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ORIGINAL ARTICLE

Explaining the survival of public organizations: Applying density dependence theory to a population of US federal agencies

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Why do some public organizations survive for many decades, whereas others are terminated within a few years? This question of organizational survival has long intrigued public administration scholars. To explain longevity, public administration research has focused on organizational design features and adaptive capacities. The results have been inconclusive. This article explores an additional explanation for survival and demise: the density dependence theory as formulated in the field of organizational ecology. The underlying premise of this theory is that certain environments can only sustain a certain number of similar-type organizations. A rising number of organizations fuels competition for scarce resources, which inevitably leads to the demise of organizations. Density theory has often been tested in the business literature, but has been rarely applied to public sector organizations. In this article, we test whether this theory can help explain organizational survival in a population of US federal independent public agencies (n = 142). Our results show that density matters. This is good news for public administration research: the inclusion of density boosts the explanatory power of traditional variables such as design and adaptation.

1 | WHY DO PUBLIC ORGANIZATIONS SURVIVE (OR NOT)?

Herbert Kaufman (1976) was one of the first scholars to study why public organizations survive or not. He noted that some public organizations live on seemingly for ever, outlasting their original purpose. Some were quickly terminated after birth, some lived for decades and then got terminated. A substantial body of research has since been devoted to understanding the termination and survival of public organizations (Lewis 2002, 2004; Carpenter and Lewis 2004; Boin et al. 2010).

Most of this research has focused on design characteristics or adaptive strategies (or a combination of both). One approach has been to test whether an organization can be designed or 'hardwired' to survive. Prominent design factors are legislative design and formal autonomy (Lewis 2003; Carpenter and Lewis 2004; Boin et al. 2010; Park 2013; Greasley and Hanretty 2016; James et al. 2016; Kleizen et al. 2018). While these factors matter (Lewis 2003), they do not tell the whole story. Another approach has focused on the adaptive qualities of public organizations: can they change in time to escape termination? Intriguingly, there appears to be little actual evidence that the adaptive capacities of individual organizations enhance their survival chances. In fact, a public organization's proactive adaptation anticipating relevant legislative change may well decrease this public organization's odds of survival (Boin et al. 2017).

Despite an impressive body of research, there is no overwhelming evidence that one factor, or one particular set of factors, can explain why some public organizations survive longer than others (Kuipers et al. 2018). In this article, we widen our scope and include an organizational ecology perspective to help explain organizational survival and termination. This approach has a distinctive pedigree in the field of organization theory, where the fate of (mostly private) organizations has long been the object of investigation (Hannan and Freeman 1977).

The ecological approach views organizations as members of a particular population (hairdressers, bakeries, schools, banks, labour unions, etc.). It assumes that the demand for the products or services provided by a population of organizations is inherently limited (a city can only sustain so many hairdressers or bakeries). When the population becomes too large for its sustaining environment (too many bakeries in the neighbourhood), or an environmental shift occurs (people do not like bread that much anymore), organizations will be culled. Ecologists thus argue that beyond a certain threshold, increased population density fuels deadly competition. While this density dependence theory cannot predict which particular organization will survive or succumb, it offers a way of predicting the general survival chances of organizations in a particular population.

Organizational ecologists argue that density dependence theory can be applied to organizational populations of any kind, as long as individual organizations in the population have to compete for the same scarce resources that are vital for their survival. This theory has been empirically confirmed, again and again, in a wide variety of business populations. It has also been tested on populations outside the realm of for-profit enterprises, including interest groups (Gray and Lowery 1995, 1999), social movements (Langton 1987; Bevan 2013), labour unions (Hannan and Freeman 1987, 1988), high schools (Divarci et al. 2017) and political parties (Lowery et al. 2011, 2013). Density dependence theory has rarely been applied to understand the survival of public organizations (cf. Peters and Hogwood 1991).[1]

The aim of this article is modest: we seek to establish whether this theory is relevant for understanding the survival chances of public organizations. We first explain in more detail what this theory entails. Next, we test the explanatory power of this approach in a population of 142 US federal independent agencies during 1933–2011. After presenting our findings, we contemplate what these findings mean for the research on the survival of public organizations.

2 | AN ECOLOGICAL EXPLANATION OF ORGANIZATIONAL SURVIVAL

2.1 | Ecological logic

The population ecology school has been a prominent perspective in organization theory for decades (Perrow 1986; Aldrich 1999). Many longitudinal data have been collected as a result. There is a broad spectrum of different ecological perspectives, but they all focus on the question of organizational survival (Hannan and Freeman 1977, p. 929). In all these perspectives, competition for vital resources is thought to affect birth rates and survival chances in populations of similar types of organizations. The effects of competition, in turn, depend on the density of the population

[1]Lewis (2004, p. 399; 2002, p. 99) does control for a specific count of density. His models do not include time-varying effects of contemporaneous density, however, but only that of density at founding. For a more complete approach, see the research on state-owned corporations by Zhou and van Witteloostuijn (2010).

(Hannan and Freeman 1989). Density is the sum total of the number of organizations that operate in a given population.

Low density enhances survival chances. In an emerging population, there is little competition. New entrants will seek to exploit the benefits of this emerging market. For example, when a new restaurant opens in a suburb as the first entrant, its success will invite other restaurants to open and benefit from the demonstrated demand. Low density typically has a positive effect on organizational births and enhances survival chances. We say that the selection effect of density on entry is positive (encouraging similar organizations to enter the population) and the effect on exit is negative (increasing survival chances).

