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Political Learning from Rare Events: Poisson Inference, Fiscal Constraints, and the Lifetime of Bureaus

Daniel P. Carpenter
Department of Government, Harvard University, and
Center for Advanced Study in the Behavioral Sciences,
Stanford University, Stanford, CA 94305
e-mail: dcarpenter@latte.harvard.edu

David E. Lewis
Woodrow Wilson School and Department of Politics,
Princeton University, Princeton, NJ 08544
e-mail: delewis@princeton.edu

How do political actors learn about their environment when the "data" provided by political processes are characterized by rare events and highly discontinuous variation? In such learning environments, what can theory predict about how learning actors will take costly actions that are difficult to reverse (e.g., eliminating programs, approving a risky new product, revising a security policy, firing or recalling an appointed or elected official)? We develop a formal model for this problem and apply it to the termination of bureaucratic agencies. The conventional wisdom that "the older a bureau is, the less likely it is to die" (Downs 1967, *Inside Bureaucracy*) persists but has never been properly tested. This paper offers a learning-based stochastic optimization model of agency termination that offers two counterintuitive predictions. First, politicians terminate agencies only after learning about them, so the hazard of agencies should be nonmonotonic, contradicting Downs's prediction. Second, if terminating agencies is costly, agencies are least likely to be terminated when politicians are fiscally constrained or when the deficit is high. We assess the model by developing a battery of tests for the shape of the hazard function and estimate these and other duration models using data on U.S. federal government agencies created between 1946 and 1997. Results show that the hazard rate of agency termination is strongly nonmonotonic and that agencies are less likely to be terminated under high deficits and divided government. For the first 50 years of the agency duration distribution, the modal termination hazard occurs at five years after agencies are enabled. Methodologically, our approach ties the functional form of a hazard model tightly to theory and presents an applied "agenda" for testing the shape of an empirical hazard function. With extensions, our model and empirical framework are applicable to a range of political phenomena.

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1 Introduction

How do political actors learn about their environments when the real world supplies not continuous data with regular variation but instead only rare events? Learning in many political and policy situations—detecting security threats; inferring the faithfulness of a congressional committee, a new agency, or an appointee; learning about the quality of a new shuttle launch system; making conclusions about the safety of a newly approved product or the reliability of a new worker safety, transportation safety, or nuclear safety program; inferring the effectiveness of a counterterrorism policy—has a "lumpy," discrete character. The relevant data for inferences in these situations—the political infidelity or malfeasance of an appointee, a terrorist attack, a safety disaster—occur rarely and discretely. In many financial and scientific situations, more continuous observations and processes are available for inference. For instance, learning in financial markets may occur through repeated observation of an asset price (or aggregate of prices) whose movement is nearly continuous and where variation is always present. While politics may sometimes offer more or less continuous data from which to make inferences—weekly polls, contribution aggregates, or unemployment numbers—it very often does not. One reason is that even if the underlying process about which political actors seek to learn is more or less continuous, the process by which such data are revealed—through the media, investigation, or auditing—is often discrete.

Political actors learning about their environments through observation of rare events also confront one other problem: the costly reversibility of action that is conditioned on learning. Often political actors learn so as to inform costly action that is also costly to reverse—the creation or abandonment of a new policy, the firing of an appointee, the termination and replacement of an agency, the approval or recall of a new product with potential safety hazards, the launching of a military or counterterrorist attack. How, then, do political actors balance the benefits and costs of waiting for more information when the information is not readily available? How does this balancing affect the character and timing of costly political activity?

In this article we analyze this problem both theoretically and empirically. Theoretically, we elaborate a model of Poisson inference in which a politician must learn about rare but costly events and use this information to take a specific form of costly and irreversible action. Empirically, we are interested in the empirical manifestations of rare events learning, particularly when such learning informs observable costly action.

We approach this problem through a case study of sorts, by studying the termination of government agencies. Bureau termination is an ideal case for our exploration of politically motivated learning for two reasons. First, agencies make the news very infrequently, and when they do, the news is usually bad and the underlying events are usually costly to politicians. Second, termination is the ultimate act of political control and can be cleanly observed.

The purpose of this paper is to construct a model of political learning about rare events and to wed it to the analysis of agency lifetimes. Using a stochastic optimization model of learning about rare events, we offer an alternative argument about the lifetime of bureaus, and operationalize it in such a way as to approximate critical tests between this argument and the current wisdom. The theoretical alternative proposed here is based on two simple intuitions: creating an agency is a risky act and terminating an agency is costly. Agency creation is risky because agencies can thwart the best intentions of politicians by defecting from their wishes or bungling their tasks even when they are faithful. Agency termination is costly because it is irreversible and because replacing one agency with another is costly. Our model suggests that politicians will be unlikely to terminate agencies when the brute administrative costs of termination exceed both (1) the value of waiting to learn more about the current agency, and (2) the difference in the value of any agency that replaces the current one. We also intuit that when the political costs (or bargaining costs) of termination rise, agencies should live longer. We test the competing predictions using data from Lewis (2002) on agencies created between 1946 and 1997.

Methodologically, our paper offers a rare attempt in a political science setting to tie the estimation of an observed hazard function to an underlying deductive theory (see Diermeier and Stevenson 2000 for another). One implication of our study is that the functional form of an empirical hazard may be a useful testing ground for theories. We also present something of an applied "agenda" (Granato 1991) for testing the shape of a hazard function, using a combination of semiparametric and parametric approaches to assess the monotonicity or nonmonotonicity of the hazard rate in the observed data.

Our article also has some contemporary and policy implications. With recent proposals for consolidation of domestic intelligence agencies and proposals to eliminate Amtrak and other agencies, administrative organization has become a vital and current policy issue. The analysis here has important implications not only for the lifetime of bureaus but also for those interested in political control of bureaucracy and the theory and practice of agency shutdown. Agency termination is the ultimate act of political control. Many current models of political control assume the extreme durability of political institutions as a means of either guaranteeing a bargain or locking in the policy preferences of a dominant majority. If agencies are eliminated frequently or are at risk in predictable ways, this fact calls into question some basic assumptions and tenets in the literature on political control of the bureaucracy. Finally, the conclusions of our model—that shutdown costs can be prohibitively high in the short run and that agency vulnerability follows a regular pattern—will be of interest to practitioners interested in budget cutting and agency shutdown.

2 Increasingly Durable Bureaus?

To date, students of bureaucracy have found impressive durability in government agencies. Over a decade before Downs, Simon and his colleagues succinctly stated the logic of agency resilience (1950, p. 421): "Each administrative agency seeks in its relationships with groups in the legislature, with its own clientele, and with other interested groups to find sources from which it can draw the power it needs to carry on its program and survive." Simon's argument identifies the survival of government agencies with their ability to develop tight links with specific clienteles. A similar logic motivated Downs and Lowi to vest Simon's "durability hypothesis" with a probabilistic form: the longer agencies last, the stronger these affiliations to clientele become (Downs 1967, pp. 8–9, 22–23). Lowi (1979) claims that "once an agency is established, its resources favor its own survival, and the longer agencies survive, the more likely they are to continue to survive." Taken prima facie, this argument can be expressed in a very simple (and testable) probabilistic assertion: the probability of agency termination is highest immediately after agency creation and is monotonically decreasing.

Previous studies of agency termination have loosely (though not wholeheartedly) concurred with the Downsian argument. Kaufman's (1976) impressive study, *Are Government Agencies Immortal?*—which was restricted to executive agencies—agrees in part with the durability hypothesis, though Kaufman does not set out to test their claims specifically. One reason is that maximum likelihood hazard estimation was not sufficiently well developed when Kaufman wrote his masterpiece, so Kaufman was restricted to assessing relatively qualitative claims such as the mean duration of government agencies during the period of his sample.

Lewis (2000, 2002, 2003) takes advantage of advances in hazard models to examine agency mortality between 1946 and 1997, but he does not test these predictions about the hazard rate directly.[1] He explains the causes of termination and durability rather than the impact of agency age on the likelihood of termination. He argues that agencies are terminated more frequently than was previously realized and that agency mortality increases with political turnover, although some insulated agencies are more durable than noninsulated agencies. While these works make an important contribution, they do not directly address the claims of Downs, Lowi, and Simon. The actual shape of the hazard rate remains an open question.

It is important to note that there is an incongruence between the Downsian hypothesis and theories of rational agency design (McCubbins et al. 1989; Moe 1989). If politicians were so talented at insulating agencies and coalitions were so zealous in protecting their administrative creations, why would we ever expect agencies to be terminated quickly, as the Downsian hypothesis would imply? Why would new agencies find their survival so precarious? At a minimum, coalitions are extremely unlikely to change during two-year election cycles, but it is also rare that they change drastically over the course of a single election. In this view, the probability of termination is lowest right after creation and is monotonically increasing. Agencies are the most protected at the time of their creation and become more vulnerable over time as coalitions protecting them dissolve.[2]

2.1 *Hazards to Agency Survival*

Termination, when it does occur, has three primary causes: agency failure, political opposition, or competition among agencies for scarce resources (Bardach 1976; de Leon 1983, 1987; Lewis 2002). Political actors terminate agencies in response to large observable failures that focus congressional (presidential) attention on an agency (Carpenter 2000, 2001). As Kaufman (1976, p. 17) noted, agencies "expire because they make mistakes or become the victims of mistakes." For example, the Federal Home Loan Bank Board (FHLBB) and its subsidiary, the Federal Savings and Loan Corporation, were abolished in the summer of 1989 after the highly publicized savings and loan crisis. The regulatory responsibilities of the FHLBB were parceled out to the new Office of Thrift Supervision, the new Federal Housing Finance Board, and a restructured Federal Deposit Insurance Corporation (Cranford 1988, 1989).

Agencies are also targeted for political or ideological reasons. In some cases an agency purposefully sets policy at variance with the preferences of Congress, or the preferences of Congress change by virtue of electoral turnover (Lewis 2002). In 1995 Congress eliminated the Office of Technology Assessment (OTA), an agency designed to provide information to Congress on the technical and scientific impact of administrative and legislative actions and proposals. The Republican leadership justified the termination of the OTA as an effort to trim legislative appropriations. Many Republicans, however,

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[1] Lewis assumes different shapes of the hazard rate in different works. Lewis (2003), like Downs, Lowi, and Simon, assumes a monotonically decreasing hazard rate. Lewis (2000) assumes a nonmonotonic hazard rate, and Lewis (2002) is agnostic about the shape of the baseline hazard rate, claiming that "the graph of the product-limit estimates of the hazard rate, an analysis of nonnested models with the Akaike Information Criterion . . . and graphs of the Cox-Snell residuals are inconclusive" (96–97).

[2] Another possibility is some sort of hybrid where the lifetime of bureaus is shaped by both dynamics. Theories of rational agency design could imply a type of nonmonotonic hazard rate where risks to agencies are low to start, increasing over time as the initial coalitions protecting the agency dissolve and then decreasing after a time due to the dynamics described by Downs and Lowi, where agencies build new coalitions of support.

targeted the OTA because they resented what they believed was unwarranted expansion into areas outside the OTA's initial charter, such as health care.[3] As long as the Democratic majority controlled Congress, the OTA's expansion was overlooked, but once there was electoral turnover, the OTA was at risk.

Finally, almost all efforts to terminate government agencies are justified as an attempt to cut costs or reduce the deficit (Lowi 1979; Frantz 1997; Arnold 1998).[4] As Kaufman suggests, one of the hazards to agencies' survival is competition among agencies for scarce resources. The probability of agency termination is higher when competition among agencies for scarce resources is greatest. As a consequence, fiscal constraints should increase the probability that an agency will be terminated.

