq 0} \quad \mathbb{E}_y\Big[\sum_{m=1}^{M} \beta^{m-1}\alpha_m v(x^*_{ym}) + \beta^M W(\tilde{A}_{y+1}) - \lambda \sum_{m=1}^{M} \beta^{m-1} x^*_{ym}\Big]$$

Since Congress and the agency place the same value on spending (ignoring the cost of funds), we know that for a given budget allocation the expected value of spending to Congress is equal to the agency's value function evaluated at that budget allocation:

$$W(\tilde{A}_y) = \max_{B_y \geq 0} \quad \mathbb{E}_y\Big[V_1(\tilde{A}_y + B_y) - \lambda \sum_{m=1}^{M} \beta^{m-1} x^*_{ym}\Big]$$

The first-order conditions for Congress are therefore $\frac{d}{dB_y}\mathbb{E}\Big[V(\tilde{A}_y + B_y)\Big] = \lambda$. At the optimal budget allocation, the marginal benefit of an additional dollar in budget authority is equal to the social cost of funds. The optimal budget B^*_y is implicitly defined by $\tilde{A}_y + B^*_y = \bar{A}(\lambda)$ where $\bar{A}(\lambda)$

is a constant that depends on the social cost of funds λ. But since $dB_y^*/d\tilde{A}_y = -1$, Congress will decrease the agency's budget one-for-one to offset any rolled over funding. Since the agency values spending, the agency can increase its objective by exhausting all of its budget authority and not rolling over any resources.

A.4 Proposition 4

To show that full rollover is optimal, we will show that for any budget rule that does not have full rollover, there exists a full rollover budget with the same expected costs and a higher expected value of spending. This implies that the optimal budget rule must have full rollover.

Consider any budget rule that does not allow for full rollover $B_y^* = \Gamma(A_{y-1,M} - x_{y-1,m}) \neq \bar{B}$. Associated with this budget rule is a discounted expected level of spending $\mathbb{E}\left[\sum_{m=1}^{M} \beta^{m-1} x_{ym}^*(B_y^*)\right]$. Now consider allowing full rollover. Let B_y^{**} indicate the full rollover budget that has the same expected level of spending as the budget without full rollover, implicitly defined by the equality $\mathbb{E}\left[\sum_{m=1}^{M} \beta^{m-1} x_{ym}^*(B_y^{**})\right] = \mathbb{E}\left[\sum_{m=1}^{M} \beta^{m-1} x_{ym}^*(B_y^*)\right]$.

To show that the value of spending is higher in the full rollover scenario, consider the first-order conditions for the agency. With full rollover, the objective for the agency is identical to the objective for Congress. With incomplete rollover, the agency is distorted away from the optimal spending path for Congress and therefore produces a lower value of spending.

Thus we have shown that for any non-rollover budget rule, there exists a policy rule with full rollover that has the same costs but higher value of spending for Congress, implying that full rollover is optimal.

B The Impact of Appropriations Timing on the Within-Year Pattern of Government Procurement Spending

It is the exception rather than the rule for Congress to pass annual appropriations bills before the beginning of the fiscal year. Between 2000 and 2009, the full annual appropriations process was never completed on time. Although defense appropriations bills were enacted before the start of the fiscal year four times, in eight of the ten years, appropriations for all or nearly all of the civilian agencies were enacted in a single consolidated appropriations act well after the start of the fiscal year.

Analysts have attributed some of the challenges facing federal acquisition to the tardiness of the appropriations process, since these delays introduce uncertainty and compress the time available to plan and implement a successful acquisition strategy (Acquisition Advisory Panel, 2007). In this subsection we analyze the relationship between the timing of the annual appropriations acts and the within-year pattern of government contract spending. For this analysis, we use the full 2000 to 2009 FPDS data, even though the data prior to 2004 are of lower quality. Apparently, in these earlier years, some contracts were all assigned dates in the middle of the month. Therefore, the within-month weekly pattern of spending is not fully available.

Appendix Figure A1 shows results from regressing measures of end-of-year spending on the timing of annual appropriations. This analysis has two data points for each year, one representing defense spending and the other representing non-defense spending. For each observation, we measure the share of annual contract spending occurring in the last quarter, month, and week of the year and the "weeks late" of the enactment of annual appropriations legislation.[48] "Weeks

[48]Enactment is defined by the date the President signs the legislation.

late" measures time relative to October 1 and takes on negative values when appropriations were enacted prior to the start of the fiscal year. For defense spending, "weeks late" measures the date that the defense appropriations bill was enacted. For non-defense spending, the date is assigned from the date of the consolidated appropriations act, or, in the case of the two years in which there was not a consolidated act, a date that is the midpoint of the individual non-defense appropriations acts.[49]

There is a clear pattern in the data in which later appropriation dates result in a greater fraction of government spending occurring at the end of the year. In the plots, we show the separate slopes of the defense and non-defense observations. Defense spending tends to be appropriated earlier and to have less end-of-year spending, but the slopes for the two types of spending are similar. The labels show the regression coefficients, including the coefficients from a pooled regression in which defense and non-defense spending have different intercepts but are constrained to have the same slope. The estimates show that a delay of ten weeks—roughly the average over this time period—raises the share of spending in the last quarter by 2 percentage points from a base of about 27 percent. A ten-week delay raises the share of spending in the last month by 1 percentage point, from a base of about 15 percent. Both coefficients are statistically significant at the 1 percent level. As we mentioned above, we do not have reliable within-month data on timing for the years prior to 2004, so we exclude the pre-2004 years for the analysis of spending during the last week of the year. The estimates indicate that a 10-week delay raises the share of spending occurring in the last week of the year by 1 percentage point on a base of 9 percent. Due to the smaller sample, the estimate is less precise, with a p-value of 0.07.[50]

C Calibrating the Welfare Gains

This section describes the procedure we use to estimate the welfare gains from rollover and discusses the results in more detail. To estimate the welfare gains, we first calibrate the model to fit the spike in spending and drop-off in quality under the status quo in which rollover is not allowed. Given the calibrated parameters, we then simulate the pattern of spending when rollover is permitted using value function iteration. A comparison of welfare under these regimes gives us the welfare gain from rollover and from alternative counterfactual policies.

