Article

The Geography of Newspaper Circulations: A Spatial Taxonomy of "News(Paper) Deserts" in the United States

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Abstract
Using the newspaper circulation data collected through the Alliance for Audited Media (n = 1,925 across five years), this study provides the first empirical spatial analysis of newspaper circulation in the US, employing the theoretical framework of communication geography and the analytical tool of spatial econometrics. From 2018 to 2022, a steady decline (at an average of 24.1% per year) in newspaper circulation was observed in most of the counties in the dataset, after controlling for spatial and temporal random effects. A positive and significant spatial autocorrelation was found across the US. The local indicators of spatial association results identified four types of spatial clusters that offer a more nuanced understanding of the local spatial distribution of newspaper circulation: news deserts, news oases, news islands, and the fringe of news deserts. The study also used Bayesian spatiotemporal modeling to pinpoint the regions that are more sensitive to the spatial structure regarding the decline of newspaper circulation.

Issue
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1. Introduction

Despite the ongoing digitization of the news industry, print media (i.e., newspapers and magazines) remain an essential part of the news landscape in the US. Moving beyond the "death of print" narrative, O'Sullivan et al. (2017) contended that the materiality of the printed newspaper could encourage more social interactions and encounters with audiences. Although some scholars argue about the displacement effect of digital media on print media, others suggest that there could be a potential complementary relationship between these two types of media outlets (Gentzkow, 2007; Jang & Park, 2016). Meanwhile, some media outlets have attempted to shift from print to online media to combat the growing threat of "post-print obscurity" for newspapers across the globe (Thurman & Fletcher, 2018). However, Chyi and Tenenboim's (2017) longitudinal study revealed that the majority of these newspapers suffer from their unsuccessful transition, with the printed edition remaining the

core product in the local market. As noted by O'Sullivan et al. (2017), newspapers persist in their efforts to innovate by themselves or reap the benefits of innovations by the innovation of other information commodities. In a recent study conducted by Finneman et al. (2023) in North Dakota, South Dakota, Nebraska, and Kansas, their findings indicated that rural readers in America still favor print subscriptions (51.9%) over digital subscriptions (35%) as a means of supporting the revenue stream of rural newspapers. Therefore, print media are still vital, especially for information access in local and rural communities, where they can generate and maintain a sense of locality (Mathews, 2022).

The declining trend in daily newspaper circulation is not a recent development. As Chittum (2014) has pointed out, based on the data from the Newspaper Association of America, newspaper circulation has steadily declined since 1984, well before the advent of digital transformation. Furthermore, its declining pace even accelerated from 2003 to 2009 at the country level

(Chittum, 2014). According to Abernathy (2020), 25% of newspapers in the US have vanished since 2004, resulting in 1,800 communities that had a news outlet in 2004 having none by 2020, becoming "news deserts." Amongst the 3,143 counties in the US, two-thirds have no daily newspaper while 225 of those counties lack any type of news outlet at all (Abernathy, 2020). Abernathy (2018, p. 16) expanded on the original definition of news deserts, which referred to "a community without a local newspaper," by introducing a broader definition that includes any community where residents experience significantly reduced access to important news and information that sustains grassroots democracy and democratic governance. To clarify, the news deserts in this article refer specifically to the absence of newspapers, as the "newspaper deserts."

While there has been a substantial amount of research on the impact of news deserts on local/community journalism, information access, and community health (Ferrucci & Alaimo, 2020; Mathews, 2022; Smethers et al., 2021), the spatial dimension has been long overlooked in the literature despite the term "desert" in its name. Nonetheless, the concept of space or geography plays a crucial role in local journalism and newspaper, as it underpins the community-centric coverages while providing locative and contextual perspectives (Mersey, 2009). The University of North Carolina at Chapel Hill and Ohio University (the Media Deserts Project) teams have done a tremendous job in mapping out the news deserts in the US (Abernathy, 2020; Ferrier et al., 2016). However, to the best of the author's knowledge, previous studies have not yet undertaken a quantitative analysis of the spatial aspects of news deserts, which is the primary objective of this study. By including a spatial dimension, as considering the spatial feedback from the neighboring geographical units, this study strives to transcend the binary measurement and to develop a more nuanced identification of news deserts. The observation of distinct spatial patterns can provide valuable insights that can guide policymakers in tailoring interventions specific to the taxonomy of news deserts. Furthermore, by acknowledging the influence of spatial structure, the study seeks to provide a more accurate estimation of macro-level newspaper circulation trends. Leveraging the tool of spatial econometrics, the first part of this study investigates the spatial distribution of local newspaper circulation, aiming to identify areas characterized by spatial inequality and uneven access to local news and information. Subsequently, Bayesian spatiotemporal modeling is utilized to delineate the spatial and temporal effects locally. In other words, it seeks to discern how the spatial (and temporal) random effects differ across the geographical units in the study region. In sum, we would like to provide a comprehensive understanding of the spatiality of local newspaper circulation as well as the spatial inequality of news access, filling the gap in the news deserts scholarship.

2. Related Literature

2.1. The Demise of the Local Printed Newspaper in the US

As a long-standing, central fixture in communities, local newspapers serve both social and informational functions. In Berelson's (1949) landmark investigation on newspapers, he identified the types of uses and gratifications of newspaper consumption, including seeking information about current events, using newspapers as a daily guide, as a reprieve from personal responsibilities, attaining or displaying social status, utilizing it as a means of social contact to bridge common morality, and adopting it as a habitual practice. As he asserted, newspapers have the role of safeguarding communities by providing residents with a sense of reassurance to combat pervasive feelings of insecurity and anomie. Amongst 100 randomly selected communities across the US, Mahone et al. (2019) discovered that local newspapers, which only make up 25% of media outlets in the market, cover more than 60% of the local news stories. Local newspapers are the most effective medium for delivering public service journalism and addressing the critical information needs in the community, outperforming other types of media outlets, such as local television, radio, and digital-only news websites (Federal Communications Commission, 2011; Mahone et al., 2019). For instance, a lack of local newspaper coverage can contribute to deficits in health knowledge. Public health experts use news stories in local papers to achieve infectious disease threat communication objectives, which are critical in increasing public awareness and reaching specific groups (Jin et al., 2019). During the Covid-19 pandemic, 57% of counties with Covid-19 cases did not have access to a daily local newspaper, leaving these communities at risk of insufficient news coverage and potentially exacerbating their vulnerability to the pandemic (Hendrickson, 2020).

