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Source: *Political Research Quarterly*, Vol. 66, No. 1 (MARCH 2013), pp. 102-114
Published by: Sage Publications, Inc. on behalf of the University of Utah
Stable URL: https://www.jstor.org/stable/23563592
Accessed: 20-08-2018 00:23 UTC

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Political Research Quarterly
66(1) 102–114
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DOI: 10.1177/1065912911434161
prq.sagepub.com
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Connecting to Constituents: The Diffusion of Representation Practices among Congressional Websites

Kevin M. Esterling[1], David M. J. Lazer[2,3], and Michael A. Neblo[4]

Abstract

Legislative websites are increasingly important in the practice of representation. Since adapting old practices to new technology entails uncertainty, the authors expect legislative offices to learn website representation practices from each other. Using data from the 2006 and 2007 official home pages of members of the U.S. House of Representatives, the authors find that web design practices regarding the content of legislative websites diffuse within state delegations, that is, among members hailing from the same state, but the underlying website technologies do not. These results suggest the continued importance, even in the online world, of state delegations in congressional representation.

Keywords

U.S. Congress, websites, technology diffusion, representation, causal inference

The practice of representation is central to any legislator's responsibilities, both normatively (Pitkin 1967) and empirically (Fenno 1978). The relatively recent development of Internet-based communication technologies has the potential to transform the way legislators engage in the practice of representation (Druckman et al. 2009; Druckman, Kifer, and Parkin 2007; Lazer, Neblo, and Esterling 2011). In the United States, citizens are increasingly turning to the official web pages of members of Congress to learn about their policy positions and constituency service activities.[1] Online representation requires members to post timely and relevant content and to deploy technology that improves access to the content.

As with technological innovation in any occupational field, legislators must learn how to adopt and implement these new online communication technologies to realize the potential advantages in reaching out to constituents and others. And in general adaptation of old practices to new technology entails uncertainty. In this article, we examine whether members of the U.S. Congress learn online representation practices from each other, focusing on the extent of diffusion of website design features among representatives' official home pages. It is well known within the literature on Congress that members often discuss practices of representation with other members within their state delegation (e.g., Padgett 1990; Truman 1956). We therefore expect that a member will be more (less) likely to adopt new website content and technology design features if other members of her or his state delegation have (have not) adopted the features (Kingdon 1989, 88-91).

A major inferential issue in testing the effects of a geographically concentrated small group on technology diffusion, or diffusion among physically proximate units, is to distinguish a causal diffusion process driven by membership in the group from a process driven simply by unmeasured (latent) confounding attributes that members of the social grouping happen to have in common (see Fowler et al. 2011; Lazer 2001). Using data on the website designs of neighboring congressional districts, some of which are across state lines, we are able to control for unobserved local-level confounding variables, and so we can identify the causal effect of membership in a state delegation on website design.

Our results suggest that the state delegations play an important role in the diffusion of website design among congressional offices and that the probability of diffusion is higher in state delegations where the members tend to

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be from the same party. The dependence we observe, however, involves a design focus on content rather than on the underlying technology of the websites. Website design features do not appear to diffuse through potential cross-state communication channels between members, such as cosponsorship networks (Fowler 2006; Fowler and Cho 2010) or via a cueing process based on ideological proximity (Kingdon 1989, 74; Krehbiel 1992, 81). To the extent it exists, then, the diffusion of online representation practices appears to be driven by small-group processes within state delegations rather than through substantive policy discussion channels that cross state lines.

State Delegations and the Diffusion of Website Representation Practices

The Internet offers members of Congress the means to connect with constituents in a manner unfiltered by the news media or other elites (Lazer, Neblo, and Esterling 2011). The Internet presents a very low-cost way to communicate directly with constituents and so has the potential to transform the practice of representation, in the way representatives communicate their values and preferences and facilitate constituent services in an information-driven society. The use of the Internet also poses potential political hazards, however, since unlike face-to-face communication, the representative cannot customize messages to recipients and since online postings can spread rapidly and cannot be removed. How to navigate these opportunities and dangers while adapting to online technologies is a fundamentally tricky business, and one means to reduce uncertainty is to learn from others who also engage in the same practices.

The social networks literature has identified social conditions that foster the diffusion of innovative practices (Coleman, Katz, and Menzel 1957; Hagerstrand 1967; Ryan and Gross 1943).[2] Social network research has found that strong or "high bandwidth" relationships that often exist within a small group—those based on personal familiarity, trust, and high in frequency—are especially important in the diffusion of innovations (Allen 1978; Festinger 1950; M. T. Hansen 1999; Kraut, Egido, and Galegher 1990; Monge et al. 1985; Rice and Aydin 1991; Van den Bulte and Moenaert 1998; Zahn 1991). Learning through observing others' experiences lowers the ambiguity and perceived risk associated with an innovation (Galaskiewicz and Burt 1991; Haunschild and Milner 1997; Valente 1995). Furthermore, the behaviors of others within a small group or a social network creates a normative environment. A behavior is legitimate because others who are similarly situated are doing it, inducing mimetic isomorphism (DiMaggio and Powell 1983).