C.1 Target Moments

The calibrated infinite horizon model is characterized by a parameter that determines the curvature of the value of spending function and a parameter that determines the distribution of spending shocks. We calibrate these parameters such that simulated data from the model has the same spike in spending and drop-off in quality that we observed in the federal procurement data.

Spike in spending. We define the spike in spending as the ratio of last month spending to average monthly spending over the rest of the year. This ratio is 2.18 in the pooled 2004 to 2009 FPDS.

Drop-off in quality. We calibrate the drop-off in quality by matching the coefficient on last month from an ordered logit regression in the I.T. Dashboard data and the coefficient on last month

[49] We aggregate all non-defense spending to facilitate communication of the pattern of results while capturing nearly all of the available variation. We have also conducted analyses in which we assign each non-defense agency the date of its individual appropriations act and obtain very similar results.

[50] When appropriations bills are delayed beyond the start of a fiscal year, the government operates under a continuing resolution that typically maintains spending at the levels set for the prior fiscal year. When a new budget is passed, any changes in the budget level are prorated to account for the shorter year.

from an analogous regression in simulated data from the model.[51]

Recall from Section 2 that the quality of spending in a given month is defined as the value of spending per dollar of expenditure: $q_m = \alpha_m v(x_m)/x_m$. The logistic regression estimates of the drop-off in quality are based on the assumption that quality is determined by the data generating process

$$q_m = \beta_q Last\_month_m + \sigma_q \epsilon_m$$

where *Last_month* is an indicator for the last month of the year and the error term is the product of a type-I extreme value random variable ϵ and scale factor $\sigma_q > 0$.

In the I.T. Dashboard data, we do not observe this underlying quality variable but instead observe a categorical overall rating variable, which we assume is an index of underlying quality. Because our outcome variable is categorical, we can recover an estimate of β_q/σ_q with an ordered logit regression of overall rating on the *Last_month* indicator and controls.[52] In the simulated data from the model we observe quality directly. We recover β_q/σ_q in these data with a straightforward logistic regression of quality on the *Last_month* indicator variable.

Appendix Table A11 shows odds ratios of the coefficient on last month from ordered logit regressions in the I.T. Dashboard data. In our preferred specification, which includes year, agency, and project characteristic covariates, projects that are originated in the last month of the year have 0.42 odds of having a higher quality score. We calibrate the model so that the drop-off is the same in the simulated data from the model.

C.2 Calibrating the Model

We match these two moments by calibrating the model's two parameters: σ and γ. Specifically, we assume that the uncertainty shocks, α, are drawn from a log-normal distribution, $\ln \alpha \sim N(0, \sigma)$, parameterized by a standard deviation parameter, σ, and the value of spending function, $v(x_m; \gamma)$, is parameterized by a curvature parameter, γ. Let $\theta \equiv \{\sigma, \gamma\}$ denote the parameters of the model. We calibrate θ and calculate welfare in the no-rollover regime in the following manner:

- Step 1. For a given θ, we calculate the value $V_m^{NR}(A, \theta)$ to the agency from having A assets in month m by backward induction, numerically integrating over the distribution of α.

- Step 2. For a given initial budget B and θ, we simulate forward a pattern of spending using the estimated $V_m^{NR}(A, \theta)$ from Step 1.

- Step 3. For each B, we find the θ that matches the spike in spending and drop-off in quality moments using a quadratic loss function. The objective is convex with a unique minimum value. Label these values $\theta(B)$.

- Step 4. We search over the domain of B and associated $\theta(B)$ to find the budget that maximizes welfare for Congress net the social cost of funds. Label this budget B^{NR}.

The parameters B^{NR} and $\theta(B^{NR})$ uniquely determine the value of spending, cost of spending, and welfare when rollover is not permitted.

[51] The approach of matching regression coefficients in actual and simulated data is sometimes referred to as indirect inference (Gourieroux, Monfort and Renault, 1993). See Voena (2012) for a recent application of this technique.

[52] Coefficients in a logistic regression model are identified up to the scale factor σ_q. See Train (2003) for an in-depth discussion of this issue.

C.3 Model Fit

In our baseline calibration, we specify a CRRA, $v(x) = \frac{x^{1-\gamma}}{1-\gamma}$, value of spending function with curvature parameter γ. We conduct robustness checks to examine the sensitivity of our results to a CARA functional form. We set the number of months per year to $M = 12$ and the monthly discount factor to $\beta = 0.996$.[53] We normalize the social cost of funds to $\lambda = 1$.

Panel A of Appendix Table A12 shows the target and calibrated moments. The ratio of last month to rest-of-year spending is 2.18 in the pooled 2004 to 2009 FPDS. The odds that a project started in the last month of the year has a higher quality score is 0.42 in the I.T. Dashboard data.[54] The moments calculated from the simulated data are very similar. Panel B shows the underlying parameter estimates of γ and σ from the model.[55]

Appendix Figure A2 examines how the model fits the monthly pattern of spending. Panel A plots the percent of spending each month in the pooled 2004 to 2009 FPDS and simulated data from the model with a CRRA value of spending function. Recall that the model is calibrated to the ratio of last month to rest-of-year average monthly spending but not to the shape of this increase by month. Nevertheless, the CRRA model does a good job matching the flat profile of spending over the first part of the year and the sharp spike at year's end.[56] The simulated data from the CARA specification, shown in Panel B, also match the pattern of spending over the year. Because the CARA specification does not capture the sharp uptick in spending between August and September as well as the CRRA function form, we choose CRRA as our preferred specification.

Calibrating the model is computationally intensive. Relative to a standard stochastic, dynamic programing problem, our application is complicated by two factors. The first is that because our value function varies by calendar month, we need to estimate M value functions. The second is that our model has two optimizing agents. At the beginning of each year, Congress decides on a budget for the agency, taking agency behavior as given. At the beginning of each month, the agency chooses its level of spending, taking Congress's behavior as given. We account for this in the calibrations by estimating how the agency would behave over a grid of possible budget values $B > 0$ and then searching over this grid to find the budget B^* that maximizes Congress's objective. To speed computation, the calibrations were performed using 12 cores in parallel, running continuously for approximately one week.

