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Trade-offs in a bigger pie: how the relationships between digital civic infrastructure and political participation vary across rural and urban communities – the case of Michigan

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ABSTRACT

This study draws on a survey sample of the U.S. state of Michigan, combined with public data, to test the interrelationships among local storytelling networks, broadband availability, and political participation. Expanding upon Communication Infrastructure Theory, our analysis presents original findings indicating that the relationship between digital civic infrastructure and voter turnout varies across geographic divisions: Among rural residents, access to local information is more negatively associated with voter turnout for those with higher broadband availability, while the opposite pattern is found among urban residents. Moreover, the study aligns with previous research, confirming a positive relationship between local organization connectedness and civic participation. Our quantitative case analysis opens new avenues for future work exploring the democratic potential of the internet, integrating geographic context.

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Communication infrastructure theory; civic engagement; voting behavior; survey research; rural broadband

This article examines two competing hypotheses regarding the internet's potential impact on democratic mobilization: The *trade-offs hypothesis* (Prior, 2005; 2007) suggests that the high-choice media environment leads people away from political participation by substituting political attention for other activities (i.e., entertainment). In contrast, *a bigger pie hypothesis* (Lelkes, 2020) states that the internet's unlimited information supply enhances political sophistication and promotes political participation. The mixed evidence supporting these conflicting arguments (Boulianne, 2009; 2015; Boulianne & Theocharis, 2020; Zhuravskaya et al., 2020) calls for a holistic research scope to scrutinize the internet's effects on political engagement.

Our study also responds to concerns about the geographically uneven distribution of digital infrastructure and its potential to exacerbate structural inequality (Katz &

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Gonzalez, 2016; Robinson et al., 2020). For instance, the 2023 County Health Rankings National Findings Report (University of Wisconsin Population Health Institute, 2023) highlights the correlation between broadband availability and voter turnout, underscoring the significance of digital infrastructure, particularly in rural areas with limited internet access. Consequently, we extend Communication Infrastructure Theory (CIT; Ball-Rokeach et al., 2001; Kim et al., 2006; Kim & Ball-Rokeach, 2006) to examine the relationship between digital resources and voter participation.

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), the influence of digital infrastructure has received limited attention. This study attempts to bridge these two areas of existing scholarship by examining how digital infrastructure impacts rural and urban areas within the U.S. state of Michigan, an emerging political battleground and prime example of spatial disparities in civic resources including broadband availability (American Immigration Council (AIC), 2022; Durkan, 2022).

This study supports prior CIT research by affirming a positive relationship between civic participation and affiliation with local community organizations. Furthermore, this research extends to the CIT literature by finding that the relationship between CIT factors and voter turnout differs across geographic divisions, with the trade-offs hypothesis being more pertinent to rural residents and the bigger pie hypothesis more applicable to urban residents. The present quantitative case analysis opens new avenues for future work to explore the internet's democratic potential through connections between online civic behaviors, digital infrastructure, and their geographic contexts.

Literature review

Potential of the internet to address participation gaps

A series of meta-analyses on the internet's impact on engagement reveal a shift in its effect on democratic mobilization from negative to positive over the past decade (Boulianne, 2009; 2015; Boulianne & Theocharis, 2020). However, there is still no consensus on the 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 diverse content available on the internet (i.e., entertainment) can lead politically unmotivated individuals to deepen their political apathy (Prior, 2005; 2007), further increasing political disengagement. Although evidence is mixed, recent research suggests that the internet's information-rich environment may perpetuate the passivity of politically disconnected groups (e.g., Gil de Zúñiga et al., 2017; Kümpel, 2020; Zhang, 2022).

On the other hand, Lelkes (2020) challenges the trade-offs hypothesis by arguing that it assumes 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 information supply leads to political sophistication, fostering political participation. Specifically, the study provides evidence that residents of counties with higher-speed internet

bandwidth are more likely to be politically engaged. Similarly, Weeks and colleagues (2022) present strong evidence that the internet's features increase the likelihood of incidental news exposure, reducing the knowledge gap between political junkies and the disengaged.

Geographic differences in the internet's impact

Current literature highlights geographical differences as a key factor in understanding the intricate relationship between internet access and civic outcomes. According to the 2023 County Health Rankings National Findings Report (University of Wisconsin Population Health Institute, 2023), a positive correlation exists between county-level broadband internet availability and voter turnout, warning that inadequate digital infrastructure can hinder democratic representation, particularly in rural areas. Stern and colleagues (2011) found that rural broadband internet users were more likely to engage in active community participation than non-users. However, Whitacre and Manlove's (2016) study indicates that broadband adoption, rather than access, significantly impacts specific types of civic engagement in rural communities. These types include participation in local organizations, contacting public officials to share opinions, and expressing opinions online while negatively impacting voting likelihood. These inconsistent findings suggest that the democratic impact of broadband internet may vary by the type of participation, particularly across different geographic contexts.