But the demand for any product or service in any population has a ceiling, referred to as 'carrying capacity' (van Witteloostuijn and Boone 2006). The carrying capacity of a population puts an upper bound on the number of organizations that can viably operate in this population. There is a limit to the number of restaurants that a neighbourhood can carry. When the density of a population surpasses the threshold, competition kicks in and density starts to have a negative impact on survival chances. More and more organizations have to compete in a finite ecological space and fight for limited but essential resources, vital for their very survival. The density effect on entry becomes negative, and that on exit turns positive. After the saturation point has been reached, each new restaurant puts pressure on the others. It becomes more likely that a restaurant will fold. We just do not know which restaurants will disappear: density dependence theory is silent about which particular incumbent is most likely to be affected; the theory only predicts a general effect.

The carrying capacity of a population is, of course, not static. The carrying capacity can increase (a growing number of high spenders in the neighbourhood) or decrease (an economic recession or eating out becoming less fashionable). Density effects must therefore be studied in conjunction with the carrying capacity of a population.

The density dependence thesis has been confirmed so many times for so many different types of organizational populations, including emerging and mature populations, that this theory is now part of organizational sociology's standard corpus (Baum 1989; Hannan and Freeman 1989; Amburgey and Rao 1996; Bogaert et al. 2015). Organizational ecologists are therefore convinced that they have formulated 'a general theory of organizations' (Hannan and Carroll 1992, p. 25).

This 'density logic' is indeed visible in quite a few non-business populations. Consider, for instance, the ecology of political parties (Lowery et al. 2011, 2013). Political parties must fight for their share of votes in a finite electoral space. Or consider the ecology of rules: research shows that the likelihood of a new rule is affected by the current number (or density) of existing rules (van Witteloostuijn and de Jong 2008, 2010; Kaufmann and van Witteloostuijn 2016). Political scientists apply a similar logic to explain why some issues enter political and policy agendas, whereas so many others do not. Politicians and policy-makers only have so much attention to give to problems (policy scholars say that policy agendas have a limited 'carrying capacity'). Issues must therefore compete for scarce attention (Cobb and Elder 1972; Baumgartner and Jones 1993). The logic applies to lobbying organizations as well: limited congressional attention affects the survival chances of competing lobbying organizations (Lowery and Gray 1995; Gray and Lowery 1999).

Yet public administration scholars are wont to argue that this theory has little relevance for populations of public organizations. Two arguments play a role here. First, there is the argument that public organizations are not like restaurants, as there are vast differences in tasks and design (Verhoest et al. 2012; Van Thiel and Yesilkagit 2014). Public organizations do not produce similar goods or services, and they are not in the zero-sum game of attracting customers. Many public organizations may be described as state-protected monopolists that produce whatever they are supposed to produce without the threat of competing offers by rivals, implying that they can live their sheltered lives in different, non-competing spheres. These organizations do not operate in a market environment with scarce demand as most (for-profit) organizations studied by ecology scholars do.

Ecologists would argue that all organizations must compete for scarce resources. Public organizations are not fundamentally different in this respect. Public organizations must also fight for scarce resources, such as support from politicians or a slice of the government budget. Without sufficient funds, public organizations cannot perform

their tasks (whatever these might be). Density theory would argue that a rising number of public organizations or a decrease in carrying capacity increases competition for limited resources. Survival chances are then reduced.

While there is little empirical research to support this thesis, public administration scholars frequently offer observations that at least make the thesis plausible. It appears that a rising number of public organizations to be funded from a limited budget will fuel competition (Greasley and Hanretty 2016; Götz et al. 2018). When budgets become tight, governing elites are tempted to terminate or replace agencies (Carpenter and Lewis 2004; Flinders and Skelcher 2012, p. 328; Greasley and Hanretty 2016; Götz et al. 2018). The ideologies of 'starving the beast' and 'dismantling the welfare state' typically rely on proposals to cut government expenses in order to curb government expansion (Pierson 1994; Greasley and Hanretty 2016 p. 166).

Public administration scholars may bring in a second argument against density dependence theory. It is almost an article of faith to assume that (the leaders of) public organizations have an impact on their autonomy and survival (Carpenter 2001; Bertelli and Sinclair 2018; Tomic 2018). Many studies in public administration, as well as in business and management and (organizational) sociology, suggest that only those organizations that continuously, and preferably proactively, adapt in anticipation or response to changes in their environment can stay alive (Downs 1967; Thompson 1967; Drazin and Van de Ven 1985; Aldrich 1999; Parker and van Witteloostuijn 2010; Kettl 2016; Boin et al. 2017; Corbett and Howard 2017). There are many case studies celebrating how entrepreneurial leaders managed to adapt their public organizations in the light of impending threats (see for instance Doig and Hargrove 1987).

Organizational ecologists agree that a good fit between organizational characteristics and a changing environment is critical. For instance, we know that smaller organizations are more likely to survive than their larger counterparts in dense populations (Boone et al. 2002). An organization that adapts to a changing environment would thus appear more likely to survive. But ecological scholars are sceptical about an organization's adaptive capacities (Aldrich 1999, pp. 43–48). The conventional wisdom in this school is that individual organizations, for a variety of reasons, will fail to adapt adequately. Ecologists speak of 'relative' and 'structural' inertia: organizations do not know which changes to make and are hence tardy in making the right changes in time ('relative inertia'). And even if they did, organizations would have a hard time implementing changes in the core of the organization ('structural inertia').

As organizational ecologists have not widely studied the adaptation successes and failures of public organizations, we cannot simply adopt their line of argumentation. There are plenty of case studies that suggest that organizational adaptation can be effective and timely (see Ansell et al. 2015). But this does not take away from the ecological argument that enhanced density reduces survival chances.

