

The Ecological Dynamics of Organizational Change: Density Dependence in the Rate of Weibo Adoption by Populations of News Organizations

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This study examines how ecological forces constrain the rate of Weibo adoption by organizational populations within the news media in China. Organizational adoption of Weibo is conceived of as a process of organizational entries into Weibo space. Based on an archival source that covers the names of all news organizations operating in China, the present study identified 1,552 newspapers, broadcast networks, or news websites adopting Weibo at least once between August 2009 and December 2015. The results show that population density in both the intrapopulation and the interpopulation can significantly influence the rate of Weibo adoption by news organizations. Theoretical and practical implications are discussed.

Keywords: media industry, diffusion, organizational ecology

The widespread use of social media has substantially changed the way people receive news and information. In response to the changing media landscape, many news organizations have strategically adopted social media platforms to increase their survival chances (Weber, 2012). For example, *The Washington Post* has opened accounts on Facebook, Twitter, and Instagram to guarantee its presence on social media. Social media platforms provide a valuable context for examining shifting journalistic practices, so it is surprising that prior research on diffusion and adoption, organizational communication, and journalism has paid scant attention to the factors that drive the diffusion of social media among news organizations. It is imperative for researchers to develop a theoretically sound and practical model to explain why the populations of news organizations have not fully embraced social media even though the utility of social media has been well recognized (Evans, 2018; Weber & Monge, 2017). Informed by density dependence theory in organizational ecology (Hannan & Freeman, 1989), this study offers a macro view of social media adoption and diffusion in news media, or newspapers, broadcast networks, and news websites. By examining the ecological dynamics of organizational change, this work demonstrates that news organizations react differently to density change in their decisions to adopt social media or not.

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The article is organized as follows: The first two sections give a brief overview of research on organizational ecology and relate this approach to the study of the diffusion of new technologies among organizations. Then, the theoretical link between population density and the rate of adoption is proposed. After an empirical analysis of the diffusion on Weibo among Chinese news organizations, this work concludes and discusses the theoretical and practical implications of the findings.

Organizational Ecology and Communication

The past 40 years have witnessed the development of theories of organizational ecology (e.g., density dependence, niche width, resource partitioning) in organizational sociology and management (Aldrich & Ruef, 2006; Bogaert, Boone, Negro, & van Witteloostuijn, 2016; Hannan, Pólos, & Carroll, 2007; Lander & Heugens, 2017). First developed in the late 1970s, organizational ecology is concerned with how environmental constraints determine the size and diversity of organizations' populations (Hannan & Freeman, 1977). Populations consist of "all those organizations that compete for resources in the same environmental niche" (Scott, 2004, p. 8). Prior research relied mainly on conventional industrial categories to define populations (Delacroix & Carroll, 1983) because categorization provides cognitive foundations for firms and stakeholders to make sense of the complex industrial world (Vergne, 2012). The basic premise of organizational ecology is that organizations collectively evolve as open systems. Rather than seeking individual-level explanations for organizational change, ecologists shift the analysis to organizational populations and examine how the emergence, transformation, or decline of populations is shaped by interdependence within and among other populations and environmental change (Aldrich & Ruef, 2006).

Communication scholars have applied the organizational ecology approach to examine the transformation of the media industry (Bryant & Monge, 2008; Dimmick, 2003; Weber & Monge, 2017), the emergence of new organizational forms (Lowrey, 2017; Weber, Fulk, & Monge, 2016), the evolution of interorganizational ties (Lee & Monge, 2011), and the fitness of Internet-based organizations (Lowrey & Kim, 2016) and groups (Lai, 2014; TeBlunthuis, Shaw, & Hill, 2017). For example, Weber and colleagues (2016) conceptualized social networking sites (SNSs) as new organizational forms. They further revealed that SNSs emerged and became legitimized through interactions with the resource environment and adjacent populations.

Adoption and Diffusion of New Technologies Among Organizations

Organizational communication researchers have long been interested in investigating the factors that shape ICT adoption and diffusion among organizations (Rice & Leonardi, 2014; van den Hooff, 2017). This stream of research has employed or developed several theoretical frameworks and models to examine this issue, including strategic management theory (Hackler & Saxton, 2007), contingency theory (Nah & Saxton, 2013), resource dependence theory (Nah & Saxton, 2013), institutional theory (Zorn, Flanagin, & Shoham, 2011), and unified theory of acceptance and use of technology (Peters, 2011). However, few studies have investigated this communicative phenomenon through the lens of organizational ecology (for notable exceptions, see Dimmick, 2003; Dimmick, Chen, & Li, 2004; Lin, 2011). Although prior studies of adoption have generated many insights by analyzing individual organizations, this micro-level perspective has largely overlooked the macro-level social processes that

shape ICT use (Kee, 2017; Rice & Leonardi, 2014). In contrast, ecological thinking departs from the traditional approach of communication scholars by shifting attention away from single organizations and toward organizational populations. A unit of analysis other than the individual or single organization can offer additional explanations for organizational use of new ICTs and can bridge this knowledge gap in a promising way.

The ecological approach also enables scholars to further clarify the distinction between adoption and diffusion and to provide a more nuanced understanding of the diffusion process of new technologies. As Kee (2017) states:

Adoption is an individual or organizational process that leads to diffusion as a systemic process. Studies of adoption tend to focus on the perspective of the adopters while studies of diffusion usually examine the perspectives of the market and society as a whole. Although diffusion and adoption are commonly used together in the literature, the two are different levels of processes. (p. 41)

As a macro-level analytical perspective, organizational ecology fits well with the endpoint of diffusion. For a long time, diffusion research has paid great attention to explaining and predicting the rate of adoption, which is "the relative speed with which an innovation is adopted by members of a social system" (Rogers, 2003, p. 221). Accordingly, the rate of adoption can be measured as the total number of social actors that adopt a specific new technology in a given period of time. Prior research has shown that the rate of adoption is largely driven by antecedent factors such as perceived attributes of innovations, psychological and network characteristics of adopters, communication processes, and social norms (Rogers, 2003; Valente, 1995).