As such, current scholarship on this topic calls for an expanded research approach that addresses (1) which online civic behaviors are more closely related to political participation than others, (2) how structural factors like broadband availability moderate the relationship between online behaviors and offline outcomes, and (3) how the digital divide, which is often geographically defined, creates differences in civic outcomes between rural and urban residents. In response to this call, this study utilizes an ecological model that integrates individual communication behaviors and broader communication contexts to investigate the varying impacts of the internet.

Communication infrastructure theory

Communication Infrastructure Theory (CIT; Ball-Rokeach et al., 2001; Kim et al., 2006; Kim & Ball-Rokeach, 2006) is a multi-level ecological model proposing two primary components of communication infrastructure: (1) storytelling network and (2) communication action context. The storytelling network is a dynamic process in which individuals within a specific geographic community actively 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) serve as communication resources for community problem-solving.

This study employs three types of communicative actions associated with each level of the storytelling networks: (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. This sense of 'we' encourages people to seek collaborative solutions to community issues (McLeod et al., 1996). Lastly, interpersonal community storytelling indicates discussion about local issues among community members. This micro-level communication practice promotes the sharing of community concerns and consensus-building among people in the community.

We adapt the CIT concepts to digital information ecologies by incorporating various *online* behaviors corresponding to each level of the storytelling networks (Kim et al., 2019; Nah et al., 2021; Nah & Yamamoto, 2019). Within the context of local information connectedness, the current analysis includes 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 incorporate 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. Drawing on Habermas' concept of the public sphere, Ball-Rokeach and colleagues (2001) contend that storytelling networks are bounded by 'boundaries of a residential area as defined by shared convention' (p. 396). These characteristics include physical dimensions such as place and street, sociocultural factors such as ethnicity and class, and technological features such as internet connectivity.

Previous 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 their reliance on self-reporting, which measures access as a dichotomous variable. In line with the present research objective, we address the limitations of self-reporting methods by operationalizing broadband internet availability – extracted from public data aggregated at the county level – as a technological feature of communication action context.

Lastly, this paper uses *digital civic infrastructure* to encapsulate the interaction between storytelling networks and the communication action context of broadband availability. Expanding upon the CIT framework, the idea 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 (see Matei & Ball-Rokeach, 2003). As a technological feature of shared conventions, the availability of internet resources within a community may moderate the relationship between residents' digitally mediated communicative behaviors and their civic activities. In other words, if we liken storytelling networks to software, then communication action context, broadband availability herein, is the hardware that drives that software.

Two types of political participation

Following van Deth's (2014) taxonomy, this study focuses on two types of political participation as a function of digital civic infrastructure: (1) civic participation and (2)

voting. First, civic participation refers to a set of voluntary actions in which people cooperate with a specific purpose to address public issues that are difficult to tackle individually. As a mode of *non-institutional* participation, these actions target an issue, community, or government (Ekman & Amnå, 2012; van Deth, 2014) are thus grounded in the organic, grassroots nature of democracy (Skocpol, 1997).

Within the CIT framework, civic participation refers to the enactment of civic engagement, which comprises cognitive, psychological, and behavioral dimensions (see Nah et al., 2021 for an overview). This objective component includes activities such as signing petitions, participating in demonstrations, and volunteering at social events. In this context, CIT scholarship outlines effective communication infrastructures that support individuals' collective actions within geographically defined communities, thereby fostering active civic participation (Ball-Rokeach et al., 2001).

Specifically, Kim and Ball-Rokeach (2006) emphasize that the multi-level storytelling network is 'the most important individual-level factor in civic engagement' (p. 431). Consistently, CIT scholarship has found a positive relationship between the storytelling network variables and civic participation (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 participation as the current model's outcome variable:

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

Second, voting is a prime example of *institutional* political participation (van Deth, 2014). In democratic states, political parties institutionalize societal conflict by mobilizing existing social cleavages (Aldrich, 2011; Lipset & Rokkan, 1967). Voter turnout integrates citizens' community agendas into the broader electoral system, facilitating the implementation of desired changes as public policy. As such, the inclusion of 'signing a petition for a candidate or issue' and 'working for a political campaign' as essential indicators of *civic participation* underscore the pivotal position of *voting* in political participation (Ekman & Amnå, 2012).

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 yet to be empirically tested. Aside from CIT scholarship, evidence of the internet's impact 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 a 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 et al., 2018; Lelkes, 2020). Therefore, it is worth exploring the relationship between storytelling networks and voting behavior. This study investigates how storytelling networks relate to voter turnout in the 2020 general election.

RQ1: How do local information connectedness (RQ1a), interpersonal community communication (RQ1b), and local organization connectedness (RQ1c) relate to turnout in the 2020 general 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). 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, and 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 about whether this definition is too liberal as it may be inadequate for many internet activities, especially those of heightened importance during the pandemic.[1] 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 100/2 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 cases, increased reliance on mobile hotspots and tethering (Yaacoub & Alouini, 2020).