In this article, we want to check whether the 'density dependence thesis' holds true for a population of public organizations. We follow the ecological logic and envision the public sector as a population with a limited carrying capacity (see Peters and Hogwood 1991). There are only so many public organizations that the system can carry. Many public organizations may be monopolists in terms of what they have to deliver in the public domain (the demand or output side), but they are competitors in a defined and bounded executive and political space (the supply or input side).[2] The more public organizations operate in the same ecological space, the harder they must fight for a share of the same pool of scarce resources. When there are too many, the chance of being terminated rises.

This leads us to formulate the following hypothesis, *ceteris paribus*: a public organization's likelihood of survival (and hence exit) is affected non-monotonically by the density of its population. Low density has a positive effect on survival (and hence a negative one on exit); at high density, competition rules, providing a negative effect of density on survival (and hence a positive one on exit). Together, these forces produce a hill-shaped relationship between density and the likelihood of survival, and a U-shaped relation between density and exit.

In addition, we will test whether the resource environment at the time of an organization's founding has a long-run effect on the newcomer's survival chances. Ecologists assume that this is the case because density at founding

[2]This space may, of course, expand (or contract). In the empirical analysis, we have to control for such changes. We will return to this point.

defines the availability and quality of resources that the entrant carries into the future. Organizations thus benefit or suffer from a blueprint impact, which ecologists refer to as the density-delay effect (Lomi and Larsen 1998).

To be sure, even if the density theory proves correct, we are still left with the question why some organizations are selected for the scrap heap, whereas others are allowed to persist. In our research design, we therefore include the more traditional variables—birth characteristics and adaptation—that public administration scholars have used to explain the survival chances of public organizations. We can then study whether the interaction with density can further our understanding of organizational demise as affected by other variables.

3 | RESEARCH DESIGN

To explore the plausibility of density theory for government organizations, we studied the population of 142 US federal public agencies. These are the organizations that have been listed in the US Government Manual (USGM) during the period 1935–2011 as an 'independent agency' for at least one year of their existence.[3] These organizations have a degree of insulation from executive interference in common (as opposed to cabinet bureaus) (see Lewis 2003, pp. 10–11).[4] Moreover, they all largely depend on federal funding (by definition a scarce resource).[5]

All independent agencies have their own entry (section) in the US Government Manual, presenting valuable information that allowed us to collect, code and compare data on those agencies. Sixty-eight of the 142 agencies were still alive at the end of our time window on 31 December 2011. Due to unavailability of data for 2012/13 at the time of data collection, we decided to take 31 December 2011 as an artificial end point. The survivors (48 per cent of the total) give right censorship, which implies that the outcome in terms of agency survival for this subsample is yet unknown. Right censorship is common in many, if not all, ecological survival analyses, which can be corrected for by using tailor-made statistical techniques (see below). The 20 cases (14 per cent) that were created before 1933 (we assume that the 1935 USGM reliably covers all information from 1933 onwards) are left-censored. Only three agencies date from before the 20th century—the oldest being the US Postal Service, which was created in 1789.

Left-censorship may bias the results since 'some organizations may enter the time period with long and successful histories, others may be fledgling organizations founded in controversy, and yet others may be "dinosaurs" which have outlived their usefulness' (Peters and Hogwood 1991, p. 88). Still, we decided to collect data on these agencies in order to be able to explore explicitly whether the inclusion of these cases in our population does or does not introduce substantial error. We traced all federal agencies for every year of their existence since 1935, or since their creation, in order to overcome issues due to middle-censorship (as a result of information lacking on events occurring between two points in time).

We randomly sampled 20 cases from our population (representing both short-lived and durable agencies) and checked inter-coder reliability between the two researchers who did all the coding work. Out of 12,800 observations, we found 665 differences, which results in inter-coder reliability of 94.8 per cent. Each difference in observation (even if this pertained to only a fraction difference on a code scale) was interpreted most strictly, as full difference.

[3]For reasons of size, organizational unity and distinctiveness, we excluded the following six organizational types: (a) bilateral or multilateral organizations; (b) monuments, celebrations (e.g., bicentennials) and commissions; (c) foreign claims commissions; (d) committees, advisory councils or boards consisting of only *ex officio* members (such as the Secretary of Defense and State together advising the president as 'Council X or Y') or functionaries or representatives of other organizations, which do not form a standing organization; and (e) agencies with only a single state purpose (e.g., Delaware River Basin Commission, Virginia State Boundary Commission, and Alaska Power Administration).

[4]We excluded cabinet bureaus because their dependence on the whims of executives is itself an explanatory factor for survival. Neither did we include agency components and sub-offices, as by their very nature these organizational units perish much more easily and frequently than the independent agencies they are part of. In organizational ecology parlance, the key is that intra-organizational units operate in a selection environment different from that of the organizations hosting these units.

[5]Some organizations in the population had some limited revenue-sharing capacity. We control for this capacity in the empirical analysis.

3.1 | Model specification

We define the dependent variable, Agency termination, as the likelihood that an agency is terminated in a given year (provided this agency is still alive in that given year). We took the date specified by law or executive order (if available) as the end date; otherwise, we assumed that the date when the agency terminated its operations according to the USGM is this agency's termination date.

In defining creation and termination of organizations, we kept our definitions as closely as possible to those of scholars who wrestled with this challenge before us (e.g., Carroll and Delacroix 1982; Meyer 1985; Pennings et al. 1998; Lewis 2002, 2003; Rolland and Roness 2011; MacCarthaigh 2014). We consider organizations to be terminated when they are explicitly referred to as terminated or abolished in the USGM (and there is no indication whatsoever of continuity beyond this official termination), split into two or more new organizations (secession), absorbed into another office, or merged with another office. A merger or secession signals the birth of one or more new agencies (see Boin et al. 2010, p. 390). We view an organization as terminated and replaced by a new agency when the latter has a new name, a new organization structure, tasks that are different from a possible predecessor, and new leadership.[6]

Our independent variable must capture density dependence (whether density affects survival chances). We use the two density variables that are standard in (organizational) ecology: Number of agencies and Number of agencies squared. The squared density term is required to test for density's hypothesized non-monotonic effect. This pair of variables is based on the count of the number of US federal independent agencies that was operational in each year. We also take into account the possible impact of Density at founding, defined as the number of other agencies in existence in the year a given agency was founded. We test whether density at founding affects an agency's likelihood of survival.