2.2 *Costs of Termination*

Contrary to the preceding claims about cost cutting, however, the literature on agency termination—both the agency termination literature specifically and agency termination literature in the reorganization context—notes how rarely such efforts achieve their stated goals (Meier 1980; Salamon 1981; Szanton 1981; Khademian 1996; Frantz 1997; Arnold 1998). Put simply, agency termination is costly both fiscally and politically. First, it is irreversible. It is virtually impossible to recreate the same agency after terminating it. Second, because programs often continue after an agency has been terminated, replacing an agency (by creating a new one or by delegating programs to new bureaucracies) is also costly. When testifying before Congress about Republican attempts to eliminate the Department of Energy in 1996, Secretary Hazel O'Leary claimed that "dismantlement by itself will create little if any long term savings, while creating inevitable increased costs in the short term. Also, the resulting disruptions in programs will create inefficiencies and increased costs."[5] Judith Frantz (1997, p. 2101), in a review of case studies on policy termination, notes that "the conceptual literature of policy termination consistently recognizes that policies that close down public programs may increase costs at least in the short run." In his advice to those pursuing agency termination, Robert Behn (1978) recommends that they be willing to accept short-term cost increases to achieve their ultimate goal.

Other short-term costs attached to agency termination include costs to assuage the constituents of the agency, costs to help agency employees (job counseling, relocation assistance, severance pay, lump sum leave payments, etc.), and expenditures to buy approval of other key political actors (Bardach 1976; Behn 1978; Hogwood and Peters 1985; Frantz 1992, 1997). In the same way that the road for adopting unpopular public policies like tax increases can be smoothed by raising more revenue than necessary to buy support from key interests, the road to terminate an agency can be smoothed by agreeing to other spending increases in exchange for agency termination (Behn 1978; Rubin 2000). Indeed, if agencies are successful at cultivating relationships with members of Congress and key interest groups, there will be substantial fiscal costs attached to overcoming opposition to agency termination.

There can also be longer-term costs associated with efficiency losses depending on new administrative arrangements. If the federal government has the same statutory responsibilities, terminating particular agencies does not imply lower long-term costs at all

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[3] *Congress and the Nation* IX (1998; Washington, DC: CQ Press), 895.

[4] As Frantz (1997) notes, however, very little research addresses the question of cost savings directly and so the effectiveness of termination for securing cost savings is an open question.

[5] She cited a Congressional Budget Office study of Reagan administration proposals that reported only a $3.5 million savings, due to the elimination of her office and staff. See U.S. Congress (1996, p. 48).

(Meier 1980; Salamon 1981; Szanton 1981). Testifying about attempts to eliminate the Energy Department, Secretary O'Leary argued that

> the overwhelming majority of programs of the Department of Energy would continue even under the rubric of abolition. This false advertising is unavoidable because most of the Department's missions are not discretionary efforts; they are enduring government responsibilities and requirements.[6]

There is no guarantee that the new administrative units employed to carry out persisting statutory responsibilities will be more effective or loyal than their predecessors. The assumption of long-term cost reductions depends on the new administrative apparatus being less likely to fail or defect, so much so that the benefits outweigh the shutdown and transition costs.

3 A Stochastic Process Model of Learning About Rare Events, Applied to Agency Lifetimes

We now try to incorporate these trenchant insights from the existing literature into a formal model of agency termination. We model the choice of a representative politician as to when, if at all, to terminate an agency she has created. Our model describes the optimal choice patterns of an uncertain politician (or coalition of politicians) that learn about a potentially runaway, potentially ineffective agency. The model assumes that agencies can be terminated for two reasons: they are ideologically or spatially unfaithful to the goals for which they were erected (i.e., they are "morally hazardous") or they are relatively ineffective (or new and better methods have arisen for achieving their ends). Both of these rationales for termination invoke underlying properties of the agencies created—either the drift of their policy preferences from those of the coalition that created them or structural or personnel flaws that make effective policy implementation unlikely.[7]

The model offers a novel way of thinking about the faithfulness and efficacy of bureaucratic agencies. Agencies satisfy politicians' wishes only to the degree that they minimize two processes—a "defection" process and a "failure" process—both of which are characterized by rare events that are nonetheless costly for politicians.[8]

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[6] See U.S. Congress (1996).

[7] We admit that our model abstracts from the complex bargaining and coalition building that occur when agencies are created and terminated. Our aim is that by focusing squarely on the learning dynamics that accompany agency creation and oversight, we can shed light on factors that a coalition-building approach alone might not reveal.

[8] See Fiorina (1989) for an argument that agency failures may be valuable to politicians insofar as politicians may wish to have a consistent target to blame when policy goes awry. While this is plausible, we believe that the assumption of costly failures better reflects the empirical reality of bureaucratic politics. The first reason is that an entire (theoretical and empirical) literature on political control of the bureaucracy characterizes agency "drift" as costly to politicians. Second, and more important, empirical studies in this literature find strong and consistent support for the proposition that politicians take costly measures (statutory specificity, design of judicial review, and administrative hearings proceedings) to prevent such defections and to punish agencies that do engage in defections.

As a first approximation, we assume that agency defection and failure are exogenous. These are strong assumptions that we impose only to purchase mathematical tractability. We envision relaxing these assumptions (see the concluding section for proposed extensions), but we also think that they are defensible as first approximations go. Although agencies clearly choose whether or not to defect from politicians' wishes, and while strategic choices undoubtedly affect administrative failure, it may be extremely difficult, if not impossible, for agencies to choose their levels of failure and defection over time. First, if defection results from the divergent preferences of numerous bureaucrats, then an aggregate attempt to reduce defection will always face a collective action problem (see Ting 2003). Bureaucrats may expect penalties to the agency as a whole from defecting or failing but will often find it in their own interest to continue their individually preferred pattern of behavior, knowing that others face the same incentives. Second, by virtue of civil service laws that protect lower-level employees from firing and salary reductions, it is difficult for even the most scrupulous agency executive to root out incompetence or ideological defection in an agency. We thank an anonymous reviewer for this point.

There are several reasons to believe that administrative failures are rare events, at least as observed by politicians. First, administrative efficacy is, from the vantage of a politician, only partially observable. Unlike most agents in a contracting framework, administrative agencies do not have readily measurable "output." This is not a function of the data or of administrative idiosyncrasies, but rather of the nature of political delegation. Agencies do not return an income stream to the legislature, and the connection between administrative actions and electoral payoffs is fuzzy. Second, administrative efficacy is bounded from above. The essential goals of legislation are contained in the provisions of statutory enactments. Under these statutes, agencies are given a set task, a law or a program with whose implementation they are charged. A politician's utility is maximized to the degree that these provisions are carried out to a tee. That is, there is a level of maximum electoral benefit encoded in most laws that is equal to the expected net benefits of the program if implementation were costless and states of the world were freely observable. It is generally impossible for the agency to deliver to the legislature more than this maximum level of utility—more than is provided for in the expenditures of the bill. It is, however, possible for the agency to effect substantial reductions in a politician's utility by administrative failures.

Third, even if failure and/or corruption is a continuous process, *publication* of the process takes the form of rare events, and it is these rare events, not the continuous process, that impose costs on the legislature. The reason concerns the rarity of media reporting and "fire-alarm" complaints. As Wilson (1989) argues, day-to-day failures are not reported by media organizations, and administrative successes are almost never reported. When news media report on an agency, it is almost always a negative report. Wilson's point is very simple: the appearance of program failure imposes costs on politicians. The less a program is in the news, the better for politicians. The paradoxical result here is that a failure-prone agency imposes electoral costs on politicians only when these failures are reported. In most cases, the agency can do no better than to keep the program out of "bad news" into perpetuity. A similar logic governs fire-alarm reports of administrative failure (McCubbins and Schwartz 1984). Constituents (organized or not) will rarely if ever contact their representative to laud the job that an agency is doing, and the sort of constituency complaints that motivate serious concern (as opposed to ombudsmenlike responses from Congress) are rare.

Similar arguments may be entertained for the rarity of administrative infidelity. Administrative fidelity is, for one, bounded from above just as administrative effectiveness is; bureaucrats can perform no more faithfully than to execute to a tee the law as politicians designed it. Moreover, whatever the frequency of administrative defection, it is rarely observed by politicians.[9] Administrative agencies engage in millions of actions per day. Even if a trifling fraction of these actions represent divergence from the wishes of the politicians who created the agency, defection is common but is probably rarely observed.

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[9] We assume that the *incidences* of failure and defection are perfectly observable to politicians even if their underlying propensities (δ and ϕ) are not. One could potentially relax this assumption in the model by assigning to each agency an observability parameter (say β_t, $0 \leq \beta_t \leq 1$), which would be a function of information asymmetries and interest-group organization in the agency's policy domain. We then would expect failure and defection to be less visible (and a politician's learning problem that much harder) where interest groups were less wealthy and less organized and where agencies had greater private information on policy vis-à-vis politicians. We thank an anonymous reviewer for suggesting consideration of this point. Empirically, of course, it is easier to monitor and learn about some agencies than others (Meier 1980; Wilson 1989; Khademian 1996). Some agencies have measurable, observable output and others do not. The ease of learning will alter the shape of the hazard rate. Those agencies that produce observable outputs may have a modal hazard closer to the agency's creation, while those that are difficult to observe may have modal hazards further out. All should have the same general shape.

Seldom-observed infidelity prevails because even well-designed fire alarms cannot monitor all bureaucratic actions, in part because politicians' attention may be (rationally) focused on other matters. This does not imply, of course, that fire alarms and agency oversight are ineffective. They may be the best control mechanisms that exist. It does mean that, for any given agency, observation of defection (if it occurs at all) is rare.[10]

3.1 *Formalizing the Termination Process*

If defections and failures are rare but costly events, then the simplest distribution describing their evolution is the Poisson process. More formally, we assume that each agency (agency i) is characterized by two variables—a propensity to defect δ_i and a propensity to fail ϕ_i. The legislature knows the population means of these parameters (the failure and defection propensities of "the average agency") but does not know these propensities ex ante for an agency. Both parameters must be learned.

3.1.1 Assumptions

Assumption 1. Agency defection as a Poisson process. A defection is an act taken contrary to the wishes of the agency's political superiors. More specifically, we construct the process by which defections occur in continuous time as follows. Let there be two nonoverlapping sets of possible actions for the agency, the set of a politician's preferred administrative actions B and the set of other possible actions D. For any discrete time period t, let a_t represent the agency's action in that period. We can regard fidelity as the event that the agency chooses an element of the set B ($a_t \in B$) and defection as the event that the agency chooses an element of the set D ($a_t \in D$). The sets B and D exhaust the possible actions that the agency can take, such that $\Pr(a_t \in B) + \Pr(a_t \in D) = 1$.

The underlying defection process may be modeled as Bernoulli if (1) the probabilities are fixed across all trials [a sufficient condition for this is $\Pr(a_t \in D) \equiv p_d, \forall t$], (2) the trials are independent, and (3) the events $\{B,D\}$ occur in discrete time intervals. Imagine then a variable X_t indexed in discrete time, valued 0 if $a_t = \mathrm{B}$ and 1 if $a_t = D$. The sequence $\{a_t\}$ [$= a_1, a_2, \ldots, a_N$] may then be modeled as a sequence of Bernoulli trials. The sum of defections in N periods—call this $X_{N,p}$—is then described by the binomial distribution. Now consider the limiting case in which $N \to \infty$ and $p_d \to 0$ such that $Np_d = \mu > 0$. By the law of rare events (Taylor and Karlin 1998, p. 27–28), the distribution for $X_{N,p}$ becomes, in the limit, the Poisson distribution. Using continuous time we may then define the defection process as a Poisson process, as follows.[11]

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[10] This discussion of rarity is intended to justify the mathematical specification of agency failure and agency defection as Poisson processes (see below). It is worth nothing here that the results of this article hold even when more continuous processes are considered, for example, continuous state-space processes such as Brownian motion.