We invite this debate into the CIT framework: the study operationalizes broadband availability as the technological communication action context of *digital civic infrastructure* and explores whether the 100/20 Mbps benchmark moderates the relationships between storytelling networks and political participation. For civic participation, as previous CIT research suggests, we expect the proposed positive relationship to be stronger for residents in 'served' counties than 'underserved' counties. However, for voter turnout, 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 broadband availability and storytelling network variables – local information connectedness (H2a), interpersonal community communication (H2b), and local organization connectedness (H2c) – are positively related to civic participation.

> **RQ2**: How do interactions between broadband availability and storytelling network variables – local information connectedness (RQ2a), interpersonal community communication (RQ2b), and local organization connectedness (RQ2c) – relate to turnout in the 2020 general election?

Within Michigan, internet access is an ongoing area of opportunity, with the state ranking 27th in the country for internet coverage, speed, and availability (BroadbandNow, 2023). Additionally, approximately 14 percent of Michigan individuals or households lack internet access (broadband, satellite, dial-up, cellular data only) (BroadbandNow, 2023). Affordability concerns are more likely to be barriers to connectivity 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 didn't have access to broadband internet (American Immigration Council (AIC), 2022).

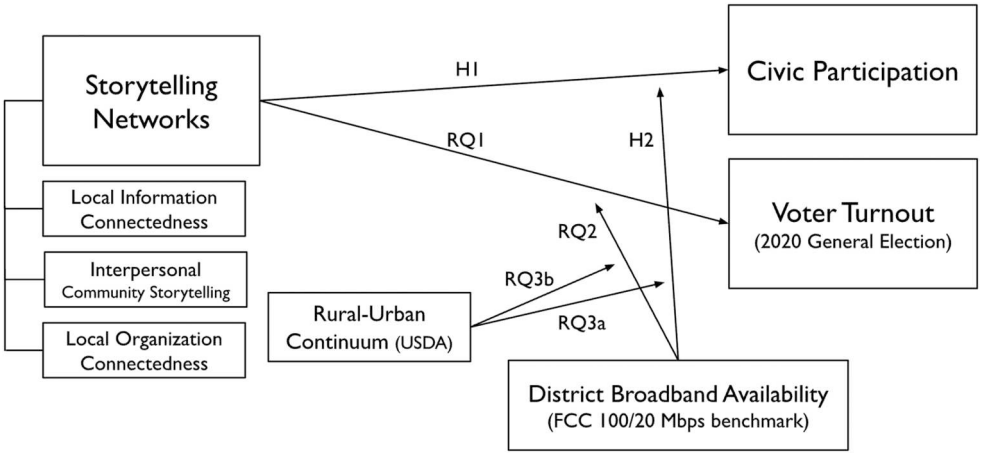

Figure 1. Conceptual model.

These conditions render Michigan a compelling case for examining the role of digital infrastructure in spatial disparities in political participation. Its moderate ranking in internet access – closely aligned with national trends – reflects broader patterns of digital resource distribution in the U.S.; fixed broadband coverage at the 100/20 Mbps benchmark as of June 2023: 90.98% nationwide, 89.24% in Michigan (Federal Communication Commission (FCC), n.d.). Additionally, the state's urban affordability barriers and rural infrastructural deficiencies exemplify the nation's characteristic digital inequalities (Reddick et al., 2020). Collectively, these factors make Michigan a critical site for investigating how geographic context moderates the interrelationship between digital civic infrastructure and residents' civic behaviors; Examining these dynamics within a single state ensures a coherent analysis within a consistent administrative framework (Figure 1).

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

Data and method

Participants

Dynata, a professional research panel, was used to survey adult Michigan residents in October 2023. A total of 1,009 participants completed the survey, of which 892 responded appropriately to the attention check item (pass rate: 88.4%; Rural: 313, Urban: 579). Most notably, data were collected from 80 of Michigan's 83 counties, with purposive oversampling of rural residents – 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 (U.S. Census Bureau, 2021). The urban sample averaged 50 years of age and included more female (57.2%) than male (41.3%); the racial composition was 78.0 percent white and 15.1 percent Black. In the rural sample, the average age was 55, and the racial composition was 91.1 percent white, reflecting the actual rural demographics. However, female respondents were severely overrepresented in the rural sample (Female: 77.3%, Male: 21.2%).

Dependent variables

Civic Participation

Respondents were asked about the extent to which they participated in nine activities related to non-institutional political participation, including 'Attending a local forum or meeting' and 'Signing a petition for a local candidate or issue' (van Deth, 2014) (Table 1; Cronbach's $\alpha = .85$).

Voter Turnout

Respondents were asked whether they voted in the 2020 general election ('Did you vote in the last general election (held in November 2020)?'; 1 = Yes, 0 = No). 81.4% of respondents reported that they voted in the 2020 general election. The percentage is higher than the actual turnout of Michigan (73.9%). Despite the common over-reporting in voter participation, the approximately 7% differential observed does not appear to impair its validity substantially, given the elevated level of political engagement among opt-in survey participants (Karp & Lühiste, 2016).

