Trade-Offs in a Bigger Pie: How the Relationships between Digital Civic Infrastructure and Political Participation Vary Across Rural and Urban Communities in the U.S.—the Case of Michigan

Abstract

This study draws on a unique survey sample of the U.S. state of Michigan, combined with public data, to test the interrelationships among local communication infrastructure, broadband availability, and civic and political participation. Expanding upon Communication Infrastructure Theory (CIT), our analysis presents original findings indicating that the relationship between digital civic infrastructure and voter turnout varies across geographical divisions: Among rural residents, access to local information is negatively associated with turnout for those with higher broadband availability, while the opposite pattern is found among urban residents. Additionally, we replicate elements of CIT, demonstrating that on-offline connectedness to local organizations is positively related to civic engagement. Our quantitative case analysis not only contributes to understanding the democratic potential of the Internet but also offers nuanced policy recommendations tailored to specific regions.

Keywords: Communication infrastructure theory, internet/technologies, civic engagement, voting behavior, survey research, rural broadband

This article examines two competing hypotheses about the Internet's potential for democratic mobilization: The first, *the trade-offs hypothesis* (Prior, 2005; 2007), is that the high-choice media environment leads away from political engagement by substituting political attention for other activities (i.e., entertainment). The second, *a bigger pie hypothesis* (Lelkes, 2020), states that the Internet's unlimited supply of information leads to political sophistication, which in turn promotes political participation. The mixed evidence supporting the two conflicting arguments (see Boulianne, 2009; 2015; Boulianne & Theocharis, 2020) calls for a holistic research scope to scrutinize the Internet's effects on engagement.

The present study also responds to increased calls to examine the geographically uneven distribution of digital infrastructure and its potential to exacerbate inequality across groups of citizens (Katz & Gonzalez, 2016; Robinson et al., 2020). Offering an extension to Communication Infrastructure Theory (CIT) (Ball-Rokeach et al., 2001; Kim & Ball-Rokeach, 2006; Kim et al., 2006), we test how access and connectedness to communication infrastructure is connected to engagement. To do so, we combine measures of broadband internet availability with individual-level survey reports of local media connectedness. Finally, we operationalize the interaction of online communication behavior and broadband internet availability as *digital civic infrastructure*.

To explore geographic digital divides, the current data collection focuses on the U.S. state of Michigan and examines how connectedness to digital civic infrastructure impacts rural and urban areas within the state. Information Communication Technologies (ICTs) provide transformative opportunities for building networked societies, but they also exacerbate existing social inequalities via information and technology access. While recent research has explored the role of the rural-urban divide in political attitudes, beliefs, behaviors, and participation (e.g., Cramer, 2016; Lunz Trujillo, 2022; Van Duyn, 2021; Wells, et al., 2021), there has been limited exploration into the influence of the rural-urban digital divide and digital civic infrastructure. The present work attempts to integrate these two areas of existing scholarship.

Our findings replicate prior CIT research, showing that localized civic communication behaviors are positively related to civic engagement. However, the results show that the relationship between CIT factors and voting behavior varies by geographic divisions, with greater support for the trade-offs hypothesis among rural residents and the bigger pie hypothesis among urban residents. As such, the current unique sample in the U.S. state of Michigan surfaces a nuanced picture of how geographic contexts differentiate the functions of digital civic infrastructure. Ultimately, our quantitative case analysis opens up new avenues for future research that explores the democratic potential of the Internet, as well as fine-grained policy proposals.

Literature Review

Potential of the Internet to Address Participation Gaps

A series of meta-analyses of the Internet's impact on engagement show that the effect of Internet use on democratic mobilization has gradually shifted from negative to positive over the past decade (Boulianne, 2009; 2015; Boulianne & Theocharis, 2020). However, there is still no consensus on the direction of causality and conditional factors of the effect. Two competing hypotheses characterize this ongoing debate. First, the trade-offs hypothesis responds to early empirical research on the negative impacts of the Internet (e.g., Kenski & Stroud, 2006; Nisbet & Scheufele, 2004; Schlozman et al., 2010). It presumes that the wide variety of content on the Internet (i.e., entertainment content) can lead politically unmotivated individuals to deepen their political apathy (Prior, 2005; 2007), which in turn leads them to be further politically disengaged. Although the evidence is mixed at best, there is a steady accumulation of recent research suggesting that the Internet's information-rich environment perpetuates the passivity of politically disconnected groups (e.g., Gil de Zúñiga et al., 2017; Kümpel, 2020; Zhang, 2022).

Lelkes (2020), on the other hand, challenges the trade-offs hypothesis by arguing that it presupposes a finite amount of information that individuals can acquire from the Internet. Instead, the study proposes a bigger pie hypothesis: that the Internet's unlimited supply of information leads to political sophistication, which in turn fosters citizens' political participation. Specifically, it provides evidence that residents of counties with higher-speed Internet bandwidth are more likely to be politically engaged. Recently, Weeks and colleagues (2022) also presented strong evidence that the affordances of the Internet increase the likelihood of incidental news exposure, reducing the knowledge gap between political junkies and the disengaged.

Perhaps the most recent encapsulation of the Internet's potential for democratic mobilization is the 2023 County Health Rankings National Findings Report (University of Wisconsin Population Health Institute, 2023). The U.S. nationwide report shows a positive correlation between the availability of broadband internet and turnout rate. It warns that democratic representation can be stifled in rural areas lacking digital infrastructure.

However, in rural areas, the relationship between broadband internet and civic engagement is mixed. Stern and colleagues (2011) suggest that the Internet as a medium for local information improves the potential for rural individuals to encounter mobilizing information, resulting in increased civic participation opportunities. The authors found that rural broadband Internet users were more likely to engage in active community participation than non-users (e.g., membership/leadership in voluntary organizations and activities intended for community change). Later research indicates that broadband adoption, rather than access, has the most significant impact on specific types of civic engagement in rural communities (Whitacre &Manlove, 2016). This includes participation in local organizations, contacting public officials to share opinions, and expressing opinions online. Yet, there is a negative relationship between broadband adoption and voting likelihood (Whitacre & Manlove, 2016).

While extant research tends to affirm the Internet's potential for democratic mobilization, scholarly attention is needed to grasp what conditions the effects on whom; that is, the current scholarship on this topic calls for a holistic research scope that addresses (1) which online civic behaviors are more closely related to political participation than others, (2) how structural factors such as broadband availability moderate the relationship between online behaviors and offline outcomes, and (3) how the reality of the digital divide, which manifests itself along geographic lines, creates differences in political and civic outcomes between rural and urban residents. Responding to this call, we employ an ecological model encompassing individual-level communication behaviors and aggregate-level communication contexts to explore the differential effects of the Internet comprehensively.

Communication Infrastructure Theory

Communication infrastructure theory (Ball-Rokeach et al., 2001; Kim & Ball-Rokeach, 2006; Kim et al., 2006) is a multi-level ecological model that proposes two primary components of communication infrastructure: (1) storytelling system and (2) communication action context. The storytelling system is a dynamic process in which individuals within a specific geographic community actively adjust and adapt to communication resources at micro- (interpersonal communication), meso- (local organizational communication), and macro- (media communication) levels. The resulting integrated storytelling networks (Kim et al., 2006) function as communication resources for community problem-solving. While traditional CIT work has focused on offline behaviors, more recently, various community-based online behaviors, such as localized social media usage, have been suggested as catalysts for integrating the multi-level storytelling system (e.g., Kim et al., 2019; Nah et al., 2021).