[11] More specifically (see Taylor and Karlin 1998, p. 270), a Poisson process of intensity, or "rate" $\lambda > 0$, is an integer-valued stochastic process $\{X(t);\ t \geq 0\}$ for which

(i) for any time points $t_0 = 0 < t_1 < t_2 < \cdots < t_n$, the process increments

$$X(t_1) - X(t_0), X(t_2) - X(t_1), \ldots, X(t_n) - X(t_{n-1})$$

are independent random variables;

(ii) for $s \geq 0$ and $t > 0$, the random variable $X(s + t) - X(s)$ has the Poisson distribution

$$\Pr\{X(s+t) - X(s) = k\} = \frac{e^{-\lambda t}(\lambda t)^k}{k!} \quad \text{for } k = 0, 1, \ldots;$$

(iii) $X(t = 0) = 0$.

Let the ith agency's ideal point be A_i and the representative politician's (or legislature's) be C. The ideological divergence of the agency from the legislature is then $|A_i - \mathrm{C}|$. Agency defections are generated by an agency-specific Poisson process $X_i(t) = X_{i,t}$ $\{X_{i,t}; t \geq 0\}$ with an agency-specific defection rate $\delta_i = |A_i - \mathrm{C}| > 0$, and the probability of k defections in a time period of length Δ is

$$\Pr\{X_i(t+\Delta) - X_i(t) = k\} = \frac{e^{-|A_i - C|\Delta}(|A_i - C|\Delta)^k}{k!} = \frac{e^{-\delta_i\Delta}(\delta\Delta)^k}{k!} \qquad (1)$$

for $k = 0, 1, \ldots$. The probability of a single defection in the time interval t to $t + \Delta$ is $\delta_i\Delta + o(\Delta)$, where $o(\Delta)$ denotes any expression such that $o(\Delta)/\Delta \to 0$ as $\Delta \to 0$. Similarly, the probability of more than one administrative failure in the time interval t to $t + \Delta$ is $o(\Delta)$.

Assumption 2. Agency failure as a Poisson process. We may define a failure as a (nondeliberate) malfunction of the agency such that it does not complete or succeed in a stated function, a function that both the agency itself and the politician would prefer to have completed. As with defections, we model agency failures as generated by a Poisson process $Y_i(t) = Y_{i,t}$ $\{Y_{it}; t \geq 0\}$ with failure rate $\phi_i > 0$ for agency i, and the probability of k failures in a time period of length Δ is

$$\Pr\{Y_i(t+\Delta) - Y_i(t) = k\} = \frac{e^{-\phi_i\Delta}(\phi_i\Delta)^k}{k!} \quad \text{again for } k = 0, 1, \ldots.^{12}$$

Assumption 3. Defection and failure are independent across and within agencies. For any sample of agencies indexed by i, $\mathrm{cov}(X_\mathrm{i}, Y_\mathrm{i}) = 0$, and "stochastic innovations" [i.e., $X_\mathrm{i}(t+1) - X_\mathrm{i}(t)$, $Y_\mathrm{i}(t+1) - Y_\mathrm{i}(t)$] are also independently distributed. A sufficient condition for this result is that ϕ_i bears no functional or stochastic relationship to A_i. In other words, ideologically extreme agencies are no more likely to fail at their tasks than are ideologically faithful agencies. In addition, "left-wing" agencies are no more likely to fail than "right-wing" agencies and vice versa.

While independence may be violated in many real-world agencies, it is actually a weak assumption in the model here. If defection and failure are not independent and if politicians know this (and they know the precise correlation), then they can always use information about failure to make inferences about the defection rate, and they can use information about defection to learn about failure. In other words, our assumption of independence is actually a strong constraint on the information of politicians as they confront agencies.

Assumption 4: Exponentially distributed cost of failure and defection. To simplify exposition, we will assume that defections and failures each have costs K (a defection cost K_x and a failure cost K_y) that are distributed according to an exponential distribution (with parameters κ_x and κ_y, respectively). In other words, failure costs and defection costs are allowed to vary across events (failures or defections), and the stochastic processes are no longer simple Poisson variables but compound Poisson variables.[13]

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[12] We will use $X(t)$ and X_t (and $Y(t)$ and Y_t) interchangeably throughout. We hereafter drop subscripts i to simplify.

[13] What if the failures and defections are not rare but frequent? Mathematically, the Poisson distribution converges to the normal distribution, and the Poisson process converges for large rates to a Gaussian process. More restrictive assumptions on the state space are required for a Komlos approximation to Brownian motion.

3.1.2 The Political Utility Function

The Poisson processes $X(t)$ and $Y(t)$ give the accumulated *incidence* of defection and failure for the finite time interval [0, t). We can now represent politicians' accumulated losses from an agency of age t as the sum of (1) the accumulated incidence of defections, each defection multiplied by its cost K_x, and (2) the accumulated incidence of failures $Y(t)$, each failure multiplied by its cost K_y. Since $M(t)$ and $N(t)$ are compound-Poisson distributed and are independent, their sum is also Poisson, and we denote this by Z(t), or

$$Z_t = M_t + N_t = \sum_{j=1}^{X_t} K_{x,j} + \sum_{j=1}^{Y_t} K_{y,j}. \tag{2}$$

In creating an agency, we assume that politicians received some sort of payoff from constituency benefit or from informational specialization. Call this B. We also assume in this model that, if an agency turns out ex post to defect or fail with high propensity, the only option for stemming the blood is to terminate the agency.[14] This termination is costly, as we have discussed, and we denote this cost by C_{term}.

What if agencies die because better alternatives arise? Of course some agencies are terminated because better alternatives (e.g., new ideas, reorganization, or agency merger) come along. This is entirely consistent with our model. We should expect policymakers to be more interested in generating ideas about alternative agency arrangements precisely when the existing agency is poor in some sense (it defects or fails a lot). So even when the process that kills agencies is the process by which better (better politically, or better efficiency-wise) ideas/agencies surface, that too is a Poisson process, and learning about it will yield a nonmonotonic hazard function much like the one we predict below.

3.1.3 A Dynamic Utility Function

Our model is decision theoretic, analyzing the choice of a representative politician as to when, if at all, to terminate an agency once it has been created. We can now posit a dynamic utility function under which a politician's losses are equivalent to (1) those costs accruing from defections and failures while the agency is still alive, plus (2) expected losses from termination of the agency under an optimal policy. Let $U(z,t)$ be the politician's loss function (assumed continuously differentiable in z), with derivative $u(z,t)$. Also assume τ^* to be the optimal termination time (possibly infinite, for agencies that politicians decide to let live perpetually). The politician's problem is

$$\inf U(z,t) = -E_{zt}\left\{\int_t^{\tau^*} e^{-\rho(s-t)} u(Z(s))ds + e^{-\rho(\tau^*-t)} F[Z(\tau^*)]\right\}, \tag{3}$$

where E_{zt} is the expectation operator conditioned on $Z(t) = z$ and t [that is, a specific value of Z observed at time t], s is a variable of integration, ρ is the constant factor by which the politician discounts later losses relative to earlier ones, and F is the *termination value* under the optimum policy [$F = C_{term} + Z(\tau^*)$, such that C_{term} is nested in F]. The termination value is the expected value (under the optimal policy) that the politician receives from termination. [The lower the probability of optimal termination, the smaller the contribution of the second term to Eq. (3).] In our model, the politician seeks a rule that translates terminations into optimal solutions of the problem in Eq. (3).

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[14] That is, we assume for now, the absence of any intermediate restructuring option.

3.1.4 The Optimal Termination Policy

Creating agencies entails risks that politicians cannot fully escape. If politicians knew ahead of time that their creations might defect or fail with high propensity, then some failure-prone and defection-prone agencies would never be created. Unfortunately for politicians, such ex ante omniscience about the agencies they create is rarely if ever possible. The properties of agencies must be learned through costly experience. Put differently, agency defection and failure are “experience goods,” not “inspection goods.”

A politician observes the agency after enabling it, learning about its propensity to defect and its propensity to fail, and terminates (1) those agencies that seem very defection prone (or ideologically distant), (2) those that appear highly failure prone, or (3) those that exhibit a particularly high combination of defection and failure. Terminations are thus *learning conditioned.*

To formalize the optimal termination rule, we need two more expressions. First, let λ_{pop} be the population mean of the cumulative loss process $Z(t)$. In other words, λ_{pop} is the known rate at which the average agency imposes losses by defection and failure. (This parameter serves as politicians’ Bayesian prior estimate of expected losses from creating the average agency.) Again, in our model, politicians know how often the “average” agency defects and fails, but they do not know with certainty the specific defection and failure propensity of the specific agency they have just created. Second, we subtract λ_{pop} from $Z(t)$ to define a “compensated” loss process $S(t)$, or

$$S(t) = z_0 + Z_t - \lambda_{pop}t, \tag{4}$$

where z_0 is the starting point of the process $Z(t)$, or $Z(t{=}0)$. $S(t)$ thus defines a sort of “mean-deviating” failure and termination process in which agency processes vary relative to population means.

Politicians thus face an optimal stopping problem. They must decide when, if at all, to “stop” observing $Z(t)$ [or $S(t)$], which they can do only by terminating the agency, so as to minimize the loss function in Eq. (3). Like many other stopping problems in statistics—optimal folding in a sequence of gambles, optimal investment, optimal job quitting—the optimal solution to this problem consists of specifying a “reservation” criterion at which the agent is indifferent between taking a costly action (here, terminating an agency) and waiting further. Where $S(t)$ is above this line, the agency will be terminated; where $S(t)$ is below it, the agency will live for another day (mathematically, another dt). Proposition 1 now states the optimal termination rule.

Proposition 1. For the utility function given in Eq. (3), a politician’s optimal agency termination rule is to terminate the agency when (if and only if) the process $S(t)$ as given in Eq. (4) passes for the first time through a barrier η^*, where η^* is given by the following expression:

$$\eta^* = \frac{\alpha}{\pi(\lambda_{pop}\pi - \alpha)} + C_{term}, \tag{5}$$

where $\pi = (\kappa_x + \kappa_y) > 1$, and $\alpha = \delta + \phi$ such that $0 < \alpha < \lambda_{pop}\pi$.

Proof: All proofs are in Appendix A.

