Human Capital, Intrinsic Motivation, and Productivity: Evidence from the Hidden Costs of Government Shutdowns*

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We study how intrinsic motivation affects human capital retention and productivity using millions of employee records for the U.S. federal government. Exploiting heterogenous exposure to government shutdowns as shocks to intrinsic motivation, we show that affected employees are 31% more likely to leave in the following year. Younger employees with better outside opportunities are more likely to quit, while more experienced employees with vested pensions are more likely to retire. Consistent with a loss of valuable employees, productivity at affected government bureaus decreases, leading to financial losses. Affected bureaus outsource activities to contractors, which increases labor costs.

JEL classification: J21, J24, J45, J63

keywords: government shutdowns, furloughs, government productivity

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The creation and retention of human capital, a major organizational asset, has gained increasing attention as developed economies transition towards services that more heavily rely on high-skilled labor (Zingales 2000). While the existing literature in financial economics extensively examines the role of monetary incentives as it pertains to human capital, fewer studies examine the role of nonmonetary factors in potentially driving human capital accumulation and retention. With almost 90% of younger workers reporting a sense of purpose as a key driver of their employment decisions,[1] understanding the effect of intrinsic, nonmonetary motivation on human capital and organizational performance is an issue of major importance, and the main objective of this paper.

Evaluating the effect of intrinsic motivation on human capital and organizational performance is challenging for multiple reasons. First, employees' intrinsic motivation is difficult to measure. Second, employees endogenously match with employers and join organizations due to unobserved characteristics that may correlate with their intrinsic motivation and future employment decisions, as well as with organizational performance more generally. Third, it is difficult to isolate the effect of motivation since events that shock intrinsic motivation often affect all employees equally while simultaneously affecting organizational performance.

In this paper, we overcome these challenges by studying the effect of intrinsic motivation on employee retention and organizational performance in one of the largest employers in the world: the United States federal government. We exploit the 2013 U.S. government shutdown as a plausibly exogenous shock to the intrinsic motivation of government employees.

Government shutdowns occur when Congress fails to approve a government budget for the upcoming fiscal year without passing temporary funding. In the absence of funding the federal government furloughs non-essential employees. We leverage heterogeneity in employee exposure to the furloughs using a difference-in-differences framework. This allows us to effectively compare the response of employees with the same occupation, qualifications, and demographic characteristics, working for the same employer at the same location at the same point in time, but with differential exposure to furloughs caused by the shutdown. Using detailed micro-level data on millions of government employee records, we document a sharp increase in voluntary separations of employees exposed to furloughs, followed by a substantial decrease in organizational performance and subsequent financial losses.

[1]See, for example, the 2024 Gen Z and Millennial Survey, available at https://www.deloitte.com/content/dam/assets-shared/docs/campaigns/2024/deloitte-2024-genz-millennial-survey.pdf?dlva=1.

Being exposed to furloughs can affect an employee's intrinsic motivation through three major avenues, as identified by the psychology literature (White 1959). First, furloughs disrupt employees' ability to work and the satisfaction they derive from it, particularly by reducing perceived self-determination. Second, furloughs can affect employees' perceptions that their work is meaningful and serves a greater good, a particularly relevant aspect in the context of public service. Third, the disruption of pay associated with furloughs can translate into a substantial liquidity challenge (Baker and Yannelis 2017; Gelman et al. 2020); this can reduce an employee's perceived sense of stability, even if the missed payments are eventually recovered. Thus, we posit that government shutdowns constitute a negative shock to the intrinsic motivation of furloughed employees, which effectively allows us to study the link between intrinsic motivation, human capital, and productivity.

We focus on the 2013 government shutdown, the third longest shutdown in U.S. history.[2] More than ten million quarterly employment records for more than 347,000 federal civilian employees in 115 of the largest government bureaus allow us to closely track employees' work histories as well as their exposure to the government shutdown. It is not possible to know which employees were furloughed, since the government could not locate these individual-level records, per a response to a Freedom of Information Act inquiry (FOIA). Instead, we exploit the heterogeneity in an employee's furlough probability across government bureau. Some bureaus do not furlough any employees because they receive funding from alternative sources (e.g., U.S. Patent and Trademark Office fees). Other bureaus must continue to provide essential services (e.g., protection of life or property) during a shutdown and can only furlough some, but not all, of their employees. The probability of an employee being furloughed (at the bureau level) resembles a bimodal distribution: over 25% of our sample employees work in bureaus that furloughed almost no employees, and over 20% of our sample employees work in bureaus that furloughed almost all of their employees, leading to an intuitive definition of exposure to the shutdown in a setting in which more than half of all employees are furloughed. We compare individuals employed in these *affected bureaus* to individuals in the remaining bureaus (i.e., the control group). We use a difference-in-differences framework that controls for historical differences in outcomes between employees in affected versus unaffected bu-

[2]This government shutdown lasted 16 days and has only been surpassed by the 2019 and the 1996 shutdowns, which lasted 35 and 21 days, respectively. We focus on the 2013 government shutdown due to its clean-ness and data availability: the 2019 government shutdown is contaminated by the COVID-19 pandemic through its effects on labor markets, and the necessary data surrounding the 1995–1996 shutdown is more limited. Nonetheless, we are able to confirm that our main findings hold in the 1996 shutdown, results we discuss in section 4.4.

reaus.

We find that the probability that an affected employee voluntarily leaves the federal workforce one year after the shutdown increases by 1.48 percentage points (ppt). This effect is equivalent to a 31% increase relative to the average one-year turnover rate in our sample (4.77%). The effect of the shutdown is increasing in a bureau's furlough rate and it accumulates over time, reaching its peak about two years after the shutdown. Consistent with the shutdown having a long-lasting effect on the stock of human capital, once employment levels stabilize, the lost workforce is not replenished. We also show additional support for the validity of government shutdowns as a shock to intrinsic motivation based on data from the Federal Employee Viewpoint Survey, which shows a direct link between employees' exposures to furloughs, the self-perceived impact of the shutdown on their work, and their desire to leave government service as a result of the shutdown.

Employees can leave government employment in different ways. Thus, we examine the modes of employee exits in more detail. Employees can voluntarily exit the federal workforce either because they quit or because they decide to retire. We find that the shutdown motivated employees to leave the government due in part to both of these decisions. The richness of our data allows us to control for detailed characteristics of employees (e.g., age, education, years of service) and their jobs (e.g., pay grade, occupation) in our regressions, which also enables us to conduct cross-sectional analyses. Our analysis shows that younger employees and employees with better outside opportunities are more likely to quit, while more experienced employees with higher pay are more likely to retire. Moreover, we find stronger retirement effects for employees whose pensions are fully-vested. Overall, these results are consistent with employees reacting to changes in intrinsic motivation while simultaneously considering monetary incentives (Krueger, Metzger, and Wu 2023).

An ample set of additional tests validate our results and rule out alternative explanations. First, we show that there is no evidence of differential pre-trends between affected and unaffected bureaus. Second, the effect of shutdown exposure on separations is robust to using (a) multiple specifications with various controls and fixed effects, (b) multiple subsamples of employees, (c) a matching approach based on employee characteristics, and (d) alternative definitions of *affected bureau*. Moreover, our results hold both within Washington D.C. and the rest of the U.S., are absent in a placebo test focusing on forced terminations as opposed to voluntary separations, and are not driven by the 2013 federal budget sequester.

The result that government employees who leave after the government shutdown are not replaced in the following years raises the question of whether these departing em-

ployees were necessary in the first place. We find that departing employees tend to be more experienced and better compensated, but it is possible that these employees departed from bureaus that were already overstaffed. Consistent with the idea that government shutdowns cause a loss of valuable human capital, we find that the most affected bureaus respond to the shutdown by increasing their contract spending on temporary workers from external staffing agencies. For the two years after the shutdown, the aggregate cost of increased outsourcing activity outweighs the savings from lower payrolls and benefits by a factor exceeding two, resulting in a net increase in costs of roughly one billion dollars during this period. A concerning implication of this result is that temporary workers are possibly not well suited for these vacant positions, which may also require a learning period in order to be performed effectively.

Finally, we examine whether the shutdown-induced loss of government employees translates into losses in government productivity in the form of lower output and higher costs. Given our result that departing employees tend to be more experienced and better compensated, we focus on three settings typically associated with these types of workers for which agency- or bureau-level data are available.

First, we examine the accuracy of agency payment processing as a measure of government functionality. Accounting departments at government agencies processed over $3 trillion in payments to employees and service providers in fiscal year 2013, 4% of which were found to be inaccurate in regard to the amount or recipient (U.S. Government Accountability Office 2015). Consistent with a loss of productivity, we find that government agencies with higher percentages of furloughed employees experience a 1.12 ppt increase (annually) in inaccurate payments in the four years after the 2013 government shutdown. This translates into hundreds of millions of dollars in additional costs to the government due to incorrect payments that are never recovered.

Second, we examine legal enforcement actions, which are common proceedings across different government functions. For example, the U.S. Environmental Protection Agency (EPA) enforces environmental regulations, the Securities and Exchange Commission (SEC) enforces investor protection, and the Department of Justice (DOJ) prosecutes a broad range of criminal offenses and represents the U.S. government in court. Also consistent with a drop in productivity, in which the majority of employees were furloughed experienced a reduction in legal enforcement output.

Third, we examine government patenting activity. Consistent with the shutdown causing a loss of valuable human capital, we find that government agencies with employees more affected by the shutdown experienced a large reduction in the number of patents they filed relative to other agencies. Moreover, we confirm that patent inven-

tors employed by government agencies more affected by the shutdown effectively quit at higher rates after the shutdown.

The finance theory literature has long recognized the importance of intrinsic motivation for employment and firm performance (Baker, Jensen, and Murphy 1988; Zingales 2000; Carlin and Gervais 2009) and recent empirical work highlights the value of human capital for firm value (Edmans 2011). Our paper adds to this literature by providing empirical support for the relationship between nonmonetary incentives, labor supply, and productivity in a well-identified and novel setting.

The labor and finance literature examines the effect of negative financial shocks to firms on employee employment decisions. Specifically, employer financial distress induces employee departures (Babina 2019), especially among high-skill employees (Baghai et al. 2021). Gortmaker, Jeffers, and Lee (2022) show that employees begin searching for new jobs shortly after their employer's credit rating is downgraded. One potential explanation for these findings is that firms' financial distress can both have an adverse effect on employee mental health (Kárpáti and Renneboog 2023) and lead to individual financial losses (Graham et al. 2023). Relatedly, other research shows that personal financial distress has negative effects on employee productivity (Maturana and Nickerson 2020). Our paper contributes to this literature by showing that negative shocks to *intrinsic* motivation translates into losses of human capital and organizational performance, complementing the research on shocks to extrinsic monetary incentives. We also complement the research that connects organizational efficiency with employee satisfaction (Green et al. 2019), pay inequality (Breza, Kaur, and Shamdasani 2018; Green and Zhou 2019), and labor strikes (Mas 2008). Moreover, our paper adds to our understanding of labor reactions to furlough schemes, which were widely implemented by financially distressed firms to mitigate labor costs during the COVID-19 pandemic.

Given the special importance of the government as a service provider and employer, the economics literature that examines the effects of government shutdowns is surprisingly underdeveloped. Baker and Yannelis (2017) and Gelman et al. (2020) show that the 2013 government shutdown constituted a significant liquidity shock that affected the spending and saving patterns of affected employees. Gil and Macis (2015) show that the 2013 shutdown temporarily decreased population density and economic activity in Washington, D.C., which in turn affected local crime. Gabe (2016) documents large declines in park visitation and local tourism-related sales for Acadia National Park during the 2013 shutdown. We contribute to this literature by showing that government shutdowns have implications for the government's capacity to retain key talent and maintain productivity.

Recent government investigations highlight the *direct* costs of government shutdowns.

For example, the last three government shutdowns cost taxpayers at least $3.7 billion in back pay to furloughed employees and caused significant losses in GDP due to reduced government spending (U.S. Senate 2019). However, less attention has been paid to the *indirect* costs of government shutdowns, such as the potential loss of human capital due to affected workers leaving government agencies. Our results indicate that government shutdowns are significantly more costly than typically thought. Given that more than 800,000 government employees were furloughed during the 2013 government shutdown (0.7% of the nation's full-time workforce at the time[3]), our regression estimates translate into the shutdown causing around 11,800 employees to leave public service within a year. A back-of-the-envelope calculation reveals that merely re-hiring these workers would cost the government around $240 million, and our estimates suggest that the costs from productivity loss can be in the order of billions of dollars and that shutdowns can significantly impair the government's ability to provide key services for citizens.

1. Background

1.1. Government Shutdowns and Employee Furloughs

U.S. federal government shutdowns are a distinct feature of the U.S. government budgeting process. Under 31 U.S.C. 1341, the government cannot "make or authorize an expenditure or obligation exceeding an amount available in an appropriation or fund for the expenditure or obligation." Consequently, when Congress fails to pass an appropriations bill (i.e., a budget for each government agency), the government ceases non-essential operations. One major implication of this process is that non-essential employees are *furloughed*, which the U.S. Office of Personnel Management defines as "the placing of an employee in a temporary nonduty, nonpay status because of lack of work or funds, or other nondisciplinary reasons" (U.S. Office of Personnel Management 2015). The decision of which employees are furloughed is typically made at the government bureau level. Excepted ("essential") employees are required to remain working, but their compensation is guaranteed. Importantly, the designation as excepted carries no information about an employee?s performance or overall relevance for the government?s performance. It merely reflects whether the termination of a specific function would directly and immediately endanger life or property.

During furloughs, employees are not allowed to engage in any part of their work, including voluntary unpaid work (31 U.S.C. 1342). Furloughed employees are guaranteed

[3]See https://www.bls.gov/news.release/archives/work_12162014.pdf.

back pay immediately following a shutdown as of 2019.[4] In contrast, exempted employees are required to report to work during shutdowns. These exempted employees are either paid in full on regularly scheduled paydays or are guaranteed back pay.

Many individuals are attracted to government jobs because of their stability, predictable schedules, benefits, or because individuals feel a call to public service. Furloughed employees can feel uncertain about their career prospects within their bureau or feel disillusioned in terms of their views of the federal government more broadly, leading to a decrease in their intrinsic. Furloughed employees can also feel additional stress due to uncertainty about when or whether (before 2019) they will receive back pay. The delay and reduction in pay can cause substantial liquidity stress for some employees.[5]

1.2. The 2013 Government Shutdown

The 2013 federal government shutdown was triggered by a dispute between the Republican-controlled House of Representatives and the Democrat-controlled Senate over President Obama's signature policy project: the Patient Protection and Affordable Care Act (ACA). On September 10, 2013, House Republicans passed appropriations resolution H.J. Res. 59, which defunded the ACA. The Democrat-controlled Senate voted against including these provisions. The two congressional chambers were unable to reach agreement and pass an appropriations bill, and, as a result, the government entered a shutdown on October 1, 2013.[6] More than 800,000 federal employees were furloughed without pay during the government shutdown, which lasted 16 days, until both political parties compromised on an appropriations bill. The 2013 government shutdown was highly unanticipated. For example, as late as September 2013, online prediction markets indicated that the probability of a shutdown was less than 20% (Baker and Yannelis 2014).

[4]This policy was implemented on January 16, 2019 by means of the Government Employee Fair Treatment Act. Prior to this, furloughed employees were not guaranteed back pay, although Congress could, and historically did, award back pay.

[5]Baker and Yannelis (2017) estimate that furloughed employees decreased their consumption by 6 to 10% during the 2013 government shutdown. Similarly, Gelman et al. (2020) estimate that furloughed employees spent $0.58 less for each dollar of lost liquidity during the shutdown. They also find that the most liquidity-constrained tercile of government employees had, on average, a combined checking and savings account balance of zero.

[6]The federal government's fiscal calendar for a given year begins on the first day of October of the preceding calendar year.

2. Empirical Framework

We examine the effects of the 2013 government shutdown on federal employment using a difference-in-differences framework. First, we assign treatment. Our data do not allow us to observe whether a particular employee is furloughed. Instead, we exploit heterogeneity in an employee's furlough probability as captured by the percentage of furloughed employees in 2013 at the employee's bureau. Figure 1 shows that this percentage varies significantly across bureaus. Its distribution is almost bimodal: over 25% of our sample employees work in bureaus that furloughed fewer than 10% of their employees, and over 20% of our sample employees work in bureaus that furloughed more than 90% of their employees. In our main empirical tests, we compare individuals in bureaus in which more than 50% of employees were furloughed (i.e., the treated group) to individuals in the remaining bureaus (i.e., the control group). This criterion leads to a relatively even split of our sample into the treatment and control groups.

Next, we select two cohorts of employees. The first cohort, which we label the "post-shutdown" cohort, consists of individuals employed by the government at the start of 2013.IV (i.e., the fourth quarter of 2013, which began on the same day as the shutdown). The second cohort, which we label the "pre-shutdown" cohort, consists of individuals employed by the government at the start of 2009.IV. The pre-shutdown cohort allows us to study the effects of the shutdown up to four years after its occurrence. The fourth quarter of 2009 is far enough from any government shutdown; however, in most of our tests we focus on one-year employment outcomes to mitigate concerns about potential confounding factors. We estimate specifications of the form

$$\textit{Separated}_{ijt} = \alpha + \beta \textit{Majority furloughed}_{j} \times \textit{Post-shutdown}_{t} + X_{ijt}^{'}\Gamma + \epsilon_{ijt}, \tag{1}$$

where $\textit{Separated}_{ijt}$ is an indicator variable that takes the value of 1 if employee i at bureau j in time cohort t leaves the federal government within one year. Throughout our analysis, we vary the definition of $\textit{Separated}_{ijt}$ to capture different modes of leaving government service (e.g., quitting, retiring) and different time horizons (e.g., two years, three years, four years). The indicator variable $\textit{Majority furloughed}_{j}$ takes the value of 1 if the employee works at a bureau where 50% or more of employees were furloughed during the 2013 government shutdown. The indicator variable $\textit{Post-shutdown}_{t}$ is equal to 1 if the employee belongs to the 2013.IV (post-shutdown) cohort. Finally, $X_{ijt}^{'}$ represents a set of individual and job controls, as well as bureau, occupation, and geography-cohort fixed

effects.[7] The coefficient of interest is β, which captures the average treatment effect on treated individuals. If employees who are more likely to be affected by the 2013 government shutdown decide to leave government service after the shutdown, then β should be positive.

3. Data, Sample, and Summary Statistics

3.1. Data Sources

Federal Personnel Records Data. Our main dataset is the Central Personnel Data File (CPDF), an administrative database managed by the Office of Personnel Management (OPM). It contains the near universe of U.S. federal employment records. We study quarterly employment status and separations records for civilian non-defense employees from 2009.IV to 2017.III. The OPM data include detailed job appointment information (e.g., bureau, type of appointment, occupation, length of service, supervisory status, salary) and demographic characteristics (e.g., level of education, age, county of employment) on most salaried civil service members at the individual level.

Our CPDF data stem from two sources. For federal fiscal years 2010 to 2016, we use data published by BuzzFeed News. This news outlet obtained these data via a series of Freedom of Information Act (FOIA) requests (Singer-Vine 2017). For fiscal year 2017, we use data shared with us by the OPM in response to our own FOIA request for a more current version of these same records.