This article employs three types of communicative actions associated with each level of storytelling system, respectively: (1) macro-level local information connectedness, (2) meso-level local organization connectedness, and (3) micro-level interpersonal community storytelling (Ball-Rokeach et al., 2001; Kim & Ball-Rokeach, 2006). First, local information connectedness refers to communication behaviors for learning about local community issues from various news media and other sources. This allows local people to know what is currently on the public agenda in their geographic communities. Second, local organization connectedness is a community-building process in which residents take on a collective identity by forming or belonging to local organizations. The sense of "we" allows people to seek collaborative solutions to the problems their communities face (Mcleod et al., 1996). Lastly, interpersonal community storytelling indicates having conversations about local issues with people in the local community. This micro-level communication practice promotes the sharing of community concerns and consensus-building among people in the community.

We adapt the concept to update information ecologies by incorporating various *online* behaviors corresponding to each level of the storytelling system (Kim et al., 2019; Nah et al., 2021; Nah & Yamamoto, 2018). Within the context of local information connectedness, we include social media use for local information or subscriptions to public newsletters in addition to local or national news media consumption. Similarly, we break down interpersonal community storytelling into face-to-face and digitally-mediated communication (i.e., chat via messaging apps). Lastly, we integrate locally-based online community activities into local organization connectedness.

The second component of CIT is the communication action context, which comprises the structural factors of a communicative environment. Ball-Rokeach and colleagues (2001) draw on Habermas' concept of public sphere and contend that storytelling systems are bounded by "boundaries of a residential area as defined by shared convention" (p. 396). These conventions include physical dimensions such as place and street, sociocultural factors such as ethnicity and class, and technological features such as internet connectivity.

Prior CIT research on communication action context has focused on how ethnic diversity and residential stability condition individual-level communication behavior (Ball-Rokeach et al., 2001; Kim & Ball-Rokeach, 2006). While some early research examines the role of internet access as a structural variable (e.g., Matei & Ball-Rokeach, 2003), these studies are limited by reliance on self-reporting, which measures access as a dichotomous variable (see Lelkes, 2020, for a review). Aligning with the present research objective, we mitigate the limitations of self-reporting methods by operationalizing broadband internet availability—extracted from public data aggregated at the county level—as a communication action context.

Lastly, this paper uses the term *digital civic infrastructure* to encapsulate the interplay between storytelling systems of individual-level civic communication and the communication action context of Internet access availability. Drawing on the CIT framework, the concept of *digital civic infrastructure* helps create an integrated perspective of online behavior and the digital environment, suggesting that the interplay between these components characterizes civic communication (Matei, 2001). Within this, it includes not only how actively or passively individuals *consume* content but also the extent to which individuals *communicate* information about their geographic community (or the state or country itself) with other citizens, leading to the formation of a community storytelling network. In other words, if we liken storytelling systems to software, then communication action context is the hardware that drives that software.

Two Types of Political Participation

Following Van Deth (2014)'s taxonomy, we focus on two types of political participation as a function of digital civic infrastructure: (1) civic engagement and (2) voting. First, civic engagement refers to a set of voluntary actions in which people cooperate with a specific purpose to address public issues that are difficult to deal with individually. As a mode of unconventional and non-institutional engagement, it essentially targets an issue, community, or government (Van Deth, 2014; Ekman & Amnå, 2012). As such, civic engagement is predicated on the organic, grassroots nature of democracy (Skocpol, 1997) and thus includes various activities such as signing a petition, demonstrating, volunteering at social events, etc.

The original CIT outlined the ideal communication structures to stabilize individuals' collective actions within a geographically-defined community, resulting in civic engagement (Ball-Rokeach et al., 2001). Specifically, Kim and Ball-Rokeach (2006) emphasize that the multi-level storytelling system (i.e., local information connectedness; interpersonal community storytelling; and community organization connectedness) is "the most important individual-level factor in civic engagement" (p. 431). Similarly, CIT scholarship has consistently found a positive relationship between the storytelling system variables and civic engagement (e.g., Kang, 2016; Kim et al., 2019; Lee et al., 2023; Nah et al., 2021; Ognyanova et al., 2013). Therefore, it is logical to consider civic engagement as the current model's outcome variable. We thus attempt to replicate the established relationships first:

H1: Local information connectedness (H1a); interpersonal community storytelling (H1b); and local organization connectedness (H1c) are positively related to civic engagement.

Second, voting is a prime example of political engagement and a foundation for all democratic participation (Van Deth, 2014; Ekman & Amnå, 2012). In democratic states, political parties institutionalize societal conflict by mobilizing existing social cleavages, and voters integrate community issues into policy decisions at the ballots (Aldrich, 1995; Cox, 1997; Dahl, 1989; Lipset & Rokkan, 1967).

While CIT premises that localized community communication can mobilize people to set public agendas to solve conflicts within their communities collectively (Ball-Rokeach et al., 2001; Kim et al., 2006), the relationship between digital civic infrastructure and voter participation has not yet been empirically tested. Aside from the CIT scholarship, the evidence on the impact of the Internet on voting behavior is mixed. While a recent national report demonstrates a positive correlation between broadband access and voter turnout (University of Wisconsin Population Health Institute, 2023), another national-level study shows an overall negative impact of mobile 3G internet adoption on county-level turnout (Melnikov, 2021). Studies that combine aggregate-level data with survey data also show conflicting results depending on the types of public data or survey instruments (Campante & Sobbrio, 2018; Lelkes, 2020). Therefore, it is worth exploring the storytelling systems' relationship with institutional political behavior: We investigate how storytelling system variables are related to individual-level turnout in the 2022 midterm election in Michigan.[1]

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[1] The November 2022 midterm elections fit the geographic-community focus here in that they were centered around state-level gubernatorial elections.

RQ1: How does local information connectedness (RQ1a); community interpersonal communication (RQ1b); and local organization connectedness (RQ1c) relate to turnout in the 2022 midterm election?

Rural vs. Urban Divides and Their Implications for Information

Rural Americans are less likely than their urban and suburban counterparts to have internet availability (Ali, 2020; Perrin, 2019)[2]. Availability is defined as the presence of fixed-broadband infrastructure, such as fiber, cable, DSL, satellite, or fixed wireless internet (FCC, 2023). The FCC National Broadband Map compiles data on fixed-broadband availability including information on providers, service types, or maximum advertised download/upload speed, as self-reported by Internet Service Providers (ISPs). The FCC considers locations with fixed broadband infrastructure with an advertised maximum speed of 25 megabytes per second (Mbps) download and 3 Mbps upload as being "served." Locations that fall below this threshold are considered "*un*served."