In this article, we examine the extent to which representatives learn to utilize their official websites from their peers in their own state delegation. Scholars have long recognized (Deckard 1972; Kessel 1964; Padgett 1990; Truman 1956) the tendency of members from the same state to meet and discuss legislative policy and process.[3] Kingdon (1989, 88-91) describes several mechanisms for influence among delegation members. First, members from the same state often know each other personally, often for extended periods, have friends in common, and as a result have more trust in each other.[4] Second, members from a state delegation are likely to share similarities and hence are more likely to accept behavioral cues from each other. Third, state delegation members often have incentives to act cohesively and not to stand out from the group. As a result, delegation members are more likely to mimic each others' websites, to ask each other for advice, or to hire common outside web design firms.

We therefore expect to discover dependence among the websites among members from a common state delegation, or the small-group cohesion that Truman (1956), Deckard (1972), Padgett (1990), and Kingdon (1989) observed for voting decisions. Our main hypothesis holds that a member's use of a website design feature depends on the propensity of other members in her or his state delegation also to adopt those features. Furthermore, we expect this dependence to be greater in smaller and more homogeneous delegations.

Note that we do not attempt to identify the mechanism or mediating variables through which state delegation membership has a causal effect. In particular, we are agnostic whether diffusion occurs as a result of communication within the delegation; one also would observe this dependence with mimetic or competitive processes (DiMaggio and Powell 1983). Identifying this sort of mediating causal effects, even under the best of circumstances, requires very strong assumptions (Imai et al. 2010). Instead, we seek to identify and estimate the "black box" causal effect of state delegation membership on the diffusion of online representation. Identifying this causal effect requires that we account for similarities among websites that is the result of the group members' spatial or geographic proximity. To show the causal effect of membership in a state delegation requires that we hold constant all other commonalities members might have, other than belonging to the same delegation, by virtue of their geographic proximity, such as having similar constituencies, districts, and political orientation.

Data

Within the U.S. House of Representatives, congressional offices are 440 (including nonvoting delegates) small, functionally identical, public organizations with a set of

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policy and procedural outputs (Hedlund 1984; Salisbury and Shepsle 1981). This enables a large-N statistical study of members' adoption of new practices in online representation.[5] Web technology is changing rapidly in this time period, and so we do not offer this analysis as a journalistic account of contemporary web practices. Instead, we argue that examining the dynamics of web practices as they emerged is useful as a case study of how legislators adapt their representation practices to technology at a time when the state of the technology is in flux (Bimber 2003, 8).

In this section we describe our measures of website design features, how we created the district adjacency and state delegation matrices, our strategy for identifying the causal effects of state delegation given these data, and some covariates (Druckman, Kifer, and Parkin 2007; Esterling, Lazer, and Neblo 2005) that also are of substantive interest.

Outcome Variables: Measuring Online Representation

The dependent variables we use for this analysis are drawn from the 2006 and 2007 Congressional Management Foundation (CMF) coding of the official website for each member of Congress (for similar coding efforts, see Druckman, Kifer, and Parkin 2007; Johnson 2004; Owen, Davis, and Strickler 1999; Stromer-Galley 2000). In the summers of 2006 and 2007, CMF staff coded each official website. CMF trained teams of coders, who accessed and coded each official website based on nearly one hundred operational criteria. CMF identified and defined the criteria using a number of sources regarding best practice standards for legislative websites, specifically by asking focus groups of citizens to spend time on a sample of sites, by conducting interviews and surveys with office staff and citizens, and by conducting web industry research (Johnson 2004). This field research established standards for the practice of online representation, focusing on policy content, constituency services, and relevant technology (Burden and Hysom 2007). CMF conducts formal evaluations of the websites of all members of Congress, and these evaluations receive widespread attention on Capitol Hill (e.g., Brotherton 2007; Yehle 2009).

The coding for the twenty-one variables we use for this study, the instructions given to the coders, and descriptive statistics are listed in the online appendix (available at http://prq.sagepub.com/supplemental/). The appendix also reports on our analysis of intercoder reliability and the validity of the coding rules.

The data set includes four items that measure the presence and quality of policy-relevant issue information on each site. These are coder ratings of the quality of information regarding national issues, state and local issues, and issues of special importance to the member and the presence of rationales that help explain the member's voting decisions.

We use seven items to measure the overall quality of constituency services on the website. These include coders' rating of the quality of casework FAQ answers, the presence of information on how to initiate casework with the member's office, whether the website includes an online casework initiation form, the presence of links to federal agencies and to FirstGov.gov (now www.usa.gov), and information about local district resources and services.

For items measuring the technical quality of each website, we include measures of whether or not the site contains video or audio and has a text-only option, a blog, an RSS feed, and podcast capabilities. The final three items, navigability, readability, and timeliness, measure general technical properties of the website design, each measured on a 5-point scale.

State Delegation and Alternative Adjacency Measures

Following the discussion above, we expect membership in a state delegation to have an influence on members' decision to adopt the online representation practices listed in the previous subsection. To account for members' state delegations, the statistical model we use requires that we construct an "adjacency matrix," in which two members are "adjacent" if they belong to the same state delegation. We constructed this adjacency matrix with rows representing members, columns with labels identical to the rows, cells $[i, j]$ equal to one if members in row i and column j are in the same state, and equal to zero if members i and j are in different states.[6] The diagonal of this matrix is a zero vector. Our random effect model also requires a matrix of district adjacencies. This matrix is similar to the state delegation matrix, with the exception that the cells are equal to one if two members' districts are adjacent, and zero otherwise.[7]