The dramatic decline in circulation and coverage of local news sources has both short-term and long-term democratic consequences in civic engagement (Hayes & Lawless, 2018; Schulhofer-Wohl & Garrido, 2013; Shaker, 2014). As local newspapers play a significant role in attaining local political knowledge, promoting community advocacy, and informing public policy decision-making, their demise undermines the sense of community and public trust in democracy at all levels (Barthel et al., 2016; Hayes & Lawless, 2015; Mathews, 2022; Shaker, 2009). Many of these communities have lost their access to a local newspaper and have no reliable sources of local and regional news on topics such as politics, economics, and the environment (Abernathy, 2014). Residents living in news deserts are typically less informed about important issues in their community, and, therefore, are less likely to participate in local elections (Filla & Johnson, 2010; Hamilton & Morgan, 2018). Meanwhile, Darr et al. (2018) detected a causal effect in the decline of split-ticket voting across votes

for the presidency and the US Senate for the communities where newspaper closure occurred. Nonetheless, they posited that the increase in polarized voting is attributed to partisan heuristics resulting from an augmented dependence and exposure to national media, rather than a general loss of political information. Also, in a Kentucky case study, the closure of *The Cincinnati Post* resulted in decreased competitiveness in local elections and a depressed effect on voting turnout has endured for multiple years (Schulhofer-Wohl & Garrido, 2013). Moving beyond the circulation, the findings by Hayes and Lawless (2018) indicated that regions with lower coverage of congressional campaigns were linked to a lower level of voter turnout and political knowledge amongst a representative sample of Americans. Focusing on 11 local newspapers in California, Rubado and Jennings (2020) found that the municipalities served by newspapers with significant decreases in newsroom staffing experienced a reduction in political competition as well as voter turnout during mayoral races. In a special report released by *POLITICO*, it was found that during the 2016 US presidential election, former President Donald Trump outperformed in the areas that lacked traditional news outlets (Musgrave & Nussbaum, 2018). Additionally, concerning other potential political consequences, Matherly and Greenwood (2022) demonstrated that the closure of newspapers results in a substantial increase in political corruption within the districts those newspapers once served. They highlighted the agenda-setting function of newspapers as a possible mechanism underlying this effect. It was found that the rise of online news vendors fails to alleviate the situation and there was no replacement effect between newspapers and their digital counterparts in this particular case.

2.2. Re-Spacing Place in "News Deserts"

Spatial journalism, as defined by Schmitz Weiss (2015, p. 125), is the integration of "a place, space, and/or location into the process and practice of journalism." In recent years, scholarly research in journalism has delved into the role of emerging technologies in enhancing news narratives and empowering users by fostering a sense of presence within the virtual and augmented space (Kukkakorpi & Pantti, 2021; Papacharissi, 2015; Wu, 2022). However, until now, communication and journalism scholars have largely neglected the physical aspect of spatial dimensions when studying news deserts. Papacharissi (2015) discusses the concept of "space" in a hybrid model of digital journalism in the new age, and her analysis emphasizes social media and digital platforms rather than the physical space. But the related but distinct concept of "place" is not unfamiliar in journalism research. Journalism research and practice have a longstanding tradition of analyzing how places are portrayed and perceived through the use of maps and cartography, as part of a place-making process that aims to illustrate contextual narratives to the audience (Gutsche

& Hess, 2020). Usher has called for putting "place" in the core of journalism research, as the journalistic practice could have the professional power control or cultural authority over the domain of "where," through the "act of place-making" in news production (Usher, 2019, p. 85; see also Usher, 2021). As argued by Leupold et al. (2018), the concept of social cohesion in an urban setting is intricately tied to the communication channels that exist within it. Specifically, local journalism plays a critical role in shaping the image of social cohesion in a city and establishing a sense of place-based identity, serving as an informational backbone through which individuals gain insight into the social fabric of their community. Nevertheless, we seldom formally put the news ecosystem or the information infrastructure into space, until recent scholars start to advocate for a *spatial turn* in communication and media studies (Waldherr et al., 2021).

Harrison and Dourish (1996) highlighted the critical differences between "place" and "space" in the mediated collaborative system. In particular, they considered space as a natural entity of the properties that define "the essential reality of setting of action," and place as a social product, as a set of understanding (Dourish, 2006, p. 300). Goodchild and Janelle (2010, p. 6) argued that space is the fundamental linkage between virtual and geographical processes, and that place is a social context that is embedded with social advantages and disadvantages. In human geography literature, as Adams and Jansson (2012) pointed out, place is a concept capturing the subjective experience produced in the local environment and dialogue, and space indicates the potential and actual movements of different entities, such as humans, goods, and information. The subfield of *communication geography*, also known as *spatial communication*, has emerged as a means of building an epistemological and ontological bridge between the disciplines of journalism studies and human geography (Adams & Jansson, 2012; Jansson & Falkheimer, 2006). Adams further proposed a quadrant taxonomical framework of communication geography: places and spaces in media/communication, as well as media/communication in places and spaces (Adams, 2011; Adams & Jansson, 2012). However, as an evolving cross-disciplinary subfield, Adams and Jansson did not provide an empirical examination, particularly from a quantitative approach. We argue that media consumption could be "situated, localized, and specialized" in space (Rodríguez-Amat & Brantner, 2016, p. 1041). Therefore, the spatiality of newspaper circulation, which can be classified as media/communication in spaces, should be examined as an essential part of the journalistic infrastructure of a local community (Napoli et al., 2017).