C.4 Welfare with Rollover

We assess the welfare gains from rollover by comparing the non-rollover status quo to three counterfactuals. The first is the compensating variation from rollover, defined as the reduction in budget authority that allows for the same expected value of spending as in the no-rollover regime. The second is the welfare gain from rollover when Congress can re-optimize the budget it provides to the agency. The third counterfactual is the welfare gain from the first-best level of spending, defined as the level of spending in each period that equates the marginal social value of spending to the marginal social cost of funds. Compared to rollover which effectively allows agencies to save,

[53] This monthly discount factor implies an annual discount factor of $0.95 = 0.996^{12}$.

[54] The estimate is from an ordered logit specification of overall rating on last month and a full set of controls with the observations weighted by spending. Appendix Table A11 shows alternative specifications of this model.

[55] We are identified because we have two parameters and two moments. If we calibrated the model using only the spike in spending, we would be unable to separately identify the parameters because a large spike could arise from little curvature in the value of spending function and substantial variance in the α's or from substantial curvature in the value of spending function and little variance in the α's.

[56] The model naturally under-predicts spending in October and March because it does not separately account for spending on items like building leases that reset on an annual or semi-annual basis.

the first-best effectively allows agencies both to save and to borrow. The welfare gains from this counterfactual are an upper bound because agencies can acquire extra resources in extenuating circumstances through mid-year supplemental appropriations from Congress.

The value to the agency $V_m^R(A)$ in the rollover regime from having assets A in month m is calculated by value function iteration. Let superscripts index iterations of the value function. The algorithm for updating the value function is

$$V_m^{j+1}(A) = \begin{cases} \max_x \alpha v(x) + \beta \mathbb{E}_\alpha \left[V_{m+1}^j(A - x) \right] & \text{if } m < M \\ \max_x \alpha v(x) + \beta \mathbb{E}_\alpha \left[V_1^j(B + A - x) \right] & \text{if } m = M \end{cases}$$

Notice that this is mathematically identical to iteration on a single composite value function

$$\tilde{V}^{j+1}(S) = \max_x \quad \alpha v(x) + \beta \mathbb{E}_\alpha \left[\tilde{V}^j \left(g(S, x) \right) \right]$$

where the month index is subsumed into the state variable $S = \{A, m\}$ and the function $g(S, x)$ governs the evolution of months and assets. As such, the existence and uniqueness of the solution follows directly from the standard conditions that $v(\cdot)$ is concave, the constraint set generated by $g(S, x)$ is convex and compact, and there is discounting $\beta < 1$ (Ljungqvist and Sargent, 2004).

We calculate welfare in the regime with rollover in the following steps:

- Step 1. For a given initial budget B and $\theta(B^{NR})$ from the within-year calibrations, we estimate the value function $V_m^R(A)$ for each month $m = 1 \ldots M$ by value function iteration.

- Step 2. For this budget, the present value of spending to the agency is the beginning of year value function evaluated at this budget allocation $V_1(B)$, the net present cost of spending is the discounted sum of annual budgets B, and welfare is the difference in these values.

- Step 3. We search over the domain of B to find the value that maximizes welfare. Label this value as B^R for budget with rollover.

The parameter B^R determines the value of spending, cost of spending, and welfare with rollover

Appendix Table A13 shows the welfare gains from the three counterfactual scenarios. The first column shows the percent change in the value of spending; the second column shows the percent change in the social cost of spending (the amount of spending times λ); and the third column shows the difference between the first two columns, which gives the percent change in overall social surplus. Values are scaled by the social cost of spending under the no-rollover status quo. With the preferred CRRA specification, the compensating variation from rollover is 13 percent of the social cost of spending. That is, Congress could allow rollover, reduce the agency's budget by 13 percent, and the value of spending would be identical to the status quo.

Allowing for full Congressional re-optimization leads to slightly higher welfare gains. Spending levels (social cost) are lower than in the no rollover case. This is the result of two offsetting effects. Because agencies on average enter the year with rolled-over funds, Congress does not need to provide as much funding to ensure that the agency can take advantage of high α periods. On the other hand, Congress is more willing to provide funds given that agencies will not squander them on projects with a value below the social cost of funds. The total value of spending is slightly lower than in the no-rollover scenario with the CRRA specification and slightly higher with the CARA functional form.

The final scenario shows the first-best in which the agency does all spending that exceeds the social value of funds and no spending that is below. Comparing the rollover scenarios to the first-best scenario we see that rollover allows the government to capture two-thirds of the benefits of moving from no-rollover to the first-best.

C.5 Intermediate Policies

Whether these welfare gains can be achieved depends on Congress's ability to commit to future budgets. While Congress cannot completely tie its own hands, it can design policy to increase the likelihood of commitment. For example, Congress could specify that rolled over amounts are not reported in standard budget tables, increasing the cost of obtaining this information. Similarly, Congress could allow agencies to roll over funding for a time-limited grace period.[57] Such a grace period would not simply result in a spike in spending at the new deadline. Because next year's budget authority would provide a de facto rainy day fund, even a few months of rollover would allow agencies to draw down their previous year's savings over a longer time period.[58] Finally, Congress could provide more funding on a multi-year basis. While the full implications of less frequent fiscal policy are outside the scope of this paper, one benefit of multi-year budgeting is that it reduces the frequency of wasteful year-end spending. Below we first describe how we simulate the welfare gains from these intermediate policies and then present our results.

Partial commitment. Suppose that Congress can only commitment to allowing rollover with commonly known probability π. Simulating welfare under this regime requires two modifications to the algorithm described above:

- The period M continuation value is replaced by $\mathbb{E}_\alpha\left[\pi V_1(B+A-x)+(1-\pi)V_1(B)\right]$, the average of the no-rollover and with-rollover continuation values weighted by their probabilities.
- For each B, the cost of spending is decreased by the expected level of reclaimed funds. This value is calculated by simulating forward a pattern of spending using the estimated value functions. The expected level of reclaimed funds is discounted to account for the fact that the budget authority is reclaimed a year after it is authorized.

Partial rollover. Suppose that agencies can roll over budget authority for no more than $\bar{m}$ months. Since we assume that budget authority is fungible, this policy constrains period $\bar{m}+1$ budget authority to be no greater than the annual budget B. To simulate welfare under this regime, we make the following modification to the algorithm described above:

- The continuation value is replaced with $\mathbb{E}_\alpha\left[V_m(\min\{B+A-x,B\})\right]$ in periods $m>\bar{m}$.