However, there is ongoing debate as to whether this definition is too liberal as it may be inadequate for many internet activities, especially those of heightened importance during the pandemic.[3] Additionally, these more lenient definitions allow more locations to be considered served. Increasingly, advocates for rural broadband utilize terms such as "*under*served," which indicates access at or above 25/3 Mbps but not at 100/20 Mbps, the starting maximum level of service in urban areas. Ongoing debate pushes for 100/20 Mbps to be the new benchmark for being "served." Being underserved results in lower-quality internet (Ali, 2020) and, in many

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[2] Rural access disparities are deeply embedded, mirroring other historical technological divides, such as the delayed deployment of rural electrification and telephony. Similarly, ISPs are reluctant to expand costly Internet infrastructure to sparsely populated areas due to anticipated low returns on their investment (Ali, 2020).

[3] The FCC notes that activities related to being a student or telecommunter require a minimum of between 5-25 mbps download speed. See https://www.fcc.gov/sites/default/files/broadband_speed_guide.pdf

cases, increased reliance on mobile hotspots and cell phone tethering (Yaacoub & Alouini, 2020).

We invite this debate into the CIT framework: We operationalize broadband availability as the technological communication action context of *digital civic infrastructure,* and explore whether broadband availability at 100/20 Mbps benchmark conditions the relationship between storytelling systems and political participation. For non-institutional civic engagement, as previous CIT research suggests, we expect the proposed positive relationship to be stronger for residents living in "served" counties than "underserved" counties. However, for voter turnout as an outcome variable, we test the two competing hypotheses (i.e., trade-offs vs. bigger pie) given conflicting evidence on the impact of the Internet on voter turnout:

H2: Interactions between district broadband service availability and storytelling system variables – local information connectedness (H2a); community interpersonal communication (H2b); and local organization connectedness (H2c) – are positively related to civic engagement. .

RQ2: How do interactions between district broadband service availability and storytelling system variables – local information connectedness (RQ2a); community interpersonal communication (RQ2b); and local organization connectedness (RQ2c) – relate to turnout in the 2022 midterm?

Within Michigan, internet access is an ongoing area of opportunity, with the state ranking 27th in the United States for internet coverage, speed, and availability (BroadbandNow, 2023). Additionally, approximately 14 percent of Michigan individuals or households lack any type of internet access altogether (broadband, satellite, dial-up, cellular data only) (BroadbandNow, 2023). Affordability concerns are more likely to be barriers to connectivity than infrastructural access in urban areas, such as the case with Detroit, where an estimated 25 percent of residents do not have internet access (Fernandez et al., 2020). In contrast, infrastructural access drives digital inequalities in rural areas. In 2019, it was estimated that approximately 53 percent of rural Michiganders had no broadband internet access (American Immigration Council, 2022).

While CIT scholarship has shown that communication infrastructure can operate differently between communities that differ racially, geographically, and cross-culturally (e.g., Matei & Ball-Rokeach, 2001; 2003; Nah et al., 2021; Nah & Yamamoto, 2018), there remains an opportunity to study the roles of multi-level digital civic infrastructure in the divergence between urban and rural areas.

RQ3. Do the relationships between digital civic infrastructure and civic engagement (RQ3a) and turnout (RQ3b) vary across rural-urban divisions?

[Figure 1 here]

Data and Method

Participants

We used Dynata, a professional research panel, to survey adult Michigan residents in October 2023. Dynata enables researchers to reach participants in both rural and urban areas in Michigan. Considering imbalanced rural (18%) and urban (82%) populations in Michigan (U.S. Census, 2021), the present purposive sample includes residents of 26 urban counties and 54 rural counties in Michigan based on the U.S. Department of Agriculture's (USDA) Rural-Urban continuum codes (2020). In addition, we verified the accuracy of the place-based classifications by asking respondents' county, zip code, and street address in the survey instrument. We set a target ratio of rural to urban participants of 45:55, intending to recruit approximately 450 rural participants, the maximum we could draw from the pool of registered rural panelists.

A total of 1,009 participants completed the survey, of which 893 responded appropriately to the attention check item included in the final dataset (pass rate: 88.4%; Rural: 313, Urban: 579). The sample did not meet the targeted ratio, but it has a much higher rural percentage than the population (35.1% in the sample, 18% in the latest census). Most notably, samples were collected from 80 of the 83 Michigan counties, showcasing the inclusiveness of the survey scope. While age and gender quotas based on census data were stratified for the urban sample, the rural sample could not warrant this stratification. The urban sample averaged 50.13 years of age and included more females (57.2%) than males (41.3%); the racial composition was 78.0 percent white and 15.1 percent black. In the rural sample, the average age was 54.70, and the racial composition was 91.1 percent white, reflecting the actual composition of the rural population. However, females were severely overrepresented in the rural sample (Female: 77.3%, Male: 21.2%).

Dependent Variables

Civic Engagement. Respondents were asked about the extent to which they participate in the nine activities that are related to non-institutional political engagement (Van Deth, 2014; see also Ekman & Amnå, 2012) (see Table 1; Cronbach's *a* = .85).

Voter Participation. Respondents were asked whether they voted in the 2022 midterm election ("Did you vote in the last Midterm election (held in November 2022)?"; 1= Yes, 0 = No). 74.5% of respondents reported that they voted in the 2022 midterm election. The percentage is higher than the actual turnout of Michigan (56.8%). While it is common for opt-in survey participants to be more politically engaged (Karp & Lühiste, 2016) and voting participation is commonly overreported, recent research has shown that self-reported turnout is not necessarily less accurate than validated turnout (Berent et al., 2016).

Independent Variables

Storytelling Systems. Drawing upon CIT research (Ball-Rokeach et al., 2001; Kim & Ball-Rokeach, 2006; Kim et al., 2019; Nah et al., 2021), we employed three civic communication behavior measures: (1) local information connectedness (LC); (2) intensity of interpersonal neighborhood storytelling (INS); and (3) scope of connection to community organizations (OC) (see Table 1). LC was estimated with 11 media types for the behavior (Cronbach's a = .83). INS was gauged by the amount of in-person and digitally-mediated interpersonal communication between local community members (Cronbach's a = .80;). Third, to estimate the level of OC, respondents were asked if they belong to seven types of community organizations, both online and offline. Respondents' affiliations with the listed organizations were summed to create a net score, ranging from 0 to 7.

[Table 1 here]

Digital Communication Action Context. Respondents' residential information was linked to the index of district fixed residential broadband service availability from the FCC's National Broadband Map (2023) as of December 2022. The calculated percentage of residential, fixed broadband service availability as self-reported by ISPs is aggregated at the county level, with multiple tiers of service quality (with speeds at least Download/Upload: 25/3 Mbps, 100/20 Mbps, 250/25 Mbps, 1,000/10 Mbps; see Figure 2). In this study, we used the tier of 100/20 Mbps, as the benchmark for the district fixed broadband service availability (DBSA). For example, if a respondent lives in a county with 100/20 Mbps broadband coverage rate of 78.34%, their DBSA is entered as 0.7834 (M = .8351, SD = .1917).