We use data on separations (e.g., quitting, retirement, terminations) to construct the outcome variables in our difference-in-differences implementation. The OPM compiles its personnel records quarterly and defines a pseudo-identifier unique to each employee. This allows us to design a panel of employees centered around the 2013 shutdown.[8] Due to a 2015 data breach of personnel records, the OPM has omitted this pseudo-identifier in its quarterly CPDF releases starting in 2014.III. For these quarters, we construct our own pseudo-identifier and link it to the pre-2014.III identifiers using unique instances of employee names.[9]

[7] Note that because X'_{ijt} includes bureau and cohort fixed effects, the variables *Majority furloughed*$_j$ and *Post-shutdown*$_t$ are not necessary in the regression.

[8] Executive Branch agencies—which employ more than three-quarters of individuals in our main sample—report their personnel records directly to the CPDF in real time. This ensures that, for example, the file date for the separation record of an employee who left her job on the last day of 2013.III is dated September 30, 2013.

[9] In Table IA.1 we focus on short-term employment outcomes using data before 2014.III and show that our main results are unaffected by this procedure.

Bureau-Level Furlough Counts. No dataset contains information on the furlough status of individual employees during any shutdown. Thus, for bureaus with more than 100 employees in September 2013, we manually collect bureau-level data on furlough counts from federal agency contingency plans for the shutdown. As the shutdown became increasingly likely in the weeks before the start of the 2014 fiscal year, all Executive Branch agencies were required by law to submit their shutdown contingency plans with the Office of Management and Budget (OMB). Each contingency plan includes bureau-level information on the number of *non-seasonal full-time permanent employees* (NSFTPs) who would be furloughed in the event of the shutdown.[10] We obtain the September 2013 contingency plans for each agency from the Obama administration's website using the Wayback Machine, a repository of website archives.[11]

Supplementary Data. We augment our primary data with additional data from multiple sources. First, we obtain aggregate data on local labor markets. These series include (1) the number of unemployed persons to job openings from the Bureau of Labor Statistics' Job Openings and Labor Turnover Survey and (2) the gap between private sector and federal wages from annual reports of the Federal Salary Council posted on OPM.gov. Second, we obtain data on contract spending on temporary help services (i.e., staffing agencies) from USAspending.gov. Third, we obtain data on inaccurate payments by the federal government from PaymentAccuracy.gov. Fourth, we obtain data on federal legal case proceedings managed by attorneys within the federal government via Justice.gov. Finally, we obtain data on public servants who hold patents from the U.S. Patent and Trademark Office (USPTO) and link these data to data on patent applications submitted by federal agencies from U.S. Patent and Trademark Office (2016).

3.2. Final Sample and Summary Statistics

We partition our sample in two 16-quarter periods before and after the 2013 shutdown. This time window spans nearly the entirety of the Obama administration, and it allows us to study both the short-term and the long-term employment effects of the shutdown. We focus on NSFTPs on the General Schedule, a uniform pay system that determines

[10] Post-shutdown internal audits show that the contingency plans were indeed implemented by bureaus as described.

[11] The NSFTP counts from the contingency plans align with those from the OPM data almost perfectly for all agencies in our sample. This boosts our confidence in the accuracy of the administrative personnel records.

how over 70% of federal employees are paid.[12] We exclude blue-collar employees and employees who are most likely excepted from furloughs.[13] We also exclude employee records with suppressed name information or missing information for any of the following variables: percent furlough, education, General Schedule grade, supervisory status, age, salary, and county of employment. Finally, for quarters after and including 2014.III (i.e., the first period in which employee pseudo-identifiers are no longer reported), we focus on records with names that are unique in each quarter from 2014.III to 2017.III. Internet Appendix A provides a detailed description of the sample construction process.

Our final sample includes 51,672 separations among 288,965 employees in the pre-shutdown cohort and 38,898 separations among 210,993 employees in the post-shutdown cohort.[14] Voluntary separations (i.e., quits or voluntary retirements) comprise 87% and 91% of all turnovers in our pre- and post-shutdown cohorts, respectively. Our final sample individuals are employed in 121 bureaus, including 100 bureaus across the 12 (out of 14) non-defense Executive Branch agencies for which furlough data is available.

Table I presents sample averages for employee characteristics (Panel A) and employment outcomes (Panel B) for our pre- and post-shutdown cohorts, stratified by treatment group. Recall that we assign an employee to the treatment group (*majority furloughed*) if she worked in a bureau in which 50% or more of NSFTPs were furloughed during the shutdown. Panel A shows that employees from bureaus with higher furlough rates tend to have higher salaries, higher pay grades, more managerial power, and more education than their counterparts.[15]

Panel B of Table I informs the intuition of our difference-in-differences approach. For example, for the sample affected by the 2013 government shutdown, there is a larger difference between the one-year separation rates of employees at bureaus in which most employees were furloughed and employees at the remaining bureaus. The corresponding difference-in-differences estimate is equal to 1.41 ppt $((6.04 - 5.01) - (4.06 - 4.44) = 1.41)$.

[12]The General Schedule system has 15 pay grades. Lower grade levels are appropriate for less-skilled, entry-level positions while higher grade levels are reserved for more-skilled, top-level positions. For more detail, see https://gogovernment.org/all-about-government-jobs/pay-and-the-general-schedule/.

[13]Employees belonging to the following occupational series groups are far less likely to be furloughed during shutdowns: *Miscellaneous Occupations* (primarily comprised of law enforcement officials); *Medical, Hospital, Dental, and Public Health*; and *Equipment, Facilities, and Services* (U.S. Office of Personnel Management 2015).

[14]Figure IA.1 plots the distribution of federal employees across counties and shows that there is significant variation in the locations of employee offices, with 28.2% of employees working in the Washington, D.C. area and the rest working throughout most of the U.S. Table IA.2 shows that our results remain unchanged when focusing only on D.C.-based employees from our analysis.

[15]Appendix A provides details on these variables.

4. Government Shutdowns and Federal Employment

4.1. Separations

We start by examining the effect of the 2013 government shutdown on the probability that an employee leaves the government (for any reason) one year after the shutdown. In later sections we examine separation rates at longer horizons as well as different reasons for separations. As discussed in Section 2, we compare individuals employed by bureaus in which most employees were furloughed with individuals from the remaining bureaus. To address the possibility that employee turnover could structurally differ across the two groups of bureaus, our comparison incorporates individuals employed by the government in 2009.IV. The main identifying assumption underlying our analysis of employee exits is that, had the 2013 government shutdown not occurred, exit trends would have evolved in parallel for employees in majority and non-majority furloughed bureaus. Figure 2 provides evidence consistent with this assumption by plotting cumulative separation rates for employees in majority furloughed bureaus and non-majority furloughed bureaus for the pre- and post-shutdown cohorts of employees. In Panel A the separation rates for both types of employees show similar trends around 2009. In contrast, Panel B shows that separation rates for majority furloughed bureau employees were higher for employees in the cohort affected by the 2013 shutdown.

Next, we estimate regressions of the form of Equation (1) to control more formally for any potential structural differences between majority furloughed bureau employees and their counterparts. Table II presents the estimation results. The dependent variable is the separation indicator of whether the employee leaves the federal government within one year, and the coefficient of interest is associated with the variable *Majority furloughed* $\times$ *Post-shutdown*. Recall that this variable is the interaction of *Majority furloughed* (an indicator that takes the value of 1 if the employee works at a bureau in which 50% or more of employees were furloughed during the 2013 government shutdown) and *Post-shutdown* (an indicator that takes the value of 1 if the employee belongs to the 2013.IV cohort). Following Abadie, Athey, Imbens, and Wooldridge (2023), standard errors are clustered at the treatment assignment level, that is, the bureau level.

The regression in Column 1 includes metropolitan statistical area (MSA)-cohort and bureau fixed effects to account for the fact that government employee turnover likely depends on local economic conditions, seasonal fluctuations in local labor markets, and time-invariant unobservable characteristics of government bureaus. The coefficient estimate associated with *Majority furloughed* $\times$ *Post-shutdown* indicates that employees in majority furloughed bureaus were 1.57 ppt more likely to leave the government after the

2013 shutdown. This effect, which is statistically significant at the 1% level, is equivalent to an effect that is 33% of the sample mean separation rate of 4.77%.

The very similar trends in the separation rates for pre-shutdown cohort employees are reassuring from an identification perspective (see Figure 2). However, Panel A of Table I shows that employees at majority furloughed bureaus differ from those at the remaining bureaus along a number of dimensions. We control for these differences in Columns 2 and 3 of Table II. First, in Column 2 we include controls for personal characteristics, including age, education level, and years of government service (tenure). The coefficient estimate of interest remains similar at 1.56 ppt. Second, in Column 3 we further add detailed controls for each employee's job characteristics, including General Schedule pay grade, whether the employee is a supervisor, and occupation fixed effects.[16] The effect of the government shutdown decreases slightly to 1.48 ppt (statistically significant at the 1% level and equivalent to 31% of the sample mean separation rate). Internet Appendix Figure IA.2 shows that this effect is robust to alternative definitions of *Majority furloughed* based on various fractions of furloughed employees ranging from 30% to 70%. Moreover, Table IA.3 shows that this effect is robust to using a matched subsample of employees from majority furloughed bureaus and non-majority furloughed bureaus based on state, occupation, supervisory status, salary, tenure, education level, and propensity score (estimated on the same set of controls used in our main specification, as well as salary).[17]

In another robustness exercise we investigate the potential interference of another political event preceding the shutdown, the 2013 so-called "sequester." On March 1, 2013, automated budget cuts were put into effect across the federal government, cutting spending by $42bn. Since the budget cuts led to minor furloughs, we investigate in Table IA.6 whether the sequester might partially drive our main result. We determine, for each agency, whether it instituted furloughs in response to the sequester, and repeat our main test for those agencies that were subject to both sequester related furloughs and shutdown related furloughs, relative to those that were only affected by the shutdown. We find that there is an increased rate of employees leaving government work for shutdown-furloughs in both samples. Interestingly, the separation rate for majority furloughed bureaus post

[16]Our sample represents 290 occupational series in the OPM's Handbook of Occupational Groups and Families (U.S. Office of Personnel Management 2018). Occupational series granularly describe an individual's line of work, for example, "General Attorney," "Health Insurance Administration," and "Technical Writing and Editing."

[17]In addition, in Table IA.5, we perform a placebo test by comparing the 2009.IV cohort with a cohort of employees from 2010.IV. Consistent with the absence of a shutdown during this period, we find that the difference-in-differences coefficient drops significantly for all the employment outcomes that we analyze, and this coefficient becomes statistically insignificant in all except one model.

shutdown in agencies affected by sequester furloughs increases relative to those agencies that were affected by both the sequester and the shutdown. These results are consistent with an increased treatment effect from multiple treatments, where employees that get furloughed repeatedly in short time react more strongly.

Finally, we show the robustness of the previous results to a wide range of regression specifications. First, we estimate 48 permutations of the regression using various combinations of sets of fixed effects, covariate controls, and subsamples of employees. Specifically, we keep the bureau fixed effects in all regressions, while we vary the inclusion of the MSA-cohort and occupation fixed effects. Similarly, we alternate the inclusion of the individual- and job-level controls, and we estimate the regressions in subsamples of employees based on bureau size and employee education.

Figure 6 plots the coefficient associated with *Majority furloughed* $\times$ *Post-shutdown* for each estimation, including its corresponding 90% and 95% confidence intervals.[18] Coefficients are presented in ascending order. The figure shows that the results presented in Table II are remarkably stable, with the effects of the government shutdown on employee separation ranging from 1.25 ppt to 1.81 ppt (all statistically significant at the 1% level). Our results are not driven by the largest bureaus or by employees who have a certain level of education (i.e., college or no college). Finally, note that the difference-in-differences estimate from Column 3 of Table II (denoted by the large green circle) is roughly in the middle of the coefficient range. This shows that our main specification is relatively conservative. Overall, our results strongly indicate that employees in majority furloughed agencies were substantially more likely to leave public service after the 2013 government shutdown.

4.2. Intrinsic Motivation

In this section, we investigate the relationship between being affected by the shutdown and intrinsic motivation, including employees' intention to leave the government. We obtain data from the annual Federal Employee Viewpoint Survey that followed the 2019 government shutdown. The advantage of this survey is that it directly asked federal employees about the degree to which the government shutdown affected them and their work, as well as their intention to find employment elsewhere.

In Figure 3, we sort respondents based on their own assessments of how severely the shutdown affected them, and plot on the vertical axis their stated intention to look for a

[18] This analysis is similar to the specification curve analysis in Cookson (2018) and Simonsohn, Simmons, and Nelson (2020).

position outside the federal government within the next year. The figure shows that employees who report an extremely negative impact of the shutdown on their work are 10 pp more likely to state their plan to search for outside employment compared to employees who report being unaffected or moderately affected by the shutdown. Interestingly, this represents a relative increase in the intention to leave of one-third compared to unaffected workers, roughly the same magnitude that is shown by our separation regressions.

Next, in Figure 4, we show that the reported degree to which the shutdown affected employees' work is monotonic in the likelihood of furlough. Taken together, the evidence strongly suggests that an employee's intention to leave government work is related to her experience during the shutdown. In Figure 5, we restrict the sample to employees who were in the process of looking for work at the time of the survey, and plot the fraction of employees directly attributing their decision to search for new employment to the shutdown. We find that only 10% of employees unaffected by the shutdown report that they decided to leave because of the shutdown, whereas this figure is around 75% for employees affected by the shutdown.

In the Internet Appendix, we further examine the relationship between the shutdown and the entire range of survey questions. Strikingly, we find that across in most questions, employees in majority furloughed bureaus reported lower satisfaction scores relative to employees in non-majority furloughed bureaus (see Figure IA.4). However, we find a noticeable amplification of this trend for the sub-category of questions addressing personal motivation, such as employees feeling empowered to act at work, or the idea that the workplace is meritocratic. Our results complement previous evidence showing a drop in employee morale following the shutdown (Resh, Ahn, and Moynihan 2023). Overall, the survey evidence provides a clear, direct connection between the shutdown, employee satisfaction, and the desire to leave government employment.

4.3. Separation Dynamics

Employment relationships are sticky, and labor markets have frictions (Hall 1999). As a result, the process by which an employee switches employers is unlikely to be fast. We now examine the cumulative effects of the shutdown on employee separations and whether these effects persist. We re-estimate the most complete specification from Table II for variants of the dependent variable. Specifically, we consider separation rates as dependent variables, with a range of two quarters after the shutdown to four years after the shutdown.

Figure 7 plots the coefficient associated with *Majority furloughed* $\times$ *Post-shutdown* in each regression as well as its corresponding 95% confidence interval. Consistent with the

idea that switching employers is not an expedient process, we find that the shutdown had a smaller effect (0.67 ppt) on employee separations two quarters after the shutdown than four quarters after the shutdown (1.48 ppt). Moreover, this effect increases over time and peaks in the second year after the shutdown. At this peak, employees at majority furloughed bureaus are about 1.73 ppt more likely to have left public service than their counterparts (21% of the sample mean separation rate). This effect of the shutdown eventually subsides: the coefficients at three years and four years after the shutdown remain positive but statistically indistinguishable from zero.

Our results thus far indicate that the loss of motivation from government shutdowns spur employees to leave federal employment, and that this effect peaks after one year before it subsides. This raises the question of whether this lost workforce is eventually replenished with new hires. To test this, figure 8 plots total employment levels of NSFTPs over time (relative to employment in 2013.III) for majority furloughed bureaus and non-majority furloughed bureaus. Importantly, this measure not only captures employees who leave the government but also includes new hires. While the total workforce expands at non-majority furloughed bureaus, this is not the case at bureaus that were relatively more affected by the 2013 government shutdown. Consistent with the regression results, we observe an employment decrease at majority furloughed bureaus during the first two years after the shutdown. Subsequently, employment levels stabilize, but there is no evidence that this lost workforce is replenished, at least not within the four-year period after the shutdown. These findings are consistent with concerns voiced by the government at the time of the shutdown that the shutdown would pose challenges to civil service retention in the short run and recruitment in the long run due to the lower attractiveness of government employment.[19]

4.4. Quitting Versus Retiring

In this section we examine the exact mode through which employees leave federal employment. We create two variables that capture distinct types of voluntary separations: (1) an indicator variable of whether an employee *quits* her job within one year and (2) an indicator variable of whether an employee *retires* from her job within one year. Retirement is an interesting outcome to examine because government employees are not forced to retire at a predetermined age, but most employees in our sample may decide to retire (and

[19]See government report "Impacts and Costs of the October 2013 Federal Government Shutdown," available at the Obama administration website archives (https://obamawhitehouse.archives.gov/sites/default/files/omb/reports/impacts-and-costs-of-october-2013-federal-government-shutdown-report.pdf).

receive retirement benefits) at any time after turning 57 years old. We estimate regressions of the form of Equation (1) using the two indicators mentioned above as dependent variables and present the estimation results in Table III.

Columns 1 to 3 of Table III indicate that employees in majority furloughed bureaus are more likely to quit their government jobs after the shutdown. Our most stringent specification (Column 3) shows a 0.39 ppt effect of the shutdown on quitting. This is equivalent to an effect of 31% of the sample mean quitting rate. Similarly, the 2013 government shutdown also increases an employee's likelihood of retiring (Columns 4 to 6). Specifically, Column 6 of Table III shows a 0.82 ppt effect of the shutdown (28% of the sample mean retiring rate).[20]

Quitting and retiring comprise 22% and 67% of the separations in our sample, respectively, with only 11% of separations being involuntary (e.g., health-related separations, performance-related terminations, deaths). In Table IA.7 we examine the effects of the 2013 government shutdown on involuntary separations. Specifically, we focus on layoffs due to reduction-in-force actions and terminations for performance-related reasons. In contrast to our results on quitting and retirement, neither of these two types of involuntary separations are affected by the 2013 government shutdown. This result indicates that shutdowns influence employees to leave the government voluntarily; they do not leave due to the differential effects of government decisions on their respective bureaus.

While our main tests focus on the 2013 shutdown, we also verify our inference using data on the 1996 shutdown. We find a similar increase in the likelihood of separation for majority furloughed bureaus as in the 2013 shutdown. In terms of the mode of leaving, the results are directionally the same, and economically larger, for quitting. In contrast, results are smaller and statistically insignificant for retiring. In Table IA.4 of the Internet Appendix, we document a 0.44% increase in the rate of quitting, an effect that exceeds that for the 2013 shutdown. However, we find only a relatively small, statistically insignificant increase in the rate of employees retiring, leading to a combined increase in the rate of leaving for voluntary reasons of 0.8%, slightly lower than in our main tests. These results confirm that furloughs have similar effects in different instances, although the differential impact on quitting and retiring deserve further investigation.

[20]We present additional analyses related to these regressions in Internet Appendix C. Figure IA.5 plots cumulative quitting and retiring rates for employees in majority furloughed bureaus versus non-majority furloughed bureaus. Consistent with the parallel trends assumption underlying our difference-in-differences analysis, it shows that both rates trend similarly for pre-shutdown cohort employees. Figure IA.6 repeats the specification curve analysis, with results similar to those shown in Figure 6.

