The Population Ecology of Online Collective Action

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1. INTRODUCTION

Mobilizing collective action depends on constructing collective action frames, which are shared understandings providing an impetus for participation [Snow 2008]. Yet individual attempts at framing share a context (a discursive field) with potentially myriad alternative frames. Social movement scholars have used organizational ecology to understand organizational success, growth and change in social movements [Soule and King 2008; Minkoff 1995]. We extend ecological thinking to consider framing processes in collective action organized online, an environment where texts are central to mobilization [Snow et al. 1986].

1.1 Online Petitions

Petitions are one of many popular online channels for pursuing voice. Social movements are increasingly turning to digital channels to organize, mobilize protests, distribute cultural products, and pursue discursive opportunities [Klandermans et al. 2014; Tarrow 2011; Vasi et al. 2015]. Although opportunities to speak proliferate on the internet, audiences are highly concentrated as few online activists reach a large audience [DiMaggio et al. 2001; Goldhaber 1997; Tufekci 2013].

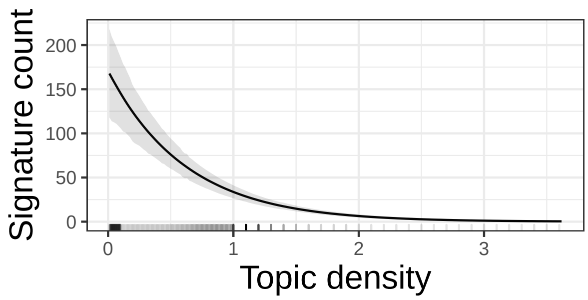


Fig. 1. Marginal effects plots showing the model predicted relationship between topic density and median signature count with the 95% credible interval. Lines on the x-axis show that most petitions are in the lower range of overlap density.

Prior explanations of participation in online petitions generally look to properties of particular petitions, such as lexical characteristics associated with popular petitions [Hagen et al. 2016]. Others look to the petition signing processes including the role of social information, technical features of petition platforms like recommendation engines, and preferential attachment, diffusion on social media [Yasseri et al. 2013; Hale et al. 2013; Margetts et al. 2015], and the role of a few highly active signers [Jungherr and Jürgens 2010; Huang et al. 2015]. Scarce resources such as celebrity endorsements can also attract signatures [Graeff et al. 2014].

1.2 Ecological Dynamics in Discursive Fields

The above approaches to explaining participation in online petitions neglect the ecological insight that individual success depends on interdependence with others. We propose that competitive and mutualistic dynamics similar to those found in social computing research to shape the growth of online communities and social movements also influence participation in online petitions [Soule and King

2008; Zhu et al. 2014]. In a competitive dynamic, individuals struggle with one another for needed resources and suffer decreased chances of growth and survival. Under mutualism, similar individuals contribute common resources that improve the chances of growth and survival of others in the group. Organizational sociologists discovered that such dynamics occur not only in biological populations but also in groups of organizations [Hannan and Freeman 1984]. We extend this approach to consider how the use of similar frames relates to ecological dynamics.

We conceptually locate ecological dynamics between online petitions within *discursive fields*, the contexts in which a discourse is embedded. This is similar to how organizations are located within organizational fields [Snow 2008]. Discursive fields involve symbolic, conceptual, and grammatical systems that define and communicate meaning, understandings of what frames are relevant and legitimate, and relations between actors, texts, and frames. In a similar vein, communication scholars consider how ecological theory applies to organizational discourse and how conversations and texts may compete or cooperate [Monge and Poole 2008]. Both perspectives see variation and interdependence between texts as an important part of the process by which particular codes or frames become accepted and powerful.

We begin understanding ecological dynamics in discursive fields using theories analogous to those established in organizational ecology: density dependence and resource partitioning. Density dependence proposes a trade-off between legitimacy and competition in discursive fields. We treat density as a function of the quantity and degrees of similarity among petitions. Hypothetically, petitions with unusual frames have low *density* and therefore lack legitimacy. Potential signers find such petitions peculiar or illegitimate are less likely to sign them. On the other hand, petitions that articulate very common frames are redundant and compete over the limited time and attention of signers. Density dependence theory predicts that participation will be maximized at intermediate levels of density:

H1: Participation will be greatest when legitimacy is high relative to competition: at intermediate levels of overlap density.