Since the agency never rolls over more than B into period $\bar{m}+1$, we do not need to account for reclaimed funds in our calculation of the cost of spending.

Multiyear budgeting. Suppose that budgets are provided on a multiyear basis. There is no rollover across budget cycles, but there is full rollover across years when there is not a new

[57] We thank Dan Feenberg for suggesting this counterfactual.

[58] Because Congress rarely passes a budget on schedule and agencies are operating under continuing resolutions, this partial rollover period often will have expired by the time that a new budget is determined. In this case, Congress would have no incentive to take this rolled over amount into consideration.

budget. We simulate welfare under this policy regime with the backwards induction algorithm used to calibrate the model with one modification:

- The number of periods is increased to $k \times M$, where k is the number of years per budget cycle. The monthly discount factor β is unaltered.

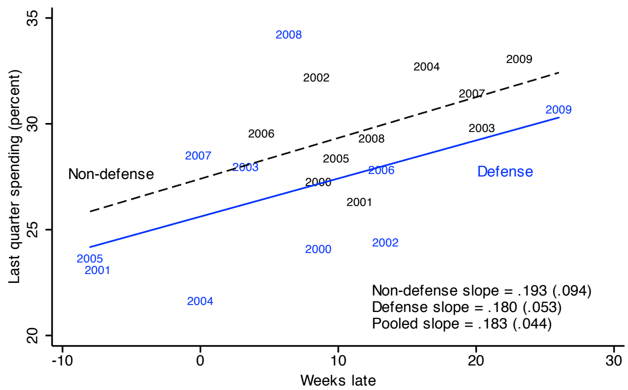
Appendix Figure A3 examines the welfare gains from these intermediate policies. In each plot, the y-axis shows the welfare gain as a percent of the welfare gain from full rollover. Each point in each plot is calculated from an independent simulation of the baseline model. Panel A examines the implications of imperfect Congressional commitment. With probability π, Congress commits and agencies are able to roll over the full amount of unspent resources into the next year. With probability $1 - \pi$, Congress reneges and unspent resources are taken from the agency and valued in the welfare function at the social cost of funds. Both the agency and Congress know this probability π and optimize accordingly. The plot shows that small commitment probabilities can achieve relatively large welfare gains. For example, a 25 percent commitment probability leads to welfare gains of more than half the full rollover value, as agencies prefer to roll over their funds than engage in flat-of-the-curve spending at the end of the year.[59]

Panel B of Appendix Figure A3 examines the welfare gains from time-limited grace periods, in which agencies are allowed to roll over unused funding for $\bar{m}$ periods of the next year. Since we assume that budget authority is fungible within an agency, this policy constrains the agency's period $\bar{m} + 1$ budget to be no greater than their beginning-of-year budget allocation B. As before, a small amount of rollover can generate large welfare gains. A one-month grace period achieves 41 percent of the welfare gains from full rollover; a two-month grace period achieves 66 percent; and a four-month grace period 90 percent. Panel C shows the welfare gains from multi-year budgets. Two-year budget cycles achieve 70 percent of the gains from full rollover; three-year budget cycles achieve 90 percent.

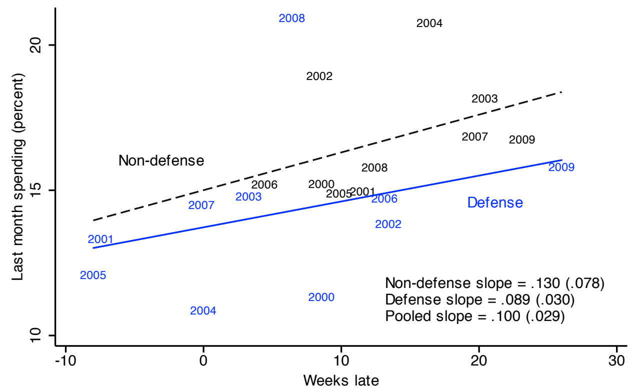
In summary, the results indicate that allowing for rollover can lead to economically meaningful gains in welfare. If Congress can fully commit, the welfare gains from rollover are over 10 percent of the social cost of funds. Even if Congress can commit with a modest probability or provide a short grace period, welfare gains of more than 5 percent could be achieved.

[59] The plot is S-shaped because the value of spending is convex in the commitment probability while the amount of reclaimed funds is concave. It is the sum of a convex and concave function which gives the plot its shape.

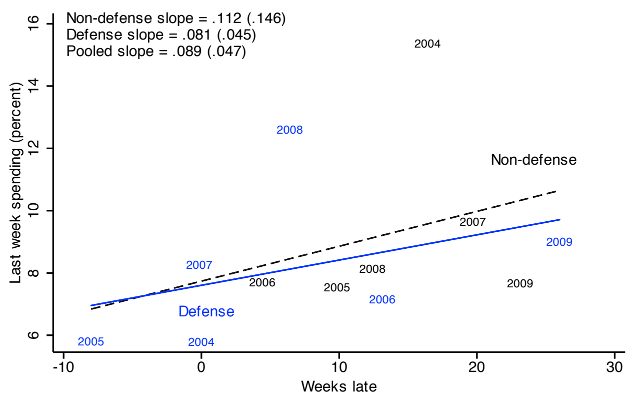
Figure A1: Year-End Spending by Appropriations Date