Two remarks about the result in Proposition 1 are in order. First, since α, π, and λ_{pop} are positive, and since $\alpha < \pi\lambda_{pop}$, the optimal termination level η^* is *above* the termination cost C_{term}. In other words, politicians do not terminate an agency when the benefits of

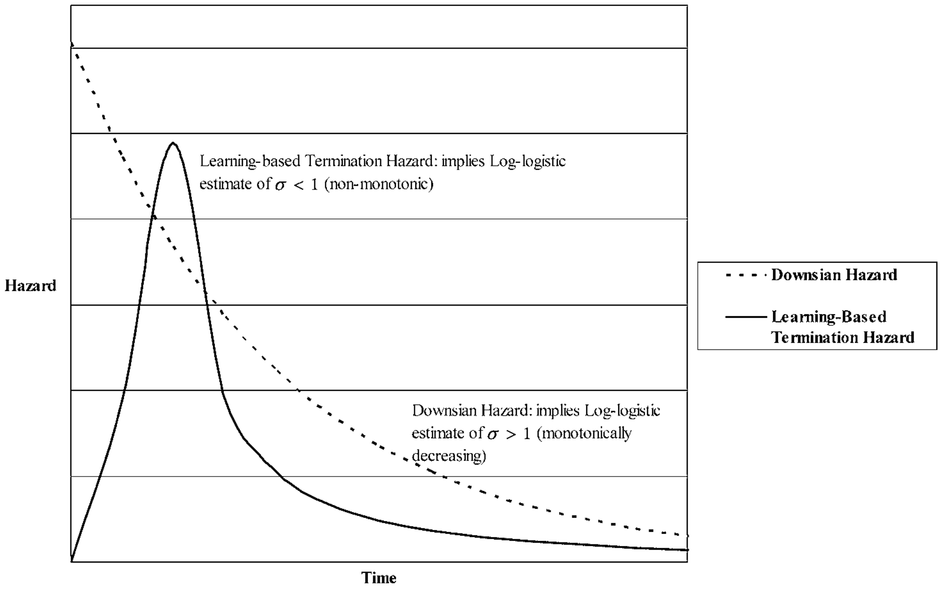

Fig. 1 Downsian versus learning-based agency hazards.

termination rise just above the static costs of termination. The extra delay reflects the value of waiting for more information given that agency termination is essentially irreversible. This value is encoded in the first term on the right-hand side of Eq. (5). Second, for agencies with sufficiently low rates of defection and failure, $S(t)$ will never pass through η^*; some agencies live "forever."

The second result concerns the form of the hazard function. Let $G^*(t) = \Pr[S(t) > \eta^*]$ be the probability of agency termination under the optimal policy, and let $g^*(t)$ be its derivative. Let $h(t)$ be the hazard function of agency termination, or $g^*(t)/[1 - G^*(t)]$. Proposition 2 is:

Proposition 2. Under the optimal policy, and given that termination under optimality has strictly positive probability (that is, $\Pr[\sup_{0<t<\infty} S_i(t) > \eta^*] > 0$ for at least one agency i), the hazard $h(t)$ is nonmonotonic, beginning at zero, rising to a unique mode, then returning to zero in the asymptote.

3.1.5 Hypotheses

The first hypothesis is directly from Proposition 2.

H1: The hazard function of agency termination is nonmonotonic, starting at zero, rising to a unique mode, then monotonically decreasing.

The hazard function derived from our model is plotted for sample values in Fig. 1, against the monotonically decreasing baseline prediction of Downs and Lowi.

The second two hypotheses invoke the property of Proposition 1 that the termination barrier, which is reached from below, is an increasing function of the termination cost C_{term}. As we have discussed previously, this cost is increasing when politicians are fiscally constrained and when bargaining or consensus costs are also higher. Combined with Proposition 1, these intuitions yield:

H2: The hazard of agency lifetimes is decreasing in the size of the government's fiscal deficit.

H3: The hazard of agency lifetimes is lower under divided government than under unified.

Another hypothesis, which may seem trivial but actually offers some interesting qualitative and quantitative lessons, is that termination occurs only after observable Poisson jumps. (It is possible to show that these will be greater than average jumps.) This marks a crucial difference from continuous time stopping models, where small movements of a continuous asset price can trigger optimal consumption or abandonment. We do not test this hypothesis here, and more theoretical work would be needed to do so. Yet one could imagine collecting data on scandals, congressional hearings, media reports, and other rare events to see whether they predict the timing of termination.

H4: Agency terminations occur soon after observable defections and failures.

4 Empirical Tests

We make three claims about the hazard rate of agency mortality: it follows a specific nonmonotonic shape and fiscal and political constraints decrease it. These predictions contradict the conventional wisdom that the hazard rate is monotonically decreasing and that fiscal constraints increase the rate of agency termination. They also contradict theories of rational agency design predicting an increasing hazard. To test these competing predictions we reanalyze data from Lewis (2002). Lewis gathered data on all administrative agencies created in the United States between 1946 and 1997. He used the *United States Government Manual* and excluded all advisory commissions, multilateral agencies, and educational and research institutions. We also exclude all agencies that were created explicitly to be temporary and two courts that were included in the initial data set, and we make use of the updates provided on Lewis's website.[15] Each agency is coded with a start date and termination date (where appropriate).[16] There are 398 agencies, 227 (or 57%) of which were terminated before December 31, 1997, the last year in the data set.[17] Summary statistics appear in Table 1.

4.1 *Nonmonotonicity*

The most obvious means of testing the competing predictions about the shape of the hazard rate is to graph it; we do so in Fig. 2.[18] The hazard rate starts greater than zero, reaches a mode at about five years, then decreases in fits and starts until it reaches a new mode at 28 years. So from birth to 30 years the hazard rate begins low, reaches what

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[15] These include recoding a handful of agencies according to whether they were created by statute and excluding a handful of agencies that should not have been included in the original data set for a variety of reasons (e.g., they were later found to be advisory).

[16] Information on agency termination was gathered using Appendix C of the 1997–1998 *USGM*. The appendix lists all agencies terminated since 1933 and their dates of termination. We use the *USGM* definition except in cases in which an agency was transferred whole to a new location or there was a simple name change. For an agency to be considered terminated, it must be considered terminated by the USGM and have a name change, a change in functions, and a change in personnel and organization.

[17] While we focus here on de jure termination, it is possible that de facto termination is also worthy of attention. It is possible, for example, that agencies are made ineffectual or effectively dead by having their budgets cut. There are arguably cases in the United States in which this has been true (e.g., ICC, CAB). We have chosen not to address de facto termination here directly for three reasons. First, termination of this type is rare. Second, budget cuts of this type are often precursors to actual direct termination. Finally, de jure termination when modeled arguably looks very much like the de jure termination we model here.

[18] Specifically, we get estimates of the cumulative hazard via the Nelson-Aalen estimator, smooth it, and take the numerical derivatives of this function to get estimates of the hazard rate. To do so we use the sts graph command in *Stata* 8.0.

Table 1 Summary statistics across observations

Variable	*N*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Survival time (agency)	398	12	—	1	52
Budget surplus (1995 dollars)	6289	$−123.2	102.25	−310.2	68.0
Unified government	6299	.36	.48	0	1
Unfriendly majority	6299	.23	.42	0	1
Unfriendly president	6299	.47	.50	0	1
Unemployment	6299	5.95	1.5	2.9	9.7
War	6299	.31	.46	0	1
Republican president	6299	.41	.49	0	1
Republican House	6299	.12	.32	0	1
Statutory creation	6278	.49	.50	0	1
Reorganization	6279	.08	.28	0	1
Departmental order	6279	.34	.48	0	1
Line in the budget	6247	.64	.49	0	1
Number of new agencies created	6299	7.68	4.88	1	22

Note. Survival time measured by agency rather than across observations and listed mean is median survival time.

appears to be a unique mode, and then declines. The bump at 28 years may be due to the fact that the hazard rate is estimated with fewer and fewer cases the higher the age. Fewer agencies can be used the higher the age, since more agencies live to be 20 than 25, 25 than 30, etc. On its face, Fig. 2 appears to support our claim that the hazard rate is nonmonotonic, and it clearly is not increasing over time. Both the Downsian and rational agency design predictions about the shape of the hazard rate appear incorrect based on these estimates. Whether or not the hazard rate has exactly the shape we predict (start low, increase to a unique mode, and then decline) will require more investigation.

While a graph of the hazard rate with no covariates can be suggestive, the shape can vary with the addition of important covariates. We therefore turn to models that include important covariates identified by the theory and existing research. Parametric models can provide additional empirical purchase on the shape of the baseline hazard rate. It should be noted, however, that parametric models are most appropriate when there are strong theoretical expectations regarding the underlying hazard. If the distribution of failure times is parameterized incorrectly, inferences about the impact of time dependency (see, e.g., Bergstrom and Edin 1992) and the covariates can be misleading (see, e.g., Larsen and Vaupel 1993).[19] We therefore choose the appropriate distribution with care and replicate the parametric models with semiparametric Cox models to verify the robustness of the coefficient estimates on the key independent variables.

While we have strong theoretical reasons for choosing a distribution that allows for a nonmonotonic baseline hazard rate, we follow a more inductive approach in model selection. This approach leads to the conclusion that a model with a nonmonotonic baseline hazard is the best. We start by estimating a generalized gamma model, which allows us to compare the appropriateness of nested models. The gamma distribution includes as special cases the Weibull (if $\psi = 1$), the exponential (if $\psi = 1$ and $\theta = 1$), and the log-normal (if $\psi = 0$).[20] Based on model estimates we can reject the hypothesis that

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[19] We thank an anonymous reviewer for pointing this out and making constructive suggestions for how to proceed.

[20] See Cleves et al. 2002.

Fig. 2 Nonparametric estimates of hazard rate of bureau mortality.

$\psi = 1$ (Weibull) and that $\psi = 1$ and $\theta = 1$ (exponential) in all cases but cannot reject the hypothesis that $\psi = 0$ (log-normal) in some specifications.[21] We then compare different parametric models (gamma, log-normal, log-logistic, Weibull, and exponential) with the Akaike Information Criteria (AIC). AIC = −2(log likelihood) + 2(c+p), where c is the number of model covariates and p is the number of ancillary parameters. Based on lowest AIC score in different specifications, the log-logistic and gamma models are the most appropriate.[22]

Both the log-logistic and generalized gamma models include ancillary parameters that can provide additional insight into the shape of the baseline hazard in fully specified models. The log-logistic hazard model is a parametric estimator that allows for two possible hazard shapes: a monotonically decreasing hazard (the Downsian prediction) and nonmonotonicity. Let the empirical duration of agency i be t_i. Letting the duration $q = \ln(t_i)$, a log-logistically distributed agency duration process has the p.d.f.

$$\sigma^{-1}\exp\left[\frac{q-\mu}{\sigma}\right]\left\{1+\exp\left[\frac{q-\mu}{\sigma}\right]\right\}^{-2},$$

where q and μ are unconstrained real numbers and $\sigma > 0$. The survivor function $\Gamma(t)$ and hazard $h(t)$ are

$$\Gamma(t) = [(1+\theta t)^{\sigma^{-1}}]^{-1}, \qquad h(t = \theta\sigma^{-1}(\theta t)^{\sigma^{-1}-1}(1+(\theta t)^{\sigma^{-1}})^{-1},$$

where $\theta = \mu^{-1}$. It is particularly useful for our purposes that, with an estimate of σ (and associated information from the asymptotic covariance matrix), one can test whether the

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[21] We used both Wald tests and likelihood-ratio tests to evaluate the nested models.

[22] It should be noted that the key coefficient estimates are not sensitive to the specification of the error density. Other models corroborate what is reported in the main text.

hazard is monotonically decreasing (the Downsian prediction for agencies) or nonmonotonic as our model suggests. For $\sigma < 1$ the hazard is nonmonotonic, and for $\sigma > 1$ the hazard is monotone declining (see Fig. 1). The Downsian hypothesis of monotonically decreasing agency hazards will receive support if we observe an estimate above unity *and* we can reject the alternative hypothesis that σ is less than or equal to one. Our model will receive support if we observe an estimate *below* unity and we can reject the alternative hypothesis that σ is *greater* than or equal to one. It cannot be the case that an estimate will support both theories, though it is possible that the test will support neither.