As Mersey (2009) pointed out, even in today's media landscape, where online media consumption is more prevalent and convenient, individuals still possess a stronger geographic sense of community when reading news articles covering a particular geographic area, irrespective of their level of online engagement. This highlights the enduring relevance of physical geography

in today's news ecosystem and therefore emphasizes the necessity of our study. In this article, we advocate for a spatial awareness of the news ecosystem and information infrastructure in the local community, in contrast to the place-based approach in the past scholarship, which centers on a particular locale within the geographic and material setting of news. Meanwhile, previous journalism literature predominantly employed abstract representations of space, such as institutional or mediated space (Pan, 2000; Reese, 2016), whereas our focus is on the tangible presence and geographical patterns of local newspaper circulation. This study sheds light on offering the very first empirical analysis of the spatial embeddedness of newspaper circulation in the US context, filling a gap in the existing literature. Specifically, our analysis reveals how the spatial patterns of newspaper circulation in the US are shaped globally and locally. We also contend that the decline in newspaper circulation is not limited to a single geographic unit at a one-time point but is intertwined and interdependent with the spatial and temporal structure. Thus, we have formulated three research questions that we seek to answer:

RQ1: What is the global spatial distribution of newspaper circulation at the county level in the US?
RQ2: What is the local spatial pattern of newspaper circulation at the county level in the US?
RQ3: Is newspaper circulation at the county level in the US sensitive to (a) spatial structure and/or (b) temporal structure?

3. Method

3.1. Data Collection

Unlike the previous approach of the University of North Carolina at Chapel Hill team that mainly used a binary *have/have-not* measure (whether a county has at least one newspaper or none at all), we employed a continuous measurement to investigate the nuances of newspaper circulation. In particular, we utilize the audited database compiled by the Alliance for Audited Media, a non-profit industry organization established in 1914 by the Association of National Advertisers to ensure reliable and impartial reporting of media metrics that allow for accurate evaluation and comparison of media performance. The Alliance for Audited Media dataset comprises 1,070 newspapers in the US, which has been widely used by journalism scholars (Chyi & Ng, 2020; Rubado & Jennings, 2020). To account for newspapers with distribution beyond their publishers' geographic location, we have collected circulation data for each newspaper in every county and aggregated it at the county level. Due to data limitations, we could only access the audited data in the news media statement from 2018 to 2022. The number of counties with audited data from 2018 to 2022 is 2,408, 2,359, 2,306, 2,209, and 1,950 respectively. The data from Alaska and Hawaii

are excluded since they are not geographically contiguous with the rest of the states. In order to perform the spatiotemporal modeling in the last part of the analysis, only 1,925 counties (in 47 states and the District of Columbia) that contain circulation data across five continuous years are retained in the final dataset. We are missing data from a huge area in the Mountain West (Idaho, Wyoming, Utah, and Colorado), the west side of the Great Plains (North Dakota, South Dakota, Nebraska, and Kansas), New Mexico, and West Virginia. Despite its limitations, Alliance for Audited Media data still offers broad coverage across the contiguous US and provides fine-grained data at the county level. Figure 1 shows the distribution density plot of the average newspaper circulation of each state in each year. Only the data from 48 states are shown in Figure 1 for visualization purposes, as the data on the District of Columbia is an outlier compared to the rest of the states. More detail of audited data aggregated at the county level in each state could be found in Supplementary File.

3.2. Data Analysis

To descriptively investigate the spatial patterns of newspaper circulation in the US, we first compute an index to capture the percentage of newspaper circulation change from 2018 to 2022 following Equation 1:

$$\Delta y\% = \frac{y_{2022} - y_{2018}}{y_{2018}} * 100\% \qquad (1)$$

Moving toward the spatial analysis in the later part, we choose the absolute difference of newspaper circulation for spatial analysis ($\Delta y = y_{2022} - y_{2018}$) and employ a Rook's continuity to construct our spatial weight matrix to define the neighbor list for each county. The typical continuity-based neighborhood structure includes Queen's criterion (when neighbors share boundaries or vertices) and Rook's criterion of continuity (when neighbors only share boundaries). In this case, the Queen's and the Rook's continuity both yield similar results of Moran's *I* (0.373 and 0.375). Following the traditions of exploratory data spatial analysis, we pick the slightly higher Moran's *I* here.

3.2.1. Global Spatial Autocorrelation

In order to incorporate the spatial dimension of newspaper circulation into the modeling process, we have drawn upon a series of spatial concepts and analytical strategies in spatial econometrics. As stated by Tobler (1970, p. 236): "Everything is related to everything else, but near things are more related than distant things." One key concept that reflects the relationship between nearby spatial units is *spatial autocorrelation* (Getis, 2010). To quantify and visualize spatial autocorrelation, geographers typically use global measures such as Moran's *I*, which provides a statistical metric that describes spatial autocorrelation on a global level.
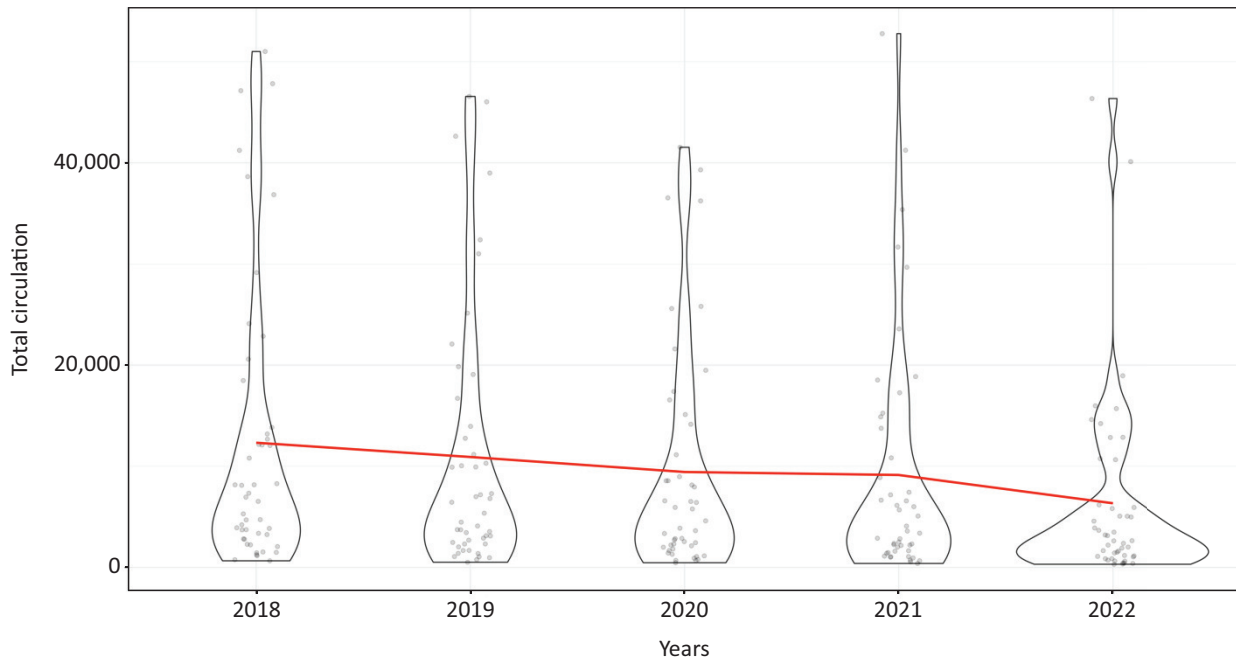
Figure 1. The newspaper circulation distribution in the US (2018–2022). Note: n = 47 states, excluding the District of Columbia.

