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The Hyperlinked Scandinavian News Ecology. The unequal terms forged by the structural properties of digitalisation

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The article presents a network analysis of 22,861,013 geocoded external hyperlinks, collected from 230 Danish, 220 Norwegian and 208 Swedish news websites in 2016. The analysis asks what the structural properties of the Scandinavian media systems—including its geography and ownership structures—mean for news outlets' centrality within the hyperlinked news ecology. The analysis finds that whereas incumbent legacy media occupy central positions, about one third of the network is absent from the hyperlinked interaction, primarily local, independently owned newspapers. A multiple linear regression analysis shows that national distribution and corporate ownership correlates to network centrality more than other predictors. As brokers in the network consist of the large, legacy, capital-based news organisations, hyperlink connectivity is primarily characterised by proximity to the centres of power, corporate ownership, agenda setting incumbency and national distribution.

KEYWORDS digital news ecology; hyperlinks; media ownership; news geographies; network analysis

Introduction

As news organisations move to online first publishing strategies, journalism becomes increasingly reliant on networked structures—the hyperlinks that disseminate news and link journalistic organisations into a digital news ecology. Not only do audiences shift to online news consumption in their daily information gathering behavior (Newman et al. 2017; Wadbring and Bergström 2017), future income streams for news media are also predicted to be largely digital (Ohlsson 2015). However, not all journalism has migrated to the digital realm on equal terms. As the research presented here demonstrates, significant parts of the journalistic sector are largely disconnected from the digital ecology—mainly local, independently owned newspapers with print-predominant publication strategies operating in small, monopolistic markets. As news media search for new ways to sustain audience reach and advertising online, local actors in the journalistic ecology are already falling behind. This is significant mainly for two reasons, the first referring to the essential role that local journalism plays in local communities (Nielsen 2015), and the second referring to the dynamics of the digital news ecology.

The main aim of this study is to ascertain what structural properties facilitate participation in the hyperlinked news ecology in Scandinavia. The question is whether centrality in the online news network is primarily facilitated by the geographies of media systems or by ownership properties. A network analysis of 22,861,013 million external hyperlinks from 658 news sites (collected in April 2016) maps the Scandinavian hyperlink structure, analysing who are the main brokers within the digital journalism landscape, who is excluded from the network, and what predicts network centrality. Through this approach, we demonstrate how a big data network analysis approach (cf. Ognyanova and Monge 2013), a method hereto largely underemployed in the

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study of journalism (Fu 2016; Weber and Monge 2011), lends itself particularly well to the analysis of the digital structures of national news media ecologies (see also Guo 2012).

While previous network analyses have studied inter-sector networks, mapping ties between news media and outside sources such as bloggers (Meraz 2009; Nuernbergk 2014; Turow and Tsui 2008), digital media infrastructure analysis requires an intra-sector approach where the linkages between different news organisations are investigated. Moreover, previous research tends to study first movers (i.e. national elite media in densely populated areas), focusing on the actors included in the network rather than those on the outside. In order to get a fuller picture of how news ecologies form and operate in contemporary society, journalism studies need to assume a broader approach. To ascertain the shape of digital news ecologies, we need to include those likely to be in the periphery of the network, or those outside altogether, and take into account the structural factors that predict network properties.

Because hyperlinking is both a citational and a commercial aspect of online news (Ryfe, Mensing, and Kelley 2016), the structures that these hyperlinks render also shape how media organisations are interlinked, conditioning participation in the digital news ecology. These structures are not digitally nascent, however, nor are they mere remnants of analogue media structures (Küng, Picard, and Towse 2008). Instead, they display how news flows (Wildman 1995) are conditioned by the incumbent position of corporate media organisations, occupying central positions in the networked news ecology. In the following, we outline the research background on digital news ecologies, hyperlinks and networked news; present our data and the network analysis method; and discuss the implications of results for digital journalism studies.