(a) Last Quarter Spending



(b) Last Month Spending

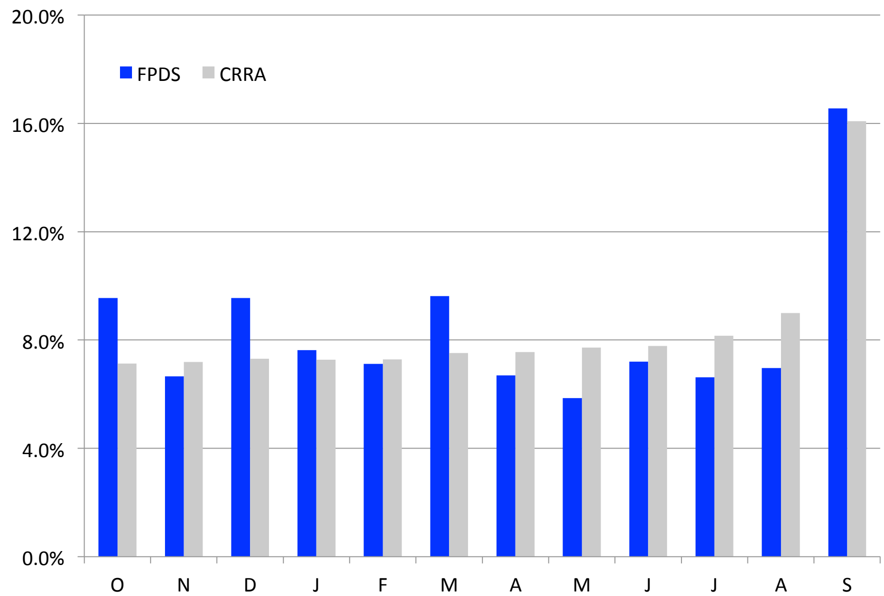


(c) Last Week Spending

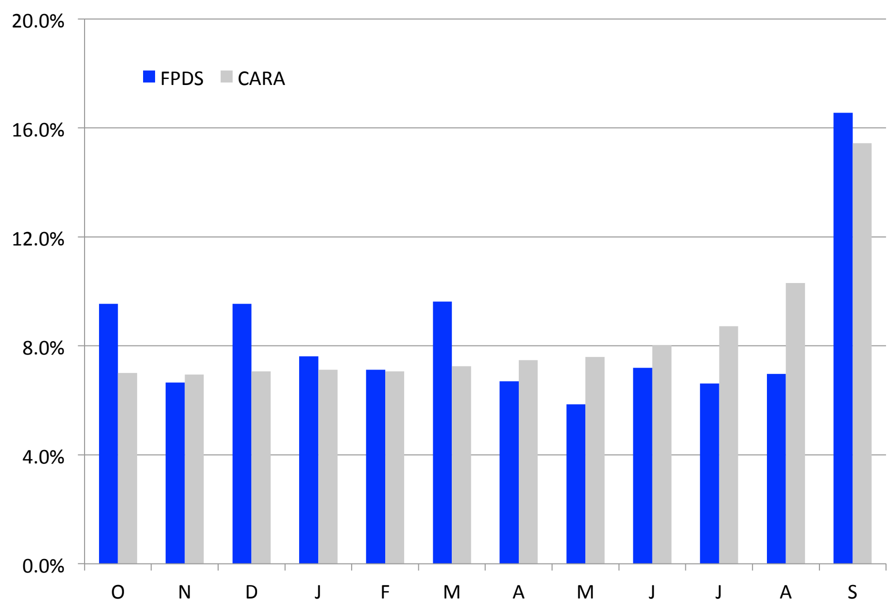
Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov and Library of Congress.

Note: Vertical axes show the percent of annual spending occurring in the last quarter, month, and week of the fiscal year. Horizontal axes show the passage dates for the non-defense and defense appropriation bills, relative to the first day of the fiscal year in weeks. For defense spending, weeks late measures the date that the defense appropriations bill was enacted. For non-defense spending, the date is assigned from the date of the consolidated appropriations act, or, in the case of the two years in which there was not a consolidated act, a date that is the midpoint of the individual non-defense appropriations acts. Plots show fitted lines and slope coefficients from bivariate regressions on defense and non-defense spending. Pooled coefficients from a regression in which defense and non-defense spending have different intercepts but are constrained to have the same slope. Robust standard errors in parentheses.

Figure A2: Model Fit



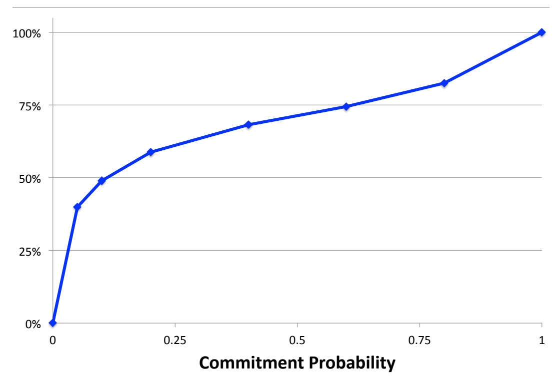
(a) CRRA Value of Spending



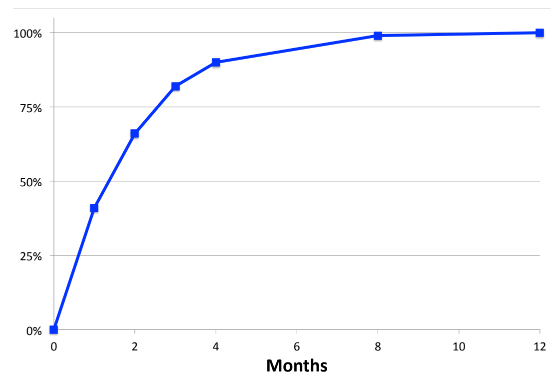
(b) CARA Value of Spending

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Dark bars show percent of spending each month in the pooled 2004 to 2009 FPDS. Light bars show predicted spending by month from the calibrated model parameterized with a CRRA value of spending function (Panel A) and CARA value of spending function (Panel B). The FPDS spending values are inflation-adjusted to 2009 dollars using the CPI-U.

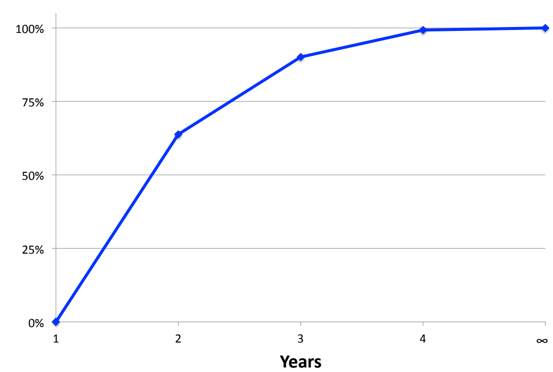
Figure A3: Percent of Full Rollover Welfare Gain



(a) Partial Commitment



(b) Grace Period



(c) Multi-Year Budgeting

Note: In all panels, the y-axis shows the welfare gain as a percent of the full rollover welfare gain. In Panel A, the x-axis is the probability that Congress can commit to allowing rollover. In Panel B, the x-axis is the number of months an agency has to use unspent funding from the previous year. In Panel C, the x-axis shows the number of years per budget cycle. Each point in each plot is calculated from an independent simulation of the baseline CRRA specification from Table A13. See Appendix C for details.