In our choice of control variables, we build on the work of Lewis (2002, 2003). We recorded a series of agency birth characteristics, all extracted from the first entry of each federal agency in the USGM. To control for differences in governing structures, we differentiated between agencies that at the time of birth were endowed with a Board or commission structure (coded 1) vis-à-vis those agencies that are not (coded 0). Each agency description in the USGM commences with a listing of job titles in which board and commission members are mentioned in a separate section. Upon creation, federal agencies are regularly equipped with a commission or board structure, as opposed to a single administrator, with the intention to insulate the agencies from political interference (Lewis 2004).

Another design variable for which we control is the presence or absence of a Sunset clause, which is a provision that specifies when an organization should cease to exist. With a sunset clause, assigned code 1, the establishing authorities give themselves the opportunity to revisit the original mandate, and put an explicit limit on the lifespan of an agency. We scored any formal manifestation of transient intentions for each of our 142 federal agencies as the presence of a sunset clause. These included stipulations about a fixed budget for the entire lifespan, attainment of a specific goal or an official cut-off date. If none of these preconditions were referred to in an agency's first listing in the USGM, it was coded 0.

The control variable Weak legislative origin was included because the statutory underpinning of a federal agency forms the basis of its design. Agencies established after lengthy legislative procedures, involving heavy scrutiny and majority requirements, are thought to be less susceptible to termination than their counterparts that are forged by executive actions. This hypothesis was confirmed by Lewis (2002) and Boin et al. (2010) in their research on US federal

[6]Here we depart from Lewis (2003), who considered an organization to be 'new' if it had a new name, new location (for instance, transferred to a cabinet department) or different functions from any previously existing agencies. The criteria used by Lewis result in more creations and terminations. Using his criteria, the life span of, for instance, the National Archives and Records Administration would have added an extra creation and termination to our dataset (the same goes for the Social Security Administration). In our view, the creation of the National Archives and Records Service (NARS) in 1949 did not qualify as a new organization because we see a strong continuity with the National Archives as established in 1934 (McCoy 1978). Wayne Grover remained the leader of the NARS. The organization remained in the same building, with the same staff. Because agencies change names and location in the government structure quite frequently, interpreting such changes as abolishment would bias our results in favour of termination and against durability.

agencies. It is contested by MacCarthaigh (2014) in research on a population of Irish state agencies. To determine to what extent the legislature was involved in the creation process of each of our 142 agencies, we traced the inception mandates of each agency in the USGM and in the USGM's History of Agency Organizational Changes (2011). We coded agencies that were initiated by legislative act as 1 (having a 'strong legislative origin'), those that had a reorganization plan at their basis as 2, those established by an executive order as 3, and those initiated by departmental or military order, which arguably could be classified as having the weakest legislative origin, were coded 4.

In addition, we had to control for a number of critical attributes of the organizations and their environment. One organizational characteristic identified as essential in organizational ecology is size: small organizations are associated with a lower likelihood of survival (ecologists refer to the liability of smallness) (Carroll and Hannan 2000). We used the Budget of the United States Government (1935–2011) to retrieve the budgets of all federal agencies for each year during their existence. After calculating the budget medium of our population, we ranked the agencies from smallest to largest budget. The agencies in the first quartile were categorized as a Small budget agency (coded 1), and agencies in the second, third and fourth quartiles are considered to be large budget agencies (coded 0).

Furthermore, we controlled for changes in the population's overall carrying capacity. Carrying capacity is defined as the maximum number of organizations that can be sustained by a population's environment (the key constraint being the availability of required resources). To determine the annual Federal revenues, the total sum collected by the federal government through taxes on a yearly basis, we used figures provided by the Office of Management and Budget (www.whitehouse.gov/omb/budget/Historicals) divided by 100. This variable provides a proxy for the funds available to finance federal agencies.[7]

We controlled for the capacity of federal organizations to generate their own revenues (and thus escape the effects of rising density and subsequent competition pressures). We added a control variable indicating whether or not the agency can be classified as a public corporation that has its own resources. We also controlled for sudden disruptions of the federal budget as a result of war. The years of the following wars were coded as War years (1, and 0 otherwise): World War II (1941–45), Korean War (1950–53), Vietnam War (1965–75), Gulf War (1990–91), Afghanistan War (2001–11), and Iraq War (2003–11).

We wanted to control for the protection that agencies are likely to enjoy from their 'founding' president. As long as the founding president is in office, these young ducklings (or presidential babies) are unlikely to be terminated (see Lewis 2003). The variable Non-founding president indicates whether the term of the founding president had been completed (1) or not (0) at the time of termination. Vice-presidents (such as the first terms of Truman, Johnson, and Ford) who took over from their predecessor without prior elections are also coded as 'Non-founding president' (for agencies that had been created by the president they succeeded).