Moran's I can be specified as follows, where N indicates the number of spatial units indexed by i and j, w_{ij} indicates the spatial weight matrix, and $W = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}$, indicating the sum of all w_{ij}:

$$I = \frac{N}{W} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \quad (2)$$

Similar to regular correlation coefficients in non-spatial modeling, the values of Moran's I range from −1 to 1. Positive spatial autocorrelation occurs when Moran's I value is close to 1, indicating that values of interest are clustered together and are not independent. In other words, if spatial units are closer together, their values are more similar. In contrast, a Moran's I value of −1 indicates negative spatial autocorrelation, where dissimilar or dispersed values are located next to each other. Thus, when spatial units are closer together, their values are less similar. A Moran's I value of zero suggests no spatial autocorrelation, meaning that values of nearby spatial units are randomly associated.

3.2.2. Local Indicators of Spatial Association

In addition to the global measure of spatial autocorrelation above, Anselin (1995) introduced local indicators of spatial association (LISA) to quantify the contributions of each location to the global index. By utilizing LISA, we can better discern the spatial association between the value of a variable of interest at a given location and its neighboring units. The local tests can facilitate the identification of where the statistically significant relationship (of neighborhood and distance) may diminish (Ord & Getis,

2001). And the local Moran's I at unit i can be defined as follows, where z_i indicates the variable x in unit i in the standardized form as $(x_i - \bar{x})/SD_x$ and w_{ij} indicates the spatial weight matrix:

$$I_i = z_i \sum_j w_{ij} z_j \quad (3)$$

The interpretation of local Moran's I is analogous to its global counterpart. Based on the local measure, Anselin (1995) further provided additional details on the local spatial clusters, which are the contiguous geographical units that exhibit significant local indicators of spatial association corresponding to representative confidence intervals in frequentist statistics (Grubesic, 2006): high-high, low-low, low-high, and high-low.

3.2.3. Bayesian Spatiotemporal Modeling

Although the current study is not interested in the determinants (i.e., demographic or socio-economic factors) which might influence the changes in newspaper circulation in the US, we employ a Bayesian spatiotemporal modeling framework to investigate the spatial and temporal patterns of the changes in newspaper circulation, while accounting for the potential bias introduced by the spatial or temporal patterns. A Bayesian framework for spatial or spatiotemporal modeling would be well-suited for dealing with count data with a negative binomial distribution like our dataset. In particular, we use an integrated nested Laplace approximation (INLA) approach in the R-INLA package to attain the Bayesian estimates in spatial modeling (Rue et al., 2009). Compared to the common approach to performing Bayesian inference

like Markov chain Monte Carlo, INLA is computationally much less expensive while obtaining robust and comparative performance in spatial and spatiotemporal modeling (Blangiardo & Cameletti, 2015). In the analytical section, we explore three types of model specifications: (a) only incorporating the independent and identically distributed (IID) component, as the IID model; (b) incorporating both the IID component and the spatial component, as the Besag–York–Mollié model; (c) incorporating the IID component, spatial component as well as the parametric temporal component. Specifically, we use the deviance information criterion (DIC) and Watanabe–Akaike information criterion (WAIC), to compare the models and decide the best model, as normally a model with a lower DIC and WAIC will be preferred. And it could be specified as follows, with $\eta_{it} = b_0 + \mu_i + \upsilon_i + (\beta + \delta_i) \times t$:

$$y_{it} = NB(\lambda_{it}); \; \lambda_{it} = E_{it} \, \rho_{it} \qquad (4)$$

$$\log \rho_{it} = \eta_{it}$$

Here, b_0 indicates the intercept to quantify the average newspaper circulation, μ_i indicates a location-specific effect, υ_i indicates a spatial-structured effect, β indicates the main linear dynamic trend or the global time effect, and δ_i indicates a differential trend, as identifying the interaction between time and space.

4. Results

First, we present the changes in newspaper circulation at the county level in the US from 2018 to 2022, as shown in Figure 2. Most of the counties in the dataset have experienced a decline in newspaper circulation with only 27 counties showing a positive change, such as Guadalupe County and McLennan County in Texas with around a four-times increase. Conversely, 117 counties across the nation have lost more than 70% of their newspaper circulation compared to 2018, as indicated by the darker red regions in Figure 2.

The univariate Moran's *I* test of the change in newspaper circulation is 0.375, which is statistically significant under the Monte-Carlo simulation with randomization of 999 permutations (pseudo-*p*-value < 0.001), indicating a positive spatial autocorrelation across the nation. Therefore, the global spatial distribution of newspaper circulation is not uniform in the study region (RQ1). Furthermore, based on the results of LISA presented in the cluster map (see Figure 3; the significance map can be found in the Supplementary File), we identify the local spatial structured pattern of newspaper circulation in the US (RQ2). In the context of this study, these local clusters could be classified as follows (for an illustration of each type of spatial taxonomy, see Figure 4): (a) high-high or the "news deserts," (b) low-low or the "news oases," (c) low-high or the "news islands," and (d) high-low or the "fringe of news deserts."