Most concerning, however, is that the DBSA parameter (i.e., the percentage of locations in a served county) cannot be equated to the specified quality-internet access for a sample of respondents. As such, claims about the impact of county-level availability changes on individual-level behavior may bear potential ecological fallacies. That said, the parameter lends itself to being operationalized as a moderating variable of the communication action context in that it represents the hard communication infrastructure of a geographic community (Ball-Rokeach et al., 2001). The high correlation between the rural-urban continuum codes (assigned to the individual respondents; see below) and DBSA provides evidence that it is appropriate to be introduced as a structural variable in the analytical models ($r = .803$, $p < .001$), indicating that DBSA closely reflects the variability in digital infrastructure levels across regions.[4]

[Figure 2 here]

Rural-Urban Continuum Codes. USDA's rural-urban continuum codes (2020) provide a classification scheme that distinguishes metropolitan and non-metropolitan counties based on population size and adjacency to a metropolitan area. The codes are entered on a scale ranging from 1 to 9 and are classified into metro areas from 1 to 3 (i.e., urban) and non-metro areas from 4 to 9 (i.e., rural). Specifically, counties that are "completely rural or less than 2,500 urban population, not adjacent to a metro area" are coded as 9, and counties in metro areas with "1 million population or more" are coded as 1 (see Appendix for detailed coding criteria). In the final dataset, the mean code point is 3.26, and the median is 2, reflecting a larger sample collected from the urban population. For ease of analysis, we reverse-coded the scale so that respondents with higher points were classified as residents of a county closer to a metropolitan area (1 = Complete rural, 9 = Complete urban).

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[4] To address this issue further, we asked respondents whether they have a broadband Internet connection at home ("Do you have broadband Internet connection at home?"; Yes = 86.6%, No = 13.4%). Independent samples t-test shows that the mean of DBSA for those with home broadband was higher than the mean for those without ($t(142.206) = 2.526$, $p < .05$), again suggesting the appropriateness of using the FCC parameter as a structural conditioning factor.

Control Variables

In setting political participation as a function of digital civic infrastructure, we addressed variables that could covary with its effects in two packages: first, there are debates that the effects of the Internet on political participation may be spurious because both of them can be correlated with unobserved variables such as income or education (see Lelkes, 2020, pp. 199-200). With this in mind, we included demographics such as age, gender, and race in the present analysis, as well as income and education.

Second, prior studies show that political participation is closely related to the levels of political interest and political efficacy (e.g., Ekman & Amnå, 2012; Ikeda et al., 2008; Oser et al., 2022; Scheufele et al., 2004; McLeod et al., 1999). This package of political covariates was entered into all models. Political interest was measured with three items ("Please indicate your interest in the following… (a) Politics; (b) Campaigns and social issues; (c) News"; 1 = Not at all interested, 7 = Extremely interested; *M* = 4.07, *SD* = 1.66, Cronbach's *a* = .88); local political efficacy was gauged with two items ("Please indicate your agreement or disagreement with the following statements… (a) Every vote counts in a local election, including yours and mine; (b) In Michigan, everyone who wants to can have a voice in what the government does; 1 = Strongly disagree, 7 = Strongly agree; *M* = 5.47, *SD* = 1.38, Cronbach's *a* = .705).

Results

We conducted four ordinary least squares (OLS) linear regression models to examine H1, H2, and RQ3a. H1 posits that the three local storytelling factors, namely, local information connectedness (H1a), interpersonal community storytelling (H1b), and local organization connectedness (H1c) are positively related to civic engagement. Regression results show that OC and civic engagement were positively related in Model 4 (Table 2), where both interaction terms of DBSA and R-U were entered ($\beta = .188$, $SE = .096$, $p < .05$). In other words, the more affiliated individuals were with on and offline local organizations, the more engaged they were in civic activities. However, we did not observe a significant relationship between civic engagement and LC or INS in this full model. Thus, H1c was supported but not H1a and H1b. Nevertheless, it is important to highlight that in Model 1, which exclusively examined the main effects of the three storytelling system variables (LC, INS, OC), all variables exhibited a significantly positive relationship with civic engagement, while controlling for demographic factors and political covariates.

H2 proposes a positive relationship between civic engagement and the interactions of district broadband service availability with storytelling system variables – LC (H2a), INS (H2b), and OC (H2c). However, contrary to the expectations, we did not find any interaction effect of DBSA with LC, INS, and OC on civic engagement: H2 was not supported.

In response to RQ3a, which asks whether there is geographic variation in the impact of digital civic infrastructure (the interaction terms of DBSA and LC; INS; OC) on civic engagement, we found that none of these interaction terms varied by geographic division. Notably, males and whites were less engaged, while those with higher education levels were more engaged in civic activities.

[Table 2 here]

Next, four generalized linear models (GLM) with binomial logit links were performed to investigate RQ1, RQ2, and RQ3b. Logistic regression models within the GLM framework were selected due to the binary nature of the outcome variable, voter turnout.

In Model D (Table 3), we did not find any strong evidence to suggest that voter turnout is a function of the storytelling system variables or their interactions with DBSA. Consequently, our findings only support null hypotheses for RQ1 and RQ2. Yet, we found evidence that the interaction of LC and DBSA has a marginally significant negative effect on voting (β = -2.201, *SE* = 1.307, *p* = .092). To be specific, the negative (but not significant) relationship between LC and turnout was *weakened* among residents of counties with higher district broadband service availability.

[Figure 3 here]

That said, surprisingly, the interaction term of LC and DBSA on voter turnout varied by R-U at a marginally statistically significant level (Model D in Table 3; β = 404, *SE* = .232, *p* = .081). As Figure 4 shows in greater detail, rural residents (closer to 1 on the R-U continuum) who were more connected to local information and had more broadband resources been less likely to vote: the richer the digital civic infrastructure, the less voter participation. In urban areas (closer to 9 on the R-U continuum), the pattern of this three-way interaction was reversed : those who were more connected to local information voted more when they had more broadband resources. Regarding the two competing hypotheses, the trade-offs hypothesis was supported in rural areas, but the bigger pie hypothesis received greater support in urban areas.

[Figure 4 here]

The effect size of the three-way interaction term (OR = 1.498, *SE* = .347) shows that a one-unit increase in local information connectedness (1.14 point on a 7-point scale) coupled with a one-unit move on the rural-urban continuum toward urban areas (2.48 point on a 9-point scale) over a one-unit increase in district broadband availability (19.17 percent of *served* areas within a county) increases the likelihood of voting by 49.8 percent. Taken together, we were able to provide statistical evidence in response to RQ3b that the interaction of local information connectedness and broadband availability varies across rural and urban areas.

[Table 3 here]

Lastly, age, education, and income levels, as well as political interest and efficacy, were significantly and positively related to voter turnout across all four models.

Discussion

Drawing on Communication Infrastructure Theory (Ball-Rokeach et al., 2001; Kim & Ball-Rokeach, 2006), we employed two components of digital civic infrastructure as a focal predictor of civic and political participation. First, we operationalized three types of localized civic communication behaviors, both online and offline, as storytelling system variables: Local information connectedness; interpersonal community storytelling; and local organizational connectedness. Second, we utilized district broadband service availability from the FCC's National Broadband Map (2023) data as a county-level technological communication action context variable.