Table A1: First Week Contract Spending for Selected Product or Service Codes, Pooled 2004 to 2009 FPDS

	Spending (billions)	First week (percent)
Leases		
Lease or rental of facilities	$29.2	26.2%
Lease or rental of equipment	$5.4	13.1%
Service contracts		
Utilities and housekeeping services	$73.7	11.1%
Medical services	$68.8	11.3%
Transportation, travel and relocation services	$39.3	15.5%
Social services	$5.5	9.3%
Other	$2,378.1	3.1%
Total	$2,600.0	4.0%

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Contract spending in the first week of the fiscal year by selected 2-digit product or service code, inflation-adjusted to 2009 dollars using the CPI-U. Categories account for 8.5 percent of overall spending but 29.7 percent of spending in the first week of the year.

Table A2: Year-End Spending by Time Zone Regressions

	Dependent Variable:			
	Last day spending		Last week excluding last day spending	
	Smaller contracts (<$100K)	Larger contracts (≥$100K)	Smaller contracts (<$100K)	Larger contracts (≥$100K)
Hours west of GMT	0.0042**	0.0003**	-0.0013	0.0002
	(0.0018)	(0.0001)	(0.0014)	(0.0004)
Year FE	X	X	X	X
Agency FE	X	X	X	X
Product and service code FE	X	X	X	X
R-squared	0.034	0.010	0.047	0.021
N	409,687	1,541,248	409,687	1,541,248
Mean of dependent variable	0.0269	0.0154	0.0634	0.0456

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Table shows coefficients from linear probability model regressions of year-end spending on hours west of Greenwich Mean Time (GMT) and controls. To facilitate the analysis, the data is aggregated to the level of the covariates and the regressions are weighted by inflation-adjusted spending in each cell.

Table A3: Summary Statistics: Major I.T. Projects as of March, 2010

	IT spending		IT projects	
	Millions	Percent	Count	Percent
Total	$129,729	100.0%	686	100.0%
Agency				
Agency for International Development	$265	0.2%	3	0.4%
Agriculture	$1,864	1.4%	33	4.8%
Commerce	$11,042	8.5%	46	6.7%
Corps of Engineers	$4,012	3.1%	11	1.6%
Defense	$14,889	11.5%	46	6.7%
Education	$1,407	1.1%	25	3.6%
Energy	$4,914	3.8%	26	3.8%
Environmental Protection Agency	$3,166	2.4%	20	2.9%
General Services Administration	$2,162	1.7%	25	3.6%
Health and Human Services	$8,990	6.9%	64	9.3%
Homeland Security	$13,068	10.1%	70	10.2%
Housing and Urban Development	$1,605	1.2%	10	1.5%
Interior	$4,557	3.5%	39	5.7%
Justice	$4,376	3.4%	15	2.2%
Labor	$2,434	1.9%	34	5.0%
National Aeronautics and Space Administration	$9,722	7.5%	22	3.2%
National Archives and Records Administration	$649	0.5%	8	1.2%
National Science Foundation	$374	0.3%	6	0.9%
Nuclear Regulatory Commission	$515	0.4%	16	2.3%
Office of Personnel Management	$497	0.4%	7	1.0%
Small Business Administration	$269	0.2%	9	1.3%
Smithsonian Institution	$58	0.0%	9	1.3%
Social Security Administration	$1,236	1.0%	13	1.9%
State	$3,705	2.9%	13	1.9%
Transportation	$12,514	9.6%	42	6.1%
Treasury	$4,921	3.8%	41	6.0%
Veterans Affairs	$16,521	12.7%	33	4.8%
Year of origination				
1981	$2,706	2.1%	1	0.1%
1991	$61	0.0%	1	0.1%
1992	$322	0.2%	1	0.1%
1993	$409	0.3%	2	0.3%
1994	$155	0.1%	2	0.3%
1996	$3,050	2.4%	7	1.0%
1997	$1,430	1.1%	3	0.4%
1998	$2,891	2.2%	5	0.7%
1999	$2,814	2.2%	10	1.5%
2000	$2,855	2.2%	15	2.2%
2001	$8,463	6.5%	17	2.5%
2002	$12,577	9.7%	32	4.7%
2003	$13,860	10.7%	60	8.7%
2004	$12,818	9.9%	87	12.7%
2005	$13,529	10.4%	95	13.8%
2006	$16,169	12.5%	126	18.4%
2007	$17,935	13.8%	121	17.6%
2008	$14,176	10.9%	75	10.9%
2009	$3,508	2.7%	26	3.8%

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov.
Note: Major I.T. investments by federal agency and year of origination, inflation-adjusted to 2009 dollars using the CPI-U.

Table A4: Summary Statistics: Quality Indexes and Project Characteristics for Major I.T. Projects

	Mean	Std. Dev.	Min	Max
Planned cost (millions)	189.11	447.06	0.10	4770.89
Overall rating	7.07	2.30	0.00	10.00
Rating subindexes				
CIO evaluation	3.95	0.94	1.00	5.00
Cost rating	8.72	2.52	0.00	10.00
Cost overrun	5.25	1.49	0.00	10.00
Schedule rating	8.43	3.09	0.00	10.00