As notable exceptions, several studies have used organizational ecology to explain the phenomenon of media substitution in the diffusion process (Dimmick, 2003; Dimmick et al., 2004; Lin, 2011). Researchers have based their theoretical rationale on the niche theory and gratification opportunities to account for how individuals assess the competitive superiority of media and their subsequent consumption decisions (Dimmick et al., 2004; Dimmick & Rothenbuhler, 1984). The niche theory is used to describe the competition process between various forms of media. Niche refers to "a location in multidimensional space defined by the resources in the environment" (McPherson, 1983, p. 520). Gratification opportunities are "properties of a medium that amplify or attenuate the opportunities for deriving gratification from the medium" (Dimmick et al., 2004, p. 22). Their basic theoretical argument is that the competitiveness of a specific medium type is determined by the ability to provide gratification opportunities to media consumers (Dimmick, 2003). For the sake of survival, an emerging medium needs to either create an entirely new niche on the gratification-opportunity dimension for itself or broaden the existing niches that have been occupied by existing media forms. By linking the macro-level niche overlap and competition with the micro-level uses-and-gratifications thinking, this research fruitfully explains why the Internet generates a displacement effect on the time spent with traditional media (Dimmick et al., 2004).

Although these studies have demonstrated the utility of ecological theories to explain technological use, their application in diffusion research has yet to be fully realized. In addition, prior studies fail to account for the diffusion process of new technologies among organizations. The objective of this study is to examine the influence of ecological factors on the rate of social media adoption by populations of organizations. It shows that, besides niche theory, density dependence theory in organizational ecology can provide important insights into our current knowledge about how the diffusion of new ICTs is shaped by the socially situated process.

Density Dependence Theory

Density dependence is one of the most important ecological processes of organizations identified by the literature on organizational ecology (Baum & Amburgey, 2002; Bogaert et al., 2016; Hannan et al., 2007). First developed by Hannan and Freeman (1989), the classical density dependence model is generally used to explain the impact of population density on important events in the organizational life cycle such as birth, transformation, and death. The concept of density dependence describes "the relationships between population growth processes and the size of population itself" (Aldrich & Ruef, 2006, p. 214). Population density is the total number of organizations in a population (Aldrich & Ruef, 2006).

The main proposition of the density dependence model is that population density is a proxy measure for constitutive legitimation and diffuse competition within a population and therefore predicts the population's subsequent growth pattern (Carroll & Hannan, 2000; Hannan & Freeman, 1989). *Constitutive legitimation* describes the extent to which "stakeholders perceive and support a certain organizational form as a natural, taken-for-granted way to perform a certain kind of action" (Bogaert et al., 2016, p. 1348), reflecting the structural context of a market niche (Überbacher, 2014). Ecologists often use this term interchangeably with *cognitive legitimacy* and *taken-for-grantedness* (Lander & Heugens, 2017). Diffuse competition stems from crowding in niche space (Lander & Heugens, 2017). As organizations do not usually engage in direct competition with all the other members in an organizational population, this term describes a more fine-grained structure of competition at the population level (Baum & Singh, 1994).

Density dependence theory predicts that legitimation grows with density at a decreasing rate, whereas competition increases at an increasing rate (Hannan, Carroll, Dundon, & Torres, 1995; Haveman, 1993). More specifically, at low levels of population density, an increase in density from zero mainly reflects the growing external legitimacy of a population, thus encouraging more entries into the population. Later, competition processes overwhelm legitimation processes and predominantly shape a population's future growth because population density reaches the environmental carrying capacity, which is the upper limit of the number of organizations the environment can support (Aldrich & Ruef, 2006). As the competition among existing organizations for limited resources intensifies in this stage, there are fewer new entries because of a lack of environmental opportunities (Carroll & Hannan, 2000; Hannan & Freeman, 1989). Prior empirical research has consistently reported an inverted U-shaped relationship between population density and the rate of entries across organizational fields (Aldrich & Ruef, 2006; Baum & Amburgey, 2002; Lander & Heugens, 2017; Stretesky, Huss, & Lynch, 2012). In addition, the

curvilinear relationship between population density and organizational entries is moderated by time-, place-, and industry-specific variables (Lander & Heugens, 2017; Vermeulen, 2013).

Hypothesis Development

This study argues that the theoretical mechanism of density dependence can explain variations in the rate of social media adoption by populations of new organizations. There are two reasons to support this argument. First, social media space is similar to a niche that houses populations of existing organizations. As in the founding process of new organizations, existing organizations need to gather information about the nature of social media and further mobilize necessary resources to pursue environmental opportunities before entering this new niche space. The number of organizations with similar forms present on social media is a possible indicator of constitutive legitimation and competition intensity and thus influences nonadopters' tendencies in entering this space. Second, the environmental conditions on social media accord with some key assumptions about resources and competition. For example, density dependence theory assumes that there are finite resources in an environment. Social media platforms present the same resource restrictions on news organizations. Although they can support an almost infinite number of new accounts, a low barrier to entry does not mean that there is no competition for resources. Clearly, social media users are scarce resources that news organizations compete for in the environment.

When applied to the diffusion process on social media, population density reflects the number of news organizations that use the technologies. Built on the logic of density dependence, this study proposes an inverted U-shaped relationship between population density on social media and the rate of social media adoption by news organizations. This hypothesized relationship is driven by the shift between legitimation and competition, which are two important inertial forces for organizations. Legitimation effects outweigh competition effects when the population density is low. An initial increase in density legitimates social media as platforms for news production and information dissemination in the community of news organizations. As a result, more news organizations enter this online platform through isomorphic mimicry. However, the number of social media users who are interested in professional journalism is not infinite. As population density continues to grow and approaches the carrying capacity of the environmental space, competition forces become dominant, suggesting a decrease in anticipated benefits of entry. The rate of adoption by news organizations thus declines.

Most prior research focuses on the density dependence process within the population because organizations in the same population have overlapping resource requirements and similar environmental constraints (Aksaray & Thompson, 2017; Hannan & Freeman, 1989; Vermeulen, 2013). This interdependence leads organizations to pay close attention to density change and to be subject to mimetic pressures within the population. Many organizational populations exist in the news media community. But this study analyzes only populations of newspapers, broadcast networks, and news websites because of their large population size and the availability of data. For example, there are only two Chinese news agencies. Clearly, this population size is rather small for a longitudinal analysis. In addition, to the best of my knowledge, no archival source has ever recorded a list of self-media, making it practically impossible to identify the boundary of this population. Taken together, this study first hypothesizes that the rate of

social media adoption is influenced by the existing number of organizations in the same population on social media.