We also wanted to control for the adaptive capacity of organizations in the face of density-related pressures. Adaptation refers to the organizational capacity to implement appropriate changes in policy, personnel or processes to restore or maintain a fit with the ever-changing expectations and values of key audiences (Selznick 1949, 1957; Andrews 1980; Burgelman 1983, 1991; Kaufman 1985; Wilson 1989; March 1991; Aldrich 1999). We take mission change as an indicator of an organization's adaptive capacity.[8] Organizational theorists argue that organizations have a very hard time making changes in their core, including their mission (Hannan and Freeman 1984; Hannan et al. 2007). Following Selznick (1957) and Wilson (1989), we assume that an organization's mission statement reflects the formal commitments of that organization (as viewed by that organization). If we can construct a measure of agencies' mission changes, we would hence have a solid indicator of organizational adaptation.

For each year after 1935, we used US Government Manual information on each US federal independent agency to identify annual mission and task changes. We looked for additions to the mission statement and removals from

[7]Of course, if Congress routinely elects to run a deficit the carrying capacity may be expanded. *Ceteris paribus* applies here: all else equal it should hold that an increase in federal revenues improves the survival chances of agencies whereas less revenue reduces the chances of agencies surviving.

[8]Here we follow Boin et al. (2017).

the mission statement. Each USGM entry was examined for newly stated purposes in its distinctly itemized mission statement (either stated separately or under the subcategory 'purpose'). Each new purpose is counted as an addition to the mission statement upon its first appearance in a USGM entry for that agency in a given year. We coded additions in absolute numbers. Similarly, we coded the number of purposes that were removed from the mission statement when compared to the agency's mission statement of the previous year (again, in absolute numbers). We include Mission change in the same year of the relevant legislative change, as well as Proactive change and Reactive change (with a two-year lead and lag, respectively). No change is added as the non-adaptation benchmark.

3.2 | Model estimation

We applied event-history analysis (Tuma and Hannan 1984) at the level of the federal agency to estimate the likelihood that an agency will be terminated in a given year. We modelled a piecewise constant exponential hazard specification. In a piecewise specification, the likelihood of failure can vary between age intervals, but is constant within each interval. The advantage of a piecewise specification vis-à-vis a parametric specification is that the former, unlike the latter, does not impose any functional form on the relation between (federal agency) age and the hazard of failure. The piecewise constant exponential model has the following general form:

$$\mu(u) = \exp(\alpha_p + ßx_u)p = 1...P, \quad (1)$$

where α is a constant that is allowed to vary between the age intervals p, and $ßx_u$ is a row vector of coefficients ($ß$) and independent variables (x). Exploration of the estimates revealed that a specification with breaks at years 3, 9, and 18 was best able to capture the age dependence of the hazard, which gives the maximum statistical model fit. Moreover, to avoid issues of endogeneity, all independent and control variables were lagged with one year. The models were estimated using the *stpiece* function of the STATA statistical software package (Sørensen 1999).

4 | FINDINGS

We now turn to the findings of our hazard rate analysis. Figures 1 and 2 plot key descriptives. Figure 1 shows that our dependent variable—agency exit—is not a rare event at all, revealing an irregular pattern over time. Figure 2

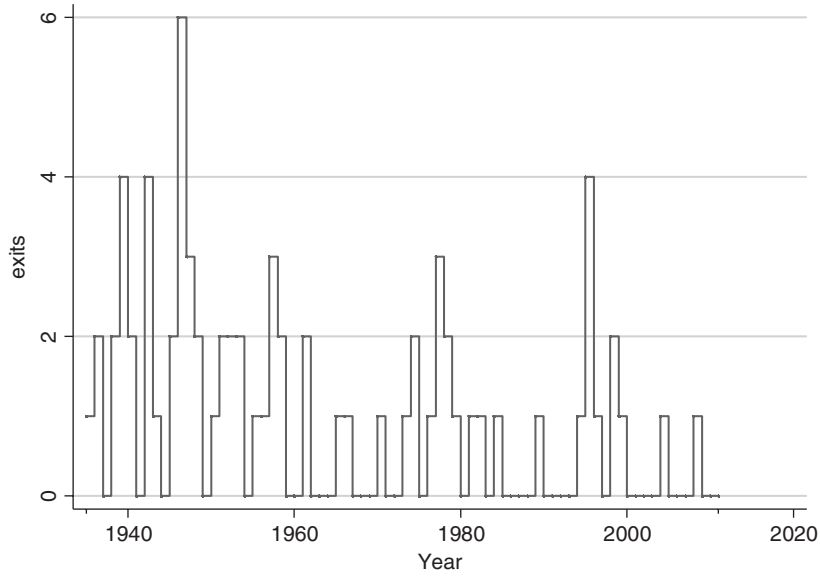

FIGURE 1 Number of agency exits by year

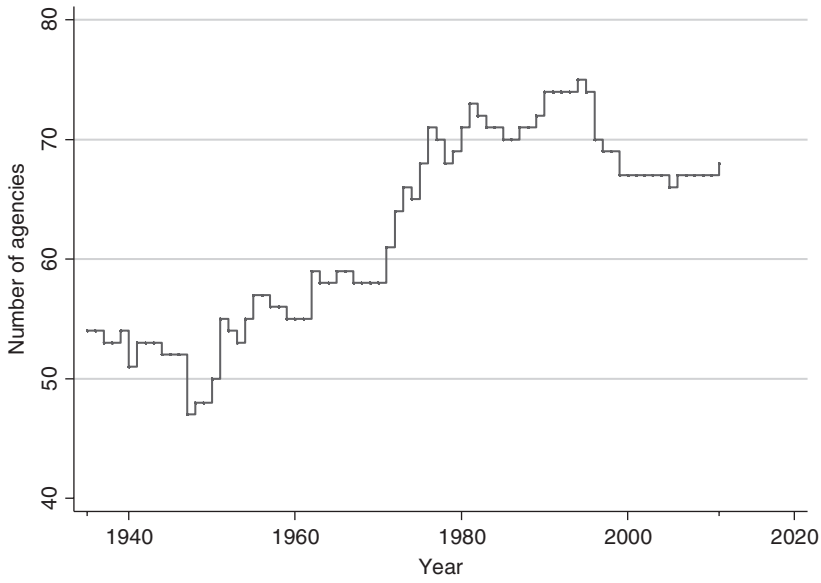

FIGURE 2 Number of agencies by year

indicates that our central independent variable—agency density—shows substantial variation, moving between a low of 47 and a high of 75.