For comparison, we also estimate the model below substituting an adjacency matrix constructed from cosponsorship data (Fowler 2006). The labels of the cosponsorship matrix are identical to those of the district and state delegation matrices, with zero on the diagonal, and off diagonal elements of the ith row equal to one if member i and member j were frequent cosponsors, where "frequent" is more than one standard deviation above the mean number of i's cosponsorships with all members. To test for possible diffusion through cueing processes (Kingdon 1989), we also estimate the model substituting an adjacency matrix where the off-diagonal elements are one if member i and member j are close to each other in DW-Nominate space (http://www.voteview.com). We define two members as "close" in DW-Nominate space

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by first squaring the deviation between member i and all other members, and then selecting the subset members who are in the lowest 12.5 percentile in distance from member i.[8]

Identifying the Causal Effect of Belonging to a Spatially Defined Group

The major inferential issue in testing hypotheses about diffusion among geographically proximate units involves distinguishing a diffusion process within the geographically concentrated small group from mere spatial heterogeneity (Congdon 2003, 274; Lazer 2001). That is, if the websites of the members of a state delegation are all likely to have a given characteristic, and websites in another state are unlikely to, we wish to be able to test whether this correlation is the result of a causal diffusion process or the result of a spurious dependence where many members of a state delegation may happen to share one or more unobserved causal variables.

In the statistical analyses below, we are able to control for spatial heterogeneity by exploiting data from several members whose congressional districts are adjacent to each other. If spatially confounding variables exist, they would most likely be evident in these localized clusters since adjacent congressional districts, even those across state lines, often share more similarities than districts at opposite ends of a state. For example, the California forty-fifth district (including the desert cities of Palm Springs and Indio) shares more similarities with the California forty-fourth district (Riverside and Corona) and with the Arizona seventh district (parts of Yuma, Maricopa, and Pima desert counties) than with the California sixth district (wine country, Marin and Sonoma Counties). Evidence is lent in support of the causal effect of state delegation on diffusion if members' web design practices are observed to be dependent within groupings defined by state delegation after having controlled for district-level spatial heterogeneity.

One can think of this approach as similar to a random effect model, where the adjacent districts serve as "repeated observations" for a given district. The websites of these adjacent district "repeated observations" allow us to estimate the latent propensity of someone representing the district to have each design feature, by virtue of representing that locality. Holding this latent propensity constant, we can estimate the causal effect of state delegation websites on the design elements of each member's website.

The persuasiveness of this quasi-experimental approach depends on the ignorability of state boundaries for unobserved spatially distributed confounding variables. Ignor ability requires that the conditional distributions of any unobserved causal variables across districts that are geographically proximate, but on either side of the state line, are similar. For example, this assumption holds that residents in Calumet City, Illinois (IL-2, in southeast Chicago), are similar to those who live in nearby Gary, Indiana (IN-1), and members who serve in each of these districts share similar qualities. One would also expect that each of these will differ demographically and politically from those in New Albany, Indiana (IN-9, near Louisville).

We can test for the ignorability of state boundaries using aggregate district-level census data. If state borders are ignorable, then variables constructed from aggregate census data should be balanced between districts that are on either side of the state border, among those that are adjacent to a district that lies on a border. At the same time, one would not expect census data to be balanced between districts within a state but not adjacent. We test balance only among the 242 districts that lie adjacent to a border and that are in a state large enough to have districts that are within the state but not adjacent (55 percent of districts in the sample meet these conditions).[9] For covariates, we use census data on district median income; the percentage of district residents who are college educated, who work in the service employment sector, who work in the blue-collar sector, who work in the white-collar sector, who are younger than eighteen, who are older than sixty-four, and who are Black; and the percentage voting for Kerry in the 2004 general election. In addition, the attributes of the members from these districts also should be ignorable. For the member attribute variables, we use the number of terms each has served and the first and second dimension DW-Nominate score (see http://www.voteview.com). Using the omnibus balance test statistic of B. B. Hansen and Bowers (2008), we cannot reject the hypothesis of balance between adjacent districts (p = .307), but we can reject the hypothesis of balance between within-state nonadjacent districts ($p < .0001$). That the adjacent districts are balanced at the local level justifies using adjacent districts as "repeated observations" in a random effect model as a method to hold constant district-level unobservable variables and so to identify the causal effect of membership in a state delegation.

Control Variables

Since our model is designed to hold all district-level covariates constant through a random effect, we do not need to include a long battery of district- or member-level covariates.[10] Instead, we hold constant only two variables that previous work (e.g., Esterling, Lazer, and Neblo 2005) found to have an effect on the quality of legislative websites and that are of substantive interest to this article. First, as we note above, staff themselves report attending to websites within their party, and this suggests the possibility of party effects. We control for the member's political party by including a variable that

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equals one if the member is a *Republican* (the majority party in 2006) and zero otherwise (M = 0.533, SD = 0.499). Second, members who have longer terms in office tend to make less effective use of website technology, and the random effect approach we adopt cannot account for differences in members' tenure.[11] To control for this, we include a measure that equals one if the member is a *freshman* in 2006 and zero otherwise (M = 0.096, SD = 0.295).

Estimation

As we state above, we hypothesize that a member's use of website design features depends on the propensity of other members in her or his state delegation to also adopt those features, and these other members themselves are in the same estimation sample. The statistical literature on geographically connected processes has devised techniques to study spatial interdependencies in a way that appropriately accounts for these reciprocal effects (Anselin 1988; Cliff and Ord 1981; Doreian 1980). For this article, we estimate spatial dependence with a conditionally autoregressive model (Congdon 2003, chap. 7) using Bayesian Markov chain Monte Carlo (MCMC) sampling to simulate a posterior distribution of all model parameters.