The gamma model is similarly flexible, nesting the log-normal, Weibull, and exponential models. The ancillary parameters ψ and θ are similarly informative. If $\psi = 0$ then the baseline hazard rate is log-normal (nonmonotonic). If $\psi = 1$, then the baseline hazard rate is Weibull and monotonically increasing or decreasing. If $\psi = 1$ and $\theta = 0$ then the model has a constant baseline hazard function (exponential). Although it still cleaves to a parametric specification, the flexibility of the generalized gamma form allows us to test for nonmonotonicity among a range of possible alternatives.

We estimate these models as a function of a number of independent variables, in particular budget surplus and unified government/divided government. We also include a series of appropriate controls identified by Lewis (2002).

4.1.1 Fiscal constraints

To measure fiscal constraints we include the real budget surplus in billions of dollars. Across observations the variable has a mean of −\$123.21 billion (budget deficit) and a standard deviation of \$102.25 billion. According to our model, an increase in the budget surplus should increase the hazard rate of agency termination or decrease the expected mean survival time. Since there are also political costs attached to agency termination, we include an indicator for unified government (0,1), implying that, all else equal, the political costs of agency termination will be lower when the president and Congress share the same party.[23]

4.1.2 Factoring in Coalition Turnover as an Alternative Explanation

One alternative explanation for the nonmonotonicity of the hazard rate is due to political coalitions rather than political learning. It could be that agency-creating coalitions are unlikely to change until a few years after an agency has been created. To control for this possibility we include measures that account for an agency's opponents being in power. The presence of a different majority in Congress is measured by a dummy variable accounting for whether or not the party controlling the House of Representatives at the start of an observation is the same party that controlled the House when the agency was created. In 23% of the observations (coded 1), a different majority controlled the House of Representatives. The presence of a president from the opposite party is measured with an indicator variable accounting for whether or not the president's party is different than it was when the agency was created (47%). Since an agency's risk of termination is greatest

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[23] Given the controversy about the influence of parties, we have also estimated models that use equivalent preference measures in place of party-based measures (McCarty and Poole 1995; Poole 1998). Coefficient estimates are signed correctly but lose significance. They are included in Appendix A. We have also estimated models using measures of the gridlock interval identified by Krehbiel (1998). We could not reject the null that gridlock interval has no influence on the hazard rate or survival time in any of the models.

when the degree of party change is most dramatic, we include an interaction of the indicators for different majority, different president, and unified government. The greater the degree of party change, the higher the risk for the administrative agency and the shorter the expected duration.

4.1.3 The Path of Agency Operating Costs as an Alternative Explanation

Another possibility is that agency operation is "cheap" at first and then rises thereafter to a maximum, and that cost-minimizing politicians would terminate the "bad" agencies only after they had reached some maximum cost level (e.g., the upward slope of a U-shaped or globally convex marginal cost curve).[24] This is plausible, but we think a learning-based explanation is better. First of all, an operating costs explanation would account for nonmonotonicity only if costs were a scalar function of agency life. If anything, agencies may learn how to reduce costs and keep them low as they live longer. A second point is that if agencies were terminated at some trigger cost level and all marginal administrative cost curves were eventually increasing, then all agencies would eventually be terminated. Under our uncertainty-based model, many agencies are terminated but some live "forever." Nonetheless, it remains a limitation of our data that we cannot directly test an operating costs explanation for agency hazard rates. This question remains open to further inquiry by quantitative scholars.

4.1.4 Controls

The parametric model also includes some of the obvious controls used by Lewis (2002), including unemployment, war, the ideological predispositions of Congress or the president, mode of agency creation, and agency size. Since Congress might not want to terminate agencies during deficit years because they coincide with high unemployment levels, the models include average yearly unemployment level.[25] We include a control for war because Congress historically has granted presidents a great deal of discretion to reorganize the bureaucracy to facilitate war efforts. Wars, however, also create deficits. Omitting a control for war could lead us to falsely attribute to deficits or surpluses what is caused by wartime mobilization.[26] We control for the political predispositions of Congress and the president for smaller government by including an indicator variable for Republican president (0,1) and Republican House (0,1). The source of agency origin (legislation, reorganization plan, departmental order, executive order) and the size of an agency can increase the ease or difficulty with which political actors can terminate an agency. Agency size is measured by an indicator variable for whether or not the agency has a separate line in the budget.[27] Sixty-five percent of the agencies in the sample have a line in the budget.

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[24] We thank an anonymous reviewer for this suggestion.

[25] Source: *Information Please Almanac*, various years; *Historical Statistics of the United States, Colonial Times to 1970*; *Handbook of Labor Statistics*, 1989; Bureau of Labor Statistics Web site (*http://www.dol.gov*).

[26] The variable is an indicator variable coded 1 for the Korean War (1950–1953), the Vietnam War (1965–1975), and the Persian Gulf War (1991).

[27] We have also estimated models using the log of agency budgets at their creation in 1992 dollars with the same results. We do not use the budget figures in the main specifications because many agencies created since 1946 do not have their own line in the budget (over 30%). We include these results in Appendix A.

4.2 *Results*

Table 2 includes estimates of the log-logistic, generalized gamma, and Cox models.[28] In general, the models fit the data well. We can reject the null of no improvement in model fit and we can reject the null that our key independent variables do not improve on a control-only model. Graphs of the Cox-Snell residuals suggest no obvious outliers, but they do importantly suggest that the models tend to overestimate agency hazards early and underestimate them later. With this caveat, the results offer a rejection of the Downsian hypothesis that the hazard of agencies is monotonically decreasing. The estimate for σ in the log-logistic model is below 1 ($= 0.74$, $p < 0.00$), indicating a nonmonotonic hazard. The estimates of the ancillary parameter for the generalized gamma regression are also informative. The estimate of ψ suggests that we can reject the Weibull model ($\psi = 1, p < 0.00$), which assumes a monotonic hazard rate. We can also reject the exponential model ($\theta = 1, p < 0.00$), which assumes a constant baseline hazard. In this model we can reject the lognormal model ($\psi = 0, p < .03$), which assumes a nonmonotonic form, but in other specifications we cannot.

Graphs of the estimated hazard help illustrate what we have described above. Figure 3 includes graphs of the predicted hazards from the log-logistic and generalized gamma models along with a third model we describe below. In the first two cases the hazard rate clearly starts low, rises to a mode between 5–12 years, and then declines.

To further analyze the shape of the hazard we estimate an additional model that places minimal restrictions on the shape of the hazard rate. It involves estimating an ordinary logit where termination is the dependent variable and a series of dummy variables to model duration dependence are independent variables (Katz and Sala 1996; Beck et al. 1998). The indicators take the following form: In the first year of an agency's existence the dummy for the first year is coded 1 and all other age dummies are coded 0. In the second year of the agency's existence the dummy for the second year is coded 1 and all other year dummies are coded 0. In the third year, the dummy for the third year is coded 1, and so forth. The marginal effects from these dummy variables are the instantaneous change in the probability of agency termination, akin to the hazard rate in cases in which time is measured as a continuous variable. Estimates from this model appear in Table 3 and a graph of the marginal effects appear at the bottom of Fig. 3.

On the left-hand side of the table we include estimates on the key covariates of interest. On the right-hand side we include coefficient estimates from the duration indicator variables. We note that the peak hazard is at either year 2 or year 5 (they are statistically indistinguishable). In the column next to the duration indicator coefficients we report Wald tests included to assess whether the other duration indicators are statistically distinguishable from the Year = 5 estimate. We find that the Year = 1 estimate is statistically differentiable from the Year = 5 estimate, which suggests an initial rise in the hazard. We

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[28] We could not reject the null of proportionality in the fully specified Cox model. Since we could reject the null of proportionality for the fiscal surplus/deficits and unemployment variables in some specifications, however, we estimated a series of additional models explicitly accounting for the possibility of nonproportionality. We estimated Cox models stratified on categorical versions of both the fiscal surplus/deficit and unemployment variables, and the results confirm what is reported in the text. The coefficient estimates on both variables become slightly larger but also slightly less precise. Since the tests for proportionality suggest that the shape parameters in the parametric models might be functions of the fiscal surplus/deficit and unemployment variables, we tested this proposition directly. In the generalized gamma model and the log-logistic models we estimated the shape parameters as a function of fiscal surplus and unemployment variables. We could not reject the null (null = no improvement in model fit) in any of the cases, although we could almost reject the null in some specifications.

Table 2 Estimates of agency hazard rates, 1946–1997

	Log-logistic	*Generalized gamma*	*Cox model*
Fiscal and political termination costs			
Budget surplus	−0.004	−0.004	0.004
	(0.001)	(0.001)	(0.001)
Unified government (0,1)	−0.54	−0.56	0.50
	(0.17)	(0.18)	(0.17)
Controls, constant, and ancillary parameters			
Unfriendly majority (0,1)	0.29	0.28	−0.32
	(0.26)	(0.26)	(0.26)
Unfriendly president (0,1)	−0.47	−0.48	0.48
	(0.18)	(0.19)	(0.17)
Unified control of one party to unified control of other party (0,1)	−1.89	−1.44	1.10
	(0.57)	(0.44)	(0.32)
Unemployment	−0.18	−0.19	0.19
	(0.08)	(0.07)	(0.07)
War (0,1)	−0.90	−0.94	0.96
	(0.20)	(0.20)	(0.18)
Republican president (0,1)	−0.66	−0.63	0.67
	(0.16)	(0.16)	(0.15)
Republican House (0,1)	−0.39	−0.57	0.69
	(0.33)	(0.31)	(0.27)
Statutory creation (0,1)	1.11	1.14	−1.04
	(0.25)	(0.25)	(0.21)
Created by reorganization plan (0,1)	0.78	0.95	−0.85
	(0.35)	(0.35)	(0.32)
Created by departmental order (0,1)	0.37	0.42	−0.38
	(0.23)	(0.22)	(0.19)
Line in the budget (0,1)	0.16	0.16	−0.13
	(0.16)	(0.16)	(0.14)
Constant	3.88	4.10	—
	(0.55)	(0.57)	
σ *[t-test of difference from unity]*	0.74*	—	—
	(0.05)		
θ *[t-test of difference from unity]*	—	1.21*	—
		(0.10)	
ψ *[t-test of difference from unity]*	—	0.37*	—
		(0.18)	
ψ *[t-test of difference from 0]*	—	0.37*	—
		(0.18)	
Number of observations	6216	6216	6216
Number of agencies	395	395	395
Number of terminations	227	227	227
LR test vs. null (13 df)	168.37	155.72	156.23
LR test vs. control model (2 df)	24.51	24.59	22.48

Note. Dependent variable: $h(t)$. Coefficients reported with standard errors in parentheses. For parameter tests (in italics), *implies statistically significant difference from comparison value. Akaike Information Criterion (AIC) values for the first two models are 957.5 and 959.3, respectively.