4.5. Cross-Sectional Analysis

We now turn to examining whether the increased likelihood of an employee quitting or retiring after the 2013 government shutdown varies with employee or job characteristics. For example, it is possible that lower-paid employees are more negatively affected by the shutdown than higher-paid employees because they are more liquidity constrained. Other factors such as one's sense of civic duty may also correlate with pay or supervisory roles. On the other hand, higher-paid employees may also enjoy better outside opportunities, which enables them to switch jobs more easily. All of these factors can affect how employees respond to shutdowns. Finally, it is likely that the decision to retire and the decision to quit are correlated with different employee characteristics (e.g., younger employees can quit, but they may be ineligible for retirement). Ultimately, how different types of employees respond to government shutdowns is an empirical question.

In Table IV we estimate regressions similar to those in Table III, with the only difference being that we add interactions of the variable *Majority furloughed* $\times$ *Post-shutdown* with employee and job characteristics (i.e., we include triple interactions of variables in the regressions).[21] Panels A and B present the estimation results when using the indicators for quitting and retiring as dependent variables, respectively. The results indicate that shutdowns motivate different types of employees to leave through different modalities: younger, less experienced employees with lower salaries are more likely to quit (Panel A), while older, more experienced employees with higher pay are more likely to retire (Panel B). In particular, Column 6 of Panel B shows that employees are more likely to retire when their pensions are fully vested,[22] consistent with full vesting reducing the pecuniary incentives to remain working, and making separation relatively more attractive. In addition, college-educated employees appear to be more likely to quit and less likely to retire, although these results are not consistently statistically significant.

Next, we consider the possibility that the heterogeneous response to government shutdowns is not only associated with differences in employee and job characteristics, but also with differences in outside opportunities and local labor markets more generally. Specifically, employees facing tighter local labor markets should find it easier to leave government service than those facing more slack local labor markets. Moreover, switching job sectors becomes more attractive when salaries in the private sector are increasing relative to federal wages.

[21] For ease of exposition, we do not display coefficients for lower-level interactions. All models are fully interacted.

[22] Pensions are fully funded at age 60 with at least 20 years of service, or at age 65 with at least 5 years of service.

Table V tests these implications using two additional variables: (1) the number of unemployed persons to job openings in a state and (2) the percent difference between private sector and federal wages for similar work in a locality pay area (i.e., a metropolitan area in which federal employees are paid a partial cost-of-living adjustment in addition to their General Schedule pay). The former variable is a proxy for labor market tightness (Davis, Faberman, and Haltiwanger 2013; Domash and Summers 2022), with higher values indicating looser labor markets, while the latter measures the *federal wage gap*.

Columns 2 to 4 of Panel A in Table V present the results of estimating our main specification on the subsamples of the top 30, 20, and 10 states (including Washington, D.C.) in terms of labor market tightness. The results show that an employee's propensity to quit after the government shutdown is increasing in local labor market tightness. In particular, among the 10 states with the strongest labor markets, the estimate for this propensity is 0.68 ppt (44% of the mean subsample quitting rate), which is considerably larger than the propensity estimated in the main sample and reported in Column 1 (0.39 ppt, or 31% of the mean sample quitting rate). Similarly, Columns 2 to 4 of Panel B present the results of estimating our main specification on the subsamples of the top 30, 20, and 10 locality pay areas in terms of the federal wage gap.[23] These estimates suggest that quitting propensity is increasing in the federal wage gap. Among the 10 metropolitan areas with the largest federal wage gaps, the estimate for this propensity is 0.511 ppt (40% of the mean subsample quitting rate), which is larger than the propensity estimated on the subsample of employees with available locality pay area data (0.401 ppt, or 33% of the mean subsample quitting rate). Table IA.9 reports analogous estimations for retirements and finds no consistent patterns in retiring along these dimensions of labor market conditions. This result is consistent with the fact that retirees, who are less likely to be re-employed, tend to be less sensitive to their outside opportunities.

While we do not have information on what federal government employees do after separation, in additional analysis we use a large professional networking platform to examine the career outcomes of a random subsample of 300 college-educated employees who quit. Consistent with the results in Table V implying that outside opportunities in the private sector are a driver for employees to quit, we find that 71% of the 104 employees for whom we found public profiles on the networking platform left the federal government to work in the private sector.

[23]The five locality pay areas with the largest within-sample federal employment counts are, in descending order: Washington, D.C.; New York; Denver; Chicago; and San Francisco.

5. Government Shutdowns and Federal Response

5.1. Temporary Workers

As shown previously, federal employees who leave their jobs after the government shutdown are not replaced with non-seasonal full-time permanent employees in the following years. Temporary staffing is one strategy the federal government might use to compensate for this loss of employees. Federal bureaus have increasingly relied on temporary workers in recent years (Schwartz and Padin 2019). We now investigate whether affected bureaus substitute full-time employees with temporary workers.

Official temporary-worker contract spending data from USAspending.gov are available at the transaction level for each bureau. We compute the annual percent growth in management consulting and temporary worker spending for each fiscal year from 2010 to 2017. In this computation, we consider service contracts only for workers who perform jobs similar to our sample NSFTPs.[24]

Table VI presents the results of estimating difference-in-differences regressions using the annual bureau-level data, with bureau and fiscal year fixed effects. The dependent variable is the annual percent growth in contract spending for temporary help services. The independent variable of interest is the interaction between *Majority furloughed* and *Post-shutdown*, with the latter now being an indicator variable that takes the value of 1 for fiscal years 2013 and after. The table indicates that bureaus with higher percentages of furloughed employees during the 2013 government shutdown increased their spending on temporary workers significantly more than their less-furloughed counterparts. In fact, the difference in the increase in spending between the two types of bureaus after the shutdown is 5.30 to 5.36 ppt annually (61 to 63% of the sample mean growth rate of spending on temporary workers).

One question that arises from our previous results is whether hiring temporary workers is an effective way of reorganizing labor following a payroll reduction. Our data allow us to estimate the overall effect of shutdowns on each bureau's labor expenses. We find that affected bureaus spend, on average, an additional 244% on contract spending for temporary white-collar workers in the two-year period following the shutdown relative to the total savings in salaries and benefits that these bureaus accrue from separations during this period. In dollar terms, the aggregate increase in outsourcing costs to replace departing NSFTPs exceeds the labor cost savings by close to one billion dollars annually.[25]

[24]That is, we consider non-blue-collar temporary help services (NAICS code ranges 560000—561499, 541200–541219, and 541600–541690).

[25]Internet Appendix B describes the estimation procedure.

This result is inconsistent with cost savings from a shrinking government payroll. While it is possible that there are long-run cost savings to a reduction in full-time work force, the combination of sharply increasing short-run costs with our observation of a longer-term reversal in head count make it unlikely that shutdowns are efficient measures to reduce government spending. The fact that bureaus relatively more affected by the government shutdown respond with additional spending on temporary workers aligns with the idea that government shutdowns reduce human capital. A concerning implication of this result is that temporary workers may not be best suited for these vacant positions (e.g., workers usually require an adjustment period before performing new jobs effectively), which may reduce government productivity (see, e.g., U.S. Government Accountability Office 2018).

5.2. Accounting Processing and Litigation Capabilities

The results presented thus far are consistent with government shutdowns causing a long-lasting loss of human capital. Therefore, it is possible that government shutdowns negatively affect government productivity through a loss of employment. In contrast, if the departing employees are relatively unproductive, or if the affected bureaus are overstaffed, then it is possible that government productivity will remain unaffected. In this section we investigate whether the 2013 government shutdown affected government productivity. Measuring and comparing efficiency across different government agencies is challenging due to the widely different functions that they fulfill. We therefore focus on the efficiency outcomes of two activities uniformly performed by all agencies: (1) payments to transfer programs and service providers and (2) legal enforcement.

Government agencies processed over $3 trillion in payments in fiscal year 2013 to transfer programs and contractors. Of these payments, 4% were inaccurate—that is, they were payments in the wrong amount or payments to an unintended recipient. Although some of these mistakes are eventually corrected, a sizeable amount of money is permanently lost, and payment inaccuracies can be costly to bureaus, government transfer recipients, and contractors more generally.[26]

We obtain data on inaccurate payments by the U.S. federal government from PaymentAccuracy.gov. These data are available at the agency-year level. Accordingly, we adjust our bureau-level furlough counts and re-compute the *Majority furloughed* variable at the

[26]Government agencies are required to track inaccurate payments and their recovery by the 2010 Improper Payments Elimination and Recovery Act (H.R. 3393). According to government data from the Chief Financial Officers Council, recovery rates from 2013 to 2017 ranged from 40% to 50% (https://www.cfo.gov/wp-content-2/uploads/2018/11/2017-Payment-Accuracy-Dataset.xlsx).

agency level using the same 50% threshold that we used previously.[27] As in our previous analysis, we define *Post-shutdown* as taking the value of 1 for fiscal years 2014 and after and focus on outcomes in the fiscal years 2010 to 2017.

Figure 9 plots federal payments and the rate of inaccurate payments across the time series for majority and non-majority furloughed agencies. The two groups show approximately parallel trends in both variables before the 2013 shutdown. For several years after the shutdown, however, the inaccurate payments rate grows for majority furloughed agencies while remaining relatively flat for the other agencies. To pin down the magnitude of this apparent gap, Table VII presents the results of estimating difference-in-differences regressions that use these two variables as dependent variables. This analysis is descriptive in nature given our small sample size, though our findings compare reasonably with the aggregate trends plotted in Figure 9. Column 1 shows that the estimated coefficient on the inaccurate payments rate is equal to 1.12 ppt and is statistically significant at the 5% level. This indicates that agencies with larger fractions of furloughed employees during the 2013 government shutdown saw an average increase in inaccurate payments of 1.12 ppt annually (20% of the sample mean inaccurate payments rate). To add further economic perspective, if we assume a 50% recovery rate for inaccurate payments, a 1.12 ppt increase translates into an additional permanent loss of nearly half a billion dollars in 2013 alone. Moreover, Column 2 shows that there is no statistically significant association between the shutdown and the difference in total federal payments across the two groups. This result suggests that the increase in the inaccurate payments rate that we document is unlikely to be driven by an unexpectedly large increase (from a staffing perspective) in payment processing demand at majority furloughed agencies after the shutdown.

Next, we examine another common activity across various government bureaus: legal enforcement actions. For example, the EPA initiates legal actions for environmental reasons, the SEC enforces investor protection, and the DOJ prosecutes a broad range of criminal offenses.

We obtain data on legal proceedings from the DOJ's Freedom of Information Act webpage.[28] Federal bureaus are required to record the number of cases received as well as the number of those cases eventually brought to court. Thus, we measure legal enforcement

[27] When aggregating bureau-level furlough counts to the agency level we value-weight furlough counts based on the total number of payments-facing employees at each bureau within each agency. Any employee with an occupation in the *Accounting and Budget* or *Business and Industry* federal occupational series is considered a payments-facing employee.

[28] See https://www.justice.gov/usao/resources/foia-library.

actions in two ways. First, we consider the ratio of cases filed by a bureau to the number of cases it received in a given fiscal year. This ratio can be interpreted as a measure of efficiency. To account for the possibility that a decrease in this ratio could be driven by a contemporaneous increase in the number of cases received, our second measure is the logarithm of total cases filed (i.e., total output). Similar to our analysis of inaccurate payments, we estimate difference-in-differences regressions (in this case, at the bureau-year level) and present the results in Table VIII. The results indicate that bureaus in which the majority of employees were furloughed experienced a reduction in legal enforcement actions.

The previous results suggest that federal employees performing accounting and legal roles respond to the shutdown by quitting or retiring at similar rates as other federal employees. We test this conjecture in Internet Appendix Table IA.8 and introduce a triple interaction between *Majority furloughed*, *Post-shutdown*, and two indicator variables separately. Specifically, in Panel A, *PFE* takes the value of 1 if an individual is a payments-facing employee (e.g., an accountant). In Panel B, *Attorney* takes the value of 1 if an individual is an attorney by occupation. If accountants and attorneys somehow display a smaller reaction to furloughs than other employees in our main sample, we would expect the coefficients on these triple interactions to be negative. In contrast, if they quit and retire at similar rates as other employees, the coefficients on the triple interactions should be indistinguishable from zero. Across all specifications in Table IA.8, we find no evidence that accountants or attorneys exhibit lower propensities to leave the federal workforce following the shutdown.

The results in this section are consistent with government shutdowns causing losses in government productivity. Importantly, our analysis focuses on the settings of government payment and legal enforcement efficiency due to the difficulty of finding cross-agency measures of government productivity. Extrapolating to other areas of government, our results suggest that the indirect costs of government shutdowns (a) can far exceed the direct costs discussed often by policymakers and pundits and (b) can significantly hinder the government's capacity to provide services essential to public welfare.

5.3. Patenting and Innovation

In this section we examine the potential effect of the 2013 government shutdown on another measure of productivity: patent applications. We focus on a panel spanning the calendar years 2009 to 2015. Similar to our previous analysis of productivity measures, we (a) aggregate *Majority furloughed* to the agency level and (b) define *Post-shutdown* as taking the value of 1 for the years 2014 and afterward. We estimate difference-in-differences

regressions with the annual number of patents held by the agency as the dependent variable, with agency and patent-filing year fixed effects.[29]

Table IX presents the estimation results. Column 1 shows that agencies with larger fractions of furloughed employees during the 2013 shutdown produced fewer patents than their less-furloughed counterparts in the years after the shutdown. Moreover, Column 2 shows that this decrease in patenting activity is driven almost entirely by agencies with the highest patenting activity (i.e., agencies that hold an above-median number of patents).

Like the results in the previous section, the results in Table IX are consistent with government shutdowns causing losses in government productivity. If these losses materialize through a loss of productive employees, this should be reflected in employees associated with patent creation leaving the federal government. To examine this possibility, we obtain data on public servants that hold patents from the USPTO and match patent inventors with our government employee records based on first and last names, as well as middle initials. This analysis is primarily descriptive due to the limited sample size that results from this matching procedure.[30]

Figure 10 plots a patent inventor's propensity to quit the government within four years by type of agency (i.e., majority furloughed vs. non-majority furloughed) and cohort (i.e., pre-shutdown vs. post-shutdown). The figure shows that patent inventors employed by the government after the shutdown are more likely to quit, and this likelihood is substantially higher for inventors in majority furloughed agencies than for inventors in non-majority furloughed agencies (i.e., 6.1% vs. 3.0%). Overall, the results in this section support the idea that government shutdowns negatively affect government productivity by incentivizing productive employees to leave public service.

6. Conclusion

We exploit the 2013 U.S. government shutdown as a plausibly exogenous shock to the intrinsic motivation of government employees. Our results show that a decrease in mo-

[29]For this analysis, we consider only agencies that held at least one patent during the sample period. This results in the inclusion of 12 government agencies.

[30]We match 384 inventors to our government employment records. These inventors are together responsible for almost 5,000 patents. An inspection of the matched employees' occupations shows that they are overwhelmingly employed in functions related to scientific discovery, which reassures us that we are effectively identifying inventors employed by the federal government. For example, the most common occupations are "Information Technology Management" (10.5%) and "Natural Resources Management and Biological Sciences" (9.5%). Our confidence in the matching procedure is bolstered by the fact that individuals in the subset of matched employees are nearly four times more likely to hold a Ph.D. and nearly twice as likely to hold a master's degree than those in our main sample of employees.

tivation has a negative effect on human capital accumulation and retention, as well as in organizational productivity in the U.S. federal government, one of the largest organizations in the world Moreover, we show that the costs of government shutdowns go well beyond the direct costs that are often the focus of policymakers and pundits, such as back pay to furloughed employees or losses in GDP due to reduced government spending. We find that shutdowns incentivize government employees to leave public service: younger employees with better outside opportunities quit, and older employees with more experience retire. The lost workforce is not replenished, and the cost of hiring temporary outside contractors far exceeds any savings from lower payroll costs.

Our results are consistent with government shutdowns generating liquidity challenges or disillusionment in employees. Importantly, labor reactions like the ones we document need not be confined to shutdowns—they arguably extend to funding crises more generally, and are relevant, for example, in the context of the recent debate about the U.S. debt ceiling and the increase in the government's risk of default (Serbu 2023). Our results may also have implications for the recent implementation of furlough schemes by firms during the COVID-19 pandemic. These implications could be especially pertinent for firms that, like the federal government, tend to attract more "altruistic" workers (e.g., firms with high corporate social responsibility ratings), who may be disillusioned to a greater degree by perceived unfair treatment from an employer held in high personal regard.

One final implication of our findings is that shutdowns lead to a reallocation of labor from the federal government to local government and private sector employers. We leave a detailed examination of these spillovers and their effects to future work.

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Appendix

A. Variable descriptions

Variable name	Description
Employment outcomes	
Separated	Indicator variable of whether an employee leaves the federal government for any reason (defined at time horizons of one to four years).
Quit	Indicator variable of whether an employee quits the federal government (defined at time horizons of one to four years).
Retired	Indicator variable of whether an employee retires from the federal government (defined at time horizons of one to four years).
Main explanatory variables	
Majority furloughed	Indicator variable of whether an employee works at a bureau in which 50% or more employees were furloughed during the 2013 government shutdown.
Post-shutdown	Indicator variable of whether an employee belongs to the 2013.IV cohort of employees.
Job characteristics	
Supervisor	Indicator variable of whether an employee performs a supervisory role.
General Schedule grade	Numerical classification of job grade on the General Schedule pay system (15 grades). Higher grades are better paid and, on average, include employees with more education or experience.
Occupation	Classification of employee occupation (main sample includes 290 occupations).
Person characteristics	
Salary	Employee base salary at the time of cohort formation.
Tenure	Years of service with the federal government at the time of cohort formation.
Age	Employee age at the time of cohort formation.
College	Indicator variable of whether an employee has college or post-graduate education.
Post-grad	Indicator variable of whether an employee has post-graduate education.
Additional variables	
Number of unemployed persons per job opening	Number of unemployed persons divided by the number of full- or part-time job openings at the state level.
Federal wage gap	Percent difference between private sector and federal wages for similar work at the locality pay area level.
Temporary help services contract growth	Annual percent growth in temporary help services contract spending at the bureau level.
Inaccurate payments	Inaccurate payments amounts at the agency level.
Ratio filed to received	Ratio of the number of legal case referrals filed by a bureau to the number of legal case referrals it receives.
Number of patents	Total number of patents applied for in a calendar year by an agency.

Table I: Summary statistics

This table describes the main sample of civil service employees used in our difference-in-differences analysis. The sample is stratified by type of bureau (i.e., majority furloughed vs. non-majority furloughed) and by cohort of employees (i.e., pre-shutdown vs. post-shutdown). Majority furloughed bureaus had 50% or more of their full-time employees furloughed for five or more days during the 16-day 2013 government shutdown. Panel A reports the means for employee characteristic variables. Panel B reports the means for employment outcome variables.