Independent variables

Storytelling Networks

Drawing upon CIT research (Ball-Rokeach et al., 2001; Kim et al., 2019; Kim & Ball-Rokeach, 2006; Nah et al., 2021), three civic communication behavior measures were employed: (1) local information connectedness (LC); (2) intensity of interpersonal neighborhood storytelling (INS); and (3) scope of connection to community organizations (OC). LC was estimated based on the use of 11 media types, including 'National Television Network,' 'Local Newspapers,' and 'Social Media Platforms' (Cronbach's $\alpha = .83$). INS was gauged by the amount of in-person and digitally-mediated interpersonal communication between local community members (Cronbach's $\alpha = .80$). To estimate the index 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 (for a complete list of storytelling network indicators, see Table 1).

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). This study used the 100/20 Mbps tier as the benchmark for the district fixed broadband service availability (DBSA). For example, if a respondent lives in a county with a 100/20 Mbps broadband coverage rate of 78.34%, their DBSA is at 0.7834 ($M = .8351$, $SD = .1917$).

Most concerning, however, is that the DBSA parameter (the percentage of served locations in a county) does not directly reflect the quality of internet access experienced by the samples of respondents. As such, claims about the impact of county-level

Table 1. Measurement indices.

Construct	Indicator	*M*	*SD*
Civic Participation	'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)? 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)?	3.44	1.50
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

availability changes on individual-level behavior may bear potential ecological fallacies. That said, the parameter lends itself to being operationalized as a moderator of the communication action context in that it represents the physical communication infrastructure of a geographic community (Ball-Rokeach et al., 2001). The high correlation

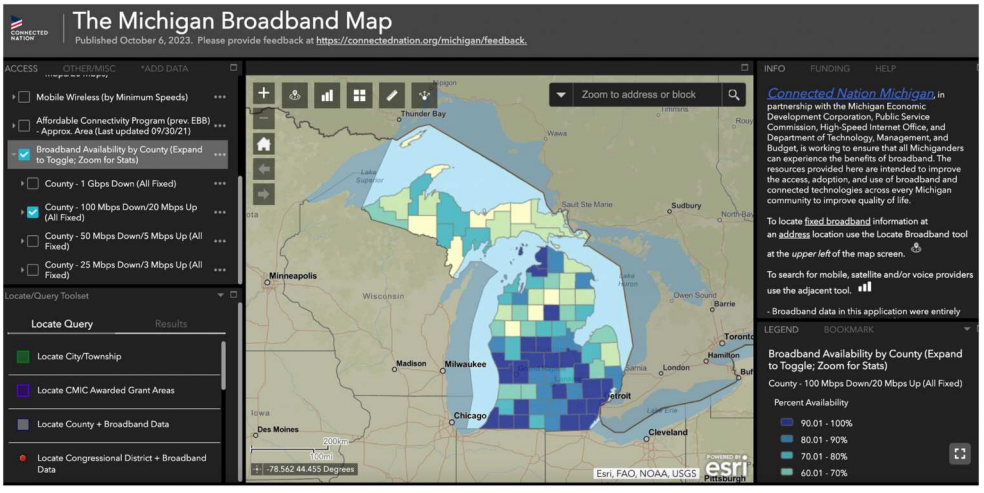

Figure 2. The Michigan broadband map based on FCC dataset.

Note: The screenshot shows the Michigan Broadband Map with the access level selected as the 100/20 Mbps tier. Captured from https://gis.connectednation.org/

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.[2]

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 as follows: metro areas from 1 to 3 (i.e., urban), non-metro areas with a sizable urban population from 4 to 7 (i.e., suburban), and non-metro areas with minimal urban presence from 8 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 Table A.3; Figure A.2 for measurement details). In the final dataset, the mean code point is 3.26 ($SD = 2.48$), 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).

Control variables

The current models, which consider political participation a function of digital civic infrastructure, include variables that could correlate with its effects in two packages. First, there are debates that the effects of the internet on political participation may be spurious because both 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). 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 $\alpha = .88$); local political efficacy was gauged with two items (McLeod et al., 1999) (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 $\alpha = .71$).

Results

Four ordinary least squares (OLS) linear regression models were conducted to examine H1, H2, and RQ3a (Table 2). While controlling for demographic factors and political covariates, Model 1 focuses solely on storytelling network factors (SN); Model 2 includes SN,

Table 2. Ordinary least squares linear regression models predicting civic participation.

	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		−.216(.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)
ΔR^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 = Local organization connectedness, DBSA = District fixed broadband service availability, R-U = Rural-urban continuum.

broadband availability (DBSA), and their interactions (SN × DBSA); Model 3 incorporates SN, urban-rural divisions (R-U), and their interactions (SN × R-U); and finally, Model 4 encompasses all of the above and their three-way interactions (SN × DBSA × R-U). While observing how adding contextual factors changes the associations between digital civic infrastructure and civic participation, we refer to the results of Model 4 for hypothesis testing. This choice enables us to depict the main effects in the presence of the moderators (Busenbark et al., 2022), aligning with the multi-layered facet of CIT ecology.