High-high or the "news deserts" are counties with a high decline in newspaper circulation surrounded by other counties with a high decline. These 203 counties represent the greatest level of newspaper decline in the nation, and they main locate in (a) Southern America (Alabama, Arkansas, Georgia, Louisiana, Mississippi, and Texas) and (b) Midwestern America (Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota).
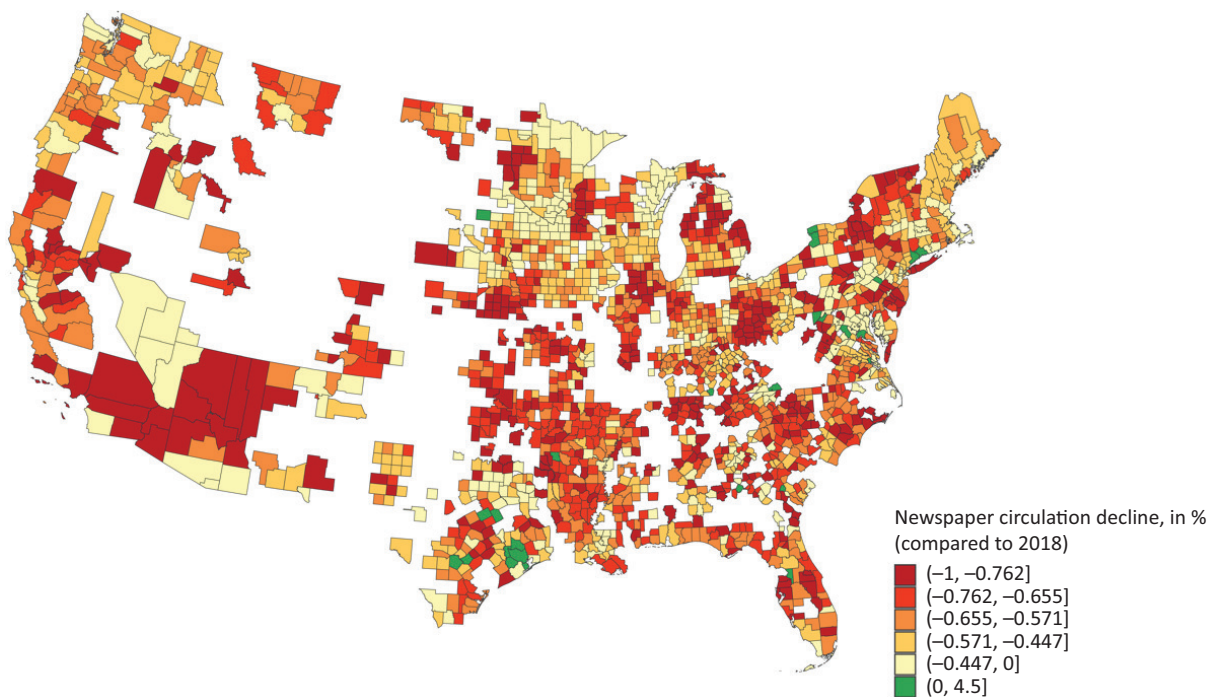

Newspaper circulation decline, in %
(compared to 2018)

- (−1, −0.762]
- (−0.762, −0.655]
- (−0.655, −0.571]
- (−0.571, −0.447]
- (−0.447, 0]
- (0, 4.5]

Figure 2. The newspaper circulation changes in the US (2018–2022).

Low-low or the "news oases" are counties with a low decline in newspaper circulation surrounded by other counties with a low decline. These 122 counties suffer less from the national decline of newspaper circulation compared to the rest of the country, and they are mainly situated in northeastern/mid-Atlantic states (Massachusetts, New Jersey, New York, and Pennsylvania, as well as the District of Columbia) and other coastal states (California, Florida, and Maryland).

Low-high or the "news islands" are counties with a low decline in newspaper circulation surrounded by other counties with a high decline. Only three counties are categorized in this cluster (Litchfield County in Connecticut, Dutchess County in New York, and Brazoria Count in Texas) and they are found adjacent to or inside of the core of news deserts; there is relatively more access to local news compared to adjacent counties, although not as much as the news oases.
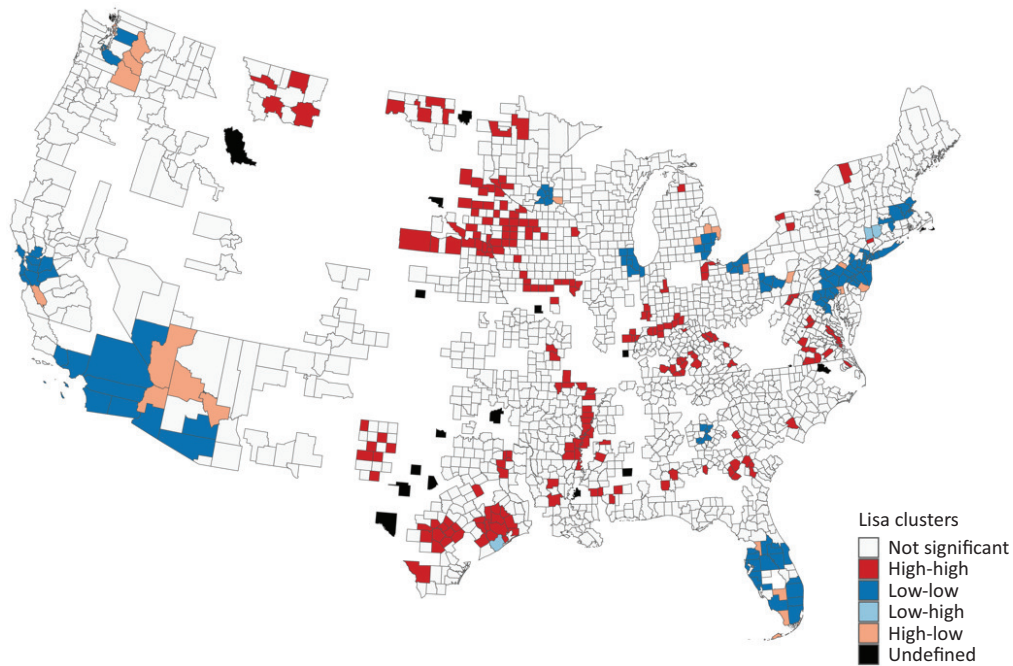