H1a: There is an inverted U-shaped relationship between the population density of newspapers on social media and the rate of adoption by newspapers.

H1b: There is an inverted U-shaped relationship between the population density of broadcast networks on social media and the rate of adoption by broadcast networks.

H1c: There is an inverted U-shaped relationship between the population density of news websites on social media and the rate of adoption by news websites.

Although most previous studies explain how the density dependence process occurs at the intrapopulation level, some ecologists argue that organizational interdependence can exist at multiple levels of analysis (Carroll & Wade, 1991). This insight from multilevel thinking has resulted in a series of empirical studies on how processes of legitimation and competition operate in both local and nonlocal settings (e.g., Barnett & Carroll, 1987; Hannan et al., 1995) and how horizontally interdependent subpopulations affect each other (e.g., Swaminathan, 1995). For example, Stretesky and colleagues (2012) revealed that the foundings of environmental justice organizations were simultaneously shaped by the densities of civil rights and traditional environmental organizations.

The community ecology perspective is another line of thinking on this topic (Astley, 1985). Community ecology emphasizes the role of higher level organizational communities in shaping the evolution of lower level populations of organizations (Aldrich & Ruef, 2006; Ruef, 2000). Organizational communities are "diverse sets of interacting populations that form functional interdependencies with each other in shared environmental spaces" (Lee & Monge, 2011, p. 760). Recently, de Figueiredo and Silverman (2012) further developed the community ecology theory and clarified the interdependence between vertically related populations. They showed that the population density of upstream firms impacted the survival rates of downstream firms.

Taken together, both the multilevel thinking and the community ecology perspectives reveal that organizational interdependence can exist between populations of organizations. Two populations of organizations can be described as interdependent if "the density of one affects the viability of the other" (Aldrich & Ruef, 2006, p. 242). Drawing upon both streams of literature, this study predicts that the density-dependent process of diffusion can operate at the interpopulation level. Specifically, the density of one population of news organizations on social media can signal the level of legitimation and competition in the environment, which finally produces variations in the rate of social media adoption by the other populations in the community. Although populations of news organizations have fundamentally different core features, identities, and social functions, they need to compete for the same limited resources (i.e., users who are interested in professional journalism) on social media. As a result, there should be competition forces at the interpopulation level. There are legitimation forces between populations as well. Recent studies of the media industry have argued that adjacent populations, defined as established populations in the news media community, can confer legitimacy on a nascent media form (Weber, 2012;

Weber et al., 2016). Based on this logic, this research contends that news organizations can enhance the legitimacy of social media through their adoption behaviors. An increase in adoption by one population demonstrates to the other populations in the community that social media provide a legitimate platform for disseminating information and news. Thus, this study hypothesizes that the density-dependent process should work at the interpopulation level when it is applied to examine the rate of social media adoption by news organizations.

H2: There is an inverted U-shaped relationship between the population density of newspapers on social media and the rate of adoption by broadcast networks (a) and news websites (b).

H3: There is an inverted U-shaped relationship between the population density of broadcast networks on social media and the rate of adoption by newspapers (a) and news websites (b).

H4: There is an inverted U-shaped relationship between the population density of news websites on social media and the rate of adoption by newspapers (a) and broadcast networks (b).

Method

Sample and Procedure

This study uses Weibo as the targeted social media platform. Launched on August 14, 2009, by Sina Corporation, Weibo (www.weibo.com, NASDAQ: WB) is the most widely used social media product in China. As of December 2015, there were 236 million monthly active users and 106 million daily active users of this platform. Akin to a hybrid of Twitter and Facebook, Weibo offers an online interface that allows its users to produce content and make social connections. Because the Chinese government has blocked Twitter and Facebook since July 2009, Weibo provides an alternative platform through which Chinese news organizations can set up homepages and broadcast professional journalism to online users.

Individual members affiliated with different populations of news organizations were retrieved from *China Journalism Yearbook*. According to media policy and regulation in mainland China, an organization must receive administrative approval from the State Administration of Press, Publication, Film and Television or the State Council Information Office before running news businesses. *China Journalism Yearbook* was specifically useful because it provides a complete list of the news organizations endorsed by the two governmental departments. The yearbook categorizes news organizations into three populations: newspapers, broadcast networks, and news websites, reflecting the way in which industrial insiders and stakeholders organize and understand the outside world (Lounsbury & Crumley, 2007). I manually recorded the name of each organization. Finally, a total of 2,904 qualified news organizations were identified. These included 2,002 newspapers, 669 broadcast networks, and 233 news websites, all of which were founded before the creation of Weibo and had survived until the end of 2015.

In the next step, I examined whether a news organization had operated a verified account on Weibo prior to the end of 2015. Data were collected in May 2016. Only the organizational accounts whose usernames corresponded exactly to the organizational names in the *China Journalism Yearbook* database

were recorded. Following this procedure, a total of 1,552 news organizations (1,110 newspapers, 288 broadcast networks, and 154 news websites) were identified on Weibo. Several news organizations had more than one Weibo account. Only the account representing the whole organization was taken into consideration.

Measures

Dependent Variable

Because the unit of the analysis is the population, this study took several steps to aggregate information from individual organizations and to construct the dependent variable. The first step was to construct the matrix of Weibo utilization, which describes whether a news organization made at least one update in any given month. The one-month time interval and the threshold number to qualify as Weibo utilization were used because Weibo records the update information of an organizational account monthly. There is a record in the archive if a focal account releases more than one post in a specific month. This information is publicly visible on the profile of each organizational account, making it easy for researchers to track the update history of Weibo users. Based on this information, this study established a 2,904-by-77 matrix with each row representing a news organization in the sample and each column representing a separate month spanning from the creation of Weibo (August 2009) to December 2015. A binary value was then coded in each cell. A 1 indicated that an organization had used Weibo in a given month, and a 0 meant that the organization had not used Weibo during a given month.