Table 1 provides means, standard deviations and correlations, revealing that multicollinearity is not an issue. Table 2 presents the results of the event-history analysis and contains four models. Model 1 shows the effects of the control variables. Model 2 adds the estimates of the adaptation variables (mission change). Population ecologists would argue that these models are underspecified, as they take a select number of variables into account. Model 3 therefore adds the density measures, which allows us to estimate the effects of population density.

Even if density matters, it still does not tell us why a particular organization is selected for termination (rather than another organization in that population). That is, models 1 to 3 are silent about what specific features of a public organization make this organization particularly vulnerable for the impact of density. To tentatively explore this issue, model 4 reports outcomes from a post-hoc analysis in which we examine the impact of one particular variable: the Non-founding president variable.

The results offer strong support for our benchmark hypothesis, which predicted that the likelihood of a given US federal independent agency being terminated would exhibit a U-shaped relationship with the overall number—or density—of independent federal agencies. The relationship between density and the termination hazard turns from negative to positive at 66 agencies, as can be seen in Figure 3. Thus, beyond 66 agencies, each increase in the number of agencies decreases the survival chances of incumbent agencies. The effect of density is such that above this threshold of 66, a further increase in density of 10 per cent leads to an increase in the multiplier of the hazard rate of 19 per cent (a substantial impact indeed).

As can be seen in Figure 2, the density hazard is a permanent force after 1973, when the number of federal agencies increased to 66 to never fall below this critical threshold again. As ecological scholars would predict, agencies that started in high-density conditions had a harder time surviving. They enter in a state of fierce competition, but without the skills or reputation that established organizations may have.

We can thus conclude that population-level selection impacts the likelihood of agency termination. Beyond a certain saturation point, agencies are increasingly likely to be culled. Also, the timing of organizational birth is significant. In short, our hypothesis is confirmed.

TABLE 1 Descriptive statistics

	Mean	*SD*	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	
1. War years	0.409	0.492	0	1													
2. Federal revenues	710.99	780.44	3.6	2568	0.18												
3. Board	0.546	0.498	0	1	0.01	0.01											
4. Sunset clause	0.088	0.283	0	1	−0.00	−0.04	−0.04										
5. Weak legislative origin	1.347	0.709	1	4	−0.01	−0.05	−0.03	0.18									
6. Small (budget) agency	0.262	0.438	0	1	0.00	−0.02	0.19	−0.13	−0.10								
7. No change	0.927	0.261	0	1	−0.03	0.04	0.01	−0.03	0.01	0.02							
8. Same year change	0.008	0.087	0	1	0.02	−0.05	−0.02	0.04	0.02	−0.02	−0.02						
9. Proactive change (2-yr lead)	0.012	0.108	0	1	0.04	0.02	0.01	0.01	0.02	−0.01	0.01	0.32					
10. Reactive change (2-yr lag)	0.014	0.116	0	1	0.01	−0.07	−0.02	0.03	0.02	−0.02	−0.00	0.46	0.28				
11. Density at founding	32.222	28.976	0	74	−0.00	0.26	−0.11	−0.07	−0.00	−0.02	0.00	−0.04	−0.00	−0.04			
12. Density	63.110	7.922	47	75	−0.15	0.62	−0.01	−0.06	−0.07	−0.04	0.02	−0.07	−0.04	−0.07	0.32		
13. Density squared	4045.639	984.757	2209	5625	−0.17	0.61	−0.01	−0.06	−0.07	−0.04	0.02	−0.07	−0.04	−0.07	0.32	0.99	
14. Non-founding president	0.877	0.361	0	1	−0.02	0.27	−0.01	−0.08	−0.10	−0.04	0.03	−0.09	−0.05	−0.08	−0.08	0.33	0.33

Note: Correlation coefficients greater than |0.04| are significant at the 5 per cent level.

TABLE 2 Piecewise exponential models of US federal agency exit

	Model 1	Model 2	Model 3	Model 4
Age segments				
Age < 3 years	−5.24**	−6.61**	12.19	−72.93*
	−0.55	−0.98	−8.63	−33.77
3 < Age < 9 years	−4.04**	−5.41**	13.51	−71.56*
	−0.33	−0.87	−8.72	−33.73
9 < Age < 18 years	−5.33**	−6.71**	12.21	−72.84*
	−0.43	−0.9	−8.63	−33.73
Age > 18 years	−5.47**	−6.87**	12.7	−72.25*
	−0.35	−0.92	−8.74	−33.76
Control variables				
War years	−0.26	−0.27	−0.28	−0.28
	−0.25	−0.26	−0.28	−0.29
Federal revenues/100	−0.03	−0.03	−0.05	−0.04
	0.02	0.02	0.03	0.03
Board	−0.38	−0.39	−0.2	−0.2
	−0.25	−0.25	−0.25	−0.26
Sunset clause	0.97**	0.94*	1.09**	1.18**
	−0.37	−0.38	−0.39	−0.4
Weak legislative origin	0.45**	0.45**	0.45**	0.44**
	−0.12	−0.12	−0.12	−0.12
Small (budget) agency	1.24**	1.20**	1.22**	1.28**
	−0.26	−0.26	−0.26	−0.27
Adaptation variables				
No change		1.41	1.36	1.33
		−0.83	−0.82	−0.78
Same year		2.49**	2.65**	2.67**
		−0.64	−0.66	−0.63
Proactive change (two-year lead)		1.57**	1.38**	1.50**
		−0.38	−0.41	−0.42
Reactive change (two-year lag)		−2.36*	−2.26*	−2.42*
		−1.11	−1.04	−1.04
Selection variables				
Density at founding			0.02**	0.02**
			−0.01	−0.01
Density			−0.62*	2.25
			−0.28	−1.17
Density squared /100			0.47*	−1.91
			0.26	−1.02
Non-founding president				94.81**
				−34.95
Non-founding president * Density				−3.19**
				−1.22
Non-founding president * Density squared				0.03*
				−0.01