Conceptualizing the interplay of the two components as digital civic infrastructure enables a theoretically grounded approach to examine the relationship between Internet use and civic and political participation. The current geographically-inclusive survey sample — addressing rural and urban residents in the U.S. state of Michigan — also lends an opportunity for probing how these relationships may vary across geographic divisions.

The present findings successfully replicated earlier CIT research showing that individual-level storytelling system variables have a positive relationship with civic engagement. However, the positive relationship was only robust for community organization connections. This effect was not sensitive to the level of broadband resources or rural-urban geographic differences. These findings suggest that meso-level storytelling systems (i.e., belonging to a community-related organization) have a greater impact on tangible offline civic outcomes than macro-level (i.e., being a recipient of locally relevant news) or micro-level (i.e., participating in conversations about the community) storytelling systems.

We observed consistent null interaction effects between storytelling systems and the technological communication action context on civic engagement, and this pattern did not vary geographically. These results imply that the agency of individuals, rather than technological conditions, plays a more central role in mobilizing both on- and offline civic communication, aligning with CIT's optimistic view that people are actively adaptive, using given communication tools to reconstruct social worlds (Ball-Rokeach et al., 2001, p. 393).

The current study is notable because it is among the first to examine the impact of digital civic infrastructure on voting behavior through the lens of CIT. Similar to the case of non-institutional civic engagement, the relationship between digital civic infrastructure – the interaction terms of storytelling systems and broadband availability – and voter turnout were not statistically significant. Interestingly, however, we found that the three-way interaction of local information connectedness, broadband availability, and geographic division had a large effect size at the marginally significant level: the relationship between digital civic infrastructure and voter participation varies across rural-urban divisions.

As such, while prior work provides conflicting evidence on the democratic potential of the Internet (e.g., Prior, 2007; Lelkes, 2020; Boulianne & Theocharis, 2020), our holistic approach, based on an ecological model of CIT, offers a more nuanced perspective that incorporates geographic context. The "winner" of the two competing hypotheses varies by region. In rural areas, *the trade-offs hypothesis* prevails: The more local information available to residents in areas with more internet access, the less they voted. More is *not always* better in rural areas. On the other hand, *the bigger pie hypothesis* gained strength as the interaction term moved closer to urban areas: Residents with higher broadband availability were more likely to vote the more they sought out local information, whereas, in lower-availability areas, connection to local information discouraged their voter participation. More is *just* better in urban areas.

Our findings suggest that policy decisions to address regional digital divides require a more granular administrative design for rural areas. The strong effect size of the three-way interaction of local information connectedness, district broadband service availability, and rural-urban divisions renders that if people in (1) digitally resource-rich (2) urban areas are (3) connected to local information, they are likely to drive policy change through institutional political participation, such as voting. For urban areas, thus, focusing on underserved neighborhoods might be a relatively straightforward approach to address multiple levels of the digital divide in one fell swoop: inequality in IT access, inequality in IT capabilities, and disparities in digital outcomes (Dewan & Riggins, 2005; Hargittai, 2002; Van Deursen & Helsper, 2015).

In rural areas, on the other hand, policy decisions are perhaps less straightforward. Our findings indicated that an increase in internet resources correlated with decreased political engagement among rural residents. However, existing research points to several possible explanations for this paradox.

Firstly, internet quality, including inconsistent service and data restrictions may force users to make strategic choices. Accessing civic information may simply not outrank data-dependent tasks that are necessary for school, work, or daily life (Freeman et al., 2020; Mathews and Ali, 2022a; b). Secondly, in response to delayed and unreliable internet access, many rural residents have developed deeply entrenched information habits that prioritize face-to-face communication and traditional media. These "old school" approaches are more resistant to digital adoption, particularly among elderly residents (Mathews & Ali, 2022b). Additionally, rural Michiganders may be more likely to hold skeptical attitudes towards internet use, associating it with moral concerns and privacy issues. This group, labeled digital doubters, are more likely to avoid internet usage entirely (Dutton & Reisdorf, 2019). Lastly, the concept of the *rural information penalty*, described by Hardy (2022), highlights the multifaceted nature of barriers in rural information access, encompassing infrastructure, literacy, technology, and social networks, which has implications for information behaviors.

As such, in rural communities, improving infrastructural access is only one piece of the pie. Policy developments should utilize in-depth exploration of information habits in these communities. Research, conducted both within and in collaboration with communities, should focus on understanding barriers that hinder digital civic infrastructure, as well as identifying successful and sustainable strategies for improving adoption. This might entail implementing civic literacy programs and supporting information campaigns that are tailored to rural information-seeking behaviors. In sum, rural residents need to be given the right tools and the training to cut the pie: It should be accompanied by a package of continued research and responsive policies that consider how the use of any communication resource will itself increase the civic utility of the geographically-delineated rural community.

A key limitation of this study is the assumption that availability is synonymous with adoption. While the FCC Broadband Map provides insights into where the Internet is available, it assumes that adoption is the natural outcome of access. However, this overlooks socio-economic barriers to adoption. As such, there are factors that we are unable to control for. Future work would benefit from working directly with local government or high-performance-computing networking non-profits to deploy state-wide adoption data collection.

Also, the current work is limited in that it resorts to cross-sectional data. However, it should be noted that we used public data as a conditional predictor. Specifically, utilizing exogenous broadband availability data may have served to set the directionality between the focal variables (see Lelkes, 2020). Moreover, while the FCC data has limitations, the fact that its data collection period largely overlapped with the midterm elections' campaign period allows us to logically infer that the online information accessibility at the time would have influenced voting behavior. Nevertheless, we highly encourage future studies to combine panel surveys with time-series broadband availability data to test for causality with rigor.

Lastly, while the current socio-technological configuration of Michigan well reflects the regional digital divide and spatial polarization in the country, our state-level analysis does not rule out the possibility that different patterns may emerge at the national-level (University of Wisconsin Population Health Institute, 2023). Indeed, geographic disparities clearly have a local context. In defense of this limited generalizability offered here, we would like to suggest that our quantitative case analysis, which maximizes comparisons between rural and urban areas, can serve as a relevant backdrop for future research on structural social divides. Our findings highlight that achieving a spatial balance in civic resource allocation benefits democracy as a whole, and digital infrastructure is no exception.