We describe the model in detail in the online appendix (for the model, we rely on Congdon 2003, 278-82). In summary, the model includes the covariates in the outcome equation and holds constant any remaining relevant local-level variables constant via a random effect that groups members using the district adjacency data. The random effect is captured in a structural parameter we label ρ_a. Holding these local-level variables constant, the model tests for the effect of membership in a state delegation by grouping members using the state delegation data, an effect that is captured in a structural parameter we label ρ_s.[12]

We estimate the model in four ways.

1. We first assume the relevant state delegation for member i contains all other members in her or his state.
2. We next assume that the relevant state delegation for member i contains only other members in her or his state that are of the same party, or same state copartisans. For the few members with no copartisans in the state, we assume that the full state delegation is the relevant reference group.
3. We then substitute the adjacency matrix constructed from cosponsorship data (described above) for the state adjacency matrix. For this model, we omit the local-level (district adjacency) random effect from the outcome equation. If ρ_s in this model is positive, we cannot distinguish between a causal diffusion within the cosponsorships network and latent dependence resulting from omitted local-level variables. If ρ_s is not positive, then we can conclude there is no evidence of dependence, causal or otherwise, within cosponsorship networks.[13]
4. Finally, we use the same models as in model 3, but this time substituting the DW-Nominate adjacency matrix. The same caveats regarding causality apply to this model that apply to model 3, above.

We estimate all four of these models first assuming cross-sectional dependence, modeling member i's propensity to have the website feature in the 2006 data as a function of other members' propensity to have the same feature in 2006. To test whether there is a time lag in adoption decisions, we also model member i's propensity to have the feature in 2007 as a function of other members' propensity to have the feature in 2006. Since an election intervened between the 2006 and 2007 panels, we set the 2007 outcomes of 2006 incumbents who did not return in 2007 to missing and impute their 2007 outcomes under missing at random conditional on the fixed and random effect variables using the method of Tanner and Wong (1987).

For estimation, we use the MCMC Gibbs sampler in WinBUGS (Spiegelhalter et al. 1996). We assume diffuse priors for the structural parameters to minimize the influence of the prior parameter distributions on the posteriors. We sample three chains and initialize each chain with overdispersed starting values. The chains show extremely good mixing using the Brooks–Gelman–Rubin diagnostic (Gelman and Rubin 1992). Below we present summaries of the marginal posterior distributions of the model parameters.

Results

One advantage of Bayesian estimation is that the results are reported as a posterior distribution. One can use the posterior distribution to evaluate the significance of parameter estimates without relying on critical-level (frequentist) hypothesis tests. The results for models using the 2006 cross-sectional data are in Table 1. The cell entries indicate the probability of dependence for each outcome variable among members of a state delegation, holding constant local-level unobserved variables and the control variables. That is, each cell gives the density of the posterior probability distribution that lies above zero for the ρ_s parameter, the structural parameter that captures dependence within state delegations.

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Table 1. Probability of Diffusion in State Delegations, 2006 Cross-Sectional Analysis.

	Same state	Same state copartisan	Cosponsorship network	Ideological proximity
National issues	0.999*	1.00*	0.655	0.138
Member's issues	0.943*	0.925*	0.394	0.396
State/local issues	0.003	0.009	0.391	0.406
Vote rationale	0.981*	0.581	0.557	0.435
Constituent FAQs	0.058	0.870	0.387	0.376
Casework initiation	0.991*	0.549	0.366	0.165
Casework form	0.013	0.305	0.532	0.682
Agency links	0.002	0.011	0.298	0.543
Link to FirstGov	0.113	0.048	0.196	0.330
Grant info	0.811	0.715	0.466	0.843
Info on district resources	0.081	0.863	0.287	0.397
Video	0.010	0.543	0.645	0.838
Audio	0.915*	0.959*	0.754	0.627
Text only	0.933*	0.519	0.492	0.471
Blog	0.740	0.142	0.517	0.503
RSS feed	0.065	0.288	0.518	0.717
Podcast	0.531	0.350	0.508	0.573
Navigation	0.986*	0.902*	0.561	0.135
Readability	0.930*	0.826	0.372	0.375
Timeliness	0.953*	0.904*	0.544	0.277
Number of items $p > .75$	10	8	1	2
Number of items $p > .90$	9	5	0	0

$N = 438$.
$^*p(\rho_s > 0) > .90$.

The bottom row of Table 1 indicates the number of items that have at least a 90 percent probability of dependence within each network. Notice that by this criterion, dependence is most likely within the same state network (dependence for nine items) compared to the networks captured in the other columns. There appears to be dependence within state delegations among a wide range of items, including those measuring issue representation (content on national issues, the member's priority issues, and her or his vote rationales), constituent needs (help with casework initiation), the technical qualities of the websites themselves (audio, a text-only feature), and the general technical qualities of websites (navigability, readability, and timeliness).

Figure 1 depicts the magnitude of the diffusion effects for six of the items for which diffusion was present in 2006. The dark line in each graph shows how the estimated change in probability that member i adopts a design element changes as the proportion of her or his full state delegation who also adopt that element increases (the light lines are random draws of parameter sets from the posterior distribution and hence depict the uncertainty for each conditional probability, similar to a confidence interval). The "rug" in each figure shows the actual range of the proportion across state delegations, so estimates beyond the rug are out of sample.