H1 posits that the three local storytelling network factors, namely, local information connectedness (LC; H1a), interpersonal community storytelling (INS; H1b), and local organization connectedness (OC; H1c), are positively related to civic participation. Regression results showed that OC and civic participation were positively related (β = .188, SE = .096, $p < .05$). The more affiliated individuals were with online and offline local organizations, the more engaged they were in civic activities. However, we did not observe a significant relationship between civic participation and LC or INS. Thus, H1c was supported but not H1a and H1b. Nevertheless, it is essential to highlight that in Model 1, which only examined the main effects of the three storytelling network variables (LC, INS, OC), all variables exhibited a significantly positive relationship with civic participation.

H2 proposes a positive relationship between civic participation and the interactions of broadband availability with storytelling network variables – LC (H2a), INS (H2b), and OC (H2c). However, contrary to the expectations, there was no interaction effect of DBSA with LC, INS, and OC on civic participation: H2 was not supported.

In response to RQ3a, which asks whether there is geographic variation in the relationship between digital civic infrastructure (i.e., SN × DBSA) and civic participation, we found that none of these interaction terms varied by geographic division. Notably, males and whites were significantly less engaged in non-institutional civic activities, while those with higher education levels were significantly more engaged.

Next, four generalized linear models (GLM) with binomial logit links were performed to investigate RQ1, RQ2, and RQ3b (Table 3). Due to the binary nature of the outcome variable, voter turnout, logistic regression models within the GLM framework were selected. Models A, B, C, and D were configured to be equivalent to Models 1, 2, 3, and 4 above, respectively. Likewise, we refer to Model D for hypothesis testing.

In Model D, we did not find strong evidence to suggest that voter turnout is a function of the storytelling network variables. Consequently, the findings only support null hypotheses for RQ1. Yet, for RQ2, which asked how the interactions between SN and DBSA were related to turnout, a positive interaction between interpersonal community storytelling and broadband availability was found ($\beta = 3.602$, $SE = 1.731$, $p < .05$). That is, residents who tend to participate in interpersonal community discussions, both online and offline, showed a higher likelihood of voting, particularly in areas with richer broadband resources. Moreover, there was a significant negative interaction between local information connectedness and broadband availability on voting ($\beta = -4.760$, $SE = 2.021$, $p < .05$). To be specific, the *higher* the broadband availability, the *weaker* the negative (but not significant) relationship between LC and turnout. It demonstrates that in sustaining voter turnout, the availability of internet resources within community-level contexts outweighs variances in local information exposure at the individual level (Figure 3).

Table 3. Generalized logistic regression models predicting 2020 general election turnout.

	Model A	Model B	Model C	Model D
Demographics				
Age	.031***(.009)	.030***(.009)	.031***(.009)	.033***(.010)
Gender (m)	−.346(.306)	−.356(.312)	−.356(.312)	−.402(.326)
Race (w)	.346(.332)	.329(.338)	.307(.341)	.373(.361)
Education	.312**(.107)	.316**(.108)	.337**(.110)	.363**(.112)
Income	.137**(.045)	.135**(.045)	.129**(.045)	.122**(.046)
Political covariates				
Political interest	.463***(.105)	.467***(.105)	.474***(.105)	.497***(.109)
Political efficacy	.320***(.096)	.315**(.098)	.298**(.097)	.328**(.103)
Predictors				
LC	−.163(.153)	−.352(.537)	−.554(.374)	2.419+(1.249)
INS	−.056(.109)	.032(.444)	.269(.306)	−1.728(1.110)
OC	.118(.102)	.425(.471)	.613+(.350)	.080(1.004)
Moderators				
DBSA		−.136(1.744)		1.759(4.538)
LC*DBSA		.237(.645)		−4.760*(2.021)
INS*DBSA		−.111(.526)		3.602*(1.731)
OC*DBSA		−.363(.538)		1.717(1.661)
R-U			.033(.144)	1.701*(.816)
LC*R-U			.062(.054)	−.662*(.331)
INS*R-U			−.050(.043)	−.222(.265)
OC*R-U			−.069(.046)	−.178(.220)
DBSA*R-U				−1.654*(.812)
LC*DBSA*R-U				.971**(.345)
INS*DBSA*R-U				−.470+(.277)
OC*DBSA*R-U				−.025(.246)
Intercept	−4.203***(.827)	−4.042***(1.619)	−4.370***(1.229)	−7.437***(2.733)
Log likelihood	−202.297	−201.998	−200.151	−191.682
AIC	426.6	434.0	430.3	429.4
N of counties	80	80	80	80
N of individuals	713	713	713	713

Note: LC = Local information connectedness, INS = Interpersonal community storytelling, OC = Local organization connectedness, DBSA = District fixed broadband service availability, R-U = Rural-Urban continuum.