	Count	Percent
Investment phase		
Full-Acquisition	59	8.6%
Mixed Life Cycle	304	44.3%
Multi-Agency Collaboration	29	4.2%
Operations and Maintenance	278	40.5%
Planning	16	2.3%
Service group		
Management of Government Resources	124	18.1%
Missing	2	0.3%
Service Types and Components	125	18.2%
Services for Citizens	344	50.2%
Support Delivery of Services to Citizen	91	13.3%
Line of business		
Administrative Management	15	2.2%
Controls and Oversight	12	1.8%
Defense and National Security	30	4.4%
Disaster Management	20	2.9%
Economic Development	9	1.3%
Education	16	2.3%
Energy	5	0.7%
Environmental Management	32	4.7%
Financial Management	81	11.8%
General Government [CA]	45	6.6%
General Science and Innovation	22	3.2%
Health	55	8.0%
Homeland Security	40	5.8%
Human Resource Management	24	3.5%
Income Security	17	2.5%
Information and Technology Management	85	12.4%
International Affairs and Commerce	7	1.0%
Law Enforcement	12	1.8%
Natural Resources	16	2.3%
Planning and Budgeting	8	1.2%
Public Affairs	13	1.9%
Revenue Collection	8	1.2%
Supply Chain Management	25	3.6%
Transportation	45	6.6%
Workforce Management	5	0.7%
Other	39	5.7%
Total	686	100.0%

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov
Note: Planned total cost is inflation-adjusted to 2009 dollars using the CPI-U. Overall rating is a quality index that combines that CIO evaluation, cost rating, and scheduling rating subindexes (see text for details). It takes values from 0 to 10, with 10 being the best score. The CIO evaluation is the agency CIO's assessment of project quality. It takes values from 1 to 5, with 5 being the best. The cost rating is based on the absolute percent deviation between the planned and actual cost of the project. The cost overrun is a non-absolute measure that assigns over-cost projects the lowest scores. The schedule rating is based on the average tardiness of the project. The cost and schedule indices take values from 0 to 10, with 10 being the best. The line of business "other" category combines all categories with 4 or fewer projects.

Table A5: Ordered Logit Regressions of Subindices on Last Week and Controls

	Odds ratio of higher subindex value				
	Evalutation by Agency CIO		Cost rating	Cost overrun	Schedule rating
	(1)	(2)	(3)	(4)	(5)
Last week of September	0.14	0.16	0.80	0.74	1.15
	(0.06)	(0.07)	(0.36)	(0.30)	(0.66)
Cost and schedule rating		X			
Agency FE	X	X	X	X	X
Year FE	X	X	X	X	X
Project characteristics	X	X	X	X	X
Weighted by spending	X	X	X	X	X
N	671	671	671	671	671

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov
Note: Odds ratios from ordered logit regressions. Coefficient of 1 indicates no effect. The CIO evaluation is the agency CIO's assessment of project quality. It takes values from 1 to 5, with 5 being the best. The cost rating is based on the absolute percent deviation between the planned and actual cost of the project. The cost overrun is a non-absolute measure that assigns over-cost projects the lowest scores. The schedule rating is based on the average tardiness of the project. The cost and schedule indices take values from 0 to 10, with 10 being the best. Project characteristics are fixed effects for investment phase, service group, and line of business (see Appendix Table A4). Standard errors in parentheses.

Table A6: Year-End Contract Characteristics Regressions

	Dependent Variable:			
	Noncomopetitive	One bid	Cost-reimbursement	T&M/LH
	(1)	(2)	(3)	(4)
Last week	-0.002	0.017	-0.032	0.004
	(0.002)	(0.002)	(0.002)	(0.001)
Year FE	X	X	X	X
Agency FE	X	X	X	X
Product or service code FE	X	X	X	X
R-squared	0.41	0.31	0.52	0.21
N	402,400	402,400	402,400	402,400
Mean of dependent variable	0.287	0.200	0.300	0.055

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Table shows coefficients from linear probability model regressions of contract type and competition type indicators on last week and controls. Noncompetitive is an indicator for noncompetitively sourced contract; one bid is an indicator for contracts that are competitively sourced but only receive one bid; cost-reimbursement is an indicator for a cost-reimbursement contract; T&M/LH is an indicator for a time and materials or labor-hours contract; the omitted category is fixed price contract. To facilitate the analysis, the data is aggregated to the level of the covariates and the regressions are weighted by inflation-adjusted spending in each cell.

Table A7: Percent of Projects in I.T. Dashboard Data

	Spending			Projects		
	All	I.T Dashboard	% in I.T. Dashboard	All	I.T Dashboard	% in I.T. Dashboard
Year of origin						
≤ 2001	$68,460	$14,538	21.2%	813	48	5.9%
2002	$114,668	$12,848	11.2%	1,018	61	6.0%
2003	$115,286	$51,004	44.2%	653	113	17.3%
2004	$53,151	$10,309	19.4%	467	71	15.2%
2005	$35,027	$16,456	47.0%	250	56	22.4%
2006	$13,023	$5,172	39.7%	191	77	40.3%
2007	$61,953	$55,665	89.8%	248	183	73.8%
2008	$19,864	$19,752	99.4%	135	127	94.1%
2009	$498	$491	98.7%	16	13	81.3%
2010	$285	$273	95.5%	13	10	76.9%
Total	$482,215	$186,509	38.7%	3,803	759	20.0%

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov and 2003 to 2010 Exhibit 53 reports, available at http://www.whitehouse.gov/omb/e-gov/docs/.
Note: All spending and projects are totals from agency Exhibit 53 reports. I.T. Dashboard spending and projects are totals in the I.T. Dashboard dataset (including projects dropped from the baseline sample due to missing values). Spending values inflation-adjusted using the CPI-U.

Table A8: Alternative Mechanisms for the Effect on Overall Ratings

	Coefficients from linear model		Odds ratio of higher overall rating from ordered logit	
	Contracting office FE weighted	Contracting office FE unweighted	Longer tenure (> 3 years)	Shorter tenure (≤ 3 years)
	(1)	(2)	(3)	(4)
Last week	-0.66	-0.82	0.07	0.28
	(0.73)	(0.40)	(0.06)	(0.22)
Year FE	X	X	X	X
Agency FE	X	X	X	X
Project characteristics	X	X	X	X
Contracting office FE	X	X		
Weighted by spending	X		X	X
R-sq	0.889	0.696		
N	275	275	235	357

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov and 2003 to 2010. CIO biographies, available at www.cio.gov. Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.