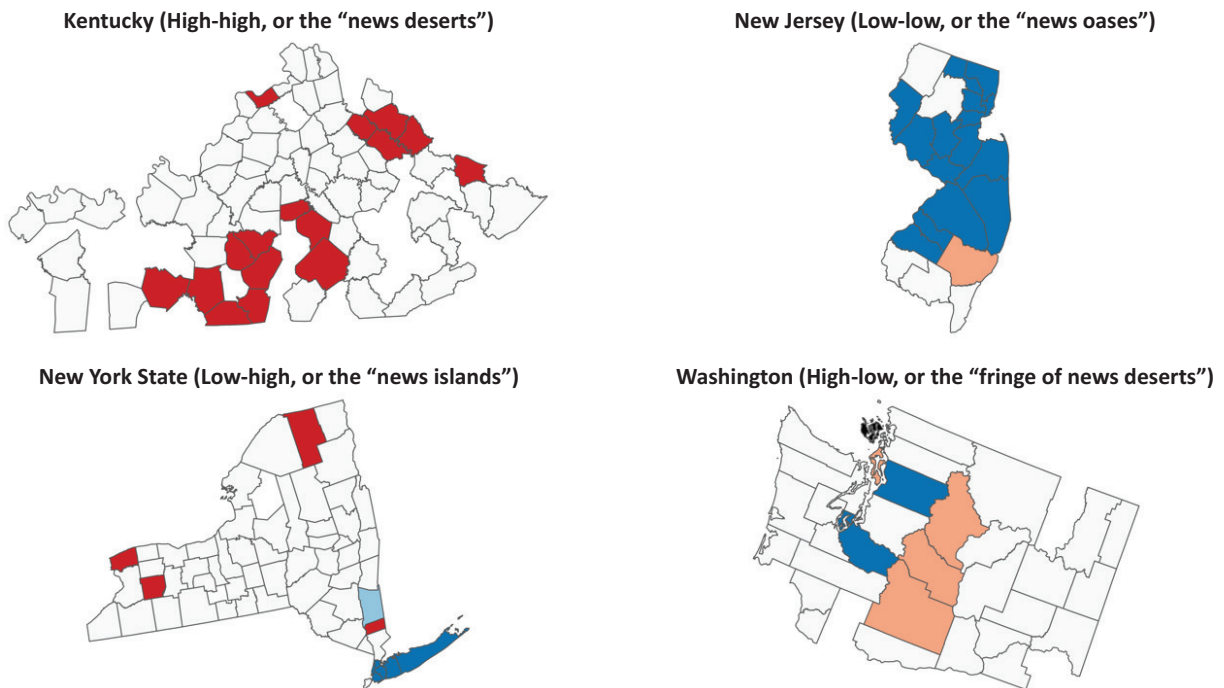**Figure 3.** The LISA cluster map of newspaper circulation changes in the US (2018–2022).

Figure 4. The illustration of the four types of spatial taxonomies of "news deserts."

High-low or the "fringe of news deserts" are counties with a high decline in newspaper circulation surrounded by other counties with a low value. Although the 22 counties are suffering a decline in newspaper circulation, they are on the edge of areas with relatively higher access to local news and not in the core of news deserts.

Lastly, we aim to investigate whether the distribution of newspaper circulation at the county level is sensitive to the spatial and temporal structure using a Bayesian framework (RQ3). Given the limited bandwidth of the dataset's timeline, we decided to use a parametric space-time model as Equation 3 presents, using the newspaper circulation data for each county in each year (1,925 counties × 5 years). Additionally, we incorporated the variable of the *year* to account for the global time effect (or the fixed effect). As presented in Table 1, we decided that Model 3, which includes both spatial and temporal structured random effect, was the best fit for our dataset since it renders the lowest DIC and WAIC values. Our analysis through the spatiotemporal model revealed that newspaper circulation in the US decreased by an average of 24.1% per year since 2018, as illustrated in Figure 5, which visualizes the posterior mean for the global time effect with its 95% credible region.

To further unpack the local patterns, we obtained the posterior mean of the spatial effect and the differential temporal effect as seen in Figures 6a and 6b. The blue areas in Figure 6a, which represent the positive values of spatial effect, are more likely to be influenced by their neighboring counties. They are primarily in the northeastern region (New York, New Jersey, Pennsylvania, Connecticut, Massachusetts, Rhode Island, New Hampshire, and Maine), Florida, the west coastal region (e.g., California and Washington), as well as the

Lake Michigan region (e.g., Wisconsin, Illinois, Indiana, and Michigan). The spatial structure among the counties is crucial in explaining the spatial distribution of newspaper circulation in the US and we can find the high spatially correlated variance in our dataset. On the other hand, we also observed a higher differential temporal trend than the average in the northeastern region and the midwestern region (e.g., Wisconsin, Minnesota, Iowa, and Indiana), as depicted by the blue areas in Figure 6b. These areas may be more vulnerable to the newspaper decline as time passes.