For RQ3b, the interaction term of LC and DBSA on turnout significantly varied by R-U ($\beta = .971$, $SE = .345$, $p < .01$). As Figure 4 shows in greater detail, rural residents (closer to 1 on the R-U continuum) who had more broadband resources and were more connected to local information were 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 (see blue lines). 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.[3]

The effect size of the three-way interaction term (OR = 2.640, 95% CI [1.40, 5.42]) indicates that for every one-unit increase in local information connectedness (on a 7-point scale), combined with a one-unit movement toward urban areas on the rural-urban continuum (on a 9-point scale), over a one percent increase in broadband availability (within a county), there was 3.03 percent increase in the likelihood of voting. Individuals in a more urban setting with higher levels of digital civic infrastructure (i.e., LC × DBSA) are more likely to vote. We provided statistical evidence in response to RQ3b that the interaction of local information connectedness and broadband availability varies across rural and urban areas.

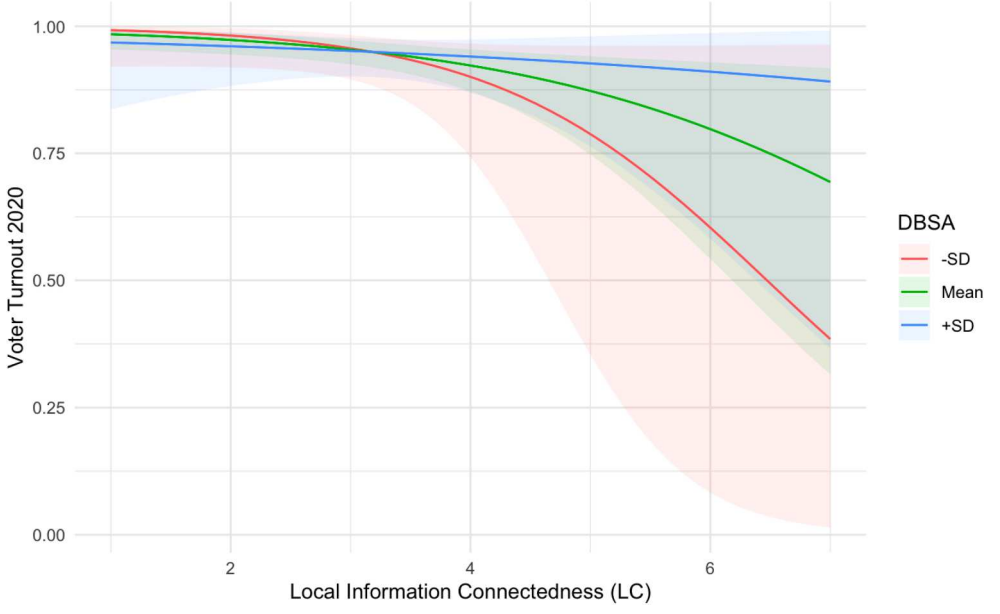

Figure 3. The interaction between local information connectedness and district broadband service availability on voter turnout.

Note: Y-axis indicates the predicted likelihood of turnout between 0.0 and 1.0. DBSA: District fixed broadband service availability at 100/20 Mbps tier.

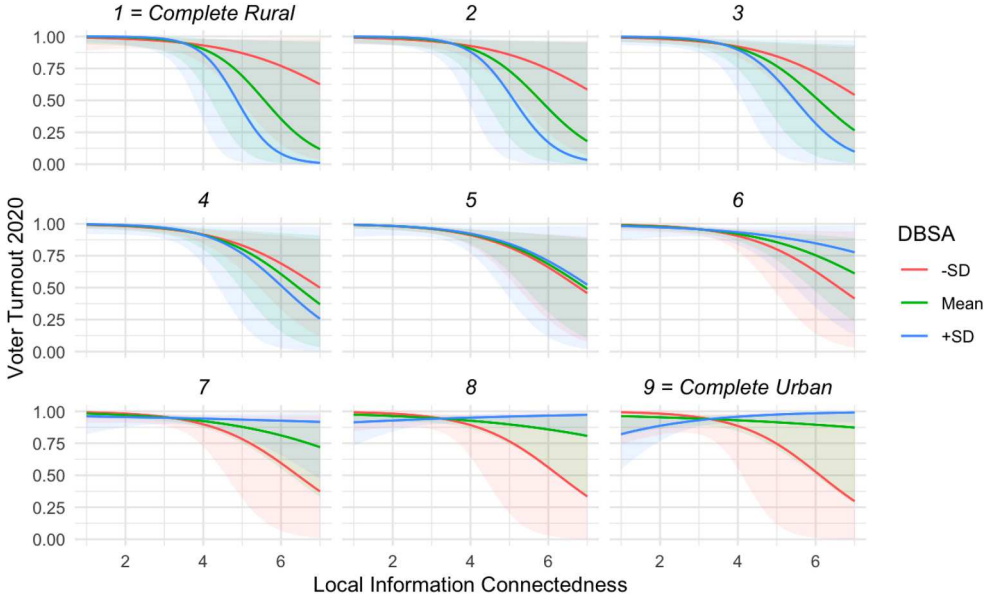

Figure 4. The three-way interaction of local information connectedness, district broadband service availability, and geographic division on voter turnout.