Note: Columns 1 and 2 show coefficients from linear regressions with contracting office fixed effects. Columns 3 and 4 show odds ratios from ordered logit regressions by CIO tenure at the agency. Coefficient of 1 indicates no effect. Overall rating is a quality index that combines that CIO evaluation, cost rating, and scheduling rating subindices (see text for details). It takes values from 0 to 10, with 10 being the best. CIO tenure is determined from CIO biographies and includes time at the agency in another position (e.g., deputy CIO). Tenure denoted as missing when tenure cannot be determined from the biographical statement. Project characteristics are fixed effects for investment phase, service group, and line of business (see Appendix Table A4). Observations weighted by inflation-adjusted spending unless otherwise mentioned. Standard errors in parentheses.

Table A9: Standard Deviations of Year-End and Rest-of-Year of Spending Volumes and Overall Ratings

	Percent of Spending		Quality of Spending	
	Std. Dev.	Residual Std. Dev.	Std. Dev.	Residual Std. Dev.
	(1)	(2)	(3)	(4)
Last Week of September	5.92	5.55	3.82	1.86
	(0.46)	(0.43)	(0.39)	(0.19)
Rest of Year	3.78	3.39	2.31	1.40
	(0.04)	(0.04)	(0.10)	(0.06)

Source: Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov and I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov. .
Note: Columns 1 and 2 show the standard deviations of the percent of spending in the full FPDS data for contracts originated during the last week of the year and during earlier weeks in the year. Columns 3 and 4 show the standard deviations of the overall rating quality index from the I.T. Dashboard data for contracts originated during the last week of the year and during earlier weeks in the year. Columns 1 and 3 show the standard deviations in the raw data. Columns 2 and 4 show these standard deviations after partialling out fixed effects. The percent of spending statistics are calculated using observations that are the percentage of spending by agency and by week in each year. The fixed effects are for agency and year. In constructing the agency-week-year observations for the I.T. Dashboard data set, the individual project data is weighted by spending on each project so that the standard deviations can by interpreted as the variation per dollar of expenditure. The residual analysis for the I.T. Dashboard data partials out agency, year, and product characteristics fixed effects. Project characteristics are fixed effects for investment phase, service group, and line of business (see Appendix Table A4).

Table A10: Difference-in-Difference Estimates of Overall Rating on Justice and Last Week

	OLS Estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
Justice X last week	3.54	2.29	2.85	2.36	2.251	2.49
	(1.19)	(1.16)	(0.75)	(0.65)	0.593	0.898
Last week	-1.91	-1.06	-0.93	-0.99	-0.814	-0.468
	(1.10)	(0.82)	(0.48)	(0.39)	0.391	0.238
Justice	0.06	-0.59	-3.33	-3.88	-4.022	-2.028
	(0.51)	(0.49)	(0.47)	(0.59)	0.578	1.01
Year FE		X	X	X	X	X
Agency FE			X	X	X	X
Project characteristics				X	X	X
Weighted by spending	X	X	X	X	Winsorized*	
R-squared	0.06	0.22	0.58	0.68	0.60	0.48
N	686	686	686	686	686	686

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov .
Note: Coefficients from OLS regressions of overall rating on fully interacted Justice and last week indicators and controls. Overall rating is a quality index that combines the CIO evaluation, cost rating, and scheduling rating subindexes (see text for details). It takes values from 0 to 10, with 10 being the best score. Project characteristics are fixed effects for investment phase, service group, and line of business (see Appendix Table A4). Robust standard errors in parentheses.
*Spending weight Winsorized at $1 billion (96th percentile).

Table A11: Ordered Logit Regressions of Overall Rating on *Last Month* and Controls

	Odds ratio of higher overall rating			
	(1)	(2)	(3)	(4)
Last month	0.57	0.65	0.54	0.42
	(0.09)	(0.12)	(0.12)	(0.11)
Year FE		X	X	X
Agency FE			X	X
Project characteristics FE				X
N	671	671	671	671

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov.
Note: Odds ratios from ordered logit regressions. Overall rating is a quality index that combines that CIO evaluation, cost rating, and scheduling rating subindices (see text for details). It takes values from 0 to 10, with 10 being the best. Project characteristics are fixed effects for investment phase, service group, and line of business (see Appendix Table A4). Observations weighted by inflation-adjusted spending. Standard errors in parentheses.

Table A12: Target and Calibrated Moments

	Target Moments	Moments in Simulated Data	
		CRRA Model	CARA Model
Panel A: Moments			
Spike in spending			
Ratio of last month to rest-of-year monthly average	2.18	2.17	2.18
Drop-off in quality			
Odds ratio of high quality in last month	0.42	0.42	0.41
Panel B: Parameters			
Curvature of value of spending (γ)		3.02	1.86
Standard deviation of shocks (σ)		1.73	2.02

Source: I.T. Dashboard data, accessed March, 2010 via http://it.usaspending.gov. Federal Procurement Data System, accessed October, 2010 via www.usaspending.gov.
Note: Panel A shows target and calibrated moments for the spike in spending and the drop-off in quality. The target spike is calculated as the ratio of last monthly to rest-of-year average month spending in the pooled 2004 to 2009 FPDS. The target drop off is the odds ratio of a high quality score from an order logit regression of overall rating on last week and controls in the I.T. Dashboard data. The specification is also shown in column 4 of Appendix Table A11.

Table A13: Welfare Gain from Rollover

	Δ Value	Δ Social Cost	Δ Social Surplus
No Rollover	0.0%	0.0%	0.0%
CRRA			
Compensating Variation	0.0%	-13.1%	13.1%
Full Congressional Reoptimization	-2.1%	-15.4%	13.3%
First Best	2.4%	-16.2%	18.6%
CARA			
Compensating Variation	0.0%	-20.5%	20.5%
Full Congressional Reoptimization	1.7%	-18.9%	20.6%
First Best	1.5%	-24.9%	26.3%

Note: Welfare gains from rollover from the calibrated model with CRRA and CARA value-of-spending functions. Compensating variation is the reduction in budget authority that could be provided to the agency with rollover to achieve the same expected value of spending as in the no-rollover regime. Full Congressional reoptimization allows Congress to adjust the budget for the agency. First best is the level of spending that equates the marginal value of spending to the marginal social cost in each sub-year period. The first column shows the percent change in the value of spending, the second column shows the percent change in the social cost of spending, and the third column shows the percent change in social surplus. All values are normalized by the social cost of spending under the no-rollover status quo. See Appendix C for details.