5. Discussion and Conclusion

This study is the first empirical analysis of the spatial patterns of newspaper circulation (or the news deserts) in the US context, utilizing the theoretical framework of communication geography to put print media into spaces. From 2018 to 2022, a steady decline in newspaper circulation is observed in most of the counties in the dataset, with a few exceptions. The findings confirm a positive and significant autocorrelation across the US, indicating a non-uniform global spatial distribution of newspaper circulation. Meanwhile, the LISA results also identify four different spatial clusters which could provide more nuanced insights into the local geographic distribution of newspaper circulation in the US. Comparatively speaking, the 122 news oases counties, were least affected by the national decline of newspaper circulation compared to the rest of the country. Meanwhile, we should pay more attention to the other three spatial clusters: news deserts (203 counties), the fringe of news deserts (22 counties), and news islands (three counties). After accounting for the spatial (and

Table 1. The results of the Bayesian spatiotemporal modeling.

|	IID model		Besag–York–Mollié model		Spatiotemporal model	
	Mean	95% CR	Mean	95% CR	Mean	95% CR
Intercept	7.515	(7.498, 7.532)	7.533	(7.473, 7.592)	7.532	(7.475, 7.589)
Year	−0.238	(−0.243, −0.233)	−0.238	(−0.243, −0.233)	−0.241	(−0.246, −0.236)
Model hyperparameters						
Overdispersion hyperparameter	8.430	(8.160, 8.711)	8.433	(8.164, 8.708)	10.037	(9.660, 10.410)
Precision for IID component	0.256	(0.240, 0.273)	0.618	(0.547, 0.695)	0.667	(0.590, 0.752)
Precision for spatial component			0.373	(0.303, 0.455)	0.377	(0.310, 0.459)
Precision for temporal component					113.399	(97.030, 131.161)
DIC	139,176.88	139,193.30	138,323.45			
WAIC	138,768.43	138,838.97	139,122.68			
Marginal log-likelihood	−73,560.57	−72,568.08	−72,436.54			
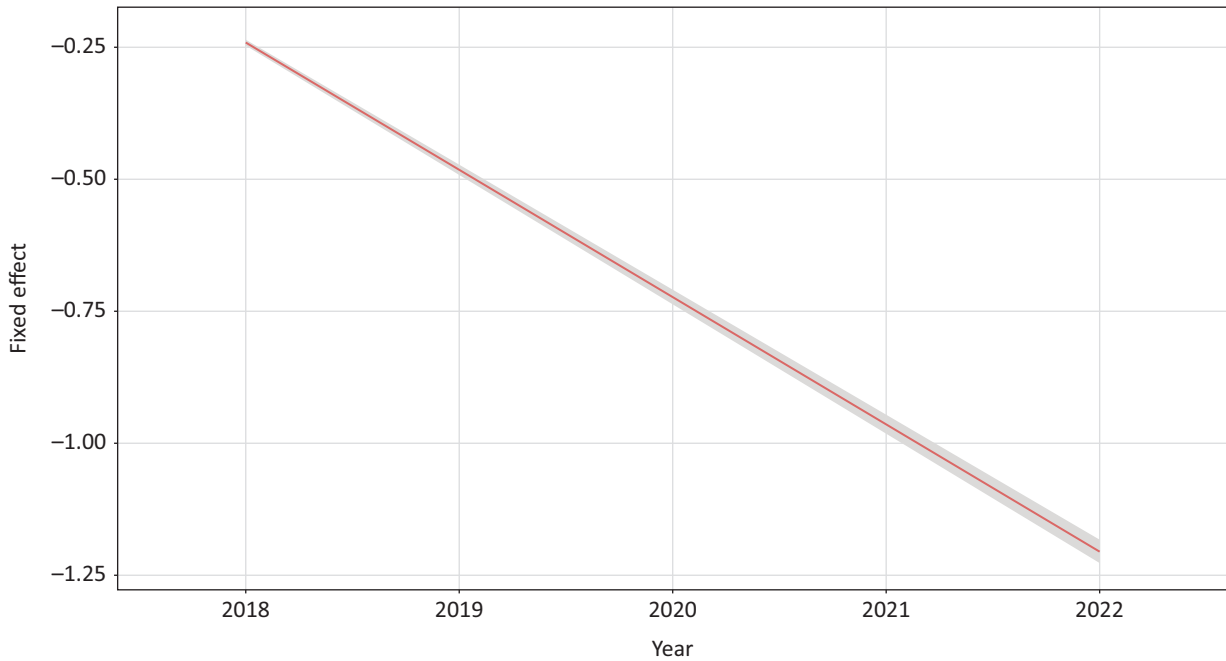
Figure 5. The global linear temporal trends of newspaper circulation in the US (2018–2022).

temporal) random effects, we are able to identify that newspaper circulation in the US has decreased by an average of 24.1% per year since 2018. We are also able to unpack which parts of the nations are more sensitive to the spatial s and temporal structure regarding the decline of newspaper circulation as shown in Figures 6a and 6b.

In this study, we address the overlooked spatial dimension of newspaper circulation and distribution, which has been a neglected aspect within both the existing research on news deserts as well as the wider field of journalism studies. In particular, it illuminates the spatial taxonomy of news deserts, surpassing the binary measurement of have/have-not, and refining the previously broad definition of the term, as pointed out by Usher (2023). Furthermore, our findings have the potential to advance current news desert mapping practices by incorporating spatial interaction among neigh-

boring geographical units, rather than treating news deserts as independent and homogeneous entities. This approach would allow for a more nuanced understanding of the complex spatial dynamics underlying the emergence of news deserts. Furthermore, the steady decline in newspaper circulation in the US over recent years is not surprising, as previous scholarship has already identified (Abernathy, 2014, 2018, 2020). However, by introducing spatial random effects as a formal method of incorporating the spatial dimension into our modeling, we were able to derive a more precise estimation of the average national decline rate in newspaper circulation. Additionally, the visualization of spatial random effect offers an additional avenue for discerning local patterns that are intricately embedded within the spatial interactions. In a formal response to the call for a spatial turn in media and communication studies (Falkheimer & Jansson, 2006; Schmitz Weiss, 2015;
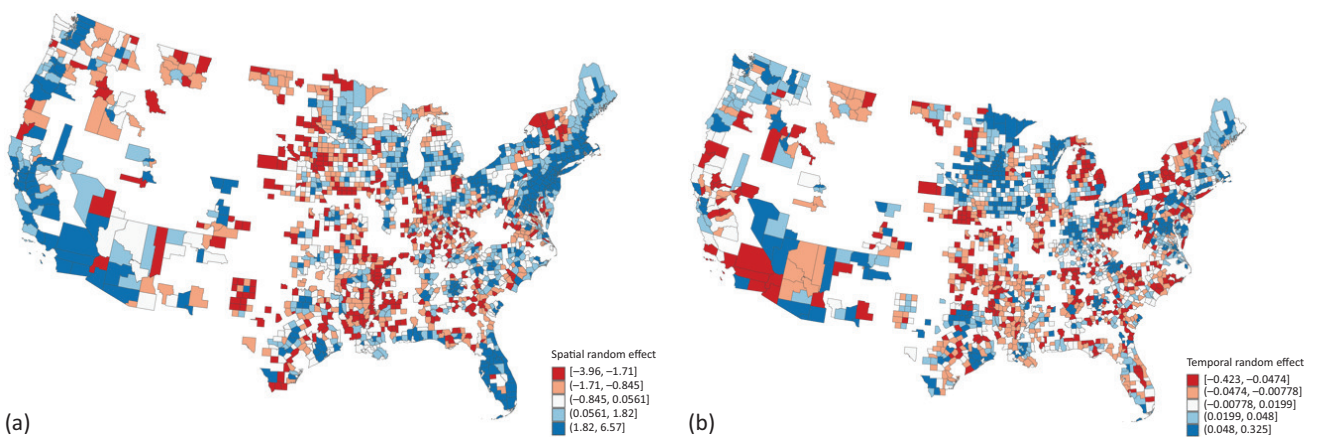