In the next step, this study transformed the matrix of Weibo utilization into the matrix of Weibo adoption, in which a 1 or 0 indicated the presence or absence of the adoption behavior. As an organization may adopt Weibo more than once, Weibo adoption occurs when an organization (a) uses Weibo for the first time or (b) restarts using Weibo after disadoption. As Weibo users are unable to delete their accounts, disadoption refers to the time when users stop using Weibo after adoption. Then, the dependent variable, the rate of Weibo adoption by newspapers, broadcast networks, and news websites, was measured as the total number of news organizations that adopted Weibo in each separate month during the observation period.

Independent Variables

Like the rate of adoption by news organizations, the main explanatory variable, the population density of news organizations on Weibo was defined at the population level. It describes the total number of newspapers, broadcast networks, and news websites that used Weibo during the one-month time interval. This variable reflects the changing balance between organizational entries and exits on Weibo. It is helpful to keep the following formula in mind:

$$\text{Population density}_t = \text{Population density}_{t-1} + (\text{Rate of Weibo adoption}_{t-1} - \text{rate of Weibo disadoption}_{t-1}),$$

where *the rate of Weibo disadoption* was measured as the number of news organizations that chose to phase out an early adoption in each month. It indicates the relative speed of organizational exits from Weibo. A disadoption was recorded when an organization ceased using Weibo, no matter how many times they had adopted it before. Figure 1 displays the population density of news organizations on Weibo over 77 observed months.

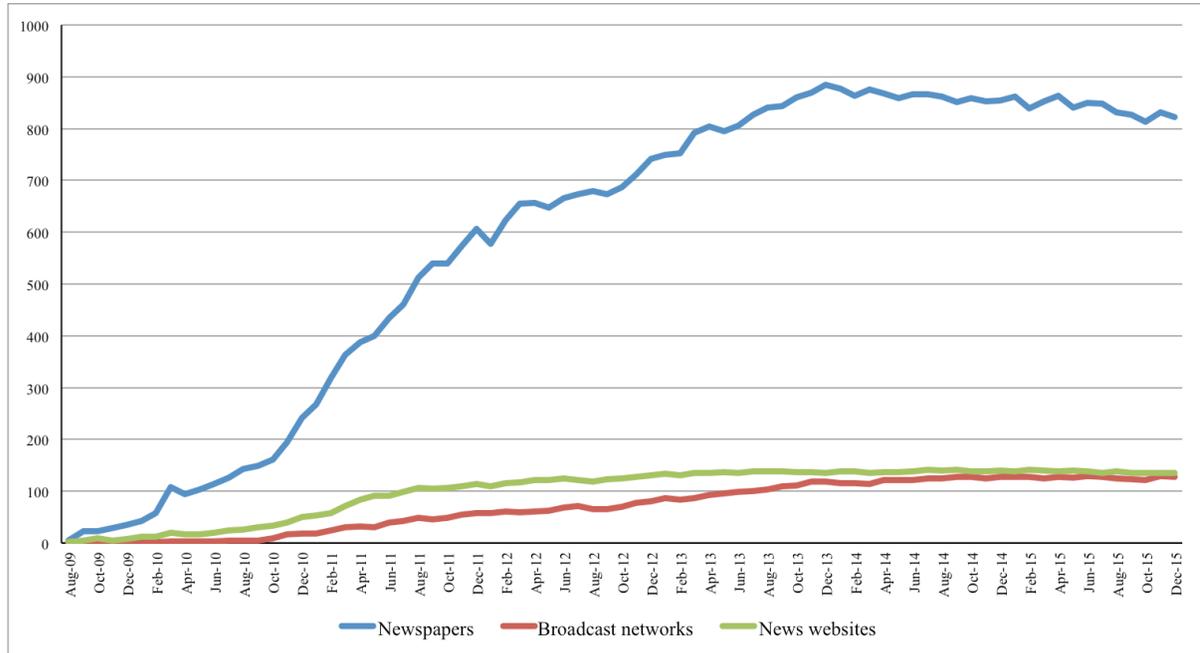


Figure 1. The population density of news organizations on Weibo from August 2009 to December 2015.

Control Variables

This study also controlled for two alternative explanations. First, an institutional account of diffusion argues that institutional forces put great pressures on nonadopters for social conformity (Tolbert & Zucker, 1983; Zorn et al., 2011). This study takes into account both sociopolitical and cognitive factors in institutional analysis (Aldrich & Fiol, 1994; Lowrey, 2017; Scott, 2013). The sociopolitical dimension of institutional environments is the extent to which government accepts a new form as appropriate (Aldrich & Fiol, 1994). It was measured as the number of articles that contained the word "Weibo" in the *People's Daily* in a given month. This measure is appropriate because the *People's Daily* is the official medium of the central committee of the Communist Party of China. As the most important mouthpiece in China's media system (Zhao, 1998), the *People's Daily* provides viewpoints of the party-state and is well known for its agenda-setting effects in directing and shaping public opinion (Chan, 2007). Consequently, the visibility of Weibo in the *People's Daily* reflects the extent to which Weibo is mentioned or even recognized by the central authority, which constitutes a sociopolitical component of the institutional environments

where news organizations make decisions on whether to adopt Weibo. Using the *People's Daily* database (<http://58.68.146.102/rmr/b/>), I finally retrieved 4,590 unduplicated articles published from August 2009 to December 2015. In addition, the cognitive dimension of institutional environments reflects the degree of taken-for-grantedness a new form has (Aldrich & Fiol, 1994). This variable was measured as the search volume of the keyword *Weibo* on the Baidu Index (<http://index.baidu.com>). These data were also collected monthly. Baidu Index is the largest search engine in China. Prior research has shown that it outperforms Google Trends in providing more search volume data when topics are related to China's issues (Vaughan & Chen, 2015). This variable is a proxy measure for the taken-for-grantedness of Weibo as a social fact.