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 fixed broadband service availability at 100/20 Mbps tier.

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

Discussion

Using Communication Infrastructure Theory (Ball-Rokeach et al., 2001; Kim & Ball-Rokeach, 2006), the study operationalized three types of civic communicative behaviors as storytelling network factors: Local information connectedness, interpersonal community storytelling, and local organization connectedness. We then employed county-level broadband availability as a technological communication action context. By conceptualizing the interaction of these components as digital civic infrastructure, we established a theoretically grounded approach to examining the relationship between internet use and political participation.

Our findings corroborated earlier CIT research, demonstrating a positive relationship between individual-level storytelling factors and civic participation. This link was most prominent for local organization connectedness and was insensitive to broadband availability or rural-urban geographic divisions. These results underscore the *collective* nature of civic participation, suggesting that storytelling networks operating at the meso-level (i.e., within community organizations) exert a more substantial influence on offline civic outcomes compared to those at the macro-level (e.g., local news consumption) or micro-level (e.g., interpersonal discussions). This aligns with the foundational conception of CIT that local community organizing behaviors, in particular, serve as a generative mechanism for cultivating social capital and, subsequently, fostering civic action (Ball-Rokeach et al., 2001).

Contrary to our expectations, we observed a consistent lack of positive interaction effects between storytelling networks and broadband availability on civic participation, with no geographic variation. These results suggest that individual agency, rather than technological conditions, plays a pivotal role in mobilizing civic communication. This supports CIT's optimistic view that people are 'actively adaptive,' using available communication tools to reconstruct social worlds (Ball-Rokeach et al., 2001, p. 393). However, the question remains: *why don't digital resources further promote non-institutional civic activities?*

One possible explanation could be civic participation's voluntary nature (van Deth, 2014). Recent studies demonstrate that broadband internet can displace some aspects of social capital within local communities (e.g., Geraci et al., 2022). If so, the persistence of voluntary engagement may not be contingent upon high-speed internet availability but rather on the efforts of community members to form local storytelling networks that produce social capital (Kim et al., 2019). Indeed, the correlation between broadband availability and civic participation ($r = .09$, $p < .05$) appears much weaker compared to the correlations identified between storytelling networks and civic participation (LC: $r = .14$, $p < .001$; INS: $r = .42$, $p < .001$; OC: $r = .62$, $p < .001$). This contrast endorses this explanation but warrants further investigation (Table A.1).

This study is noteworthy as it is among the first to examine the impact of digital civic infrastructure on voting behavior using CIT. Specifically, the present analysis supported *the bigger pie hypothesis* overall. The positive relationship between interpersonal community storytelling and voter turnout was stronger among residents with higher broadband

resources. Additionally, the negative relationship between local information connectedness and turnout was significantly weaker among those living in such *digitally-rich* districts.

However, geographic contexts reveal significant variation in the interplay of digital civic infrastructure. The 'winner' of the two competing hypotheses varies by region. In areas closer to urban centers, *the bigger pie hypothesis* gained traction: Residents with higher broadband availability were more likely to vote when seeking local information. In contrast, *the trade-offs hypothesis* is more prevalent in areas closer to rural: Residents with better internet access and access to more local information were less likely to vote. The bigger pie of internet resources suggests the trade-off of diminished rural participation.

Research suggests several possible explanations for this paradox in rural areas. A significant body of research tackles issues like digital literacy and skill development (Scheerder et al., 2017; van Deursen & van Dijk, 2014). However, unreliable service and limited data access often constrain internet usage, compelling rural residents to prioritize tasks such as work or school over accessing civic information (Hardy, 2022; Hartsuyker et al., 2021; Marshall et al., 2023; Mathews & Ali, 2022a; 2022b). In addition, historical underinvestment in rural broadband expansion and slow adoption have entrenched non-civic digital practices, echoing the undemocratic trends identified in the early 2000s (Prior, 2005). Consequently, these patterns demonstrate that addressing geographic digital divides needs to move beyond hardware, software, and connectivity to account for structural and contextual factors.

Our findings offer valuable insights for communication scholars and practitioners seeking to enhance civic engagement in the digital age, particularly by recognizing the distinct contexts of rural and urban environments. Aligned with other researchers (e.g., Gilbert & Masucci, 2020), we believe that to advance our understanding of this topic, a mixed-method, interdisciplinary approach focused on local contexts is essential for creating customized interventions and adaptable policies for digital inclusion. This is because of their ability to pull together complementary insights (Wilson-Menzfeld et al., 2024). Quantitative studies, such as surveys like ours, illuminate patterns of nonuse and demographic trends but often fail to capture the nuanced motivational, psychological, cultural, and socio-technical factors influencing adoption and usage (although see Dutton & Reisdorf, 2019; Helsper & Reisdorf, 2013). In contrast, qualitative methods, like ethnography and participatory design, highlight lived experiences, cultural contexts, and local challenges that shape the quantitative data, particularly for marginalized communities and outlier groups (Hardy & Vargas, 2019; Marshall, 2024; McMahon, 2020; McMahon et al., 2021).