Figure 6. Newspaper circulation changes in the US (2018–2022): (a) Spatial random effect and (b) temporal random effect.

Waldherr et al., 2021), we firmly assert that geography continues to hold significance within local journalistic practices. Consequently, we advocate for heightened scholarly endeavors to examine the spatial structure of the news ecosystem and information infrastructure. While the present study primarily focuses on identifying spatial clusters of newspaper circulation, we strongly encourage future research to explore the underlying mechanisms contributing to variations in the decline of newspaper circulation across different regions. This exploration should encompass an examination of diverse factors such as demographics, socio-economic conditions, political influences, and cultural dynamics. For instance, given the interconnected nature of human behaviors across geographical boundaries, it is pertinent to investigate whether these determinants exhibit spillover effects on the emergence of news deserts, utilizing spatial Durbin models. Moreover, by adopting the framework of geographically weighted regression, which accounts for spatially varying effects on the local level, we can further unpack the spatial heterogeneity inherent in these global trends.

Drawing on Harte et al.'s (2018) notion of "news black hole," the news deserts, the fringe of news deserts, as well as the news islands are also facing the consequence of the demise of local newspapers along with the departure of local journalists, resulting in a potential loss of local community representation and democratic deficits. Democracy is inherently geographically constructed, from voting behaviors to partisan identification (Fotheringham et al., 2021; Gimpel et al., 2020). The continued decline in local newspaper circulation may worsen the spatial disparity of access to news and information, exacerbating political polarization and leading to the marginalization of particularly vulnerable communities (Darr et al., 2021). The big-sort hypothesis in political geography posits that individuals tend to cluster in communities with like-minded individuals, leading to a spatially-divided political landscape (Bishop, 2009). The lack of adequate and diverse local news sources in the news deserts, the fringe of news deserts, and the news islands could lead to the entrenchment of residents in their pre-existing political beliefs and high dependence on the nationalized media environment. This could contribute to the polarization of public opinion and potentially restrict democratic discourse (Hopkins, 2018; Martin & McCrain, 2019). Thus, the spatiality of news circulation has far-reaching implications for the functioning of democracy and the maintenance of a healthy public sphere.

The previous literature has explored potential solutions to rescue or revive local and community journalism in the news deserts, which encompass establishing novel business models such as the low-profit limited liability corporation model (Pickard, 2011), crowdfunding model (Vogt & Mitchell, 2016), non-profit model (Ferrucci, 2019), private foundation model (Scott et al., 2019), membership model (Wenzel, 2019), as well as a hybrid business model and ethical advertising (Sparviero,

2021). However, there may not be a universal solution to address the issue of news deserts on a global or even national scale. The various forms of spatial inequality identified in this article may help provide distinct policy interventions tailored to the needs and characteristics of specific communities. In the news deserts cluster which suffers the most, policymakers and media organizations should continue to support the development of local and community journalism through both public and governmental funding, grants, tax incentives, and other means (Pickard, 2020). Additionally, policymakers should ensure broadband internet access as an alternative means to improve access to digital news sources through the complementarity channel (Mathews & Ali, 2022). For the fringe of news deserts, it is essential to provide access to local news through a partnership between media organizations in their adjacent counties, which have a relatively lower risk of newspaper circulation decline. Although the news islands cluster currently has a low decline in newspaper circulation decline now, we should be cautious about the potential expansion of "desertification" from their neighbors. Despite only three counties falling into this category, it would be beneficial to conduct in-depth case studies to uncover the unique characteristics that contribute to their success and replicate their model in the neighboring counties.

While this study offers valuable insights into the local spatial patterns of newspaper circulation in the US, several limitations should be acknowledged. First of all, the definition of "news deserts" should not be limited to (printed) newspapers or magazines. The existing scholarship on news deserts has been criticized for its narrow focus on newspapers, which may fail to fully capture the current hybrid local media ecosystem, including the local television, radio talk, as well as the rise of hyperlocal journalism through online community news (Friedland et al., 2022; Harte et al., 2018; Rosenwald, 2019). We do recognize the limitation of the data analyzed by the current study, which lack the ability to capture the digitalized shift of local (printed) newspaper. In other words, the decline of printed newspapers does not necessarily equate to a loss of information, which may have been ported to digital platforms. Secondly, the operationalization of news deserts in the current study is based on the (change in) newspaper circulation, which may not fully capture the quality of information, such as the credibility and comprehensiveness of news that that vital for nourishing democracy at the grassroots level (Davis, 2019). Lastly, the data available for analysis is limited in its scope, as it could only cover the temporal trend from 2018 to 2022. In the future study, a longer time frame would be more capable to detect a non-parametric dynamic trend (i.e., random walk model), as well as the space-time interactions. Although some of the newspapers audited in the dataset have their corresponding digital editions, it is rather difficult for us to isolate any potential endogenous bias that may have been introduced by the print-digital transition if happens during the analyzed time frame being.

Conflict of Interests

The author declares no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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