The second alternative explanation is that adoption behaviors are largely driven by economic considerations (Kennedy & Fiss, 2009). Based on this account, an organization is more likely to adopt a new technology if outside environments are resource rich. Resource environments describe the environmental conditions under which the populations of organizations survive. As audience is an important kind of resource that news organizations compete for (Dimmick, 2003; Weber & Monge, 2017), resource environments were measured as the number of daily active users (DAUs) on Weibo. This variable represents the maximum audience size that news organizations can attract because not every DAU necessarily uses Weibo for news or information. This measure is particularly meaningful if the percentage of DAUs who are interested in news and information is stable over time. This is quite likely because no official reports released by the company have shown that there are fundamental changes in behaviors of DAUs over years. The data were retrieved from the website for Weibo's investor relations (<http://ir.weibo.com/>). However, Weibo does not officially release any information about DAUs that existed before December 2012. In addition, the available data were collected quarterly rather than monthly. To overcome these limitations, this study used the linear interpolation option on SPSS to replace the missing values of DAUs.

Analytical Procedures

As the rate of Weibo adoption is a count variable, a Poisson regression was used to test the hypothesized relationships. The Newey-West (Newey & West, 1987) estimator of variance was used to correct for the heteroscedasticity and autocorrelation in ecological count data. The final estimation was conducted using the statistical package STATA 14.0. Following prior research in organizational ecology (Aldrich & Ruef, 2006; Hannan et al., 1995), each predictor was lagged by one year. These lagged explanatory variables help to mitigate the problem of endogeneity. Descriptive statistics of the dependent and independent variables in each predicting model are presented in Table 1.

Table 1. Descriptive Statistics of the Key Variables.

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	Min	Max
The rate of Weibo adoption by newspapers	77	33.66	14.77	5	71
The rate of Weibo adoption by broadcast networks	77	5.73	3.52	0	14
The rate of Weibo adoption by news websites	77	4.06	3.47	0	17
The population density of newspapers on Weibo	77	577.69	308.38	0	885
The population density of broadcast networks on Weibo	77	70.23	47.57	0	129
The population density of news websites on Weibo	77	99.78	49.23	0	142
The sociopolitical dimension of institutional environments	77	59.61	33.28	0	140
The cognitive dimension of institutional environments/1,000	77	91.46	43.46	0.24	165.09
Resource environments	77	44.98	31.03	0.87	106

Results

The results of Poisson regression models are presented in Tables 2 through 4. Models 1, 5, and 9 estimate the baseline effects of three control variables. Models 2 through 4, 6 through 8, and 10 through 12 report the results of hypothesis testing. Standard errors were computed by a heteroscedasticity- and autocorrelation-consistent (HAC) variance estimate. To avoid the problem of multicollinearity, three types of population density were tested separately.

Table 2. Poisson Regression Models Predicting the Rate of Weibo Adoption by Newspapers.

	Model 1	Model 2 (H1a)	Model 3 (H3a)	Model 4 (H4a)
Constant	2.996*** (.176)	2.742*** (.190)	3.007*** (.172)	2.475*** (.206)
The sociopolitical dimension of institutional environments	.004* (.002)	.006* (.003)	.005 (.003)	.006* (.003)
The cognitive dimension of institutional environments/1,000	.005*** (.001)	-.002 (.003)	.007*** (.002)	-.002 (.002)
Resource environments	-.004** (.001)	.007 (.006)	-.010 (.007)	.004 (.004)
The population density of newspapers on Weibo		.004* (.002)		
(The population density of newspapers on Weibo) ² /1,000		-.005** (.002)		
The population density of broadcast networks on Weibo			-.007 (.009)	
(The population density of broadcast networks on Weibo) ² /100			.007 (.006)	
The population density of news websites on Weibo				.039*** (.009)
(The population density of news websites on Weibo) ² /100				-.026*** (.006)
Number of observations	77	77	77	77
Deviance	321.951	295.742	316.582	264.787
Log likelihood	-363.027	-349.923	-360.343	-334.446
AIC	9.533	9.245	9.515	8.843

Note. HAC standard errors in parentheses.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Table 3. Poisson Regression Models Predicting the Rate of Weibo Adoption by Broadcast Networks.

	Model 5	Model 6 (H1b)	Model 7 (H2a)	Model 8 (H4b)
Constant	.190 (.236)	.137 (.253)	-.024 (.350)	-.333 (.368)
The sociopolitical dimension of institutional environments	.008*** (.002)	.005+ (.003)	.004 (.003)	.005+ (.003)
The cognitive dimension of institutional environments/1,000	.008*** (.002)	.005+ (.003)	.006 (.005)	.002 (.003)
Resource environments	.004 (.002)	.008 (.008)	-.003 (.006)	.002 (.005)
The population density of broadcast networks on Weibo		.021+ (.011)		
(The population density of broadcast networks on Weibo) ² /100		-.015+ (.008)		
The population density of newspapers on Weibo			.003 (.003)	
(The population density of newspapers on Weibo) ² /1,000			-.001 (.003)	
The population density of news websites on Weibo				.032* (.016)
(The population density of news websites on Weibo) ² /100				-.016 (.010)
Number of observations	77	77	77	77
Deviance	95.148	89.878	88.975	87.669
Log likelihood	-172.847	-170.212	-169.761	-169.108
AIC	4.593	4.577	4.565	4.548

Note. HAC standard errors in parentheses.

+ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 4. Poisson Regression Models Predicting the Rate of Weibo Adoption by News Websites.

	Model 9	Model 10 (H1c)	Model 11 (H2b)	Model 12 (H3b)
Constant	1.633*** (.146)	.786*** (.193)	.999*** (.163)	1.486*** (.152)
The sociopolitical dimension of institutional environments	-.005 (.003)	.003 (.003)	.003 (.003)	.001 (.004)
The cognitive dimension of institutional environments/1,000	.008*** (.002)	-.004 (.004)	-.007 (.005)	.008** (.003)
Resource environments	-.019*** (.003)	.004 (.004)	.015* (.007)	.003 (.013)
The population density of news websites on Weibo		.060*** (.017)		
(The population density of news websites on Weibo) ² /100		-.045*** (.010)		
The population density of newspapers on Weibo			.009** (.003)	
(The population density of newspapers on Weibo) ² /1,000			-.013*** (.003)	
The population density of broadcast networks on Weibo				-.019+ (.011)
(The population density of broadcast networks on Weibo) ² /100				-.002 (.009)
Number of observations	77	77	77	77
Deviance	108.602	75.507	85.681	102.950
Log likelihood	-165.238	-148.690	-153.777	-162.412
AIC	4.396	4.018	4.150	4.374

Note. HAC standard errors in parentheses.

+ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

H1 stated that there would be an inverted U-shaped relationship between the population density of news organizations on Weibo and the rate of adoption. The results in models 3 and 11 reveal that both main effects and quadratic effects are significant, thus providing empirical evidence for H1a and H1c. Specifically, the rate of Weibo adoption by newspapers first rises and then declines with an increase in the newspaper density. The turning point is 401 (see Figure 2). This curvilinear relationship also holds for news websites. Their adoption rate declines when the density of news websites on Weibo is more than 66 (see Figure 3). Model 7 demonstrates that the curvilinear relationship between the density of broadcast networks on Weibo and the rate of adoption by broadcast networks is marginally significant (main term: coefficient = .021, HAC SE = 0.011, $p = .070$; quadratic term: coefficient = $-.015$, HAC SE = 0.008, $p = .059$; see Figure 4). Thus, H1b was neither accepted nor rejected.

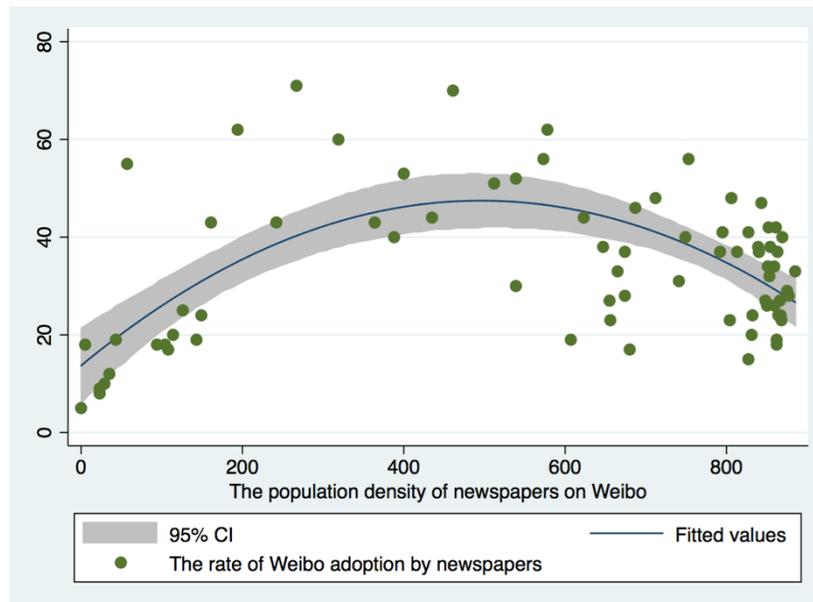


Figure 2. The curvilinear relationship between the population density of newspapers on Weibo and the rate of Weibo adoption by newspapers.

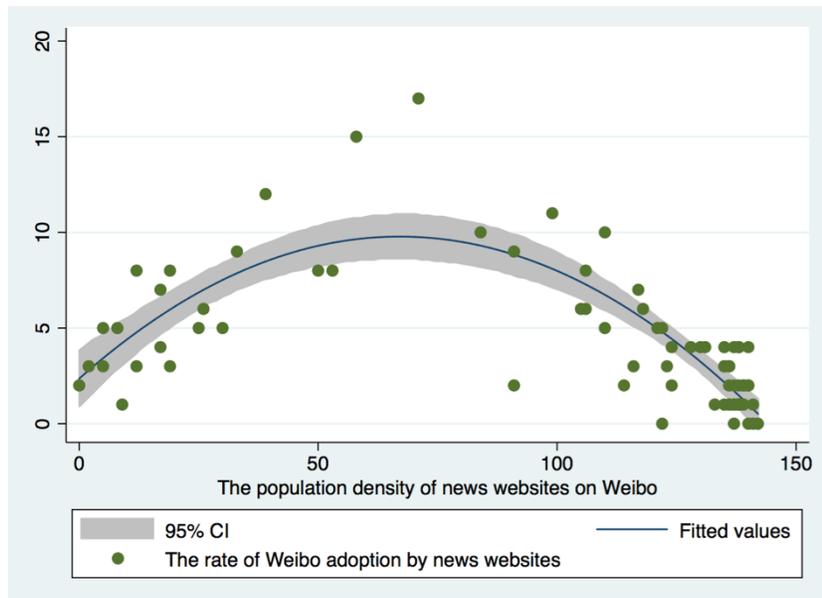


Figure 3. The curvilinear relationship between the population density of news websites on Weibo and the rate of Weibo adoption by news websites.

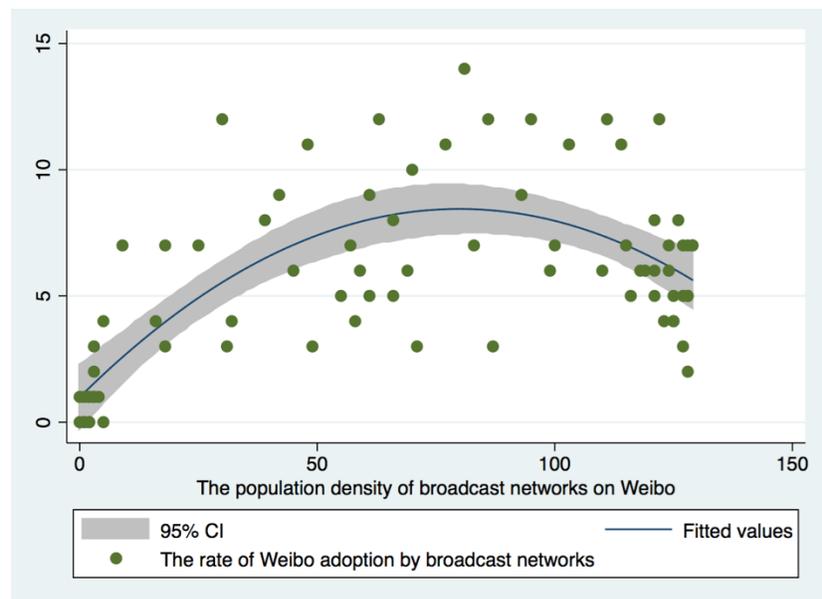


Figure 4. The curvilinear relationship between the population density of broadcast networks on Weibo and the rate of Weibo adoption by broadcast networks.