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Figure 1. *Conceptual model*

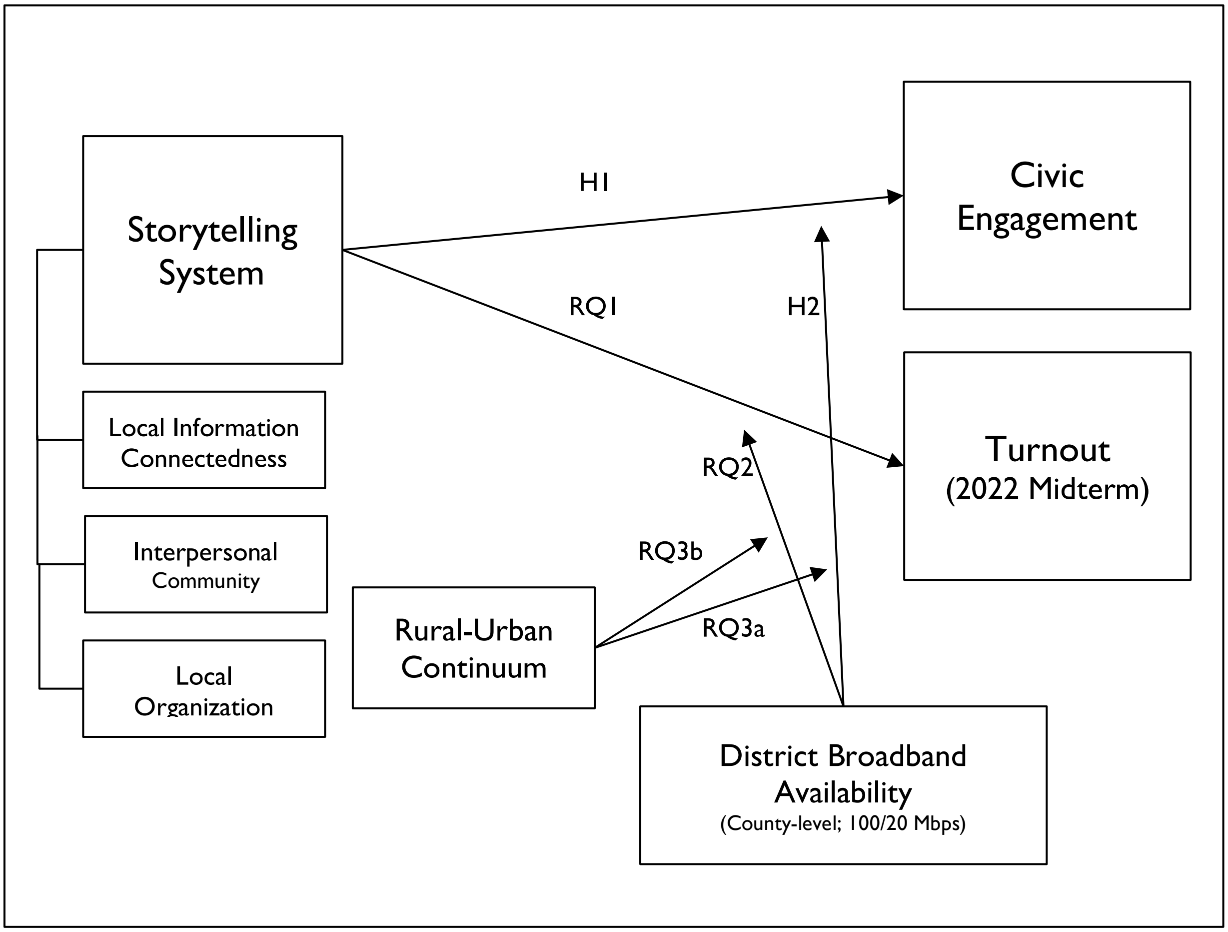


Figure 2. *The Michigan broadband map based on FCC dataset.*

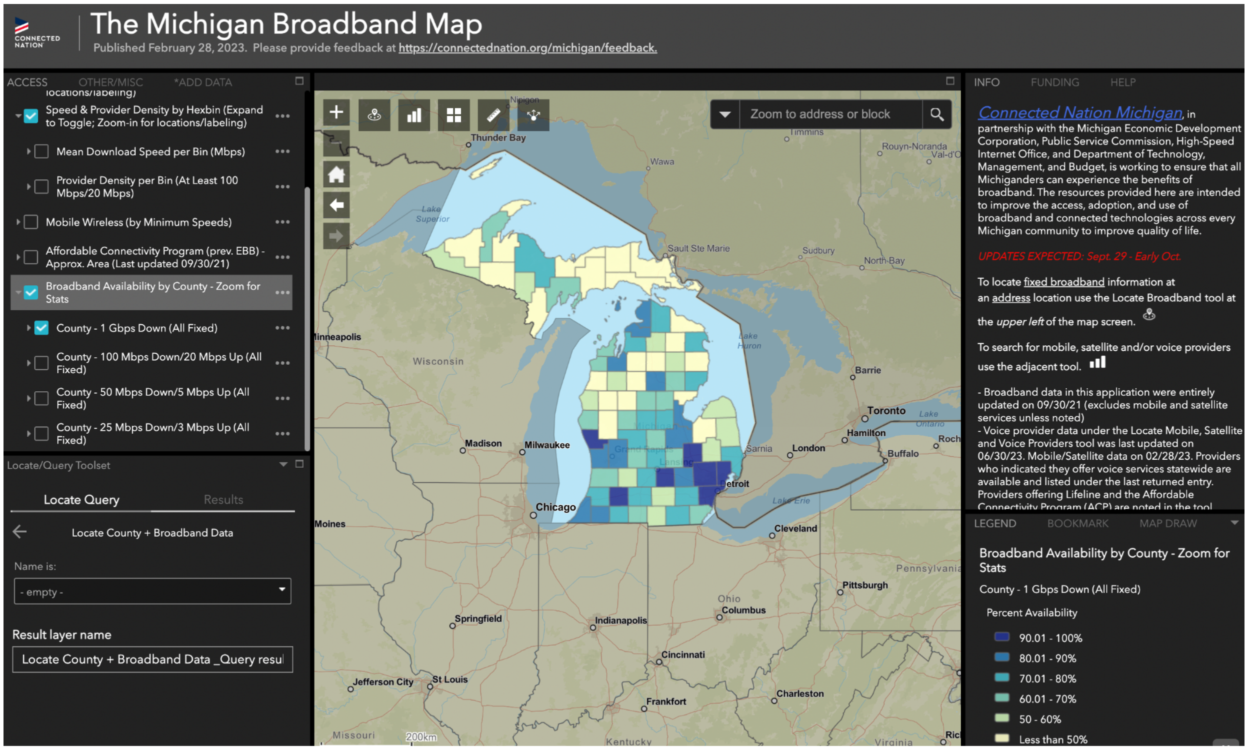
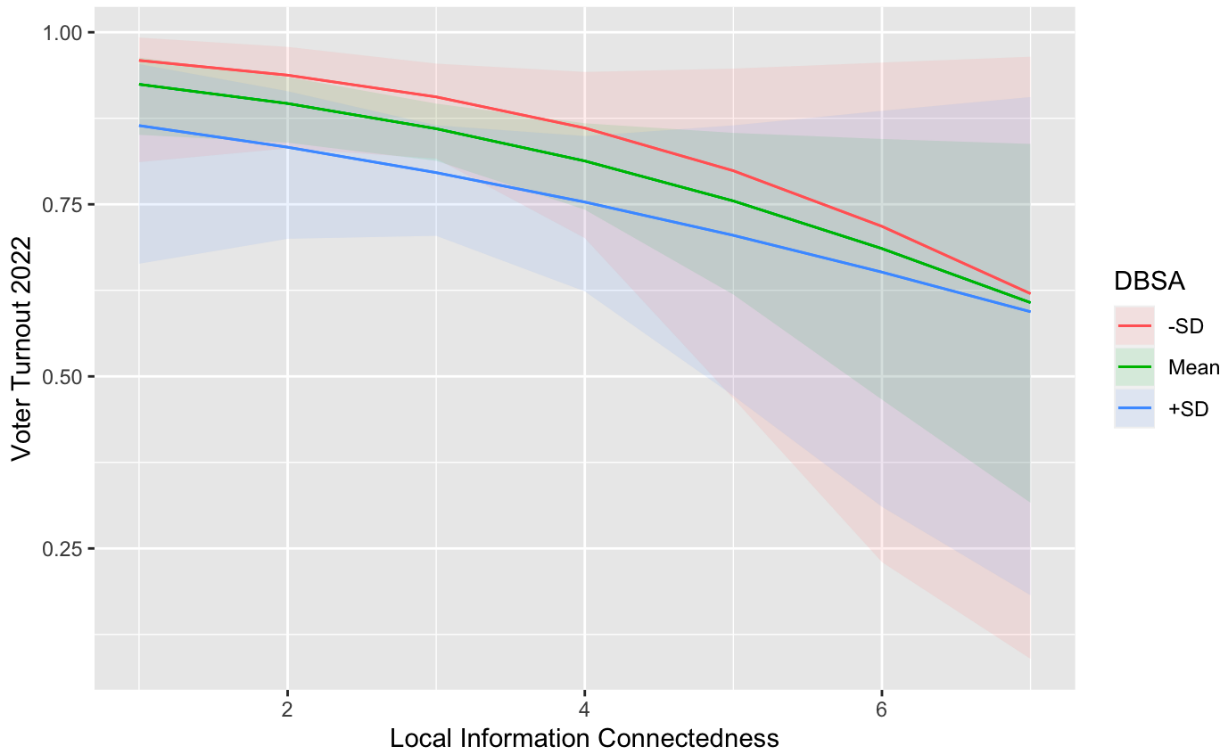
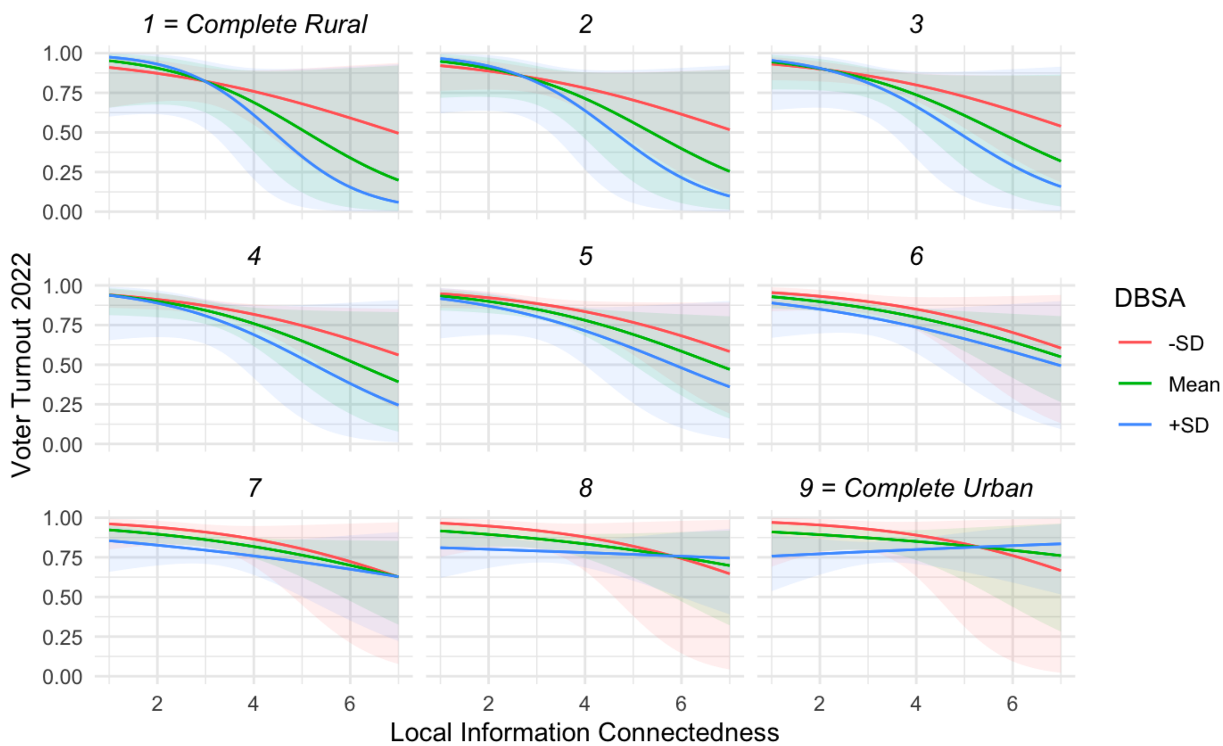


Figure 3. *Interaction between local information connectedness and district broadband availability on voter turnout.*



Note. DBSA: District Broadband Service Availability at 100/20 Mbps tier.

Figure 4. *The three-way interaction of local information connectedness, district broadband service availability, and geographic division on voter turnout.*



Note. The wrapped plot visualizes the predicted likelihood of turnout between 0.0 and 1.0. The strip number for each plot is the reversed USDA rural-urban continuum codes. DBSA: District Broadband Service Availability at 100/20 Mbps tier.

Table 1. *Measurement indices.*

Construct	Indicator	*M*	*SD*
Civic Engagement	"In the past year, how often have you participated in each of the following activities?" (1 = Never, 2 = Once, 3 = 2 or 3 times, 4= 4 or 5 times, 5 = More than 5 times) 1. Attending a local forum or meeting 2. Contacting local media 3. Signing a petition for a local candidate or issue 4. Contacting a local public official 5. Attending local rallies or protests 6. Contributing money to local social cause or organization 7. Doing volunteer work 8. Working on a community project 9. Working for a local political campaign	1.55	.66