Resource partitioning theory proposes that concentrated, unequal participation in petitions arises when petitions can avoid competition through specialization. Generalist frames invoke a broad spectrum of concepts and appeal to larger audiences while specialist frames target a narrower range of claims that may be strongly held by movement constituents. Specialists have competitive advantages in their narrow domains, but have smaller average signature counts compared to generalists. Concentration arises from the co-existence of many smaller specialists and a few large generalists. This leads to the classic result of resource partitioning theory [Carroll 1985]:

H2: Specialized petitions will be more successful in conditions of greater concentration.

2. DATA AND MEASURES

Our dataset consists of 441,966 petitions from Change.org. We only include petitions that were active for at least one week and that are at least 480 characters. Short petitions are generally poorly written, have few signatures, and are not amenable to topic modeling. We included only those petitions which could reliably be identified as written in English and removed spam using Akismet.

Our outcome is participation in an online petition as measured by the *signature count* for the petition. Signature count is the dependent variable for both hypotheses.

We use latent Dirichlet allocation (LDA) topic models to construct our remaining analytical measures, *topic density*, *frame specialization*, and *concentration* based on the notion that petitions near to one another in semantic space use similar language, and likely invoke similar concepts [Hannan 2019]. Our computational approach affords scaling our analysis has broad applications for ecological studies of discursive fields. We fit our LDA models using Mallet and present results using 150 topics, but our substantive results are robust for models with a wide range of numbers of topics.

The independent variable for **H1** is *overlap density*. We measure overlap density using the topic assignments of the LDA topic model. We group petitions by the months in which they are created, then assign topic memberships such that a petition belongs to a topic according to the probability that a word in the petition is drawn from the topic. We compute the Jensen-Shannon Divergence (JSD) between each pair of petitions in the month. Our measure of density for a given petition is the sum of it's JSDs over all other petitions. We then normalize this measure scaling the measure of density within each month by the standard deviation.

The independent variable of **H2** is the interaction between *frame specialization* and *concentration*. Frame specialization is simply the degree to which a petition focuses on few topics or on many. We measure frame specialization as the inequality of topic memberships. A petition about a few topics is more specialized than one about many. We calculate frame specialization using the Herfindahl-Hirschman index (HHI), a commonly used inequality statistic.

Concentration is defined by the inequality of the distribution of signatures. A topic where petitions have more equal levels of success is less concentrated than one with great levels of inequality. As with density, we group petitions by month and assign them to topics according to the posterior probability of the topic for the petition. We then measure the inequality of each topic, again using the HHI. Finally, we obtain our measure of the concentration of a petition's fundamental niche by taking the sum of concentration of each topic weighted by the petition's membership in each topic.

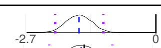
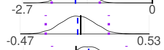
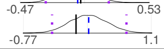
3. RESULTS

While in **H1** we hypothesized an inverse-U-shaped relationship between density and signature counts, instead we find a a strictly negative relationship. Petitions at the low end of our observed range of density are likely to recieve more signatures compared to petitions at increasing levels of density. Our model predicts that a prototypical petition at the first quintile of density (0.72) will obtain 53 signatures (CI:$[42, 65]$), but that a comparable petition with a normalized density at the fourth quintile (2.9) will obtain 1.4 signatures (CI:$[0.52, 2.6]$).

Neither do we find evidence of resource partitioning between generalists and specialists on Change.org. We hypothesized that frame specialization might be an advantageous strategy when concentration is high. This would have been indicated by a positive coefficient on the interaction term between concentration and frame specialization. However, we observe no such relationship ($\widehat{B} = 0.18$, $SD = 0.28$).

Our results present a picture of online petitioning as a competitive space for collective action. When topical areas are more popular sites for attempting to mobilize collective action, average attempts achieve lower levels of participation. While participation in petitions is highly concentrated, we observe no evidence of the prediction of resource partitioning theory that specialists that focus on a handful of topics are more successful in more concentrated environments. Our findings do not support the notion that successful petitions generally legitimate petitioning within social movements.

Table I. Bayesian Negative Binomial Regression predicting petition signature counts.Marginal Posterior plots show the distributions of coefficients in our posterior samples. Solid black lines indicate the position of 0, blue dashed lines indicate the mean, and dotted purple lines indicate the boundaries of the 95% credible intervals.

Coefficient	Mean	SD	2.5%	50%	97.5%	$\widehat{R}$	Marginal Posterior
topic density	-1.59	0.26	-2.09	-1.59	-1.09	1.00	
topic density$^{\mathbf{2}}$	-0.02	0.13	-0.27	-0.02	0.22	1.00	
concentration $\times$ frame specialization	0.18	0.28	-0.35	0.18	0.74	1.00	

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