Panel A: Employee characteristics (means)				
	Pre-shutdown (2009.IV)		Post-shutdown (2013.IV)	
	Majority furloughed	Non-majority furloughed	Majority furloughed	Non-majority furloughed
Characteristic	(1)	(2)	(3)	(4)
Furloughed (%)	82.81	16.85	82.89	16.68
Salary (thousand $)	82.21	68.34	87.20	75.01
General Schedule grade (1–15)	11.19	9.90	11.46	10.53
Supervisor (%)	16.49	12.27	22.74	13.45
Tenure (years)	18.16	15.49	17.42	14.61
Age (years)	49.12	47.99	49.39	48.36
College or post-grad education (%)	65.18	52.54	68.68	59.79
Post-grad education (%)	28.79	19.17	32.03	26.05
Observations	126,732	162,233	89,314	121,619
Panel B: Employment outcomes (means)				
	Pre-shutdown (2009.IV)		Post-shutdown (2013.IV)	
	Majority furloughed	Non-majority furloughed	Majority furloughed	Non-majority furloughed
Employment outcome	(1)	(2)	(3)	(4)
Percent separated within . . .				
1 year	4.06	4.44	6.04	5.01
2 years	8.84	8.98	11.17	9.75
3 years	13.76	13.26	15.28	13.64
4 years	18.55	17.36	19.81	17.44
Percent voluntarily retired within . . .				
1 year	2.78	2.67	3.85	2.97
2 years	6.07	5.74	7.28	5.89
3 years	9.58	8.64	10.24	8.40
4 years	13.11	11.50	13.68	11.17
Percent quit within . . .				
1 year	0.90	1.12	1.62	1.49
2 years	1.76	1.95	2.87	2.73
3 years	2.58	2.76	3.76	3.66
4 years	3.33	3.51	4.66	4.54
Observations	126,732	162,233	89,314	121,619

Table II: Separations

This table presents the results of the difference-in-differences analysis of the propensity for any type of employee separation following the 2013 government shutdown. The estimations are in the form described in Equation (1). Column 2 includes person-level controls (i.e., education, tenure, and age). Column 3 also includes job controls (i.e., General Schedule grade and supervisory status), as well as occupation fixed effects. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Separated (within 4 quarters)		
	(1)	(2)	(3)
Majority furloughed × Post-shutdown	1.566***	1.556***	1.484***
	(0.314)	(0.348)	(0.311)
Person controls	No	Yes	Yes
Job controls	No	No	Yes
MSA × cohort FE	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes
Occupation FE	No	No	Yes
Observations	499,898	499,898	499,898
Adjusted R-squared	0.00	0.03	0.03
Mean of dependent variable	4.77	4.77	4.77

Table III: Quitting versus retiring

This table presents the results of the difference-in-differences analysis of the propensity for employee quits (Columns 1 to 3) and retirements (Columns 4 to 6) following the 2013 government shutdown. The estimations are in the form described in Equation (1). Columns 2 and 5 include person-level controls (i.e., education, tenure, and age). Columns 3 and 6 also include job controls (i.e., General Schedule grade and supervisory status), as well as occupation fixed effects. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Quit (within 4 quarters)			Retired (within 4 quarters)		
	(1)	(2)	(3)	(4)	(5)	(6)
Majority furloughed × Post-shutdown	0.424**	0.430***	0.388***	0.847***	0.838***	0.820***
	(0.174)	(0.142)	(0.128)	(0.236)	(0.207)	(0.194)
Person controls	No	Yes	Yes	No	Yes	Yes
Job controls	No	No	Yes	No	No	Yes
MSA × cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes	Yes	Yes	Yes
Occupation FE	No	No	Yes	No	No	Yes
Observations	499,898	499,898	499,898	499,898	499,898	499,898
Adjusted R-squared	0.00	0.01	0.02	0.00	0.06	0.07
Mean of dependent variable	1.24	1.24	1.24	2.98	2.98	2.98

Table IV: Cross-sectional analysis

This table presents the cross-sectional results of the difference-in-differences analysis of the propensity for employee quits (Panel A) and retirements (Panel B, next page) following the 2013 government shutdown. The estimations are in the interacted form of Equation (1). All regressions include person-level controls (i.e., education, tenure, and age) and job controls (i.e., General Schedule grade and supervisory status), as well as occupation fixed effects. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

	Quit (within 4 quarters)					
	(1)	(2)	(3)	(4)	(5)	(6)
Majority furloughed × Post-shutdown	0.477***	0.471***	0.432***	0.284**	0.547***	0.445***
	(0.103)	(0.111)	(0.139)	(0.141)	(0.113)	(0.142)
Majority furloughed × Post-shutdown × Tenure	−0.030***					
	(0.009)					
Majority furloughed × Post-shutdown × Grade		−0.069*				
		(0.036)				
Majority furloughed × Post-shutdown × Age			−0.029***			
			(0.009)			
Majority furloughed × Post-shutdown × College				0.112		
				(0.148)		
Majority furloughed × Post-shutdown × Log. salary					−0.416*	
					(0.251)	
Majority furloughed × Post-shutdown × Fully vested						−0.500***
						(0.134)
All controls and FEs	Yes	Yes	Yes	Yes	Yes	Yes
Fully interacted	Yes	Yes	Yes	Yes	Yes	Yes
Observations	499,898	499,898	499,898	499,881	499,898	499,835
Adjusted R-squared	0.02	0.02	0.02	0.02	0.02	0.02
Mean of dependent variable	1.24	1.24	1.24	1.24	1.24	1.24

Table IV (continued)

	Retired (within 4 quarters)					
	(1)	(2)	(3)	(4)	(5)	(6)
Majority furloughed × Post-shutdown	0.392**	0.732***	0.464***	1.042***	0.658***	0.276***
	(0.155)	(0.187)	(0.157)	(0.309)	(0.178)	(0.098)
Majority furloughed × Post-shutdown × Tenure	0.072***					
	(0.023)					
Majority furloughed × Post-shutdown × Grade		0.040				
		(0.055)				
Majority furloughed × Post-shutdown × Age			0.064***			
			(0.022)			
Majority furloughed × Post-shutdown × College				−0.254		
				(0.278)		
Majority furloughed × Post-shutdown × Log. salary					0.347	
					(0.391)	
Majority furloughed × Post-shutdown × Fully vested						3.475***
						(1.224)
All controls and FEs	Yes	Yes	Yes	Yes	Yes	Yes
Fully interacted	Yes	Yes	Yes	Yes	Yes	Yes
Observations	499,898	499,898	499,898	499,881	499,898	499,835
Adjusted R-squared	0.09	0.07	0.09	0.07	0.07	0.10
Mean of dependent variable	2.98	2.98	2.98	2.98	2.98	2.98

Table V: Quitting, outside opportunities, and local labor markets

This table presents the results of the difference-in-differences analysis of the effect of outside opportunities on the propensity for employee quits within one year of the shutdown. The estimations are in the form of Equation (1). Panel A divides the main sample in terms of state rankings of *number of unemployed persons per job opening* in each cohort. This variable is seasonally adjusted and averaged over the four quarters following panel formation. Panel B divides the main sample in terms of locality pay area (LPA) rankings of the estimated percent difference between private sector and federal salaries for comparable non-seasonal full-time permanent roles on the General Schedule pay schedule (i.e., the *federal wage gap*) in each cohort. This variable is measured six months after cohort formation. The data for these two variables respectively come from (1) the Bureau of Labor Statistics' Job Openings and Labor Turnover Survey and (2) annual reports of the Federal Salary Council posted on OPM.gov. All columns include the full set of fixed effects and controls. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Panel A: Sample splits by labor market tightness				
	Quit (within 4 quarters)			
	All 50 States & D.C.	Top 30	Top 20	Top 10
	(1)	(2)	(3)	(4)
Majority furloughed × Post-shutdown	0.388***	0.385***	0.481***	0.683***
	(0.128)	(0.124)	(0.170)	(0.195)
Person controls	Yes	Yes	Yes	Yes
Job controls	Yes	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes
Observations	499,898	292,749	202,811	82,677
Adjusted R-squared	0.02	0.02	0.02	0.02
Mean of sample split variable	3.62	2.82	2.64	1.89
Mean of dependent variable	1.24	1.32	1.39	1.54
Panel B: Sample splits by federal wage gap				
	Quit (within 4 quarters)			
	All LPAs	Top 30	Top 20	Top 10
	(1)	(2)	(3)	(4)
Majority furloughed × Post-shutdown	0.401***	0.405***	0.428***	0.511***
	(0.135)	(0.133)	(0.129)	(0.151)
Person controls	Yes	Yes	Yes	Yes
Job controls	Yes	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes
Observations	297,015	289,075	268,708	206,259
Adjusted R-squared	0.02	0.02	0.02	0.02
Mean of sample split variable	68.49	69.30	71.08	75.38
Mean of dependent variable	1.23	1.24	1.25	1.27

Table VI: Temporary help services contracting

This table presents the results of the difference-in-differences analysis of the growth in federal contract spending on temporary help services pre- and post-shutdown (i.e., 2010.IV–2013.III and 2013.IV–2017.III) for 70 federal bureaus. Together, these bureaus comprised 45% of non-blue-collar General Schedule NSFTPs at the start of the 2013 shutdown. We require that temporary help services contracts have NAICS codes in one of three ranges: 560000–561499, 541200–541219, or 541600–541690. Contract growth is winsorized at the 5% level. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are two-way clustered by bureau and by year. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Temporary help services contract growth		
	(1)	(2)	(3)
Majority furloughed × Post-shutdown	4.756***	5.357**	5.300***
	(0.463)	(2.002)	(1.346)
Agency FE	No	Yes	Yes
Fiscal year FE	Yes	No	Yes
Observations	470	470	470
Adjusted R-squared	0.08	−0.03	0.03
Mean of dependent variable	8.47	8.47	8.47

Table VII: Inaccurate payments

This table presents the results of the difference-in-differences analysis of inaccurate payments for the four fiscal years pre- and post-shutdown (2010 to 2017) for 10 Executive Branch agencies. Agency-level payments data are from USAspending.gov. The sample includes the five majority furloughed and five non-majority furloughed agencies with available data, together comprising about two-thirds of federal spending in fiscal year 2013. When aggregating bureau-level furlough counts to the agency level we value-weight furlough counts based on the total number of payments-facing employees (PFEs) at each bureau within each agency. Any employee with an occupation in the *Accounting and Budget* or *Business and Industry* federal occupational series is considered a PFE. Outlays and inaccurate payments amounts are summed across the 10 agencies in our sample to construct separate aggregate series for the majority furloughed and non-majority furloughed groups. In addition to their interaction term, the *Majority furloughed* and *Post-shutdown* variables are included separately in the regression, but their coefficients are omitted from this table. A detailed description of all variables is available in Appendix A. Standard errors are in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Inaccurate payments (% of total outlays)	Total outlays (trillion $)
	(1)	(2)
Majority furloughed × Post-shutdown	1.121**	−0.065
	(0.448)	(0.045)
Observations	16	16
Adjusted R-squared	0.98	0.81
Mean of dependent variable	5.54	1.03

Table VIII: Federal legal caseload management

This table presents the results of the difference-in-differences analysis of legal caseload management outcomes for U.S. federal attorneys. National caseload data at the case level come from the Department of Justice's Freedom of Information Act webpage (https://www.justice.gov/usao/resources/foia-library/). We aggregate the caseload data in each bureau for each fiscal year and compute two performance measures: the ratio of filed to received cases and the total number of cases filed. The sample consists of the 12 bureaus (six non-majority furloughed and six majority furloughed) with available data from fiscal years 2010 to 2017. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are two-way clustered by bureau and by year. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Changes in federal caseload management	
	Ratio filed to received	Log. total cases filed
	(1)	(2)
Majority furloughed × Post-shutdown	−0.110***	−0.381***
	(0.020)	(0.108)
Majority furloughed	−0.109	−4.333***
	(0.102)	(0.976)
Fiscal year FE	Yes	Yes
Observations	96	96
Adjusted R-squared	0.10	0.58
Mean of dependent variable	0.77	3.83

Table IX: Patenting activity

This table presents the results of the difference-in-differences analysis of patent output. Patent data come from the U.S. Patent and Trademark Office, and they are provided at the agency level (rather than the bureau level). We aggregate bureau-level furlough counts to the agency level by value-weighting furlough counts based on the total number of employees at each bureau within each agency, and then we re-compute the *Majority furloughed* variable. The sample consists of the 12 agencies (three non-majority furloughed and nine majority furloughed) with available data from calendar years 2009 to 2015. Patent counts are winsorized at the 1% level. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are two-way clustered by agency and by year. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Number of patents	
	(1)	(2)
Majority furloughed × Post-shutdown	−13.833*	−0.617
	(6.799)	(1.753)
Majority furloughed × Post-shutdown × Above median patents		−39.650***
		(9.080)
Agency FE	Yes	Yes
Calendar year FE	Yes	Yes
Observations	84	84
Adjusted R-squared	0.72	0.92
Mean of dependent variable	9.93	9.93

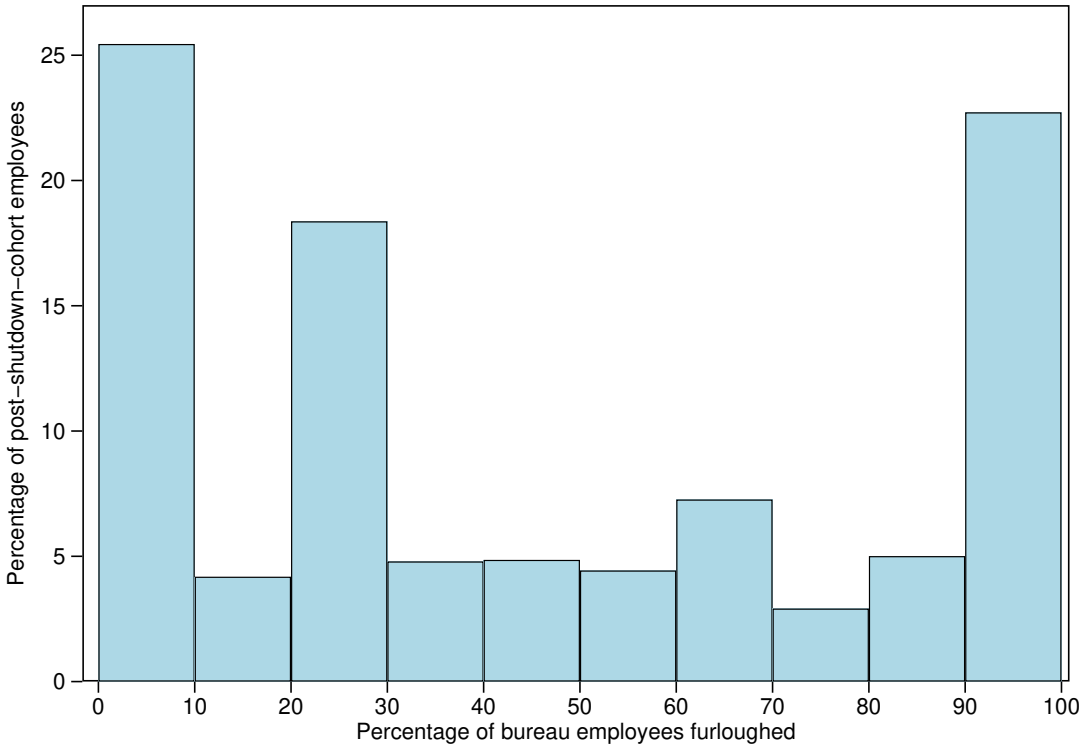
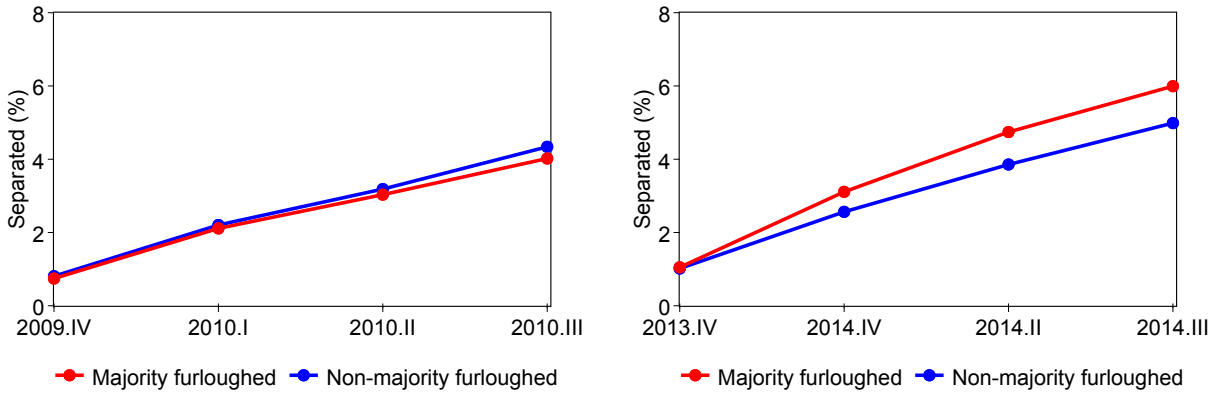


Figure 1: Distribution of Bureau Furlough Percentage

This figure plots the distribution of the percentage of employees furloughed within an employee's bureau. Only employees in the post-shutdown cohort (i.e., 2013.IV) are included in the depicted distribution.



Panel A. Pre-shutdown cohort

Panel B. Post-shutdown cohort

Figure 2: Separations Trends

This figure compares the aggregate separation rates of federal employees in the final sample across the time series for the two types of government bureaus (i.e., majority furloughed vs. non-majority furloughed) and the two cohorts of employees (i.e., pre-shutdown vs. post-shutdown).

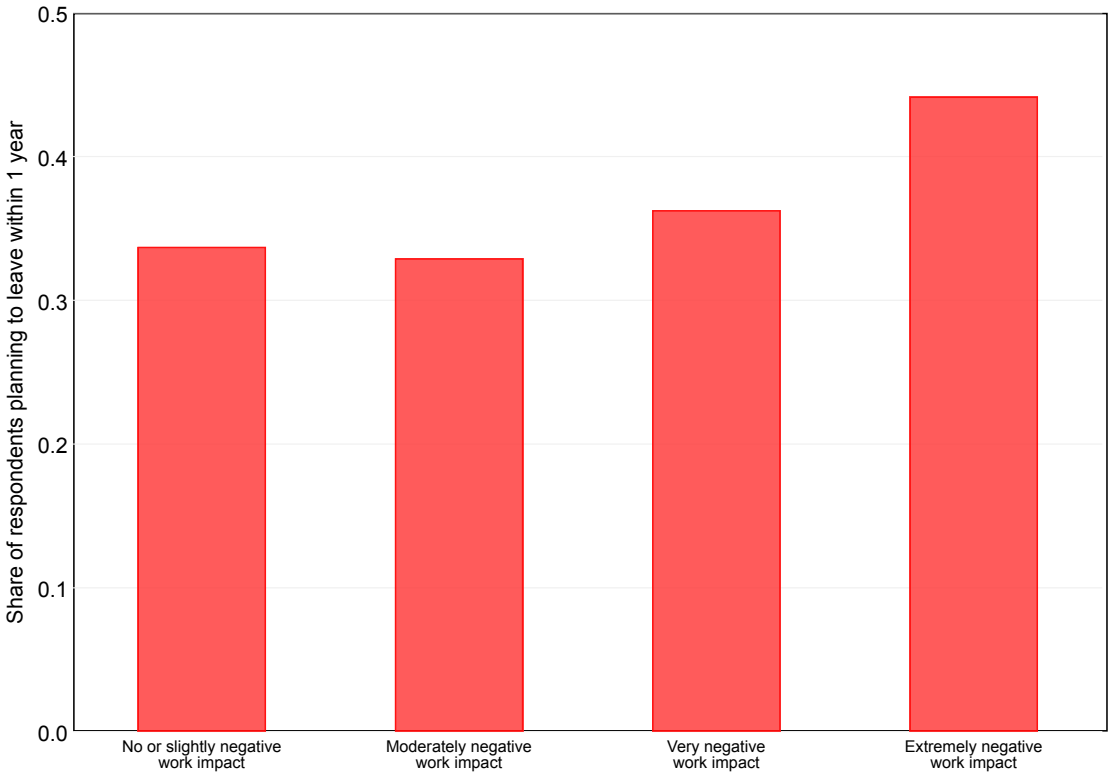


Figure 3: Shutdown Exposure and Separation Intention

This figure plots the self-assessed impact of the 2018/19 government shutdown on day-to-day work against workers' intention to leave government employment. Data stems from the 2020 Federal Employee Viewpoint Survey.