Digital News Ecologies

While the roots of media ecology refer to the role of technology in communication (McLuhan 1967), an ecological understanding of the media “implies the study of environments: their structure, content, and impact on people” (Postman 1970, 161). In a journalistic context, ecology is often used as a reference to the changing environments in which news is produced and consumed (e.g. Lowrey 2012). In Anderson’s terms (2016), ecological perspectives consider journalism and news production beyond the newsroom. Structural conditions such as ownership and geography (Lowrey and Kim 2016); globalisation (Rai and Cottle 2007); democracy (Newman, Dutton, and Blank 2012); and digitalisation (Rebillard and Touboul 2010; Schudson 2010) underpins much of this research, as influences on the uses and practices of journalistic and social media (Graves 2013; Wall and el Zahed 2015).

Most of this research, however, assumes a top-down approach to media landscapes. Trends, developments and pressures in digital journalism are investigated at the frontlines of ecological shifts, while laggards are often overlooked. An ecological approach would, however, account for the environment under scrutiny in its totality, as definitions of ecology tend to centre on the “interrelationship of organisms and their environments” (Friederichs 1958, 154). In this context, the journalistic environment should be considered as heterogeneous, consisting of a multitude of actors with different identities, audience contexts, and resource situations operating under the same structural conditions.

To that effect, news ecologies here refer to the interlinking structural framework conditions of news production, while the digital news ecology in particular refers to the networked

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conditions that digital journalism is situated within. These structures consist predominantly of news organisations, but in recent years a more heterogeneous body of entities has emerged as carriers of journalistic production, including not the least technology companies that operate social platforms. Both Google, Facebook, and Snapchat, for example, offer designated platforms for the embedding of editorial content (enabling so-called “distributed content”; see Cornia, Sehl, and Nielsen 2016), reflecting how social media constitute important sources for news consumption among young audiences in particular (Hermida et al. 2012; Newman et al. 2017). Furthermore, industry collaborations such as Google News Initiative (2015–) and Facebook Journalism Project (2017–) involve these companies in the organisational framework of news production in more actively engaged fashions than merely as carriers and platforms. The environment of the digital news ecology may therefore include many different types of actors and interconnect with other environments than those typically considered editorial.

The heterogeneity of the digital news ecology, therefore, calls for an analytical approach that can make analyses meaningful and feasible. This article therefore limits digital news ecologies to the relationships between actors that are discursively associated (they share a basic normative framework) (cf. Hanitzsch and Vos 2017), but that may also share distinct ties through, for instance, ownership or collaboration. The larger digital infrastructure for contemporary journalism may include actors such as Google and Facebook, but as these are intermediaries—the providers of technological infrastructure rather than producers of journalism—they are not discursively connected to, for example, the normativity of the traditional news ecology. Therefore, digital news ecologies here refer to the existing and potential relationships between discursively associated actors in a digital setting. In this digital setting, the hyperlink is the premier tie and backbone of relationships.

Hyperlinks

Hyperlinks are relational as they explicitly point to intended relationships. As such, hyperlinks are a “very visible form of association between webpages” (Diakopoulos 2014, 7, see also Dalrymple and Scheufele 2007). Without hyperlinks there would be no world wide web as hyperlinks are the basic structural element of the web (Berners-Lee et al. 1992; De Maeyer 2013; Park 2003; Turov and Tsui 2008). These relationships and the environments they engender can indicate traffic generation as much as they signal intentions of content complementation or aggregation (Dellarocas, Katona, and William 2013). They also indicate the extent to which websites function as sources in a news network (Gao and Vaughan 2005; Weber and Monge 2011), and how they connect political and other types of communities (Ackland and Gibson 2013; Fu and Shumate 2016; Pilny and Shumate 2012).

Network analysis allows us to study these relationships. In its simplest form, a network analysis applies a set of relations to a set of identified entities (Monge and Contractor 2003). In an online news context, a network is “a constellation of nodes that are connected to one another via links” (Himmelboim 2010, 375), where links define the direction of information flow. Hyperlinks provide data on directionality and strength in a given network. At the aggregate level, hyperlinking practices form an intra-sector network of social relationships—ecologies of affiliation and information exchange (Ognyanova and Monge 2013; Park 2003; Scott 1988). While hyperlinked digital news ecologies are much associated with the online world, forces operating in

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the offline world are likely to form these supposedly digital relationships. To the extent that we can speak of a digital news ecology, hyperlinks entail its most visible expression. The environmental factors that shape these expressions nevertheless carry offline properties that warrant attention in the analysis.