TABLE 2 (Continued)

	Model 1	Model 2	Model 3	Model 4
Observations	5,091	5,091	5,091	5,091
Log likelihood	−174.09	−164.33	−156.72	−151.86
Degrees of freedom	10	14	17	20
AIC value	368.18	356.66	347.44	343.72

Note: Robust standard errors reported below coefficients; $^{**}p < .01$, and $^{*}p < .05$.

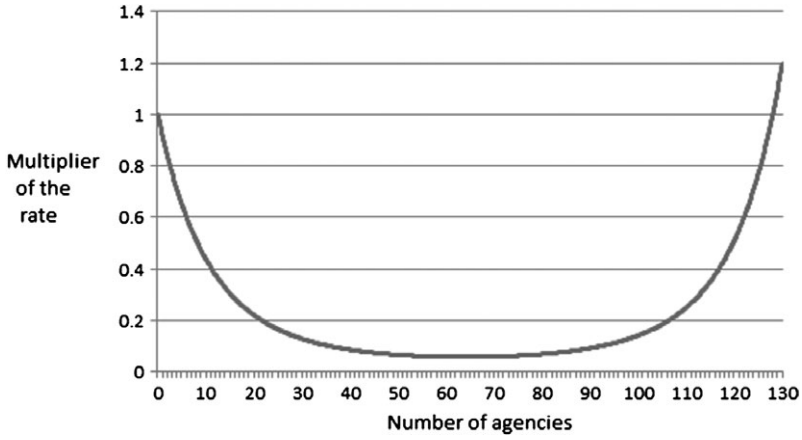

FIGURE 3 Relationship between the number of agencies and the hazard rate
Note: Based on model 3

So which agencies, then, are most likely to get axed when the saturation point has been reached? When we look at the control variables, the findings are highly consistent across all model specifications. First, it appears that small agencies (those in the smallest quartile in terms of budget) are most vulnerable to termination, in line with the liability of smallness argument (see Corbett and Howard 2017). Second, federal agencies that were established with a sunset clause or with a weak legislative underpinning ran a higher risk of being terminated, which confirms the empirical findings of Lewis (2003).[9] Third, revenue-generating capacity does not appear to matter. This dummy variable was not statistically significant, nor did it substantially alter the other coefficients in our main model (see Table 3).

Our findings strongly suggest that organizational adaptation does not enhance survival chances. This finding directly confronts the conventional wisdom among public administration scholars (it confirms the prediction of ecological scholars). All adaptation variables in models 2, 3, and 4 are significant. The findings are more subtle when we account for the timing of adaptation. Reactive change (adaptation of the mission with a two-year lag) increases survival chances. Mission change in the same year or with a two-year lead reduces the likelihood of survival. So it appears that proactive adaptation is dangerous; it works against an organization's survival chances.[10] Only reactive adaptation is useful (in terms of life expectancy). We will return to these findings in the conclusion.[11]

[9]This contrasts the finding of Boin et al. (2010, p. 400) who found no apparent statistical association between sunset clause and survival in their study of 63 New Deal agencies.
[10]These findings are in agreement with the findings of Boin et al. (2017).
[11]One might argue that agencies surviving legislative change are better able to make post-hoc adjustments, but we should note that there is no 'strong survivor' effect at work here since we are not considering cohorts of firms subject to the same legislative interventions. Legislative interventions take place at the agency level and survival chances are estimated at this level as well.

TABLE 3 Piecewise exponential models of US federal agency exit

Age segments	
Age < 3 years	−75.23*
	(33.65)
3 < Age < 9 years	−73.81*
	(33.61)
9 < Age < 18 years	−75.05*
	(33.61)
Age > 18 years	−74.49*
	(33.65)
Control variables	
War years	−0.30
	(0.29)
Federal revenues/100	−0.00
	(0.00)
Board	−0.15
	(0.25)
Sunset clause	1.28**
	(0.40)
Weak legislative origin	0.47**
	(0.12)
Small (budget) agency	1.27**
	(0.27)
Adaptation variables	−0.30
No change	1.31
	(0.76)
Same year	2.71**
	(0.62)
Proactive change (two-year lead)	1.44**
	(0.40)
Reactive change (two-year lag)	−2.39*
	(1.01)
Selection variables	
Density at founding	0.02**
	(0.01)
Density	2.33*
	(1.17)
Density squared /100	−0.02
	(0.01)
Non-founding president	96.27**
	(34.77)
Non-founding president * Density	−3.24**
	(1.21)
Non-founding president * Density squared	0.03*
	(0.01)

TABLE 3 (Continued)

Corporation	−0.55
	(0.49)
Observations	5,091
Log likelihood	−150.95
Degrees of freedom	21
AIC value	343.9

Note: Robust standard errors reported below coefficients; $^{**}p < .01$, and $^{*}p < .05$.