Local Information Connectedness (LC)	"How often do you use each of the media listed below (including online) to get local news and information (including about Michigan politics)?" (1 = Never, 2 = Very rarely, 3 = Rarely, 4 = Occasionally, 5 = Frequently, 6 = Very frequently, 7 = All the time) 1. National Television Network, such as NBC, ABC, CBS (including online) 2. Cable TV Network, such as CNN, FoxNews, MSNBC (including online) 3. Other national news organizations, such as the New York Times, The Washington Post, AP, Bloomberg (including online) 4. Local TV Network (including online) 5. Local Newspapers (including online) 6. Local Radio (FM, AM, and online) 7. Social Media Platforms, such as Facebook, Twitter (X), Instagram, TikTok, Reddit, Nextdoor 8. YouTube video, such as news channel or YouTuber subscription 9. Messaging apps, such as Facebook Messenger, Whatsapp, Snapchat, Telegram 10. Local community email newsletters or listservs 11. Local government websites or newsletters	3.26	1.14
Interpersonal Community Storytelling (INS)	"How often do you…" (1 = Never, 2 = Very rarely, 3 = Rarely, 4 = Occasionally, 5 = Frequently, 6 = Very frequently, 7 = All the time) 1. Talk face to face with other people in your local community about anything related to your local community (including Michigan local issues)?	3.44	1.50