The top four graphs in Figure 1 indicate diffusion effects for the quality of website content such as issue positions, vote rationales, and casework FAQs. For these measures, a one indicates the website was judged by the coder as having good quality and specific content on each of the dimensions. The probability that a member has high-quality content when everyone else in the state has low-quality content ranges from about 0.2 to about 0.4. For the national issues, member's issues, and casework FAQs items, the actual proportion of the state delegations with high-quality content varies from zero to nearly one. Varying this proportion increases the propensity to have good-quality national issue content by about 60 percentage points, member's issues by about 20 percentage points, and casework FAQs by about 40 percentage points, where each of these differences is statistically significant. In the sample, only about half of the state delegations had vote rationale content on their websites, but extrapolating outside of the sample indicates the diffusion effect is about the same magnitude as for the other content items.

The bottom two graphs depict two elements of website technology that show positive diffusion. In contrast to the four content items, the probability that a member has audio or text-only technology on her or his website if no one else in her or his delegation has the technology is essentially zero. The range of the actual proportion of

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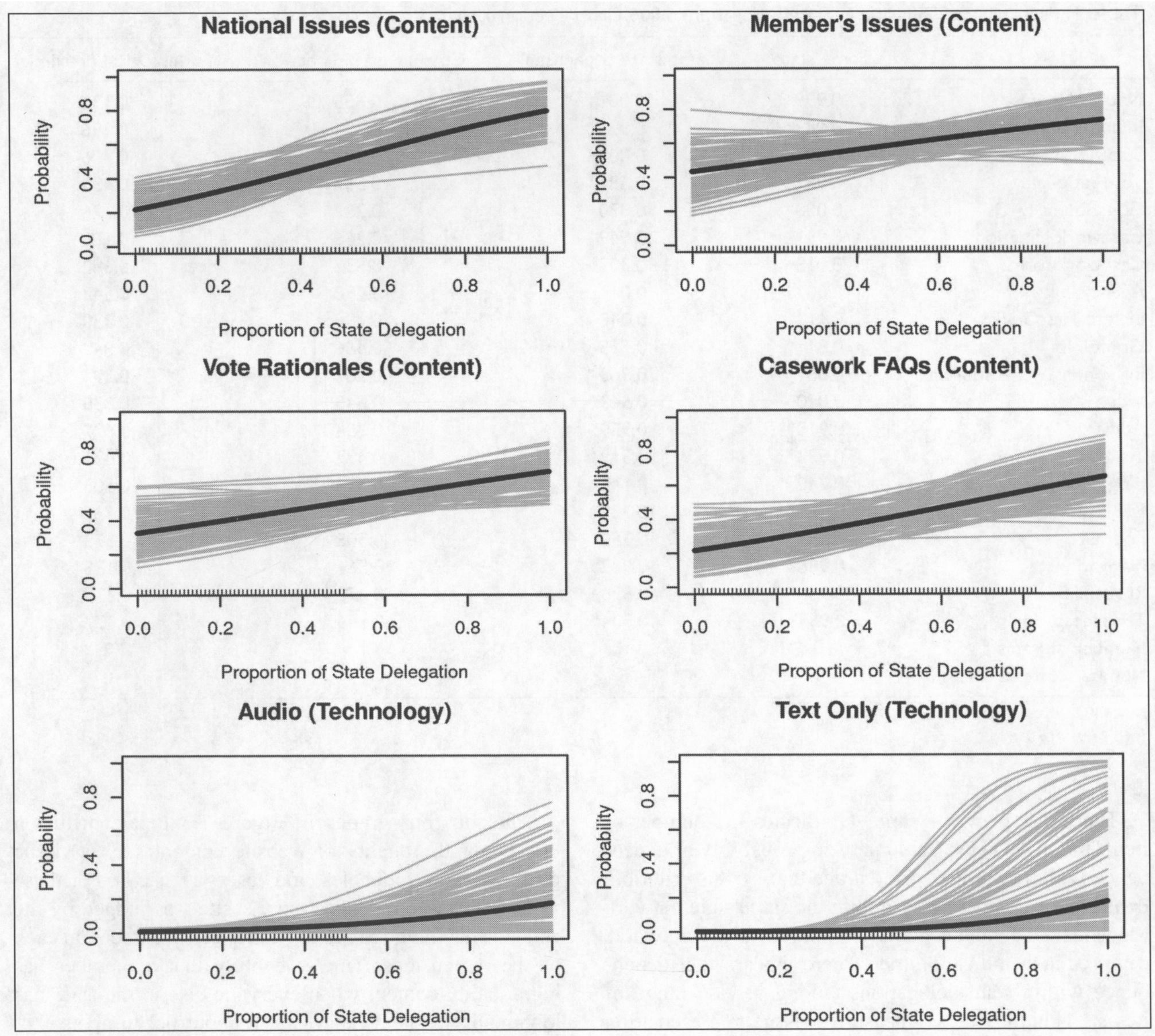

Figure 1. Diffusion effects.
The dark line shows the expected probability that a given member's website will have the design feature, conditional on the proportion of her or his state delegation that also has the feature. The light lines give the range of uncertainty for these estimates. The rug on the domain axis indicates in-sample variation for each item.

state delegation who also adopt these technologies varies only from zero to about half. Within this range, the propensity for a member to adopt one of these communication technologies increases, but only imperceptibly.[14] In comparing these to the first four graphs, it is apparent that most of the diffusion within state delegations centers on content-related design rather than on the underlying communication technology of the website.