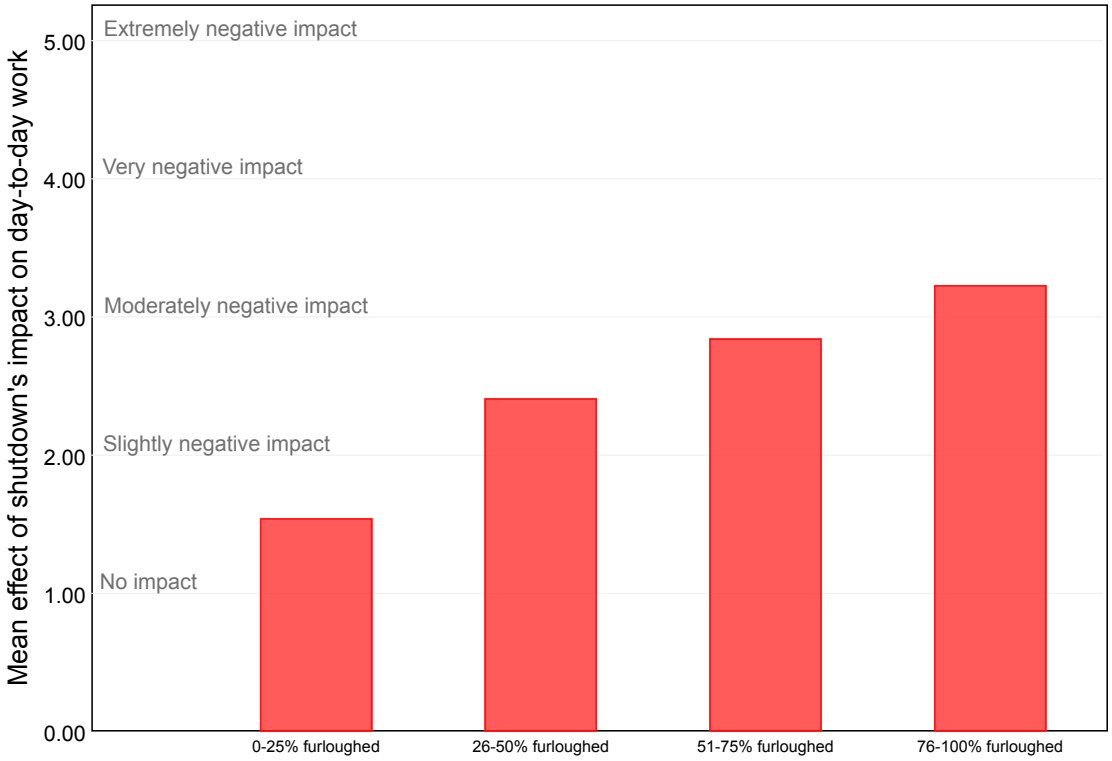


Figure 4: Actual shutdown exposure and self reported shutdown effects

This figure plots the fraction of furloughed employees during the 2018/19 government shutdown against the self-assessed impact of the 2018/19 government shutdown on day-to-day work. Data stems from the 2020 Federal Employee Viewpoint Survey.

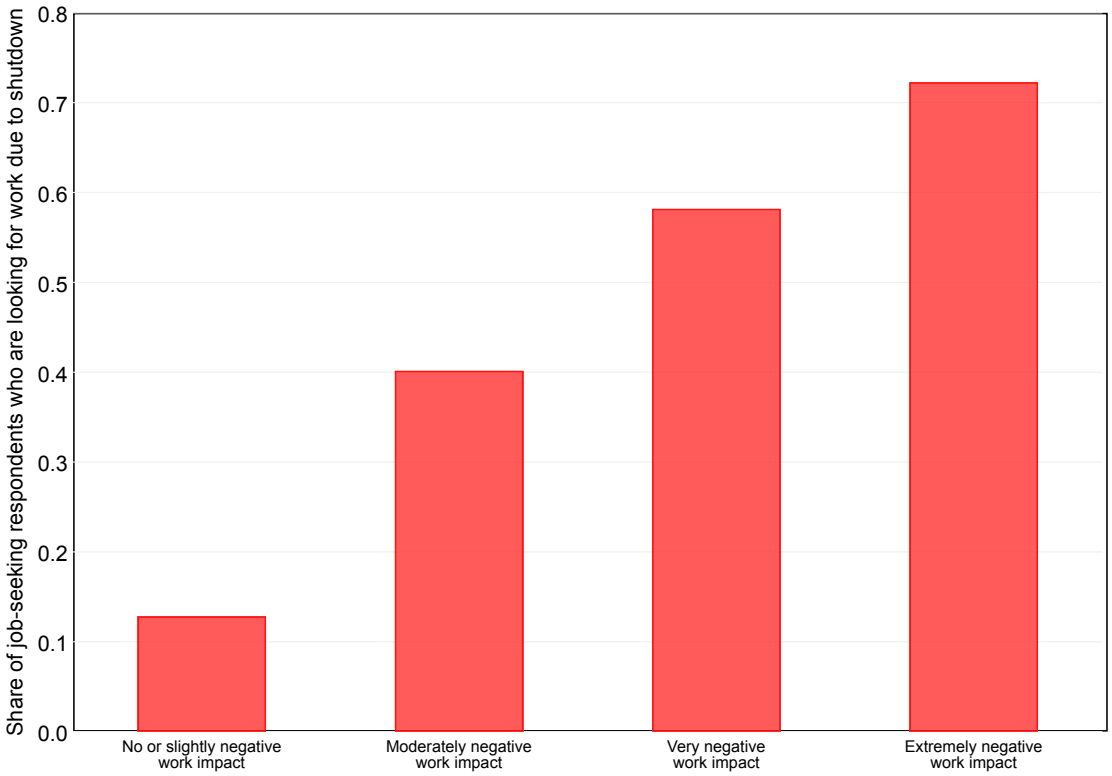


Figure 5: Leaving government work due to the shutdown

This figure plots the self-assessed impact of the 2018/19 government shutdown on day-to-day work against workers' self assessment that they are looking for new employment due to the government shutdown. Data stems from the 2020 Federal Employee Viewpoint Survey. Sample consists only of those respondents saying they are actively looking for new work.

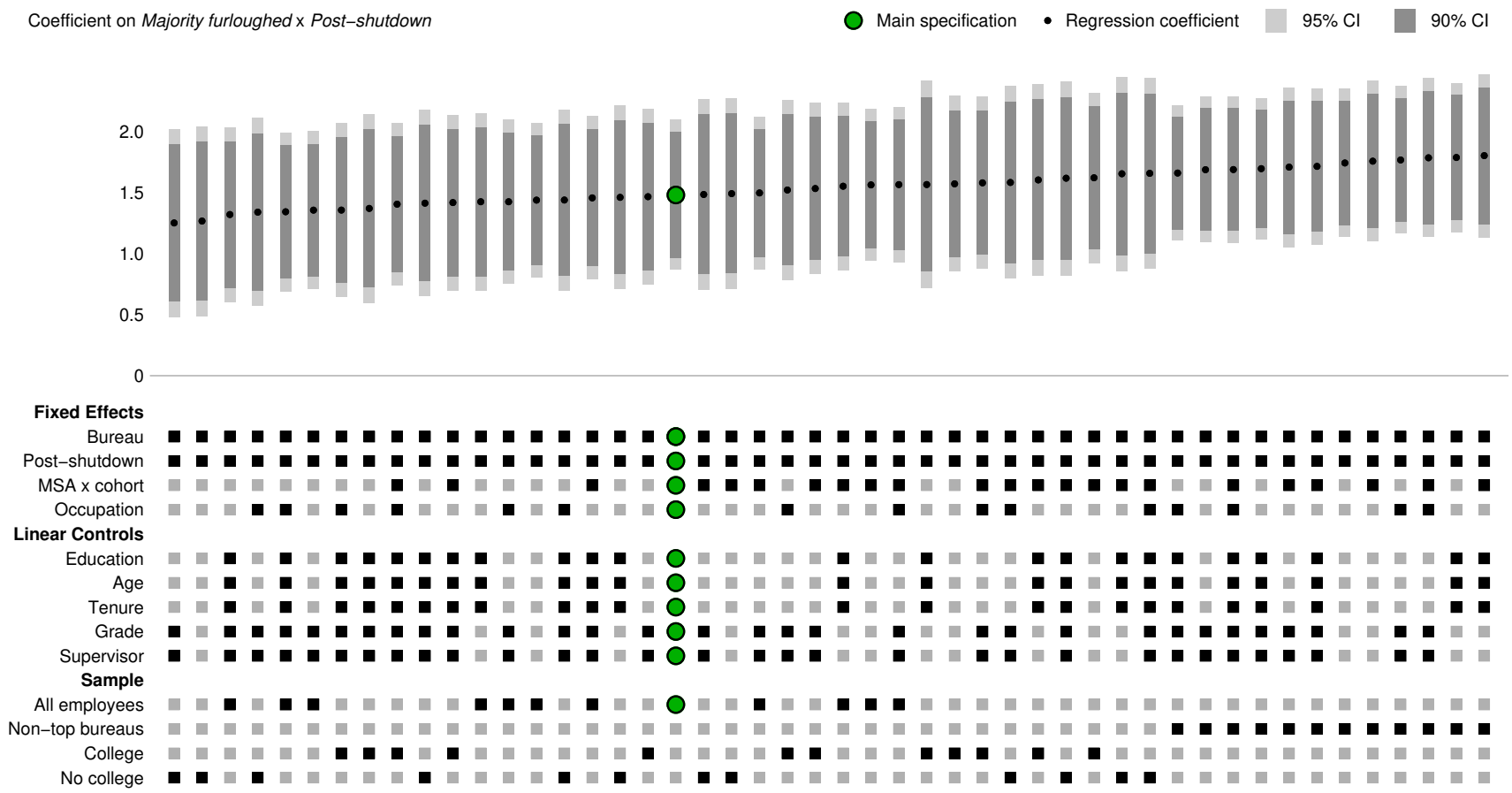


Figure 6: Specification Curve Analysis

This figure plots the coefficients on *Majority furloughed* × *Post-shutdown* and their corresponding confidence intervals for a set of regressions in which the dependent variable is an indicator for employee separation (i.e., leaving for any reason) within one year after the cohort assembly date (2009.IV or 2013.IV). The regressions include different combinations of control variables and fixed effects, and they are estimated across an array of subsamples. The non-top bureaus subsample excludes the Forest Service (the largest bureau in the majority furloughed group) and the Veterans Health Administration (the largest bureau in the non-majority furloughed group). The green circles indicate the main regression specification (estimated in Column 3 of Table II). Standard errors are clustered by bureau.

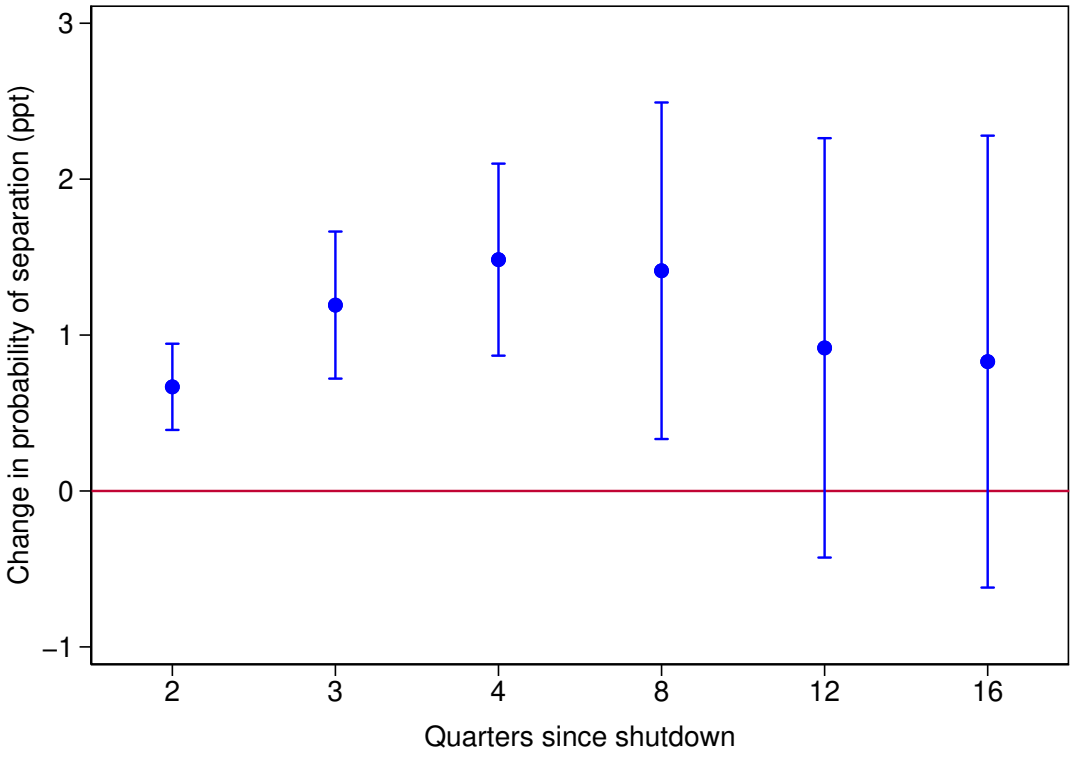


Figure 7: Effect of the Government Shutdown Over Time

This figure plots the estimated change in the probability of an employee separating against the number of quarters after the government shutdown. The coefficients are estimated using our most complete specification from Table II, replacing the left-hand four-quarter separation indicator with one- to 16-quarter separation indicators.

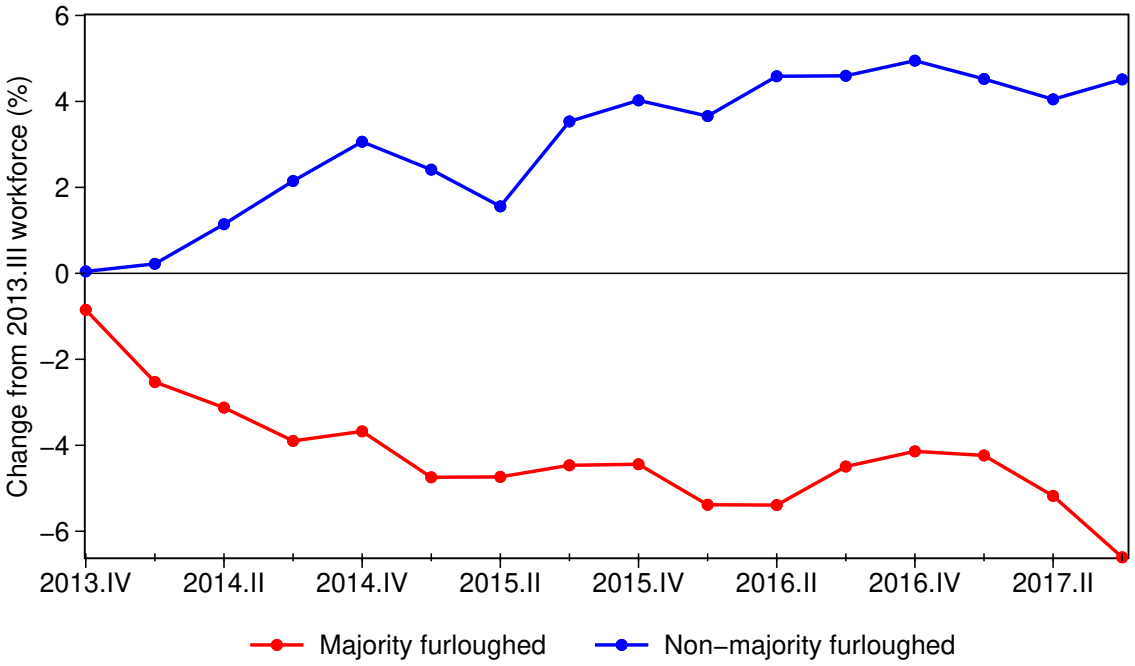


Figure 8: Post-Shutdown Workforce Replenishment

This figure plots the percentage change from the 2013.III workforce size for the post-shutdown cohort for the 16 quarters after the shutdown. The data come from raw Central Personnel Data File records (i.e., the near universe of federal personnel records) rather than our final sample. Only non-seasonal full-time permanent employees (NSFTPs) are included in the calculation.

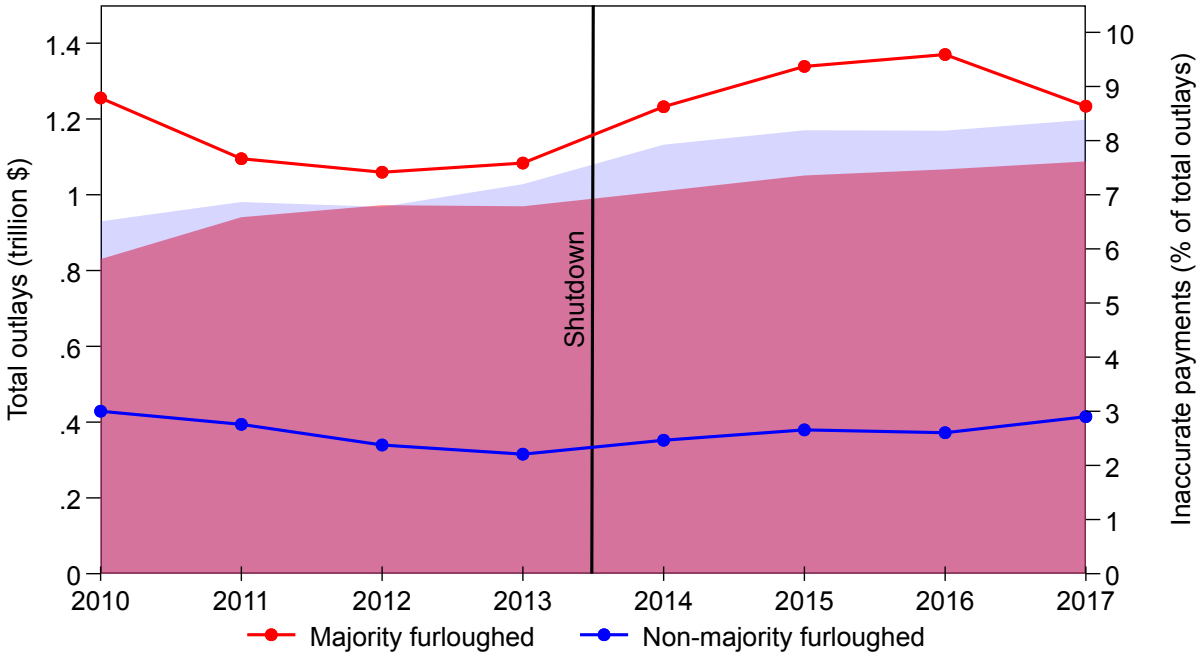


Figure 9: Federal Spending and Inaccurate Payments Trends

This figure compares the aggregate trends in total budget outlays (i.e., total payments, left) and inaccurate payments rates (right) across the time series for 10 Executive Branch agencies. Total payments levels are depicted as shaded areas while inaccurate payments rates are depicted as lines, with analogous coloring for majority furloughed (red) and non-majority furloughed (blue) agencies. Agency-level payments data are from USAspending.gov. The sample includes the five majority furloughed and five non-majority furloughed agencies with available data, together comprising about two-thirds of federal spending in fiscal year 2013. When aggregating bureau-level furlough counts to the agency level we value-weight furlough counts based on the total number of payments-facing employees (PFEs) at each bureau within each agency. Any employee with an occupation in the *Accounting and Budget* or *Business and Industry* federal occupational series is considered a PFE. Outlays and inaccurate payments amounts are summed across the 10 agencies in our sample to construct separate aggregate series for the majority furloughed and non-majority furloughed groups.