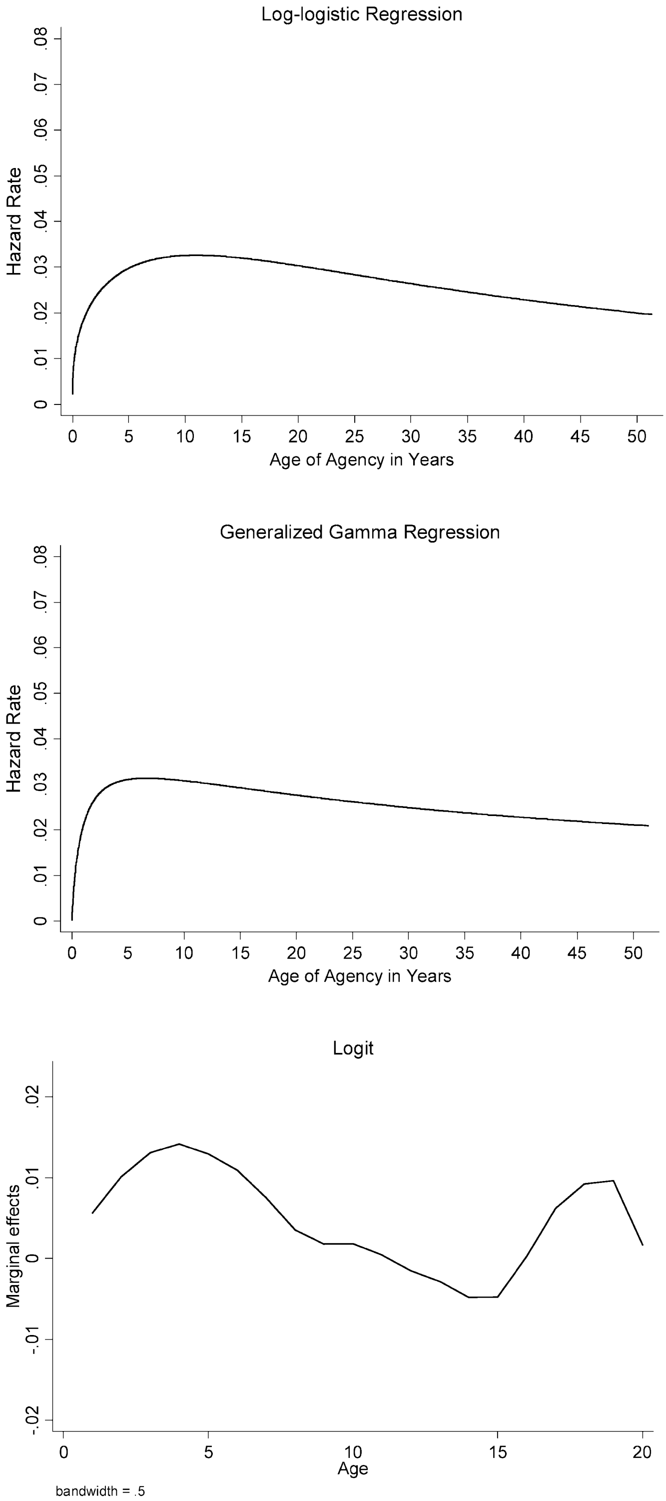

Fig. 3 Predicted hazard rate from log-logistic, gamma, and logit models.

Table 3 Semiparametric (logit) estimates of agency termination hazard, 1946–1997

Independent variables: Key covariates and controls	*Coef. (SE)*	*Independent variables: Duration*	*Coef. (SE)*[a]	*Wald test for diff from Year = 5*
Fiscal and political termination costs				
Budget surplus	0.003	Year = 1	−0.05	**2.71**
	(0.001)		(0.41)	
Unified government (0,1)	0.54	Year = 2	*0.71*	0.06
	(0.18)		*(0.33)*	
Controls		Year = 3	0.40	0.69
			(0.34)	
Unfriendly majority (0,1)	−0.14	Year = 4	0.47	0.34
	(0.26)		(0.33)	
Unfriendly president (0,1)	0.66	Year = 5	*0.65*	—
	(0.18)		*(0.32)*	
Unified control of one party to unified control of other party (0,1)	1.04	Year = 6	0.40	0.46
	(0.34)		(0.35)	
Unemployment	0.20	Year = 7	0.28	1.00
	(0.07)		(0.38)	
War (0,1)	0.93	Year = 8	0.23	1.50
	(0.18)		(0.38)	
Republican president (0,1)	0.57	Year = 9	−0.25	**4.66**
	(0.15)		(0.45)	
Republican House (0,1)	0.52	Year = 10	−0.22	**4.23**
	(0.27)		(0.47)	
Statutory creation (0,1)	−1.05	Year = 11	0.13	2.32
	(0.22)		(0.43)	
Created by reorganization plan (0,1)	−0.88	Year = 12	0.60	0.40
	(0.33)		(0.39)	
Created by departmental order (0,1)	−0.35	Year = 13	−0.65	**5.39**
	(0.20)		(0.63)	
Line in the budget (0,1)	−0.13	Year = 14	−1.68	**6.00**
	(0.15)		(1.03)	
Constant	−4.92	Year = 15	0.02	2.41
	(0.56)		(0.51)	
		Year = 16	−0.61	**4.11**
			(0.75)	
		Year = 17	0.37	0.52
			(0.56)	
		Year = 18	0.62	0.17
			(0.51)	
		Year = 19	0.72	0.08
			(0.51)	
		Year = 20	−0.32	2.57
			(0.74)	

Note. Dependent variable = 0 if agency survives year *t*, 1 if terminated in year *t*, null thereafter. $N = 6198$. LR test vs. null (33 df) = 212.95. LR test vs. control model (2 df) = 20.93.

[a] Values in italics signify possible maximums in the estimated hazards.

also find that the Year = 5 hazard estimate is statistically differentiable (above) those for Year = 9, 10, 13, 14, and 16.[29]

In short, one can reject the Downsian hypothesis of monotonically declining hazards because the hazard estimate for Year = 5 lies appreciably above that for Year = 1 in both models. Of course, the logit estimates also show that the hazard is not perfectly smooth and that there are multiple modes in the estimated hazard function. There is not, however, support for the statement that there are multiple statistically distinguishable modes after years 2–5. Put differently, if we posit a mode at Years 2–5, we can reject the hypothesis that any later hazard estimate lies *above* that hazard level in a statistically differentiable fashion. In addition, we can reject the hypothesis that many hazard estimates for years after Year = 5 are equal to this early peak hazard.

4.3 *Fiscal and Political Constraints*

One of the frequent claims made about agency termination is that it reduces expenditures and that fiscal constraints such as budget deficits decrease the probability of agency survival (Lowi 1979; Szanton 1981). Table 2 includes coefficient estimates that test this prediction directly. The coefficient estimate for the budget surplus variable is significant in all three models and it indicates that increasing the size of the surplus increases agency hazards and decreases survival times.[30] An increase in the size of the budget surplus increases the risks to agencies, or, conversely, the larger the budget deficit, the lower the risk of agency termination. If an agency existing in an environment with a constant budget surplus across time is compared to one with a budget deficit, the agency existing in the environment with a budget deficit is expected to survive longer on average. This contravenes the conventional wisdom that during periods of budget scarcity, the hazard rate for agencies should increase. It confirms our prediction that the short- and long-run costs of agency termination make termination less likely during periods when politicians are fiscally constrained.

The model estimates suggest that the political environment also alters the rate of agency termination. The coefficient on unified government is significant in the expected direction, indicating that agency hazards are higher in unified government. Agencies existing in unified government have over a 60% higher hazard rate than agencies existing during periods of divided government. When Congress and the president are from the same party, it is easier for them to come to agreement, not only about public policy but about everything, including agency termination. The political cost of terminating agencies is higher in divided government, since it is harder to come to agreement.

Figure 4 graphs the survival probabilities of agencies by different fiscal and political environments. In the first graph, we compare the survival probabilities of agencies with

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[29] We observe substantively identical results if the logit coefficients are replaced by marginal effects estimates evaluated at the means of the coefficient vector (results available from authors on request). These results are also invariant to adding or subtracting dummy variables from the battery. If dummy variables are added, the model that yields the highest log-likelihood is one with a battery of year dummies up to Year = 34. Yet this model is judged inferior to the 20-variable dummy model in two respects. First, a likelihood ratio test rejects the 34-variable model in favor of the 20-variable model. Second, when the 34-variable model is estimated, the variables Year = 22 and Year = 30 perfectly predict the binary outcomes with which they are associated and must be dropped from estimation.

[30] We note that the log-logistic and generalized gamma models are models of ln(t), or time until termination, rather than h(t), so the signs on the coefficients should be opposite what they are for the Cox model, which models h(t), or agency risks.

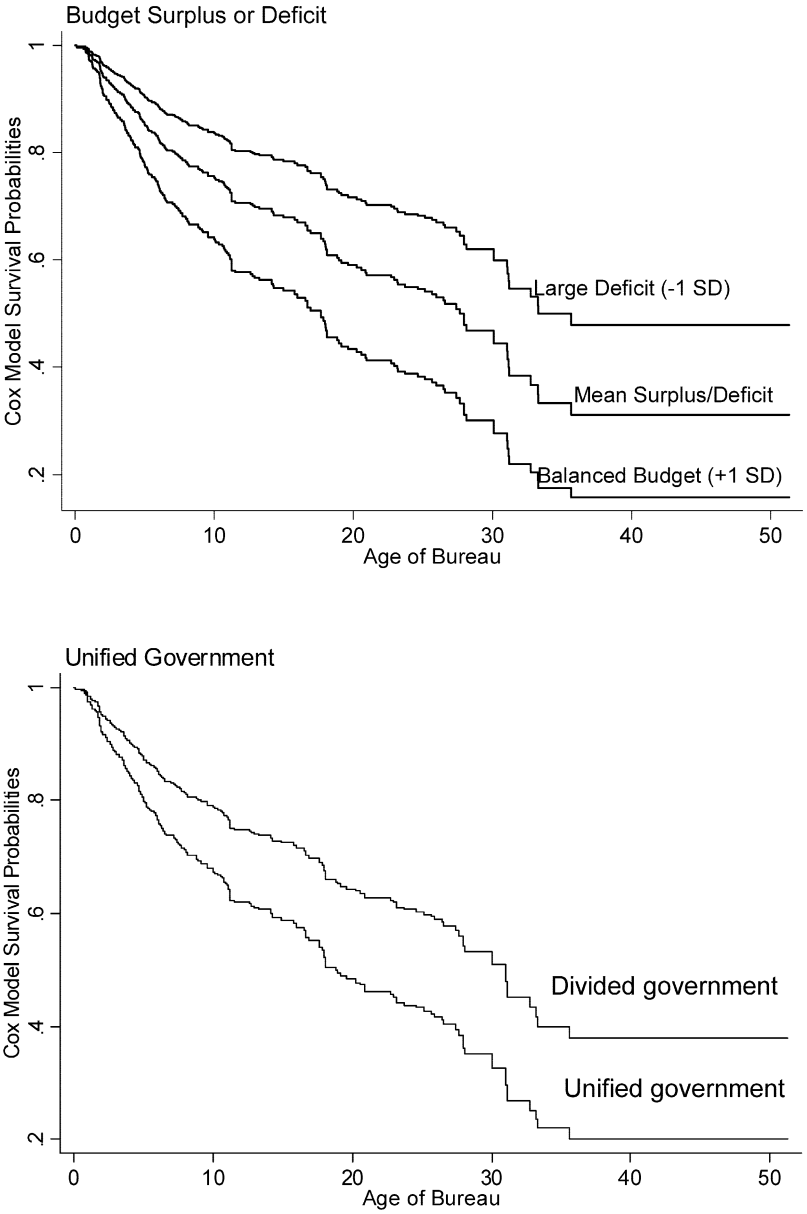

Fig. 4 Estimated survival probabilities by fiscal and political constraints.

a budget deficit to agencies with a budget surplus. The graph indicates that the agency existing in the more fiscally constrained environment has a higher probability of surviving over time. If the fiscal conditions were constant across time, the agency existing in the fiscally constrained environment (+ 1 SD) would have a higher probability of surviving for 50 years by over 0.15. The results provide evidence for what some public policy scholars have long claimed: cutting programs and agencies does not necessarily lead to cost savings or greater efficiency (Behn 1978; Khademian 1996; Frantz 1997). Indeed, the transfer of program responsibilities may increase costs, particularly in the short run, decreasing the attractiveness of agency termination.[31]

As predicted above and shown by Lewis (2002), political turnover increases the hazard rate of agency mortality. This effect is greater with a greater degree of party change. Administrative agencies appear never to escape the politics that created them. Once an agency's political opponents gain power, they seek to eliminate those agencies they opposed from the start. These findings confirm Kaufman's (1976) claim that "oscillations of power" create risks for agencies, particularly since agencies have natural supporters and enemies. Agency termination is the ultimate act of political control. Politicians hold the life of an agency in their hands, and by dint of statute or appropriations can terminate an agency any time they collectively wish. This confirms an assumption of the agency design literature that political actors fear electoral turnover (McCubbins et al. 1989; Moe 1989). They appear to do so for good reason.