The model also includes a fixed effect dummy variable, equal to one if the member is a Republican and zero otherwise.[15] Descriptively, we find that Republicans are more likely to have a number of the items on their websites in 2006, including a rationale for their votes, constituent FAQs, a casework form, audio, and a text-only feature. Democrats did not have a statistically higher propensity on any of the items. There are many reasons for this difference between the parties, including a stronger interest among the party leaders in the quality of rank-and-file websites (Adler, Gent, and Overmeyer 1998, 586), a difference in the propensity of Republicans and Democrats to take an interest in electronic representation, and the effect of majority-party status.

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Returning to Table 1, the entries in the second column indicate that dependence within the state delegation does not seem to be heavily conditioned on partisanship. The probability of diffusion is constant whether or not one takes into account partisanship within the delegation. Furthermore, we find little difference in the extent to which diffusion within state delegations differs between the two parties. To show this, we reestimate the model of column 1 of Table 1, changing the likelihood function slightly so that ρ_s is estimated separately for each party. We find that only one (out of twenty-one) of the differences in ρ parameters for each party was significantly different, or about what one would expect by chance. In addition, the point estimates for the ρ parameter for each party show no consistent pattern; sometimes the estimated ρ is higher for Democrats, sometimes for Republicans.

Overall, then, we find little evidence to suggest that members limit their attention to members of their own party within a state delegation. This finding is consistent with that of Truman (1956, 1034), who notes that partisan divides are relatively absent in discussions among members of a state delegation. Such a finding does not imply, however, that partisanship does not matter for diffusion. Our second hypothesis holds that diffusion is more likely to occur in small and homogeneous groups, where we measure homogeneity as the tendency of members in the state delegation to identify with the same political party.

To test for this, we reran this same model but this time using a random coefficient model making the state-level ρ_s parameter itself a function of state-level covariates. That is, we used a hierarchical model that allows the probability of diffusion to vary across state delegations and modeled that variation using two new state-level covariates: the size of the state delegation (ranging from one to fifty-three, standardized) and the proportion of the state delegation that is from the same party (ranging from zero to one). Technically, this random coefficient approach treats these state-level (level 2) covariates correctly as having 50 observations rather than as 438 observations. Substantively, the random coefficient approach allows us to test how the composition of the state delegation can affect the degree of diffusion, and including these two covariates allows us to test whether diffusion is simply a small-group phenomenon (i.e., a function of the delegation size) or whether it is driven by cohesion and homogeneity in the small group (indicated by the homogeneity of partisanship), or both.

We estimate this random coefficient model for the six dependent variables displayed in Figure 1. In each case (except for one),[16] we find that the size of the state delegation does not predict the probability of diffusion. We also find that, for many of the dependent variables, partisan homogeneity increases the probability of diffusion. Specifically, for the national issues dependent variable, we observe the level 2 coefficient for the proportion of the delegation from the same party to have a 90 percent posterior probably of being greater than zero, vote rationale 84 percent probability, audio 93 percent probability, and text only 92 percent probability.[17] Recall from above that we do not observe a higher rate of diffusion among same-state copartisans than we do among members of the full delegation. This implies that members do not strategically limit their attention to copartisans. That partisan homogeneity among a state delegation increases the probability of diffusion suggests instead that group homogeneity matters, as a property of the group itself, which one would expect if the diffusion process were driven by cueing within a small group.

The final two columns of Table 1 show that no dependence is evident within the cosponsorship network or within the network defined by ideological proximity. The second to last row indicates this pattern does not change when one relaxes the criterion to only a 75 percent probability. These findings suggest that most of the social influence within the institution is within state delegations as a whole, perhaps as true today as it was in the time of Truman (1956). That geographic state delegation small groups appear to matter more than D.C.-based legislative networks such as cosponsorship or ideological distance is perhaps to be expected, and this contrast is perhaps no surprise. The main purpose of the website is for the member to represent herself or himself to her or his constituents, and representation in the U.S. Congress is geographic rather than issue or ideologically based.

Table 2 gives the results for the over-time (2006–2007) analysis. Notice that the results change very little from Table 1. This indicates that diffusion within state delegations does not have a strong lag. Indeed, much of the dependence in the over-time analysis is likely the result of the path dependence within individual sites. Once a website adopts a given feature, it is unlikely to remove that feature (Esterling, Lazer, and Neblo, forthcoming).

Recall that the model also estimates a structural parameter, ρ_a, that captures any dependence that may occur among adjacent congressional districts. If we observe dependence at this level, the model cannot distinguish dependence that might come from causal diffusion processes among the offices in adjacent districts from a spurious dependence that might come from unobserved confounding variables that vary geographically. The absence of dependence at this level, however, indicated by an estimated ρ_a with posterior probability mass near zero, can rule out diffusion as well as the presence of any district-level variables that determine the content or quality of websites. We find little to no evidence of dependence at the district level.[18] For example, in the 2006 cross section, out of the twenty-one regressions of the first column of Table 1, none of the ρ_a parameters have a

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Table 2. Probability of Diffusion in State Delegations, 2006 to 2007 Over-Time Analysis.