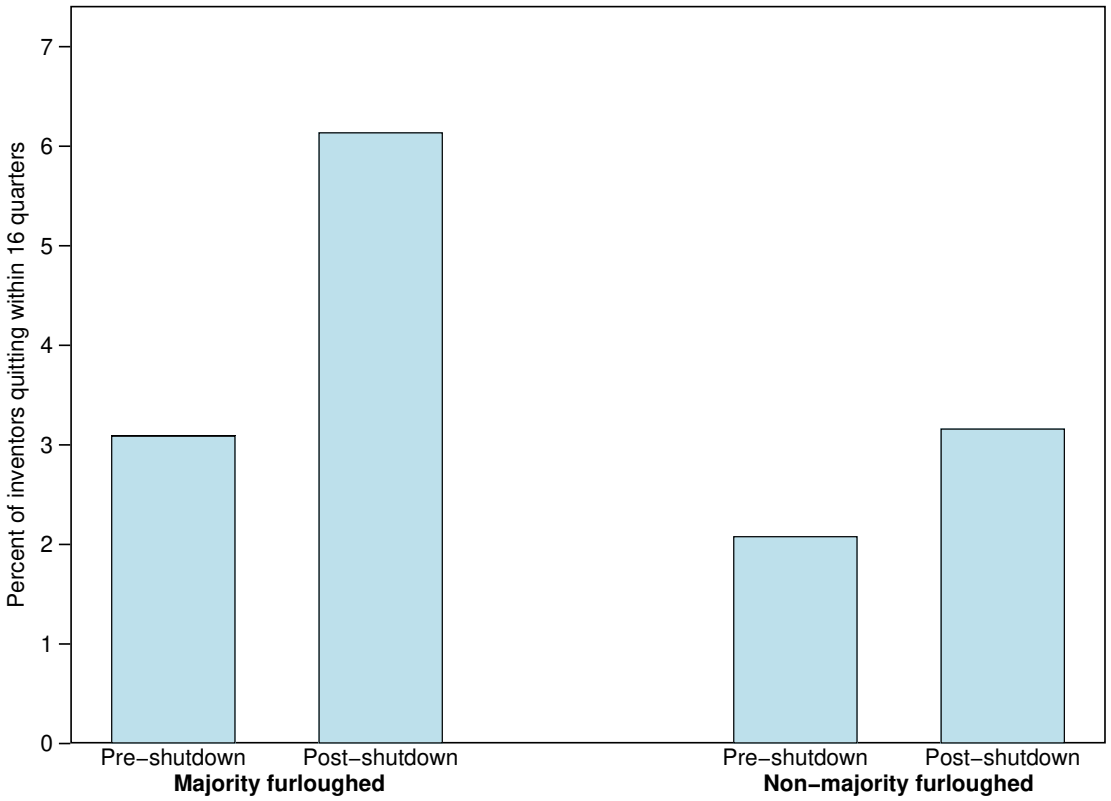


Figure 10: Inventor Quitting Propensity

This figure plots the percent of inventors who leave their federal government jobs within 16 quarters of the 2013 shutdown by type of bureau (majority furloughed vs. non-majority furloughed) and cohort (pre-shutdown vs. post-shutdown).

For Online Publication

Internet Appendix for "The Hidden Costs of Government Shutdowns"

Included in this document are supplementary results for the paper, "The Hidden Costs of Government Shutdowns." Part A of this document details the sample construction procedure for the final sample used in the paper. Part B describes the estimation procedure used to compute the relative cost efficiency of temporary staffing. Part C reports robustness exercise results as well as additional figures.

A. Sample construction

This section describes the sample construction methods used and the data filters applied to obtain our final sample. There are five distinct steps, lettered "A" to "E," as well as one pre-construction step ("Z"). For each sub-step in which the sample size is changed, the number of observations is listed next to the sub-step in **bold text**.

The steps begin by using cross-walked employment status or dynamics files from the OPM. The status files contain information on employment status; the dynamics files contain information on changes to employment status, including all separation actions (e.g., quits, retirements, terminations, reductions in force, deaths, transfers). These files are row-wise identical to the raw data, with the sole exception that their encoded values have been translated using the OPM-supplied cross-walking file. Thus, the data filters applied in this construction process are the only filters applied throughout the entire data pipeline.

Z. Post-shutdown unique names retrieval

1. For each post-shutdown status file (2013.III–2017.III), keep only NSFTPs. Then, drop non-unique names. Append all of these intermediate files and drop names that are non-unique in at least one of the status files. Keep only names observed in 2013.III. Save file ("File Z1"). **[522,030]**
2. For each pre-shutdown status file (2009.III–2013.II), keep only NSFTPs. Then, drop non-unique pseudo identifiers (IDs). Append all of these intermediate files and drop pseudo IDs that are non-unique in at least one of the status files. Keep only pseudo IDs observed in 2009.III. Save file ("File Z2"). **[676,163]**

A. Dynamics file cleaning

First, append all the 2009.IV–2017.III cross-walked dynamics files into one file. Then, clean the stacked file as follows: **[2,041,413]**

1. Keep only non-seasonal full-time employees (NSFTPs). **[981,817]**
2. Keep only dynamics actions dated between October 1, 2009 and September 30, 2017. **[980,841]**
3. Keep only non-transfer separation actions. **[500,196]**
4. Drop observations with redacted names.[1] **[351,488]**
5. Stratify the stacked file into two panels corresponding to the pre- and post-periods.

    a. 2013.IV–2017.III panel:

        i. Keep separation actions dated between 2013.IV and 2017.III. **[196,218]**
        ii. Merge this panel on employee names with the post-shutdown unique-names file (Z1). **[99,179]**
        iii. Keep only the last separation action (sorted by the effective date of the action) for each employee name. **[98,287]**
        iv. Save file ("File A1").

    b. 2009.III–2013.III panel:

        i. Keep separation actions dated between 2009.IV and 2013.III. **[155,270]**

[1] Names are redacted by OPM for security purposes.

ii. Merge this panel on pseudo ID with pre-shutdown unique-pseudo IDs file (Z2). **[127,886]**
iii. Keep only the last separation action (sorted by the effective date of the action) for each pseudo ID. **[127,191]**
iv. Save file ("File A2").

B. Status file cleaning

Clean the cross-walked status files as follows:

a. 2009.III **[1,310,733]**:
   i. Keep only NSFTPs. **[1,110,108]**
   ii. Drop observations with redacted names. **[676,594]**
   iii. Drop pseudo IDs that are not unique in 2009.III and merge on pre-shutdown unique-pseudo IDs file (Z2). **[676,163]**
   iv. Save file ("File B1").

b. 2013.III (pseudo ID-matched) **[1,334,966]**:
   i. Keep only NSFTPs. **[1,156,437]**
   ii. Drop observations with redacted names. **[722,902]**
   iii. Drop pseudo IDs that are not unique in 2013.III and merge on pre-shutdown unique-pseudo IDs file (Z2). **[537,232]**
   iv. Save file ("File B2").

c. 2013.III (name-matched) **[1,334,966]**:
   i. Keep only NSFTPs. **[1,156,437]**
   ii. Drop observations with redacted names. **[722,902]**
   iii. Drop employee names that are not unique in 2013.III and merge on post-shutdown unique-names file (Z1). **[522,036]**
   iv. Save file ("File B3").

d. 2017.III **[1,356,647]**:
   i. Keep only NSFTPs. **[1,193,547]**
   ii. Drop observations with redacted names. **[887,295]**
   iii. Drop employee names that are not unique in 2013.III and merge on post-shutdown unique-names file (Z1).
   iv. Save file ("File B4").

C. Post-cohort panel construction

Construct the 2013.IV–2017.III panel as follows:

1. Use the 2013.III unique-names status file (B3). **[522,036]**
2. Merge this file on employee name with the post-shutdown dynamics panel (A1). Keep only observations in the master or matched files, thereby dropping dynamics observations that cannot be matched to any individual employed in 2013.III.
3. Merge this file on employee name with the 2017.III unique-names status file (B4). Keep only observations in the master or matched files.

4. Keep only observations on the General Schedule pay plan. **[380,633]**
5. Merge in "percent furloughed" variable, keeping only matched observations. **[318,224]**
6. Merge in occupation types, keeping all matching types. Keep only observations in occupations that are not involved in the protection of life or property. **[236,309]**
7. Drop observations with missing age, education, years of service, occupation, or General Schedule grade information. **[235,301]**
8. Drop observations with missing salary information. **[235,207]**
9. Drop observations with missing state or county information. **[234,786]**
10. Keep only observations that are matched in either Step 2 or Step 3. That is, keep only those employees who either remained at their job or had separation actions that satisfy two conditions: (a) the name is either in the post-shutdown dynamics panel (A1) or in the last status file (2017.III) of our four-year sample period (B4), and (b) the name is missing in both (A1) and (B4). **[210,933]**
11. Save file ("File C").

D. Pre-cohort panel construction

Construct the 2009.IV–2013.III panel as follows:

1. Use the 2009.III unique-pseudo IDs status file (B1). **[617,163]**
2. Merge this file on pseudo ID with the pre-shutdown dynamics panel (A2). Keep only observations in the master or matched files, thereby dropping dynamics observations that cannot be matched to any 2009.III employee.
3. Merge on employee name with 2013.III unique-pseudo IDs status file (B2). Keep only master or matched observations.
4. Keep only observations for employees on the General Schedule pay plan. **[490,711]**
5. Merge in "percent furloughed" variable, keeping only matched observations. **[393,220]**
6. Merge in occupation types, keeping all matching types. Keep only observations in occupations that are not involved in the protection of life or property ("PLP"). **[299,449]**
7. Drop observations with missing age, education, tenure, occupation, or grade information. **[297,994]**
8. Drop observations with missing salary information. **[297,765]**
9. Drop observations with missing state or county information. **[296,006]**
10. Keep only observations that are matched in either Step 2 or Step 3. That is, keep only employees who either remained at their job or had separation actions that satisfy two conditions: (a) the pseudo ID is either in the pre-shutdown dynamics panel (A2) or in the last status file (2013.III) of our four-year sample period (B2), and (b) the pseudo ID is missing in both (A2) and (B2). **[288,968]**
11. Save file ("File D").

E. Final panel construction

Construct the 2009.IV–2017.III final sample as follows:

1. Append the post-shutdown panel (C) to the pre-shutdown panel (D). **[499,901]**
2. Drop observations that are omitted from the estimation sample of our main specification. **[499,898]**

B. Procedure for estimating the relative cost efficiency of temporary staffing

We find that, in the two years after the shutdown, replacing former salaried workers who had furlough-related separations with temporary staffers was 4.75 times less payroll-efficient on average than the counterfactual in which the same employees remained employed with the federal government. That is, affected bureaus spent $(4.75 - 1) \times 100 = 375\%$ more on average than unaffected bureaus. In dollar terms, this relative decline in payroll efficiency amounts to $969 million in increased temporary help services contract spending for affected bureaus. We describe our procedure for obtaining these calculations below.

1. Using the population data for civilian non-defense federal employees (not our final sample), we construct a panel of the total number of non-blue-collar NSFTPs and the average salaries of these NSFTPs in each bureau in the last quarter of each fiscal year. We keep only observations for the fiscal years 2014 and 2015 and compute average NSFTP counts and average salaries within each bureau in the pooled data for these two years. This leaves us with cross-sectional data at the bureau level.

2. We match this cross-sectional data to the panel of contracting data from USAspending.gov, which contains data on the contract spending on non-blue-collar temporary staffing for each bureau and each fiscal year. We keep only observations for majority furloughed bureaus. This leaves us with 45 affected bureaus compared with 89 affected bureaus in our final sample—the two differ due to USAspending.gov data restrictions.

3. For each bureau, we compute the change in temporary staffing contract spending from fiscal years 2013 to 2011, as well as the change from 2015 to 2013. We then de-trend the 2015–2013 contract spending change using the 2013–2011 contract spending change by subtracting the latter from the former. This gets us the change in temporary staffing contract spending from 2015–2013 in excess of the trend.

4. For each bureau, we compute the average number of separations by multiplying the number of NSFTPs (calculated in Step 1) by the point estimate for one-year furlough-related separations (1.484) from Column 3 of Table II. Next, we compute the total salaries of the furlough-related leavers by multiplying the average number of separations by the average salaries (also calculated in Step 1).

5. For each bureau, we divide the de-trended contract spending change (calculated in Step 3) by the total salaries of employees with furlough-related separations (calculated in Step 4) to compute the *relative payroll efficiency* of temporary workers to salaried workers. If the two are equally payroll-efficient, this quotient should equal 1. If salaried workers are more payroll-efficient, this quotient should be greater than 1, and vice versa. The mean of this quotient in our 45-bureau subsample is 4.75.

What if we account for savings in salaried employee benefits spending? A United States Department of Agriculture employee webpage claims that the federal government

spends on average 38% of NSFTP salaries on employee benefits, which is slightly higher than the number that the Bureau of Labor Statistics reports for private sector employees (30%).[2,3] Therefore, accounting for employee benefits spending brings the headline statistic reported in Step 5 down to $(4.75 / 1.38 - 1) \times 100 = 244\%$.

Implicit in these calculations are three main simplifying assumptions. The first assumption is that furlough-related separations occur at a constant rate over fiscal years 2014 and 2015, so that the total payroll savings accrued by not having to pay these workers is just the average of the total annual payrolls in fiscal years 2014 and 2015. Figure 7 shows evidence consistent with this assumption.

The second assumption is that the average affected bureau in our 45-bureau subsample has the same one-year average treatment effect of furlough as the average affected bureau in our final sample does. We find evidence consistent with this assumption as well. Removing the 44 out of 89 affected bureaus that are excluded from this 45-bureau subsample from our final sample leaves us with 440,172 observations (versus 499,898 in the final sample). Estimating our main regression specification again (Column 3 in Table II) on this 45-bureau subsample yields a point estimate of 1.345 on the main coefficient of interest with a standard error of 0.275 (clustered by bureau).

The third assumption is that all changes in de-trended temporary staffing contract spending from 2015 to 2013 are due to furlough-related vacancies. This assumption would be invalidated if affected bureaus systematically experienced greater-than-predicted workloads relative to unaffected bureaus and were unable to service this workload with their existing permanent workforce. This case appears implausible, however, given the broad variety of work carried out among affected bureaus.

[2] https://www.fsis.usda.gov/careers/incentives/federal-employee-benefits-summary

[3] https://www.bls.gov/news.release/pdf/ecec.pdf

C. Supplementary tables and figures

Table IA.1: Model estimation on alternatively-constructed data

This table presents robustness results for our main regression specification with respect to the sample construction. Our main sample tracks employees over time based on names and employment. Alternatively, the OPM has (in response to previous FOIA requests) provided individual "pseudo identifiers" that are available up to three quarters after the 2013 government shutdown. Columns 1 to 3 present results on our main sample using a three-quarter window for the employment outcomes, while Columns 4 to 6 repeat our main test using this three-quarter window for the employment outcomes while matching on personal identifiers. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Three-quarter employment outcomes					
	Main sample			ID-matched sample		
	Separated	Quit	Retired	Separated	Quit	Retired
	(1)	(2)	(3)	(4)	(5)	(6)
Majority furloughed × Post-shutdown	1.192***	0.256**	0.768***	1.116***	0.256***	0.686***
	(0.238)	(0.098)	(0.176)	(0.214)	(0.087)	(0.171)
Person controls	Yes	Yes	Yes	Yes	Yes	Yes
Job controls	Yes	Yes	Yes	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	499,898	499,898	499,898	614,421	614,421	614,421
Adjusted R-squared	0.03	0.01	0.05	0.03	0.01	0.05
Mean of dependent variable	3.63	0.90	2.36	3.66	0.99	2.31

Table IA.2: Separations for D.C.-based employees

Analogous to Table II, this table presents the results of the difference-in-differences analysis of the propensity for any type of employee separation for employees based in the Washington, D.C. area following the government shutdown. The estimations are in the form described in Equation (1). Column 2 includes person-level controls (i.e., education, tenure, and age). Column 3 also includes job controls (i.e., General Schedule grade and supervisory status) as well as occupation fixed effects. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. Washington, D.C. encompasses seven metropolitan statistical areas: Washington-Arlington-Alexandria, D.C.-VA-MD-WV; Baltimore-Columbia-Towson, MD; Hagerstown-Martinsburg, MD-WV; Chambersburg-Waynesboro, PA; Winchester, VA-WV MSA; California-Lexington Park, MD; and Easton, MD. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Separated (within 4 quarters)		
	(1)	(2)	(3)
Majority furloughed × Post-shutdown	1.241***	1.304***	1.287***
	(0.306)	(0.419)	(0.360)
Person controls	No	Yes	Yes
Job controls	No	No	Yes
MSA × cohort FE	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes
Occupation FE	No	No	Yes
Observations	138,153	138,153	138,145
Adjusted R-squared	0.00	0.02	0.03
Mean of dependent variable	4.23	4.23	4.23

Table IA.3: Model estimation on matched subsample

The table reports the estimation results for Equation (1) on a matched subsample of our final sample of employees. The subsample was matched using nearest-neighbor matching on an estimated propensity score. In order to be matched, individuals must be exactly the same in terms of the following characteristics: state of employment, occupation, supervisory status, salary tercile, tenure, and years of education. Estimated propensity scores were assigned using the same person- and job-level controls in the main specification, as well as salary. Matched individuals within a given cluster must have a difference in estimated propensity scores of less than one standard deviation of the estimated propensity score distribution (equal to 0.115).

Panel A reports the summary statistics for the matched subsample. Panel B reports the absolute normalized differences of the covariates between individuals in majority furloughed and non-majority furloughed bureaus for the pre- and post-shutdown cohorts in the main and matched samples.[4] Panel C (next page) reports the matched-subsample estimation results. All columns include the full set of fixed effects and controls. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Panel A: Matched-subsample employee characteristics (means)

	Pre-shutdown (2009.IV)		Post-shutdown (2013.IV)	
	Majority furloughed	Non-majority furloughed	Majority furloughed	Non-majority furloughed
Characteristic	(1)	(2)	(3)	(4)
Furloughed (%)	81.15	17.32	81.15	18.82
Salary (thousand $)	82.21	82.27	86.47	91.58
General Schedule grade (1–15)	11.03	10.98	11.34	11.76
Supervisor (%)	11.25	11.58	14.34	13.64
Tenure (years)	16.73	17.00	15.64	15.43
Age (years)	50.24	48.41	50.35	48.04
College or post-grad education (%)	58.07	55.33	63.50	66.22
Post-grad education (%)	24.47	21.67	27.47	30.50
Observations	22,535	20,811	15,785	17,509

Panel B: Absolute normalized differences

Sample	Cohort	Salary	Grade	Supervisor	Tenure	Age	College	Post-grad
Main	2009.IV	.48	.45	.12	.23	.1	.26	.23
Main	2013.IV	.41	.34	.24	.26	.09	.19	.13
Matched	2009.IV	0	.02	.01	.02	.17	.06	.07
Matched	2013.IV	.17	.15	.02	.02	.2	.06	.07

[4]The normalized difference for a variable X is given by

$$\Delta_X = \frac{\overline{X}_1 - \overline{X}_0}{\sqrt{S_1^2 + S_0^2}},$$

where, within a given sample, $\overline{X}_1$ and $\overline{X}_0$ are respectively the sample means of X for firms in the treatment and control groups; and S_1^2 and S_0^2 are respectively the sample variances for X for firms in the treatment and control groups. Imbens and Rubin (2015) note that linear methods for estimating average treatment effects can be sensitive to specification when absolute normalized differences of the model's covariates exceed 0.25.