Hypotheses 2 through 4 predicted an inverted U-shaped relationship between the density of a specific population in the community of news media on Weibo and the rate of Weibo adoption by the other populations of news organizations. The findings show that the rate of Weibo adoption by news websites does not decline until the density of newspapers on Weibo exceeds 364 (see Figure 5). H2b thus received empirical support. In addition, the density of news websites generates a curvilinear effect on the rate of Weibo adoption by newspapers, supporting H4b. The turning point is 73 (see Figure 6). However, the densities of newspapers and news websites do not have significant inverted U-shaped relationships with the rate of adoption by broadcast networks. Only the main effect of the density of news websites is significant. Furthermore, there is no curvilinear relationship between the density of broadcast networks on Weibo and the rate of Weibo adoption by news websites. Therefore, H2a, H3a, H3b, and H4a were rejected.

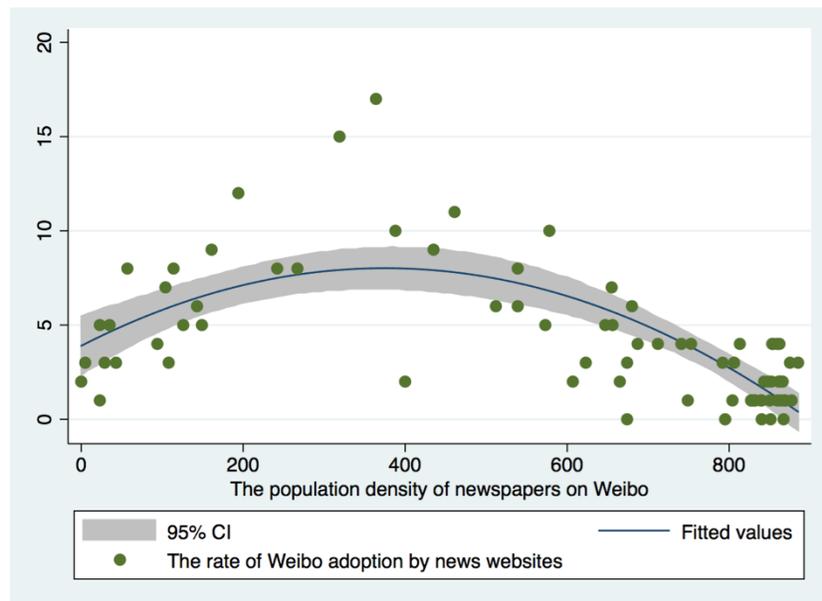


Figure 5. The curvilinear relationship between the population density of newspapers on Weibo and the rate of Weibo adoption by news websites.

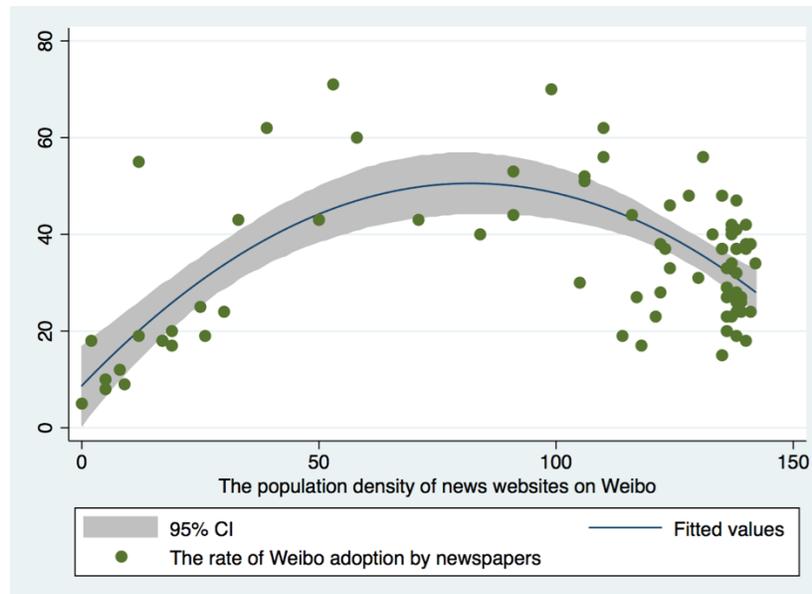


Figure 6. The curvilinear relationship between the population density of news websites on Weibo and the rate of Weibo adoption by newspapers.

Discussion and Conclusion

Social media provide a new venue for news media to disseminate information and attract audiences. The purpose of this article is to understand how ecological factors influence the rate of social media adoption by news organizations. Specifically, the current study uses Weibo as the targeted social media platform and examines how the diffusion of Weibo among populations of Chinese news organizations is determined by the density dependence process. This work conceives of organizational adoption of Weibo as existing organizations' entries into Weibo space. Based on an archival source that lists the names of all news organizations operating in China, the present study identified 1,110 newspapers, 288 broadcast networks, and 154 news websites adopting Weibo at least once between August 2009 and December 2015. Treating each entry as a repeatable event, the sourced data for investigating the process of organizational adoption of Weibo are precise to the month. The results of Poisson regression models provide general support for the hypothesis that population density at both the intrapopulation and the interpopulation levels significantly constrains the rate of Weibo adoption. Each of these results will be discussed separately here.

This study hypothesizes and confirms that density dependence is an important theoretical mechanism that affects the rate of Weibo adoption at the intrapopulation level. Overall, the adoption rate by news organizations first rises and then declines with an increase in their population density on Weibo. An initial increase in density facilitates organizational adoption behaviors because population density reflects legitimacy of new practices. But this effect holds only when this number does not reach a high

level. A continued increase in population density eventually allows competition forces to overwhelm legitimation forces. As a result, there are fewer entries into Weibo space because news organizations perceive that the competition for scarce resources is too fierce and that they are unable to generate enough benefits from adoption. A simple market explanation states that organizational behavior is driven solely by economic considerations, but the density dependence model also acknowledges that imitation results from legitimacy concerns. As economic returns of Weibo adoption are likely to be distant, the density dependence model provides a more reasonable explanation for the findings.