Collectively, these methods offer rich insights that can guide applied interventions that contribute to structural transformation (Gilbert & Masucci, 2020) through effective policy and governance. Effective strategies must balance infrastructure investments with initiatives that build digital literacy and promote social infrastructure. Broadband policies should simultaneously address demand-side barriers, such as affordability and digital literacy, and supply-side issues (Prado & Bauer, 2021). Context-specific strategies, such as participatory digital literacy programs, digital skills programming drawing on local tech practices or leveraging the strengths in existing infrastructure, have been shown to produce a more significant impact (Reisdorf & Rhinesmith, 2020; Salemink

et al., 2017; van Deursen & van Dijk, 2014; Wilson-Menzfeld et al., 2024). It is not enough to promote digital access or literacy – policies must address systemic barriers and intersectional inequities, considering material, motivational, and contextual elements that influence ICT usage (Goedhart et al., 2022).

Lastly, effective governance for digital inclusion requires instilling local agency and adaptive decision-making into policy frameworks. Socio-technical and socio-economic factors must inform governance models to ensure that policy and implementation resonate with local values and priorities while supporting sustainable growth (Bauer, 2022; Prado & Bauer, 2021). Decentralized, adaptive governance frameworks shift decision-making power to communities, enabling them to identify challenges and co-create solutions that reflect their lived experience, improving the success of digital uptake (Ali, 2020; Bauer, 2022; McMahon, 2020). Examples of community-led initiatives include grassroots approaches to addressing cost and access barriers (Fernandez et al., 2019) and 'First Mile' approaches that place communities at the forefront of broadband deployment (McMahon, 2020). Tools like the Digital Opportunities Compass provide accessible frameworks to guide policymakers in integrating technology with local contexts (Bauer et al., 2023). By aligning policy with local contexts and community needs, these frameworks foster equitable, effective, and sustainable digital inclusion, opening the possibility for similar increased access to contribute to increased political participation and its relationship to localized information practices.

As highlighted above, our study is methodologically limited in identifying factors that influence why residents with increased broadband availability were less likely to vote when seeking local information in rural areas. Similarly, another key limitation is assuming that broadband availability equates to adoption. While the FCC Broadband Map shows where the internet is available, it does not account for adoption rates. Many reasons, such as diminished trust in technology, privacy concerns, and misalignment with cultural values, may contribute to certain populations, particularly in rural areas, having lower adoption rates (Hardy, 2022; McMahon, 2020). Future research should incorporate qualitative research and work directly with local government or high-performance computing networking non-profits to deploy state-wide adoption data collection, highlighting *experiences* in rural areas.

Our approach to geography also leaves room for further improvement. Given that geographic location and geographic perception do not necessarily align (Nemerever & Rogers, 2021), residents' relationships with their environments may differ depending on how geography is measured. While the USDA's Rural-Urban Continuum Codes ensure analytical consistency at the county level – sharing the same unit of analysis with FCC broadband data, classifications centered on rural areas (e.g., Frontier and Remote Area Codes; see Wakefield, 2012), sub-county level classifiers (e.g., Rural-Urban Commuting Area codes; see Morrill et al., 1999) or perceptions of rurality (e.g., Lunz Trujillo, 2022) may offer a valuable lens to assess the study's implications from the standpoint of communities with limited access to digital resources.

Another limitation is the use of cross-sectional data. Although public broadband availability data was used as a contextual factor, which may help establish the directionality of relationships among focal variables (Lelkes, 2020), future studies should combine panel surveys with time-series broadband availability data to test for causality more rigorously.

Lastly, while Michigan's civic resource allocation mirrors spatial disparities within the U.S., our state-level findings might not readily extrapolate to the national level. However, geographic disparities hold local contexts, and our quantitative case analysis can serve as a foundation for future research on structural social divides. Based on our collective limitations, we would encourage future work to move beyond quantitative approaches and incorporate qualitative research, particularly within political communication scholarship, to better capture the unique local contexts that shape such environments. The study emphasizes that a geographically balanced distribution of civic resources benefits democracy, and digital infrastructure is no exception.

Notes

1. 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
2. To address this issue further, respondents were asked 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.
3. The same GLM models were also run for predicting turnout in the 2022 midterm election. The pattern of the relationships was similar, but the significance of the three-way interaction (LC X DBSA X R-U) shifted to the marginal level ($\beta = .404$, $SE = .232$, $p = .064$; see Table A.2).

Disclosure statement

No potential conflict of interest was reported by the authors.

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