Table IA.3 (continued)

Panel C: Matched-subsample employment outcomes			
	One year employment outcomes		
	Separated	Quit	Retired
	(1)	(2)	(3)
Majority furloughed × Post-shutdown	1.459***	0.320**	0.839***
	(0.387)	(0.161)	(0.294)
Person controls	Yes	Yes	Yes
Job controls	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes
Observations	76,570	76,570	76,570
Adjusted R-squared	0.03	0.02	0.06
Mean of dependent variable	4.40	1.17	2.76

Table IA.4: Results for 1996 shutdown

This table presents the results of the difference-in-differences analysis of the propensity for employees to leave, quit and retire following the 1996 government shutdown. The estimations are in the form described in Equation (1). All specifications include person-level controls (i.e., education, tenure, and age) and job controls (i.e., General Schedule grade and supervisory status), as well as occupation fixed effects. Sample construction is analogous to the main analysis for the 2013 shutdown. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Leave (within 4 quarters)	Quit (within 4 quarters)	Retired (within 4 quarters)
	(1)	(2)	(3)
Majority furloughed × Post	0.877*	0.440**	0.361
	(0.494)	(0.203)	(0.332)
N	772144	772144	772263
R^2	0.039	0.033	0.066
Person controls	Yes	Yes	Yes
Job controls	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes

Table IA.5: Placebo test

This table presents the results of a placebo test of our main specification for all separation types with respect to the time-indexing of the post-shutdown cohort of employees. Specifically, we consider government employees in 2010.IV as *post-period* employees. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	One year employment outcomes		
	Separated	Quit	Retired
	(1)	(2)	(3)
Majority furloughed × Post-shutdown	0.570***	0.173*	0.145
	(0.211)	(0.098)	(0.153)
Person controls	Yes	Yes	Yes
Job controls	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes
Observations	501,112	501,112	501,112
Adjusted R-squared	0.03	0.02	0.06
Mean of dependent variable	4.52	1.11	2.85

Table IA.6: Sequester analysis

This table tests whether our main results are driven by furloughs related to the 2013 federal sequester, which were implemented in the seven months preceding the shutdown. Analogous to Table II, the table presents the results of the difference-in-differences analysis of the propensity for employee separations following the 2013 government shutdown. Column 1 reports the estimation results on the subsample of agencies *had* sequester-related furloughs. Column 2 reports the estimation results on the subsample of agencies *did not have* sequester-related furloughs. The estimations are in the form described in Equation (1). Both columns include the full set of fixed effects and controls. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Separated (within 4 quarters)	
	Had sequester-related furloughs (1)	*Did not have* sequester-related furloughs (2)
Majority furloughed × Post-shutdown	2.561***	1.077***
	(0.426)	(0.345)
Person controls	Yes	Yes
Job controls	Yes	Yes
MSA × cohort FE	Yes	Yes
Bureau FE	Yes	Yes
Occupation FE	Yes	Yes
Observations	98,485	401,342
Adjusted R-squared	0.04	0.03
Mean of dependent variable	4.97	4.72

Table IA.7: Reductions in force and terminations

This table presents the results of the difference-in-differences analysis of the propensity for employees leaving civil service after the government shutdown due to (a) being laid off as the result of a reduction-in-force or (b) being terminated due to performance problems or for disciplinary purposes. The estimations are in the form described in Equation (1). Column 2 includes person-level controls (i.e., education, tenure, and age). Column 3 also includes job controls (i.e., General Schedule grade and supervisory status) as well as occupation fixed effects. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

	Reduction in force	Terminated
	(1)	(2)
Majority furloughed × Post-shutdown	0.002	0.030
	(0.010)	(0.019)
Person controls	Yes	Yes
Job controls	Yes	Yes
MSA × cohort FE	Yes	Yes
Bureau FE	Yes	Yes
Occupation FE	Yes	Yes
Observations	499,898	499,898
Adjusted R-squared	0.01	0.00
Mean of dependent variable	0.01	0.03

Table IA.8: Quitting versus retiring for payments-facing employees and attorneys

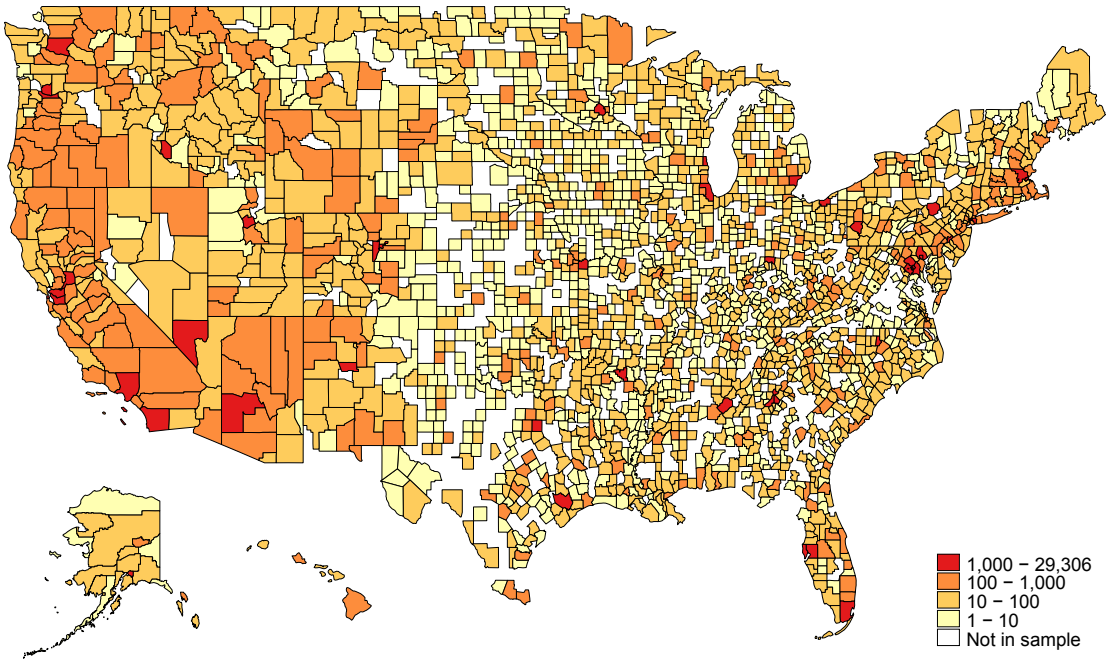
Panel A presents the results of the difference-in-differences analysis of the propensity for employee quits (Column 1) and retirements (Column 2) following the government shutdown. Any employee with an occupation in the *Accounting and Budget* or *Business and Industry* federal occupational series is considered a payments-facing employee (PFE). Similarly, Panel B presents the results of the difference-in-differences analysis of the propensity for federal employee quits and retirements among general attorneys following the government shutdown. All columns include the full set of fixed effects and controls. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. $^{**}p < 0.05$, $^{*}p < 0.10$.

Panel A: Payments-facing employees (PFEs)		
	Quit (within 4 quarters)	Retired (within 4 quarters)
	(1)	(2)
Majority furloughed × Post-shutdown × PFE	0.048	0.066
	(0.356)	(0.645)
All controls and FEs	Yes	Yes
Fully interacted	Yes	Yes
Observations	499,830	499,830
Adjusted R-squared	0.02	0.07
Mean of dependent variable	1.24	2.98
Panel B: Attorneys		
	Quit (within 4 quarters)	Retired (within 4 quarters)
	(1)	(2)
Majority furloughed × Post-shutdown × PFE	0.347	−0.038
	(0.593)	(0.388)
All controls and FEs	Yes	Yes
Fully interacted	Yes	Yes
Observations	499,846	499,846
Adjusted R-squared	0.02	0.07
Mean of dependent variable	1.24	2.98

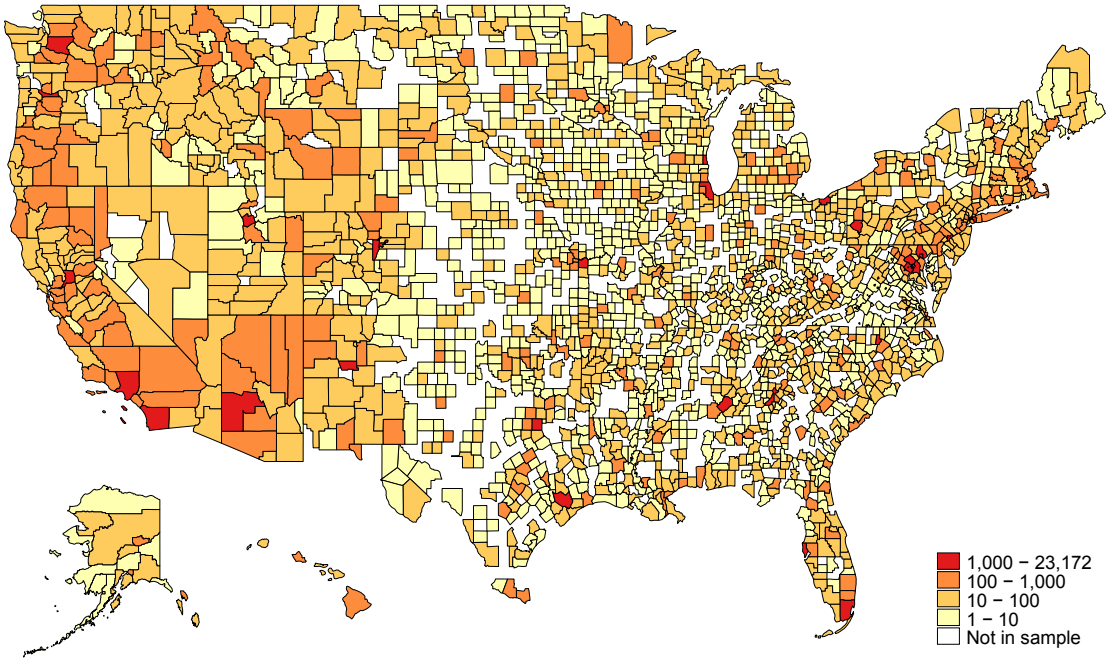
Table IA.9: Retiring, outside opportunities, and local labor markets

This table presents the results of the difference-in-differences analysis of the effect of outside opportunities on the propensity for employee retirements within one year of the shutdown. The estimations are in the form of Equation (1). Panel A divides the main sample in terms of state rankings of *number of unemployed persons per job opening* in each cohort. This variable is averaged over the four quarters following panel formation. Panel B divides the main sample in terms of locality pay area (LPA) rankings of the estimated percent difference between private sector and federal salaries for comparable occupations (i.e., the *federal wage gap*) in each cohort. This variable is measured six months after cohort formation. The data for these two variables respectively come from the Bureau of Labor Statistics' Job Openings and Labor Turnover Survey annual reports of the Federal Salary Council. All columns include the full set of fixed effects and controls. A detailed description of all variables is available in Appendix A. Standard errors in parentheses are clustered at the bureau level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Panel A: Sample splits by labor market tightness				
	Retired (within 4 quarters)			
	All 50 States & D.C.	Top 30	Top 20	Top 10
	(1)	(2)	(3)	(4)
Majority furloughed × Post-shutdown	0.820***	0.813***	0.942***	0.736***
	(0.194)	(0.215)	(0.242)	(0.258)
Person controls	Yes	Yes	Yes	Yes
Job controls	Yes	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes
Observations	499,898	292,749	202,811	82,677
Adjusted R-squared	0.07	0.07	0.06	0.06
Mean of sample split variable	3.62	2.82	2.64	1.89
Mean of dependent variable	2.98	2.89	2.79	2.89
Panel B: Sample splits by federal wage gap				
	Retired (within 4 quarters)			
	All 33 LPAs	Top 30	Top 20	Top 10
	(1)	(2)	(3)	(4)
Majority furloughed × Post-shutdown	0.949***	0.935***	0.899***	0.671***
	(0.210)	(0.211)	(0.211)	(0.221)
Person controls	Yes	Yes	Yes	Yes
Job controls	Yes	Yes	Yes	Yes
MSA × cohort FE	Yes	Yes	Yes	Yes
Bureau FE	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes
Observations	297,015	289,075	268,708	206,259
Adjusted R-squared	0.06	0.06	0.06	0.06
Mean of sample split variable	68.49	69.30	71.08	75.38
Mean of dependent variable	2.81	2.81	2.81	2.66



Panel A. Pre-shutdown cohort



Panel B. Post-shutdown cohort

Figure IA.1: Geographic Distribution of Federal Employees

This map plots the distribution of federal employees across counties in the pre-shutdown cohort (288,965 employees) and the post-shutdown cohort (210,831 employees). (Due to county geography changes, 102 employees in the post-shutdown cohort are not included in the sample from which the figure is produced.)

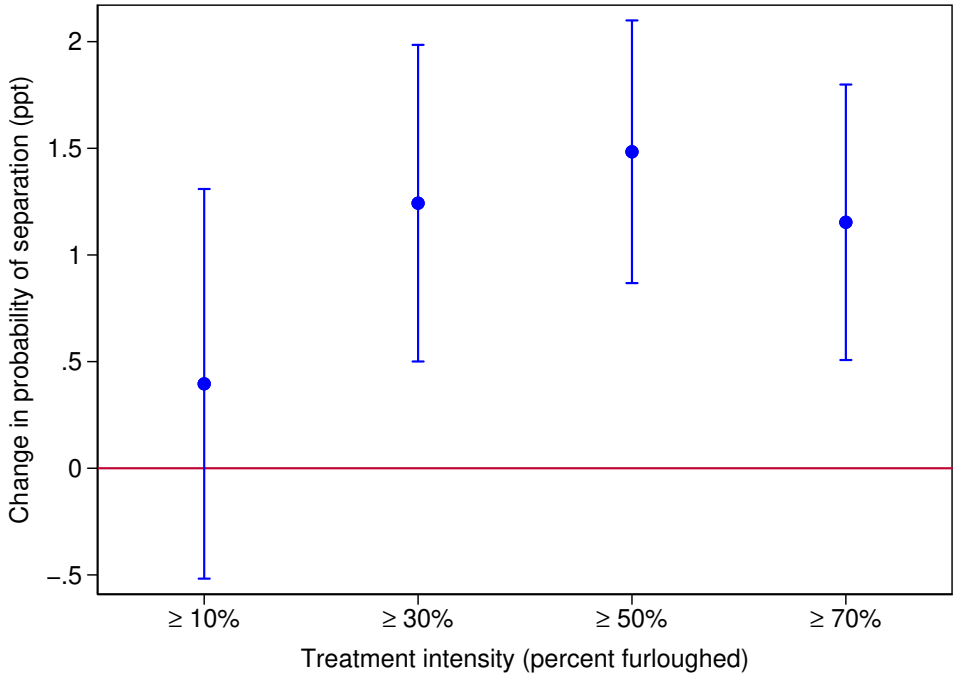


Figure IA.2: Treatment Intensity

This figure plots the estimated change in the probability of an employee leaving against the treatment intensity, captured by the percent of furloughed employees at the bureau level. The coefficients are estimated using our baseline specification in Equation (1) and by replacing the majority furloughed (i.e., 50% furloughed) indicator with analogous 10%, 30%, 50%, and 70% indicators.

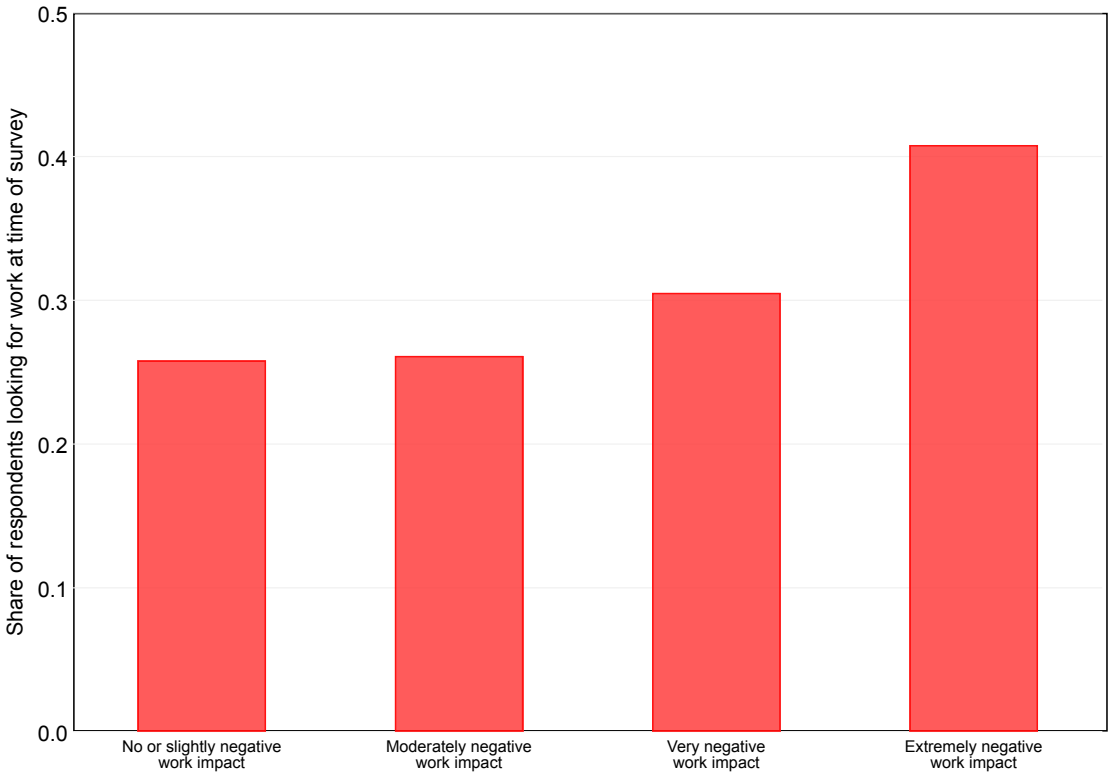


Figure IA.3: Shutdown Exposure and Looking for Work

This figure plots the self-assessed impact of the 2018/19 government shutdown on day-to-day work against workers' current status of actively looking for a new role outside the federal government. Data stems from the 2020 Federal Employee Viewpoint Survey.