Drawing upon the multilevel thinking in ecological analysis (Hannan et al., 1995) and the community ecology perspective (Astley, 1985), this work provides empirical evidence that the density-dependent process that explains the rate of Weibo adoption can be extended to the interpopulation level. Two populations can be identified as interdependent if the density of one affects the adoption behavior of the other (Aldrich & Ruef, 2006). The findings first show that organizational interdependence exists between newspapers and news websites and that this relationship is bidirectional. Consistent with the prediction of the density dependence model, there is an inverted U-shaped relationship between the density of news websites and the adoption rate by newspapers. Similarly, the rate of Weibo adoption by news websites first rises and then declines with the density of newspaper organizations.

The findings also confirm that news organizations do not react indiscriminately to the density change of the others in the community on social media. For example, the rate of Weibo adoption by broadcast networks is determined by the density of news websites, but this relationship is not fully consistent with the density-dependent process. Although the main effect of the density of news websites is significantly positive, its squared term does not reach statistical significance. As the adoption curve of the population of broadcast networks does not have a steep slope (see Figure 1) and the penetration rate is the lowest among the three populations (43.05%, 228 of 669), it is speculated that broadcasting organizations have the strongest "structural inertia" (Hannan & Freeman, 1977) for technological adaptation. In contrast, the news website is the newest organizational form among the three and is the most likely to embrace new innovations. Thus, news websites' density change on Weibo is a relatively reliable signal for broadcast networks to imitate the behavior, assuring them that Weibo is a legitimate platform for disseminating news and information. This legitimation effect is so dominant that it overwhelms the competition effect, which explains why the squared term is not significant.

In addition, there is no interdependence between newspapers and broadcast networks, and the adoption rate of news websites is not significantly influenced by the density of broadcast networks on Weibo. These results further indicate that the population of broadcast networks is the most isolated entity of the three, partially because of it has the strongest inertia in accepting new technologies.

Contributions

This research makes several theoretical and practical contributions. First, it contributes to the literature on antecedents of ICT adoption and diffusion among organizations (Rice & Leonardi, 2014; van den Hooff, 2017). Although some scholars have argued that "multiple levels of influence complicate media adoption decisions as well as media practices" (Stephens & Mandhana, 2017, p. 2), most empirical

research seeks for micro-level explanations for why individual or single organizations adopt new ICTs. By establishing an ecological model that predicts the rate of social media adoption by organizations, this study joins recent efforts in media ecology studies (e.g., Lin, 2011; Lowrey, 2017; Lowrey & Kim, 2016) and focuses on the macro-level socially situated process that impacts the diffusion of new technologies within and among organizational populations. It demonstrates that density dependence is an important theoretical mechanism that explains technological adoption at the population level. Similar to the founding process of new organizations, existing organizations need to collect information about the legitimation and competition dynamics on social media before entering. Density change is an endogenous factor deriving from the collective population that helps organizations to identify the relevant information (Lowrey, 2017).

In addition, this study makes an important contribution by extending insights from density dependence theory to those from the literature on adoption and diffusion (Kee, 2017). Although niche theory has been applied to account for the media diffusion process (Dimmick, 2003; Dimmick et al., 2004), the utility of other ecological theories in investigating this research area has yet to be fully realized. This work is a first step toward providing a more complete ecological view of ICT adoption and diffusion. It conceptualizes social media as an online niche space that can house overlapping populations of organizations. In so doing, the current research joins scholarly efforts illustrating how online communities can be profitably examined through the lens of organizational ecology in general and density dependence in particular (Lai, 2014; TeBlunthuis et al., 2017). Furthermore, although density dependence theory has been widely used to explain the foundings of new organizations (Hannan & Freeman, 1989) or market entries of existing organizations (Haveman, 1993, 1994), no prior research has looked at how well-established organizational populations migrate into the niche space afforded by social media. This research fills this knowledge gap by exploring how the presence of organizations on social media through adoption behaviors evolves over time.

There are practical implications as well. By viewing social media adoption as an action initiated by existing news organizations to integrate print, broadcast, Internet, and social media operations, this study allows journalism researchers and practitioners to have a more complete picture of media convergence in the journalistic field. Specifically, the findings show that news organizations do not react to density change at both the intrapopulation and the interpopulation levels in a similar pattern when entering this new niche space. It is also noteworthy that the best-fit model in each table is the specification of the mechanism through which the density of news websites on Weibo influences the adoption rate (see deviance, log likelihood, and AIC scores in models 4, 8, and 10). In other words, the population of news websites plays the most important role in providing signals to the community of news organizations about the legitimation or competition dynamics on Weibo.

Limitations and Future Directions

This research makes several contributions to the existing literature, but there are several shortcomings that need to be addressed by future researchers. First, this study relies on industrial categories set by *China Journalism Yearbook* to define populations of news organizations. By treating news media as something monolithic, this analytical strategy largely overlooks the diversity within populations.

Future research needs to develop more nuanced means to categorize organizational populations in the news industry.

Second, the classical density dependence theory has been challenged for the implicit assumption that each organization in a population contributes equally to the legitimation and competition process (Bogaert et al., 2016). Future studies need to empirically test whether different organizations make different contributions during this process. One possible approach is to draw on the alternative density dependence theory (Bogaert et al., 2016; Hannan et al., 2007) to explore the influence of “fuzzy density” on various forms of organizational vital rates. The concept of fuzziness takes into account the cognitive ambiguity of a category (Bogaert et al., 2016). For example, audiences may not recognize every newspaper organization as a member of the population of newspapers because many newspapers have become completely Internet based.

The third issue is about generalizability. The findings reported here are not readily generalizable to other institutional contexts. However, this work takes a first step toward building an ecological model that describes the adoption of social media by news organizations at the global level. Consistent with the call for “an institutional ecology of organizations” (Baum & Powell, 1995, p. 536; Lander & Heugens, 2017), this research conjectures that institutional differences among countries may be a boundary condition of the occurrence of density-dependent effects. The next step should be empirically testing this hypothesis.

Last but not least, diffusion research has been criticized as being pro-innovation, which discounts the process of disadoption (Lin, 2011). Therefore, the ecological process that constrains the rate of social media disadoption also warrants further scholarly attention. Despite the lack of direct investigation of disadoption over time, this study implies that the density-dependent legitimation and competition is a possible theoretical mechanism that explains this phenomenon.

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