	2. Use social media to talk with other people in your local community about anything related to your local community (including Michigan local issues)? 3. Use messaging apps to talk with other people in your local community about anything related to your local community (including Michigan local issues)?		
Local Organization Connectedness (OC)	"Do you belong to any of the following local community organizations? (including both offline and online communities. e.g., Facebook page)" (1 = Yes, 0 = No) 1. Social clubs 2. Neighborhood or homeowner associations 3. Religious organizations 4. Hobby/interest groups (including sport or recreational clubs) 5. Political organizations 6. Educational or parent-teacher organizations 7. Volunteer organizations	1.44	1.61

Table 2. *Ordinary least squares linear regression models predicting civic engagement.*

	Model 1	Model 2	Model 3	Model 4
Demographics				
Age	-.002(.001)	-.002(.001)	-.002(.001)	-.002(.001)
Gender (m)	-.061(.037)	-.075*(.038)	-.080*(.039)	-.080*(.039)
Race (w)	-.207***(.048)	-.210***(.049)	-.218***(.049)	-.227***(.050)
Education	.030*(.013)	.028*(.013)	.029*(.013)	.028*(.013)
Income	.006(.005)	.007(.005)	.007(.005)	.007(.005)
Political covariates				
Political interest	.019(.013)	.022(.013)	.022(.013)	.021(.013)
Political efficacy	-.004(.014)	.001(.014)	.000(.014)	.002(.015)
Predictors				
LC	.063**(.020)	.078(.080)	.097^{+}(.053)	.004(.136)
INS	.070***(.015)	-.021(.065)	-.012(.043)	.012(.122)
OC	.193***(.012)	.243***(.052)	.253***(.034)	.188*(.096)
Moderators				
DBSA		-.377(.254)		-.413(.610)
LC*DBSA		-.0216(.093)		.159(.232)
INS*DBSA		.107(.076)		-.055(.201)
OC*DBSA		-.059(.060)		.166(.155)
R-U			-.025(.020)	-.023(.103)
LC*R-U			-.005(.007)	.014(.039)
INS*R-U			.012*(.006)	.017(.030)
OC*R-U			-.009^{+}(.005)	-.023(.024)
DBSA*R-U				.027(.107)
LC*DBSA*R-U				-.026(.040)
INS*DBSA*R-U				-.003(.031)
OC*DBSA*R-U				.004(.025)
Intercept	.910***(.113)	1.226***(.233)	1.095***(.172)	1.250***(.375)
Δ R^2	.492	.495	.498	.502
Total adjusted R^2	.485	.486	.488	.487
N of counties	80	80	80	80
N of individuals	768	768	768	768

Note. LC = Local information connectedness, INS = Interpersonal community storytelling, OC = Community organizations connection, DBSA = District broadband availability, R-U = Rural-urban continuum.

Table 3. *Generalized logistic regression models predicting 2022 midterm election turnout.*

	Model A	Model B	Model C	Model D
Demographics				
Age	.023***(.007)	.022***(.007)	.023***(.007)	.023***(.007)
Gender (m)	-510*(.228)	-.532*(.232)	-.506*(.233)	-.419^{+}(.236)
Race (w)	.134(.262)	.041(.267)	.048(.269)	.096(.278)
Education	.224**(.078)	.236**(.079)	.240**(.079)	.235**(.080)
Income	.101**(.032)	.096**(.032)	.096**(.032)	.097**(.032)
Political covariates				
Political interest	.352***(.075)	.367***(.076)	.369***(.076)	.372***(.077)
Political efficacy	.294***(.077)	.274***(.078)	.264***(.078)	.285***(.080)
Predictors				
LC	-.161(.116)	-.207(.441)	-.311(.295)	1.042(.793)
INS	-.060(.083)	.466(.352)	.461*(.231)	.128(.655)
OC	.244**(.077)	.755^{+}(.402)	.494*(.247)	.450(.857)
Moderators				
DBSA		2.136(1.473)		3.910(3.857)
LC*DBSA		.050(.517)		-2.201^{+}(1.307)
INS*DBSA		-.639(.410)		.979(1.069)
OC*DBSA		-.580(.453)		-.182(1.242)
R-U			.216^{+}(.119)	1.608*(.665)
LC*R-U			.021(.041)	-.270(.225)
INS*R-U			-.078*(.032)	-.167(.168)
OC*R-U			-.034(.033)	.112(.210)
DBSA*R-U				-1.500*(.690)
LC*DBSA*R-U				.404^{+}(.232)
INS*DBSA*R-U				.019(.175)
OC*DBSA*R-U				-.127(.219)
Intercept	-3.627***(.648)	-5.206***(1.361)	-4.887***(1.008)	-8.549***(2.536)
Log likelihood	-329.888	-326.336	-325.023	-320.614
AIC	681.8	682.7	680.0	687.2
N of counties	80	80	80	80
N of individuals	764	764	764	764

Note. LC = Local information connectedness, INS = Interpersonal community storytelling, OC = Community organizations connection, DBSA = District broadband availability, R-U = rural-urban continuum.

Appendix

Table A.1. *Zero-order Pearson's correlations between focal and control variables.*

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age													
2. G(m)	.251**												
3. R(w)	-.214**	.012											
4. Edu.	-.127**	-.054	.084*										
5. IC.	-.79*	-.117**	.047	.384**									
6. PI	-.192**	-.204**	-.064	.214**	.109**								
7. PE	-.199**	.022	.025	.157*	.123*	.392**							
8. LC	.090*	.008	-.154**	.004	-.008	.419**	.237**						
9. INS	.308**	.105**	-.114**	-.052	-.085*	.224**	.158**	.578**					
10. OC	.067	-.006	-.153**	.258**	.156**	.245**	.132**	.405**	.346**				
11. DB	.105**	-.162**	-.154**	.077*	.049	.128**	.096**	.068	.003	.087*			
12. R-U	.122**	-.187**	-.171**	.069*	.076*	.131**	.035	.042	-.019	.072*	.803**		
13. CE	.158***	-.047	-.235**	.173**	.116**	.455***	.267***	.135***	.419***	.623***	.068	.064	
14. V22	-.250***	-.132***	.039	.255***	.224***	.338***	.313***	.083*	-.001	.191***	.032	.027	.138***

Note. G(m) = Gender (male), R(w) = Race (white), Edu. = Education, Incm. = Income, PI = Political interest, PE = Political efficacy, LC = Local information connectedness, INS = interpersonal community storytelling, OC = Community organizations connection, DB = District broadband availability, R-U = rural-urbanRurality-Urbanity continuum, CE = Civic engagement, V22 = Turnout in the 2022 midterm election.

Rural-Urban continuum codes (USDA, 2020)

1 = Metro - Counties in metro areas of 1 million population or more

2 = Metro - Counties in metro areas of 250,000 to 1 million population

3 = Metro - Counties in metro areas of fewer than 250,000 population

4 = Nonmetro - Urban population of 20,000 or more, adjacent to a metro area

5 = Nonmetro - Urban population of 20,000 or more, not adjacent to a metro area

6 = Nonmetro - Urban population of 2,500 to 19,999, adjacent to a metro area

7 = Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area

8 = Nonmetro - Completely rural or less than 2,500 urban population, adjacent to a metro area

9 = Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area

Retrieved from https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/