The ideology of the president and Congress also affect the hazard rate. Agencies are at greater risk under Republicans than Democrats, perhaps due to ideological preferences for smaller government. Those agencies that are created by statute, reorganization plan, or departmental order are more likely to survive over time than agencies created by executive order (base category). Agencies created by statute must be terminated by statute (or reorganization plan in the 1946–1983 period), while agencies created by executive or departmental order can be terminated by executive action. Surprisingly, high unemployment is significantly related to high termination rates, contrary to our expectations. This may reflect the weakened bargaining power of labor unions under conditions of high unemployment.

5 Conclusions and Extensions

Politics often compels actors to use information gained from rare events to make costly decisions. We have analyzed this class of cases by example, examining the decision to terminate an administrative agency. We have shown that politicians balancing the benefits of waiting for more information against the costs of doing so create identifiable empirical patterns in the process of agency termination. Specifically, the optimal stopping problem faced by politicians creates a specific shape in the hazard rate of agency termination. This suggests that other phenomena with similar characteristics—the approval of a risky product, program termination, revision of security procedures, perhaps even the recall of elected officials—might be fruitfully modeled in a similar fashion.

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[31] One alternative explanation for the relationship between agency termination rates and the size of the deficit is that agencies are terminated as part of larger policy changes that increase spending. For example, the creation of the Drug Enforcement Agency led to the termination of four distinct law enforcement agencies. If a budget surplus leads to the creation of larger "super agencies" at the expense of smaller agencies, we could misinterpret the meaning the budget deficit/surplus variable. High termination rates during surplus years could mask numerous terminations for cost savings in deficit years. Two factors mitigate against this conclusion, however. First, the models partly control for the degree of policy change by controlling for party and ideological change in Congress and the White House. Second, we have estimated models including controls for the number of new agencies created in a given year and the coefficients, while smaller, are still in the expected direction and signicant or close to significant in two out of three models. If the increase in the termination rate during surplus years is due to "friendly fire," we should see a corresponding increase in the raw number of new agencies in surplus years (not adjusted by the number of terminations). Including a control for the number of new agencies created should eliminate any effect of the budget surplus attributable to increased spending given to new larger, consolidated agencies. The first model in Appendix B includes this control. This inclusion makes the coefficient on budget surplus smaller and insignificant in the Cox model. When we reestimated the log-logistic and generalized gamma models with this new control, however, the coefficient on the budget surplus variable was smaller but still significant or close to significant ($p < .07$, .11, two-tailed test).

We have aimed to demonstrate some of the advantages of tightly tying empirical hazard estimation in political science to an underlying theory that offers predictions about the shape of the hazard. In addition, we suggest that our efforts here offer something of a guide for scholars who wish to make use of readily available semiparametric and fully parametric approaches to assess the shape of an empirical hazard function. In our case, we have begun with estimators (the asymmetric panel logits) that make a minimum of parametric assumptions about the hazard function, and then proceed to parametric estimators in which different hazard forms are nested within a generalized estimator.

In the case of the duration of government agencies, different theories of bureaucracy make different predictions about the shape of the hazard function, and the debate is not merely of academic importance. Future research on the durability of bureaucratic agencies—in comparative and historical contexts as well as that of the United States—should tie empirical estimation to a theoretical model that offers guidance on the form of the hazard function itself. Such analysis should also pay close (theoretical and statistical) attention to the shape of the hazard function because it can reveal much about the dynamics of agency lifetimes.

We envision fruitful extensions to our theoretical model that would highlight the dynamics of agency lifetimes. A useful first extension would incorporate agency strategy into the paper (such as in Ting's [2003] treatment of optimal redundancy in a strategic environment).[32] A second idea would be to incorporate the possibility of groups acting as fire alarms to report defections or failures to politicians. We might then expect failure and defection to be better "observed" for those agencies with well-organized constituencies. A third possibility—not necessarily a game-theoretic extension—would be to allow agencies to learn how to reduce failure over time. We could incorporate this into the present model by imagining error reduction as a form of intertemporal discounting on the error rate into the future.

A different extension of our effort might incorporate the strategic role of interest groups in protecting and monitoring agencies. Allowing groups to bring evidence of failure or defection to politicians would be a worthwhile game-theoretic extension of this model, and perhaps groups could also lobby or "vote" for or against agency termination. Empirically, it would be useful to add variables representing each agency's interest group support. Measuring over-time changes in interest group support for agencies would, however, be highly taxing because we have over 6500 agency years in our data, and measuring group influence would potentially require just as many observations on interest group ties.

These conclusions have implications for future work on agency and program durability. First, we should revisit the conventional view that bureaus are extremely durable and become more durable over time. Over half of all agencies created between 1946 and 1997 were terminated, and they seem to be most at risk not right after creation but 12 years after creation (according to our best estimate). The pattern of agency lifetimes reflects two facts: creating an agency is a risky act, and terminating agencies is actually costly. Agency creation is risky because agencies can thwart the best intentions of politicians by defecting from their wishes or by bungling their tasks even when they are faithful. Terminating agencies is costly because it is irreversible and because replacing one agency with another is costly. Our model suggests that politicians will be unlikely to terminate agencies when the brute administrative costs of termination exceed both (1) the value of waiting to learn more about the current agency and (2) the difference in the value of any agency that replaces the current one.

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[32] The difficulty here would be in deriving a game-theoretic model that preserved the learning of Poisson losses in continuous time. We thank an anonymous reviewer for these and other suggestions.

Second, we should revisit the accepted views of rational agency design. Such models suggest a monotonically increasing hazard rate. We were also able to reject this view of agency lifetimes. Graphs of the hazard rate and parametric models of agency survival both show a nonmonotonic but generally decreasing hazard rate. It may be possible, however, to reinterpret theories of rational agency design to make them consistent with these findings. It could be that agencies insulated from political control facilitate the type of interest group politics described by Downs and Lowi. Theories of rational agency design could imply a type of nonmonotonic hazard rate where risks to agencies are low to start, increase over time as coalitions protecting the agency dissolve, and then decrease after a time due to the dynamics described by Downs and Lowi. In other words, at the same time that coalitions protecting the agency may be weakening, agencies are making connections with other groups and members of Congress that will enhance their durability. Such a view of rational agency design would produce predictions about agency lifetimes that are observationally equivalent to the model we present. Future research will need to investigate the relationship between agency design and agency durability.

Finally, practitioners who believe that agencies are impossible to eliminate or that cutting agencies is a profitable means of deficit reduction should revisit their conclusions. We find that there are regular patterns of agency vulnerability. We also find, however, that taking advantage of these vulnerabilities may not result in deficit reduction. Shutdown costs can be prohibitively high in the short run and can increase costs in the long run in some cases. Focusing on the termination of government programs or responsibilities as opposed to bureaus or agencies may be a more fruitful avenue for future research (see, e.g., Daniels 1997; Corder 2001). The federal government terminates agencies frequently, but rarely does it relinquish the commitments those agencies executed. Rather, the government takes those commitments and authority and delegates responsibility for them to another agency, new or existing. As a consequence, the savings to be gained from agency termination are small, if they exist at all, and termination may actually increase costs in both the short and the long run. The federal government will still have to fund those programs or commitments, and it will accrue short-term costs from shutting down agencies and dealing with the agency's sponsors, employees, and clients. There will also be efficiency losses generated by discontinuities in policy and implementation. Terminating agencies can create long-term costs due to efficiency losses associated with balkanization of functionally related activities into different agencies.

Appendix A

Proof of Proposition 1

The existence and closed form of an optimal termination rule for the compound Poisson process have been derived elsewhere (Mordecki 1997, 1999). Here we show how the politician's problem fits into this general class of solutions. We suppress subscripts i for simplicity. Let there be a probability space $(\Omega,\Im,P)$, characterized by a nondecreasing set of σ-algebras $\{\Im_t\}$, known as the filtration. We first make use of a simple lemma, which describes the basic dynamics of the compound Poisson process in the case in which the agency is good, bad, or average.

Lemma 1. *$S(t)$ is a martingale for the average agency, a submartingale for the bad one, and a supermartingale for the good one.*

Proof: Let λ_Z be the rate of accumulation of $Z(t)$, or $\lambda_Z = \delta \times (\kappa_x)^{-1} + \phi \times (\kappa_y)^{-1}$. (Recall that the mean of an exponential distribution is the inverse of its parameter; hence $E[K_x] = \kappa_x^{-1}$.) For the average agency $\lambda_Z = \lambda_{pop}$, for the bad agency $\lambda_Z > \lambda_{pop}$, and for the good agency $\lambda_Z < \lambda_{pop}$. (Note that since $S(t)$ defines relative *losses* from defections and failures, the standard definitions of sub- and supermartingales are reversed.) Let $0 \leq t^{\sim} \leq t \leq \infty$. For the bad agency, $S(t)$ is a submartingale iff $E[S(t) \mid \{\Im_{t\sim}\}] \geq S(t^{\sim})$. But

$$\begin{aligned} E(S(t)|\Im_{t^\sim}) - S(t^{\sim}) &= \int_0^t f(Z(s) \mid \Im_{t^\sim}) \mid dZ(s) - \int_0^t \lambda_{pop} ds - [Z(t^{\sim}) - \lambda_{pop} t^{\sim}] \\ &= E(Z(t) \mid \Im_{t^\sim}) - Z(t^{\sim}) - \lambda_{pop}[t - t^{\sim}] \\ &= E((Z(t) \mid \Im_{t^\sim}) - Z(t^{\sim})) - \lambda_{pop}[t - t^{\sim}] \\ &= \lambda_Z[t - t^{\sim}] - \lambda_{pop}[t - t^{\sim}] > 0. \end{aligned}$$

The proof for the supermartingale property of a good agency is symmetric. Since supermartingale and submartingale properties are satisfied iff $\lambda_Z = \lambda_{pop}$, $S(t)$ is a "pure" martingale for the average agency.