	Same state	Same state copartisan	Cosponsorship network	Ideological proximity
National issues	0.997*	1.00*	0.570	0.267
Member's issues	0.975*	0.980*	0.498	0.502
State/local issues	0.435	0.189	0.357	0.330
Vote rationale	0.800	0.762	0.378	0.623
Constituent FAQs	0.764	0.994*	0.383	0.391
Casework initiation	0.774	0.724	0.496	0.385
Casework form	0.282	0.556	0.480	0.769
Agency links	0.961*	0.890	0.451	0.362
Link to FirstGov	0.851	0.165	0.486	0.609
Grant info	0.832	0.468	0.455	0.679
Info on district resources	0.917*	0.835	0.516	0.451
Video	0.100	0.749	0.696	0.665
Audio	0.637	0.939*	0.553	0.676
Text only	0.987*	0.715	0.491	0.458
Blog	0.986*	0.825	0.573	0.556
RSS feed	0.073	0.459	0.557	0.531
Podcast	0.752	0.771	0.424	0.540
Navigation	0.960*	0.821	0.359	0.374
Readability	0.531	0.813	0.426	0.215
Timeliness	0.693	0.666	0.739	0.741
Number of items p > .75	12	12	0	2
Number of items p > .90	7	4	0	0

N = 438.
*$p(\rho_s > 0) > .90$.

greater than 90 percent chance of exceeding the mean of the prior distribution (0.5), and only three have greater than a 75 percent chance of being greater than the prior mean (only casework form, link to FirstGov, and video), or about what one would expect to observe simply from random variation.

These findings regarding local-level dependence reinforce those from other studies that find relatively few district-level *observed* variables that are predictive of website quality (Adler, Gent, and Overmeyer 1998, 591; Cooper 2004, 352; Druckman, Kifer, and Parkin 2007; Druckman et al. 2009, 17; Ferber, Foltz, and Pugliese 2005, 147; Esterling, Lazer, and Neblo 2011). The lack of all dependence at this level further demonstrates the absence of *unobserved* causal variables measured at the district level. This independence is not especially surprising. Citizens in all districts, whether agricultural or industrial, rich or poor, liberal or conservative, care about maintaining accountability and make demands for member services. The results show that all members face uniform incentives driving the quality of websites, and most variation in website quality is likely idiosyncratic in the member's own interest in web technology, along with exposure to such idiosyncrasies in her or his state delegation.

Discussion

The above analysis provides insight into the pathways for how online representation practices diffuse within Congress. We find a significant possibility of diffusion within state delegations across a variety of measures of legislative website quality, and this probability is higher in state delegations that are homogeneous in the sense that members tend to identify with the same political party. This cohesion in a "small group" is consistent with previous research on social network effects within state delegations (Deckard 1972; Kessel 1964; Padgett 1990; Truman 1956). At the same time, we find little evidence of diffusion in cross-state communication channels driven by substantive policy concerns, either cosponsorship networks or ideological proximity.

We find that much of the diffusion is centered on website content, such as issue content and content focused on constituent casework, rather than the communication technology itself. Adoption of the underlying communication technology for these websites, such as the presence of blogs, podcasts, RSS feeds, video, and the like, is driven neither by district-level variables nor by diffusion. Overall, we observe low marginal levels of adoption of

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various technologies. That offices are not self-reflective or discursive regarding communication technology practices suggests that website technology is often a mere afterthought at best. That communication technology exists does not necessarily imply that legislators have the capacity or incentives to adopt them for democratic governance (as in Bimber 2003; Druckman, Kifer, and Parkin 2007; Fountain 2001).

At the same time, however, we do not detect any geographically distributed, district-level variables that drive website content. Instead, the quality of a legislative website appears to be idiosyncratic across members. Taken together, this suggests that the presence of high-quality content relevant to legislative representation appears to be mostly driven by the idiosyncrasies among members in a state delegation rather than a reflection of any variation among localities in demand for good-quality websites or stronger online representation.

Conclusion

These results suggest that much of the communication regarding online representation occurs within state delegations, and this gives some insight into the continued importance of state delegations for the way Congress practices democratic representation. While we cannot state the specific mechanism by which state delegations matter, it may be that offices are purposefully learning best practices regarding website content and political communication from each other. In this sense, the results suggest the presence, to some degree, of deliberation among members on the design of the institution itself.

These findings also reinforce our understanding of the invisible networks connecting members of Congress. Members' official websites offer a behavioral trace of decision processes about representation practices, traces that are easily measured for every member. The fact that there is a clustering of representation practices within state delegations provides strong evidence of the role that small groups play in organizing the social system that constitutes Congress (see Fowler and Cho 2010).

Finally, we note that the methods used in this article to net out the effects of local-level unobservables are general and could be applied to net out a wide range of confounding variables in any test of behavioral hypotheses in any district-based legislature. We show how to leverage spatial representation in a random effect framework for estimating causal effects, whenever adjacent districts can serve as repeated observations to control for local-level unobservables.

Acknowledgments

We presented earlier versions of this article at the Midwest Political Science Association annual meeting, Chicago, Illinois, April 22, 2010, and at the annual meeting of the American Political Science Association, Toronto, Canada, September 2–5, 2009. We gratefully acknowledge the intellectual contributions from our colleagues at the Congressional Management Foundation (CMF), especially Collin Burden, Nicole Folk-Cooper, Kathy Goldschmidt, and Tim Hysom. We thank Daniel Butler, Barbara Trish, Caroline Tolbert, Paul Zak, and two anonymous reviewers for very helpful comments. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or CMF. The data to reproduce the findings are available at http://tert.ucr.edu/tommy . An online appendix providing supplemental material is available at http://prq.sagepub.com/supplemental/.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This project is funded by a grant from the Digital Government Program of the National Science Foundation (award number IIS-0429452).