The post-hoc analysis in model 4 focuses attention on one other possible mechanism, beyond our set of control variables discussed above: the timing of termination. More specifically, we see an interaction effect between density and incoming presidents. Model 4 contains evidence for a 'Non-founding president' effect: federal agencies are especially vulnerable under an incoming president who did not establish that particular federal agency. The impact of density-dependent selection takes place almost entirely after the term of the president under whom the agency was created. In a population that has reached its carrying capacity, the young ducklings that can no longer rely on 'parental protection' are particularly vulnerable to the axe. Their survival chances become very sensitive to increases in density when carrying capacity has been reached. For instance, when density increases from 70 to 75 agencies, the multiplier becomes a very substantial 23 times as large.[12] Whether successor presidents are Democrat or Republican is immaterial, as earlier research has shown (Boin et al. 2010).

How can we explain this? We may speculate that, in their initial years of existence under the creating president, agencies enjoy the protection of the establishing president. They are protected from the fierce competition that is furthered by their own creation. But a new president means danger for these organizational ducklings. They must now compete, but they have had little time to build reputation or networks that might give them an angle in the fight. These agencies may have no proven usefulness when they emerge in the crosshairs of the incoming presidential administration and Congress, both looking for organizational vehicles that can make their elective promises come true. This period of sudden vulnerability is referred to in the ecology literature as the 'liability of adolescence' (Brüderl and Schüssler 1990; Fichman and Levinthal 1991; cf. Stinchcombe 1965). If they survive this critical period, they are more likely to enter a safer maturity phase. Of course, this explanation cannot be but speculative, given the nature of our data. Further work is needed to explore in more depth this and other possible explanations.

5 | DISCUSSION: TOWARDS A MORE COMPLETE EXPLANATION OF ORGANIZATIONAL SURVIVAL

This study sought to explore whether an often-used theory in the business domain might enhance our understanding of the survival question (why some public organizations persist, whereas others die young). We put to the test the 'density dependence' thesis, which holds that increased density initially (i.e., at low density) increases survival odds and later (i.e., at high density) diminishes survival chances as competition grows fiercer. We examined this explanation for survival (or, rather, termination) empirically in the population of 142 US federal independent agencies in 1935–2011. Our findings show that density has important effects.

Our findings vindicate the assertion of ecological scholars that their theory applies to all populations. Even though this type of organization does not operate in a competitive marketplace, their chances of survival are

[12]This is more substantial than the effect of adaptation: Same-year change increases the multiplier of the rate by 14 times (exp.(2.65)).

significantly affected by density effects. Moreover, our findings are very similar to the findings of research on non-public organizations. For example, younger organizations are more vulnerable than older organizations (Brüderl and Schüssler 1990; Fichman and Levinthal 1991; Baum and Shipilov 2006).

This finding that density matters will not come as a surprise to ecology scholars. But it contradicts the intuitions of their public administration counterparts. For instance, public administration scholars have not found conclusive evidence that decreasing public revenues affect the survival chances of public organizations (Carpenter and Lewis 2004; Park 2013; Greasley and Hanretty 2016; James et al. 2016; Bertelli and Sinclair 2018). Our findings clearly suggest that the size of the funding pie makes a difference, at least for the population we studied.

While we think that 'density dependence' theory probably holds true for all public organization populations, our findings with regard to the selection of individual organizations may well be specific to this particular population (i.e., US federal agencies in 1935–2011). For instance, Yesilkagit and Christensen's (2011) study on populations of public agencies in three European countries concludes that national administrative contexts have a strong impact on agency design and its effects. Future research should explore the generalizability of our findings by comparing them with those from studies of similar populations in other countries (Laegreid et al. 2010; Yesilkagit and Christensen 2011; MacCarthaigh 2014), in other time periods, and of other types of public organizations (see, for instance, the Norwegian, Irish and UK datasets on public organizations—Laegreid et al. 2010; MacCarthaigh 2014; Bertello et al. 2015; or the Structure of Government study on Germany, France, the Netherlands and the UK).[13]

Our findings show that a two-level analysis can fundamentally improve our understanding of organizational survival chances in the public sector. A density-dependency analysis helps to describe the hostility of an environment. But it strongly suggests that we take other variables into account to explain which organization is more likely to survive in the light of increasing competition. The interaction between density and organizational variables explains why some organizations survive competition, whereas others succumb to it. By way of illustration, we have shown that timing is critically important. When density cranks up competition, incoming presidents present a clear danger to young organizations. Young organizations have much better chances in a moderately dense environment. But in a highly dense environment, consisting of (too) many agencies, incoming presidents are most likely to select them for the chopping block. They do not appear to care whether their targets were fathered by predecessors of the same party. Adolescence equals vulnerability in our analysis.

Our findings provide a fundamental challenge to the common idea that organizational adaptation provides an escape route from density pressure. This finding is particularly vexing for those who present proactive change as a strategy for organizational leadership (cf. Ansell et al. 2015). If we want to keep with the underlying assumption that leadership matters, we must focus more research on the relation between density, adaptation and survival. It may well be that we did not measure what we sought to measure (adaptation may be more than mission change). But we can no longer simply assume that proactive adaptation is beneficial to the survival chances of an organization.

In closing, we think that our findings present an intriguing addition to the field of public administration research. They offer the tantalizing prospect of being able to understand why some public organizations survive while others do not. They sketch an approach that can uncover how environmental factors enhance or diminish the effect of many variables that are routinely identified in public administration research (but are rarely proven to have been significant in their effects). We do not argue that the ecological perspective is superior. On the contrary, our findings suggest that the ecological and more traditional public administration perspectives are complementary and should be used together. The addition of the ecological approach thus makes for an excellent expansion of the public administration research tool kit.

[13]See https://cms01.rz.uni-potsdam.de/sog-pro.html for a brief introduction to the SOG project.

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