Now consider again the politician's loss function in Eq. (3),

$$\inf U(z,t) = -E_{zt}\left\{\int_t^{\tau *} e^{-\rho(s-t)} u(Z(s))ds + e^{-\rho(\tau * - t)} F[Z(\tau *)]\right\}.$$

We note that this problem differs from the standard optimal stopping problem because there is a flow payoff (the integrated term) in addition to the termination payoff (the last term in brackets). It can be shown, however (Hazma and Klebaner 1995; Klebaner 1998, p. 231), that any $E[Z(t)]$ admits of a martingale representation, i.e., it is decomposable into the sum of a compensated Poisson process and a martingale error. Since this decomposition holds for $Z(t)$, then by Lemma 1 it is true for any $S(t)$. Then by the Shiryaev separation theorem (Shiryaev 1978, p. 100), the problem in Eq. (3) can be transformed WLOG into a problem in which politicians kill agencies only to minimize the termination loss F. Denote by τ a random stopping time and the let the class of all stopping times be Ψ. Noting that our politician is risk neutral, we can now restate the problem in Eq. (3) as

$$\sup_{\tau \in \Psi} E(f(S_\tau)) = E(f(S_{\tau^*})). \tag{A1}$$

In words, the rule for terminating agencies in our model has the same form as a rule for "accepting" or "investing in" agencies whose Poisson processes were "successes" or "faithful acts" but where the underlying rate of "competence" and "fidelity" were unknown.

The politician's problem in our model differs in another important way from the standard optimal stopping problem. Because $Z(t)$ and $S(t)$ move upward only by Markov jumps, the standard smooth pasting conditions for optimal stopping (e.g., Dixit 1993) fail to apply, because $Z(t)$ and $S(t)$ are not differentiable at the first-passage value η^*. We therefore rely on the method of infinitesimal generators (Kramkov and Mordecki 1995; Klebaner 1998, p. 232–233; Kramkov and Mordecki 1999).

Let $\alpha = \delta + \phi$. Now characterize the infinitesimal generator of S by Λ, such that

$$(\Lambda f)(z) = \alpha \int_0^{+\infty} [f(z+w) - f(z)] \mid dF(w) + \lambda_{pop} f'(z), \tag{A2}$$

where w is a variable of integration. Very loosely (and it is important to emphasize that this metaphor is imprecise), one can think of Λ as specifying a continuously observed first-order condition for the politician's maximization problem. Where Λ departs from zero, a change in policy is recommended. Since there are only two actions (continuation and termination), $(\Lambda f)(z) < 0$ triggers termination. To extend the metaphor to a second-order condition, it can be shown more generally (and much more technically) that like other generating functions, Λ is convex, which implies that (C1) and (C2) will characterize an infimum for Eq. (4). Denote by Q^* the continuation region of the problem under the optimal policy, or those combinations of $[t, S(t)]$ suggesting continued agency existence. Also let $l(z)$ be the *continuation value* of the politician's problem. Under the method of infinitesimal generators, a solution to Eq. (4) satisfies the following conditions (Mordecki 1997, 1999):

C1: $(\Lambda f)(z) = 0 \quad \forall z \in Q^*$

C2: $(\Lambda f)(z) \leq 0 \quad \forall z \neq \eta^*$

C3: $f(S_{\tau^* \wedge T \wedge t}) \leq V$ P-almost-surely for all $\tau \in \Psi$ and for all $t \in \Re$, where V is an integrable random variable, i.e., $E|V| \leq \infty$.

C4: $0 \leq l(z) \leq f(z) \quad \forall z \in \Re$,

C5: $f(S_{\tau^*}) = q(S_{\tau^*})$, P-almost-surely.

Condition (C1) holds that for Z in the continuation region, movements in Z generate no change in policy. Condition (C2) states that, combined with Condition (C1), movements of the state variable above η^* will return negative expected value, hence a change in recommended policy. Condition (C3) ensures the integrability of all S paths, hence the feasibility of calculating finite expectations and stopping times. Condition (C4) states simply that under the optimum policy, z will be observed only until the point at which losses from continuation exceed losses from termination. (This effectively establishes a boundary condition on the movement of S with which the reservation value η^* can be calculated.) Condition (C5) is a *value matching condition* in the theory of optimal control. Intuitively, this states that at the termination value $S^* = \eta^*$, the politician is indifferent between termination and continuation.

Since our terminology and functions differ slightly from Mordecki, we prove (C1) and (C2) here. See Mordecki (1997) for the proof of (C3) and (C4); (C5) follows immediately from (C1) through (C4).

Proof of Condition (C1): For $z < \eta^*$, the infinitesimal generator Λ may be written

$$\lambda_{pop} f'(z) + \alpha f(z) - \alpha \int_0^{\infty} [f(z+w) - f(z)]\ \pi\ \exp\{-\pi w\} dw.$$

Note that the payoff for $z \geq \eta^*$ (in which termination occurs) is $z - C_{term}$. For infinitely lived agencies, the payoff is $(z - C_{term})\exp[\chi(z - \eta)]$, where $\chi = (\lambda_{\mathrm{pop}}\pi - \alpha)/\lambda_{\mathrm{pop}}$. Substitution of these values and repeated application of integration by parts equates this to

$$(\eta - C_{term})e^{\chi(z-\eta)}\left(\alpha\chi+\alpha+\frac{\alpha\pi}{\chi-\pi}\right)-\alpha\pi\left\{e^{\chi(z-\eta)}\right\}\left[(\eta-C_{term})\left(\frac{1}{\pi}+\frac{1}{\chi-\pi}\right)+\frac{1}{\pi^2}\right]=0.$$

Proof of Condition (C2): Note that condition (C1) establishes the statement for $z < \eta^*$, so we need only prove the statement for $z > \eta^*$. If $z > \eta^*$, then $f(z) = z - C_{term}$. Then

$$\begin{aligned}(\Lambda f)(z) &= \alpha\int_0^\infty (z+w-C_{term})-(z-C_{term})\pi e^{-\pi w}dw-\lambda_{pop}f'(z)\\ &= \alpha\int_0^\infty w\pi e^{-\pi w}dw-\lambda_{pop}\left[\frac{d}{dz}(z-C_{term})\right]\\ &= \alpha\,\Big|_0^\infty \frac{1}{\pi}we^{-\pi w}-\alpha\int_0^\infty \frac{-1}{\pi}we^{-\pi w}dw-\lambda_{pop}.\end{aligned}$$

Since $\alpha_0^\infty \mid (\pi^{-1})\, we^{-\pi w} = 0$, this equation reduces to

$$\alpha\int_0^\infty \frac{1}{\pi}e^{-\pi w}dw-\lambda_{pop}=\frac{\alpha}{\pi}\int_0^\infty we^{-\pi w}dw-\lambda_{pop}=\frac{\alpha}{-\pi}\,\Big|_0^\infty e^{-\pi w}-\lambda_{pop}=\frac{\alpha}{\pi}-\lambda_{pop}<0. \quad \square$$

Proof of Proposition 2

The hazard function is $h(t) = g^*(t)/[1 - G^*(t)]$, hence it requires a probability distribution defined over (optimal) terminations such that sup $G^*(t) > 0$ for some $t > 0$. A sufficient condition for this result is that $\Pr[\sup_{0<t<\infty} S_t(t) > \eta^*] > 0$, which is assumed. Following Mordecki (1997, 1999), we characterize the probability of the running maximum of $S(t)$ for bad agencies. It can be shown (Embrechts and Kluppelberg 1993) that

$$P\left(\sup_{0\le t<\infty}(Z_t-\lambda_{pop}t)\ \ge\ b\right)=\frac{\alpha\mu}{\lambda_{pop}}e^{-\chi b},$$

where $\mu = \pi^{-1}$, $\chi > 0$, and $0 < \alpha < \lambda_{pop}$. Then, integrating out b, the expected maximum is

$$\begin{aligned}E\left(\sup_{0\le t<\infty}(Z_t-\lambda_{pop}t)\right) &= \int P(\sup_{0\le t<\infty}(Z_t-\lambda_{pop}t)\ \ge\ b)db\\ &= \Big|_0^\infty\left[\frac{\alpha\mu}{\lambda_{pop}}e^{-\chi b}\times(-\chi^{-1})\right]\\ &= \Big|_0^\infty\left[\frac{\alpha\mu}{\lambda_{pop}}e^{-\chi b}\times\left(\frac{-\lambda_{pop}}{\lambda_{pop}\pi-\alpha}\right)\right]=\frac{\alpha\mu}{(\lambda_{pop}\pi-\gamma)},\end{aligned}$$

which is an upper bound on S_{τ^*}. From this expression, we know that $h^*(t)$ lies above zero for some positive t. Also, for some set of bad agencies, $\lim_{t\to\infty} P(\sup_{0\le t<\infty}(Z_t-\lambda_{pop}t) \ge \eta^*) = 1$ by Lemma 1. But conditioned on eventual termination, for some interval of time early in the bad agency's lifetime, $\lim_{t\to 0} g^*(S(t)) = 0 \Rightarrow \lim_{t\to 0} h^*(t) = 0 \Rightarrow h^*(0) = 0$. So the hazard clearly begins at zero and rises for at least some interval thereafter. Now consider the movement of $h(t)$ for t large. By Lemma 1, for any population including at least one good agency, it must be the case that $S(t)$ tends downward in expectation asymptotically for good agencies. Hence the expected termination time for any good agency is infinite. Put differently, since for some good agencies $S(t)$ never hits η^*, the integral over all $S(t)$ paths never converges and the expectation is infinite. Then

$\lim_{t\to\infty} G^*(t)<1 \Rightarrow \lim_{t\to\infty} g^*(t)=0 \Rightarrow \lim_{t\to\infty} h^*(t)=0$, namely, the hazard must return to zero, which, given $h(0)=0$ and $\sup G^*(t)>0$ for some $t>0$, is sufficient to show nonmonotonicity. □

Appendix B Cox Model estimates of agency hazard rates, 1946–1997

	Number of new agencies (1)	*Model with preference measures (2)*	*Model with Ln(agency budget) (3)*
Fiscal and political termination costs			
Budget surplus	0.001	0.002	0.005
	(0.001)	(0.001)	(0.002)
Unified government (0,1)[a]	0.44	0.48	0.62
	(0.17)	(0.81)	(0.22)
Controls			
Unfriendly majority (0,1)[a]	−0.27	−0.01	−0.47
	(0.25)	(0.98)	(0.34)
Unfriendly president (0,1)[a]	0.42	0.43	0.48
	(0.17)	(0.27)	(0.23)
Unified control of one party to unified control of other party (0,1)[a]	1.04	25.40	0.78
	(0.32)	(6.51)	(0.46)
Unemployment	0.12	0.15	0.20
	(0.08)	(0.07)	(0.09)
War (0,1)	0.58	0.76	0.74
	(0.21)	(0.18)	(0.24)
Republican president (0,1)[a]	0.61	−0.74	0.68
	(0.17)	(0.24)	(0.21)
Republican House (0,1)[a]	0.87	1.06	0.47
	(0.28)	(0.92)	(0.38)
Statutory creation (0,1)	−1.06	−1.01	−1.21
	(0.21)	(0.21)	(0.30)
Created by reorganization plan (0,1)	−0.86	−0.63	−0.80
	(0.32)	(0.31)	(0.39)
Created by departmental order (0,1)	−0.39	−0.32	−0.27
	(0.19)	(0.19)	(0.30)
Line in the budget (0,1)	−0.13	−0.18	−0.03
	(0.14)	(0.14)	(0.03)
Number of new agencies	0.08	—	—
	(0.02)		
Number of observations	6216	6216	3912
Number of agencies	395	395	229
Number of terminations	227	227	126
X^2 (12, 13 df)	178.22	124.69	79.94

Note. Dependent variable: $h(t)$.

[a] Party measures replaced with preference measures in Model 2. Unified government is the difference between the maximum distance and the distance observation by observation between the House median and the president. Unfriendly majority is the distance between the House median at the time of an agency's creation and the time of observation. Unfriendly president is the distance between the president at the time of the agency's creation and the president at the time of observation.

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