Notes

1. In 2006, 72 percent of respondents to the Cooperative Congressional Election Study survey (http://dvn.iq.harvard.edu/dvn/dv/cces) indicated that they would use the official website to discover where their member of Congress stood on issues, compared to only 36 percent indicating they would find this information by calling or writing the office directly, 19 percent from TV news; 7 percent from TV talk shows, 8 percent from radio news, 13 percent from radio talk shows, and 20 percent from newspapers and magazines.
2. For example, Walker's (1969) classic study of the diffusion of innovations among the American states shows that diffusion tends to occur more regularly among adjacent states, which he took to proxy for more regular communication among state-level policy makers (also see Mintrom 1997).
3. At the state level, Caldeira and Patterson (1987) find similar patterns of friendship among Iowa state legislators with districts closer together.
4. L. W. Arnold, Dean, and Patterson (2000) demonstrate that friendship ties among Ohio state legislators cause members to more often vote on the same side of issues, holding other causes of members' vote similarity constant.
5. For related work on social networks in Congress, see Baughman (2006), who shows how informal staff communication among members who have overlapping committee assignments reduces the transaction costs for writing and negotiating legislation, and Fowler and Cho (2010), who

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examine the effects of cosponsorship networks on legislative productivity; also see Fowler (2006).
6. The model requires each member to be connected to at least one other member, to avoid dividing by zero. To accommodate this, we assign the few members from states with a single congressional district to an adjacent state that is most similar. It is worth noting that the U.S. Geological Survey (USGS) data from which the district adjacencies are constructed include nonvoting delegates from Washington, D.C., Puerto Rico, and the Virgin Islands, but for some reason not the ones from Guam and American Samoa. Thus, our effective sample is 438 (435 regular members plus three nonvoting delegates).
7. Generating the matrix of district adjacencies takes some doing. We downloaded the GIS shape file of congressional districts for the 109th Congress from the USGS National Atlas website. Unfortunately, this shape file does not represent districts but instead represents smaller polygons that, when aggregated, reconstruct a congressional district, and obviously adjacencies among these polygons are not of any use for this analysis. Aggregating the data up to the district level turned out to be a very complex task, requiring over a hundred lines of R code. The R script to do this is available from the authors on request.
8. We chose the 12.5 percentile as this kept the density of this adjacency matrix similar to that of the other adjacency matrices.
9. Limiting the ignorability test to these districts poses no problem. First, we conducted an additional analysis to show that our covariates are reasonably balanced between districts adjacent to a state border and districts that are not adjacent (results not reported). Second, the causal analysis requires only that we show that districts on either side of a state border are similar and so can serve as repeated observations for districts that happen to lie on a border.
10. We also estimated the model including a battery of control variables, and this model yields identical results for the effect of state delegation (both in the point estimates and their precision), a finding that lends confidence to the random effect approach that we adopt. For example, we reestimated the model for national issues content, but this time including variables indicating whether the member was a party leader or committee chair; the member's vote margin in the previous election; and the district's percentage white, average income, percentage over sixty-four, percentage under eighteen, and percentage college educated. None of these covariates show significant effects nor large point estimates, with the exception of the leadership variable. Excluding this variable does not bias our findings, however, since the number of leaders is a tiny fraction of the data set. We report only results from our two control variable model since this model converges much more readily.
11. Members gain greater electoral security with longer tenure in office because of the well-known incumbent advantages (Jacobson 1987, 26). Members with longer tenures in office have fewer incentives to seek out innovative ways to interact with constituents through their websites than those with shorter tenures. Members with longer tenures also are more likely to have well-established ways of communicating with constituents (R. D. Arnold 2004) and thus are unlikely to place much effort in this new form of legislative communication.
12. In the results section we also describe a model that allows the magnitude of ρ_s to vary across state delegations as a function of state-level covariates.
13. To improve convergence, we use an informative uniform on [−1,1] prior. This should have no effect on the results since we only care about the existence of dependence in these models, not the magnitude.
14. The ρ_s parameter in each case is significant, but only because the impact of state delegation is only to move a member from a zero probability to something slightly larger than zero.
15. The outcome equation also includes a fixed effect variable indicating whether the member was a freshman in 2006. This variable also shows little explanatory power, and inconsistent results among the point estimates, with one set of exceptions. Freshmen websites were significantly more likely to be rated highly for navigability, readability, and timeliness. That freshmen are rated higher on these dimensions suggests that 2006 websites have a bit of a slicker design when they are recently created from scratch.
16. The one exception to this pattern is the constituent FAQ dependent variable, where partisan homogeneity and size are negatively associated with diffusion, in both cases reaching conventional levels of significance. It is difficult to think of reasons, however, why diffusion of this item is larger in more heterogeneous large groups. It might be the case that this single item has an odd distribution, and so we choose not to invest too much meaning in this finding.
17. None of these effects reach the conventional level of significance ($p < .05$), but this could be expected since there are only fifty observations at this level and hence relatively little power.
18. This is true whether or not we include the state delegation grouping in the model.

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