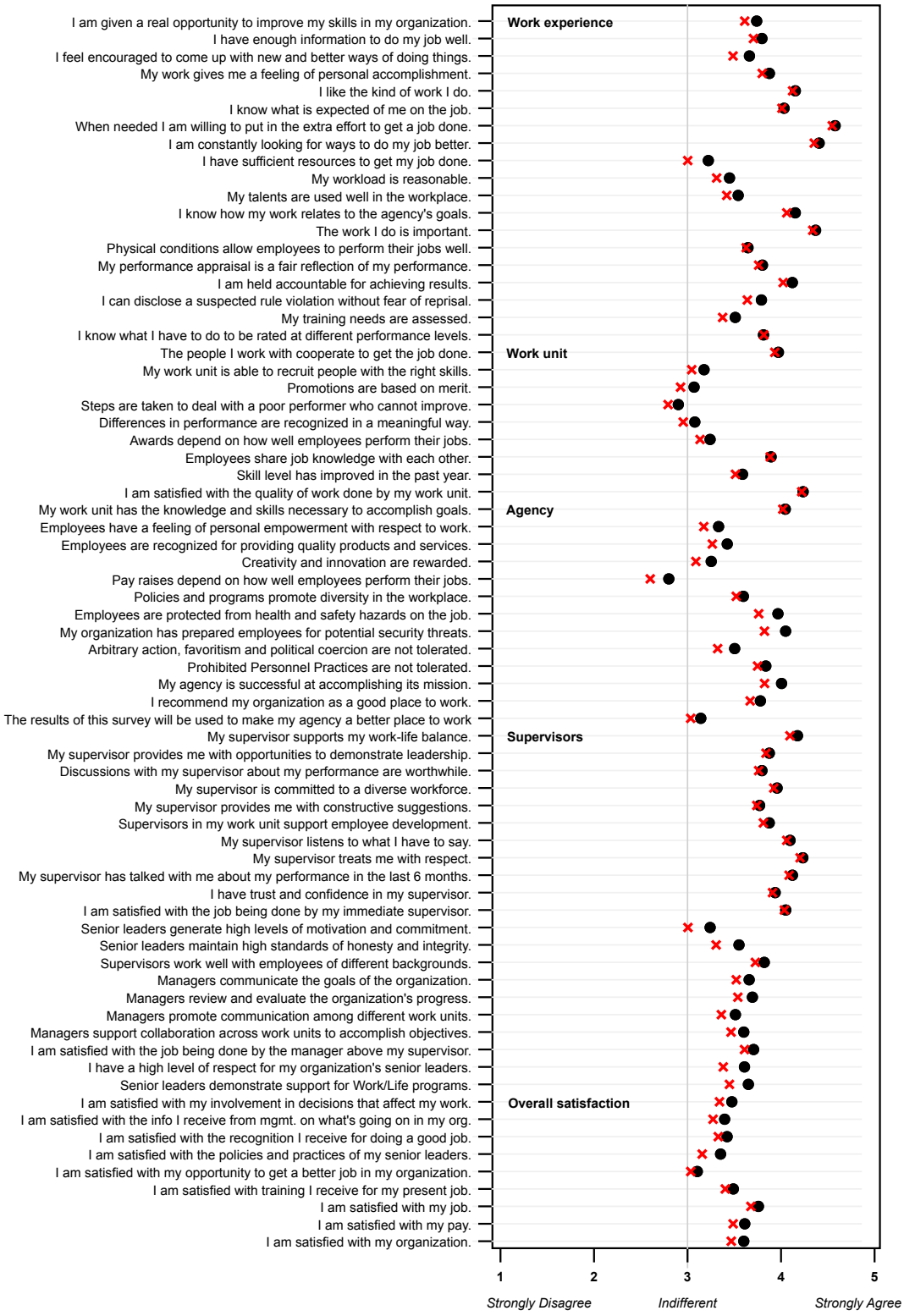
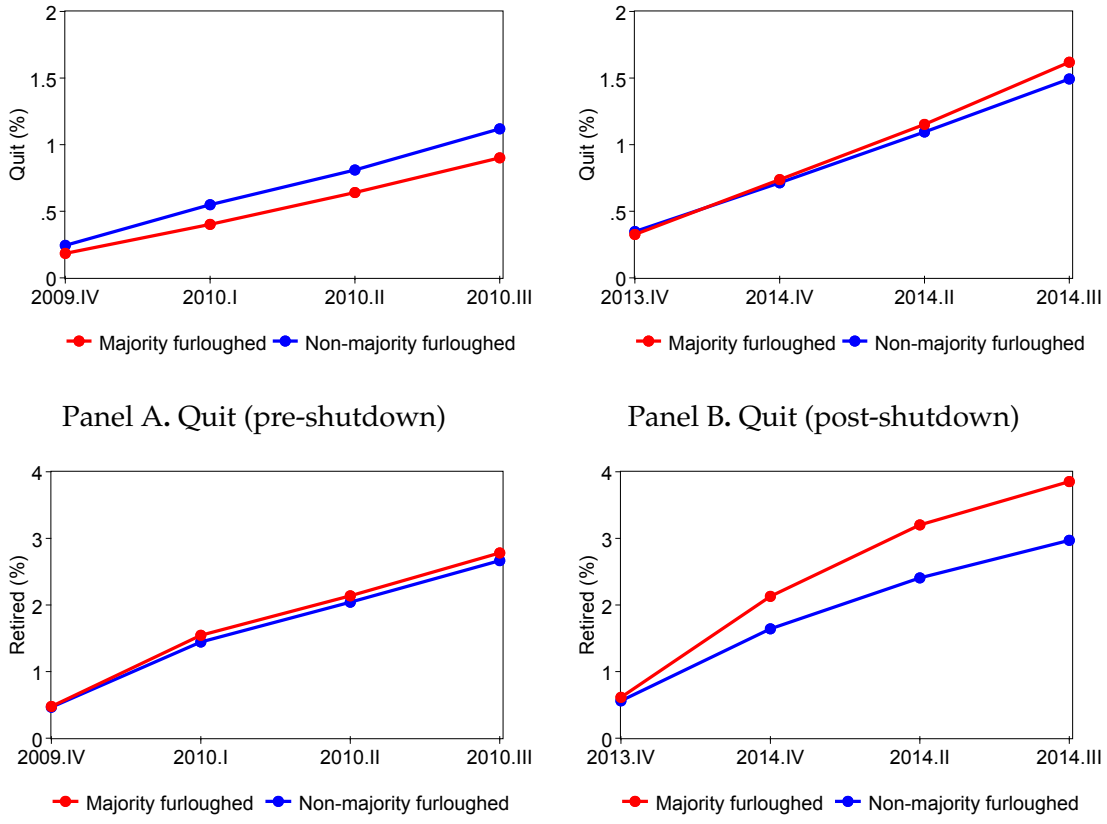


Figure IA.4: [PLACEHOLDER TITLE]

[PLACEHOLDER CAPTION] Black circles indicate mean survey responses for employees in non-majority furloughed bureaus in 2019. Red crosses indicate mean survey responses for employees in majority-furloughed bureaus in 2019. Responses weighted using the survey's accompanying survey weights.



Panel A. Quit (pre-shutdown)

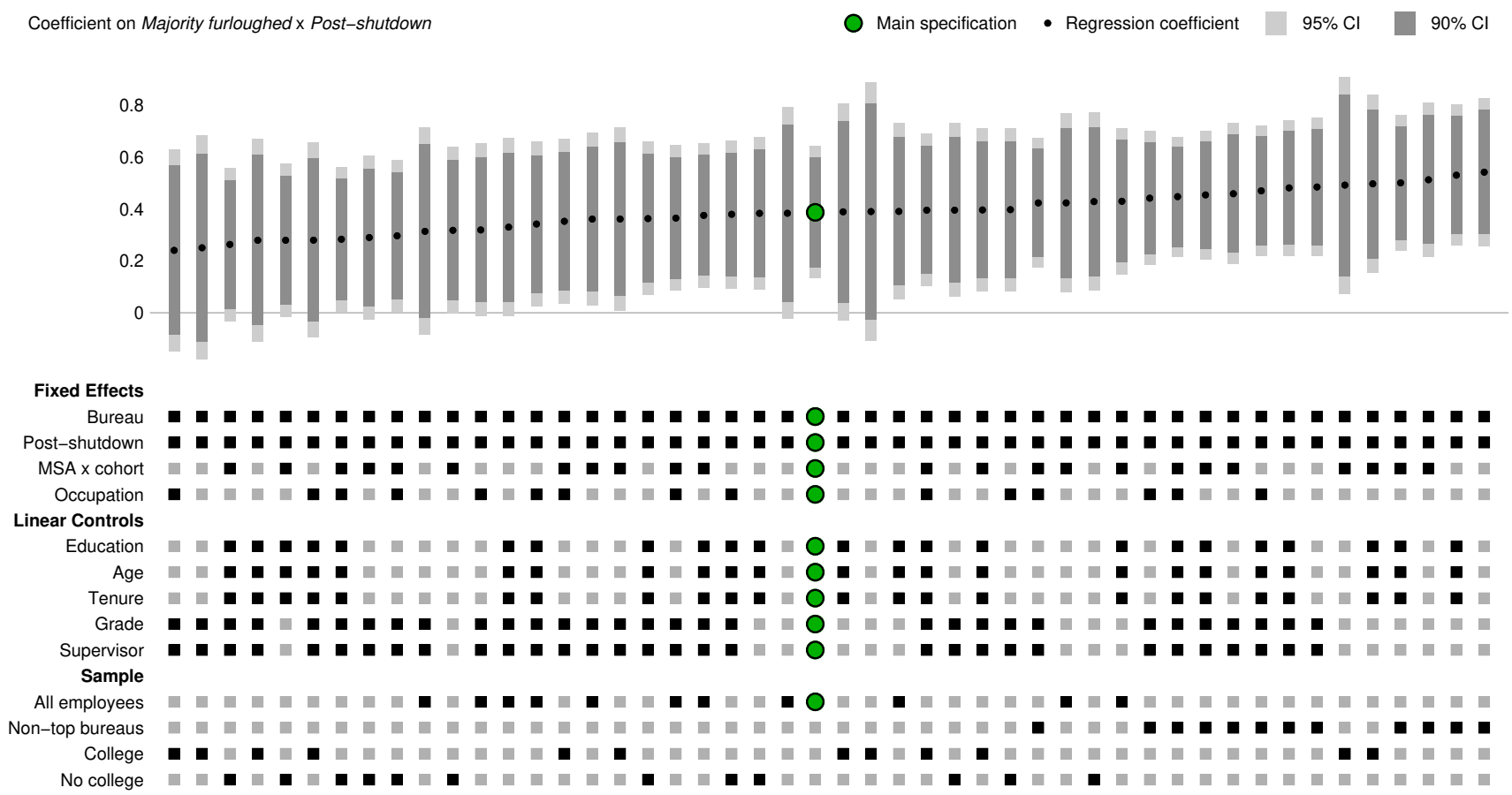
Panel B. Quit (post-shutdown)

Panel C. Retired (pre-shutdown)

Panel D. Retired (post-shutdown)

Figure IA.5: Quitting and Retirement Trends

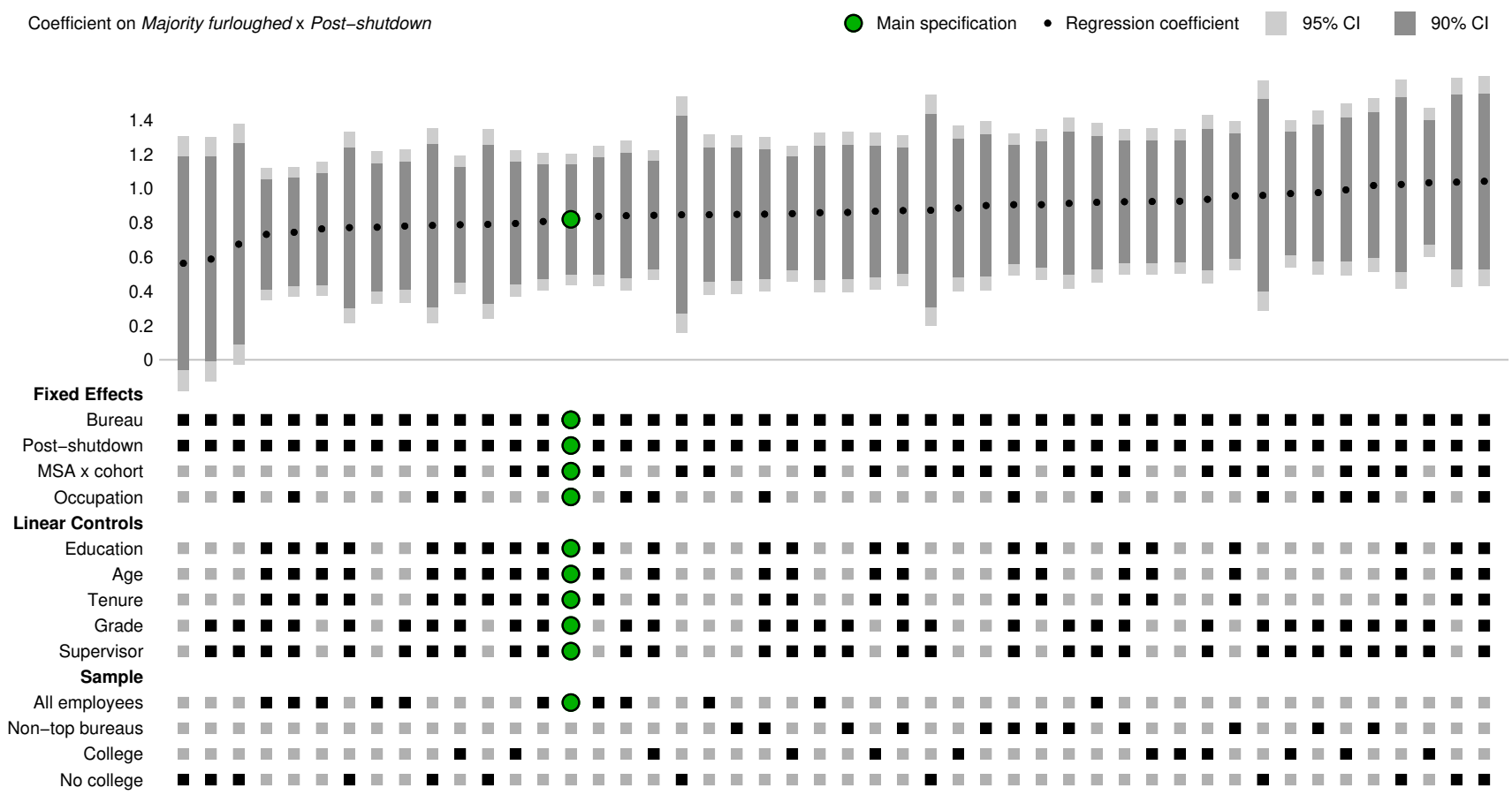
This figure compares the quitting (Panels A and B) and retirement rates (Panels C and D) of federal employees across the time series for the two types of government bureaus (i.e., majority furloughed vs. non-majority furloughed) and the two cohorts of employees (i.e., pre-shutdown vs. post-shutdown).



Panel A. Quit

Figure IA.6: Specification Curve Analysis of Quitting and Retirement

The figure plots the coefficients on *Majority furloughed* × *Post-shutdown* and their corresponding confidence intervals for a set of regressions in which the dependent variable is an indicator of either quitting (Panel A) or retiring (Panel B, next page) within one year after the cohort assembly date (2009.IV or 2013.IV). The regressions include different combinations of control variables and fixed effects, and they are estimated across an array of subsamples. The non-top bureaus subsample excludes the Forest Service (the largest bureau in the majority furloughed group) and the Veterans Health Administration (the largest bureau in the non-majority furloughed group). The green circles indicate the main regression specification (estimated in Columns 3 and 6 of Table III). Standard errors are clustered at the bureau level.



Panel B. Retired

Figure IA.6 (continued)

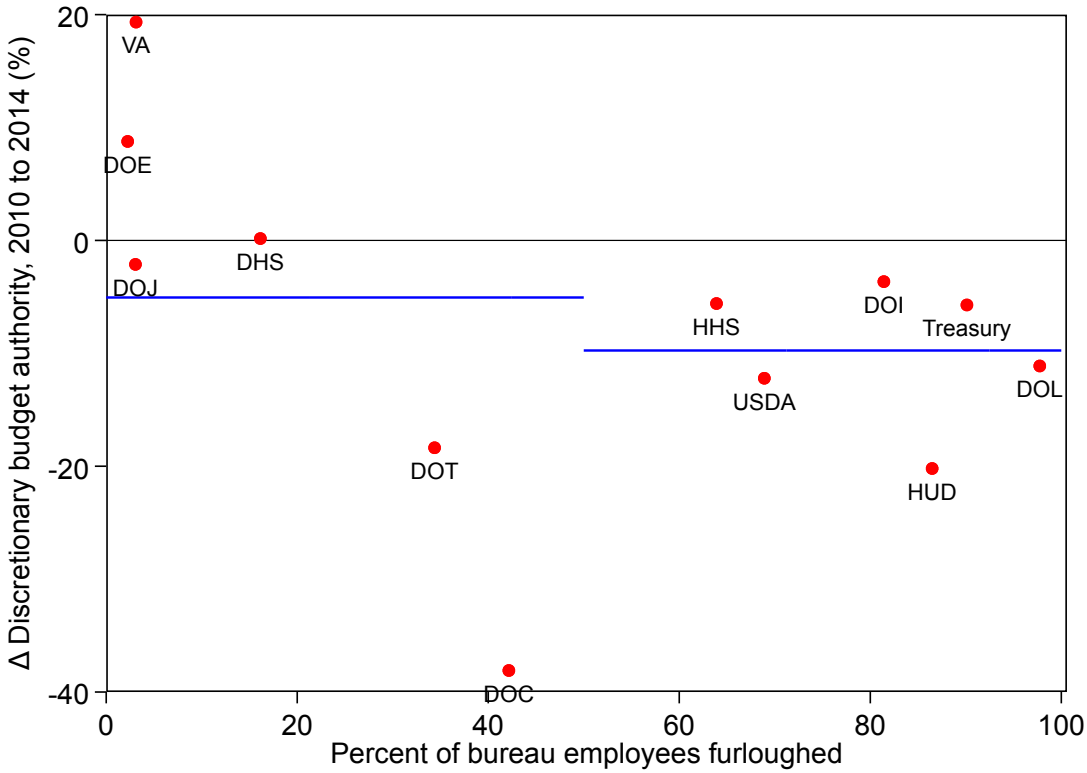


Figure IA.7: Cumulative Budget Change Prior to Shutdown

This figure shows cumulative discretionary budget changes from fiscal years 2010 to 2014 for 12 Executive Branch agencies relative to the percent of employees furloughed. Horizontal lines show budget changes for non-majority furloughed (left, $<50\%$) and majority furloughed (right, $>50\%$) agencies, respectively. Agency-level furlough counts are from U.S. Senate (2019). Discretionary budget data are from historical budget tables published by the White House ("Table 5.4: Discretionary Budget Authority by Agency," https://www.whitehouse.gov/omb/budget/historical-tables/). From least furloughed to most furloughed, the 12 Executive Branch agencies with available data are: Department of Veterans Affairs (VA), Department of Energy (DOE), Department of Homeland Security (DHS), Department of Transportation (DOT), Department of Commerce (DOC), Department of Human and Health Services (HHS), Department of Agriculture (USDA), Department of the Interior (DOI), Department of Housing and Urban Development (HUD), Department of the Interior (DOI), Department of the Treasury, and Department of Labor (DOL).