Economic and Geographic Associations

While there are arguably other factors that structure digital networks, and thus digital news ecologies, previous research has put forth two strong factors that form associations, or networks, that the digital network must relate to—economy and geography.

Economic Associations

The propensity of news outlets to link internally (De Maeyer 2012; Larsson 2013) illustrates the perceived importance of links as traffic generators and popularity indicators. There is an economic rationale to keep visitors on the site (Chang et al. 2012). On the other hand, hyperlinks also provide professional journalists with means to improve the transparency, quality and credibility of news by pointing out other media as sources (Coddington 2012; De Maeyer and Holton 2016). Corporately owned news outlets can also use online portals to promote sections of the larger business enterprise, in which case hyperlinks serve as commodities rather than sources (Vobic 2014). External links can therefore be an economic asset, not merely a cost (Ryfe, Mensing, and Kelley 2016). Evidence of increasing external linking (Karlsson, Clerwall, and Örnebring 2015; Sjøvaag, Stavelin, and Moe 2016; Weber 2012) indicates that there is a growing perception of the economic benefit of linking externally. One possible explanation for this development is that frequent hyperlinking enables news sites to occupy central positions in the network.

Research has consistently shown that core players, particularly established information sources in the United States, China and the United Kingdom, are highly connected in the hyperlinked news-flow network, while sources in poorer, more peripheral countries are not (Himmelboim 2010; Segev and Blondheim 2013). This is evidence of one-way news flow dynamics, where high-cost public goods tend to flow from large to small markets (Wildman 1995). While the focus of our study is limited to the affluent, organised, and highly digitised Scandinavian countries, we could expect patterns discovered in previous research to be repeated here. As legacy media are still the primary producers of news and the main agenda setters in the Nordic region (Ohlsson 2015; Skogerbø and Krumsvik 2015), this particularly pertains to how population centres and national, corporate media dominate the hyperlinked news ecology.

Ownership within this realm of media matters because of the assumption that owners' interests can influence the organisation of news production and its content (Reese 2001). Because journalism plays a central role in democracy, issues such as journalistic quality, gatekeeping and political influence are connected with journalism's structural properties, primarily the interests of powerful owners (Noam 2009). Concentration of ownership is therefore of concern to policy makers, not least in the Nordic region, which has a strong policy focus on external diversity at the media systems level (Syvertsen et al. 2014). Because a dispersal of ownership in the market implies a fairer "more democratic allocation of communicative power" (Baker 2007, 16), the distribution of ownership influence in the realm of digital journalism should be of concern, not least as power structures in the online realm are increasingly concentrated (Evens and Donders 2016). An apt

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question, then, is to what extent linking practices follow ownership patterns, enabling corporate media to retain core network positions.

Geographic Associations

In addition to economic associations, previous research shows that geographic dimensions such as national borders, language barriers and institutional affordances come into play, constituting important factors in the formation of network information flows (Takhteyev, Gruzd, and Wellman 2012; Vliegenthart and Walgrave 2008). Studies have, therefore, suggested that geographical proximity increases hyperlinking between sites (e.g. Barnett and Park 2014; Walter 2016).

Underlying networked media is the assumption that interdependence and relational connections influence the production, distribution and consumption of news. This explains why hyperlinked information flows are also clustered as distinct ecologies formed by language, culture and geographic associations (Chyi and Sylvie 2010; Park, Barnett, and Chung 2011). In this context, network analysis can help to “explain and predict the emergent patterns of media structures” (Fu 2016, 300), useful for charting the “outer and inner ring” of news media (Shaw and Sparrow 1999). While network perspectives can be seen to “flatten interactions” (Willson 2010), its structural basis contributes to move analyses to the political–economic dimensions of news production—the environmental elements of digital news ecologies.

Here, hyperlinked networks are social relationships between news organisations. Geocoding (i.e. the longitude and latitude of news organisations’ main offices) adds another dimension by way of their physical location. The geographic visualisation of the network enables a mapping of the direction of information flows; reveals the location of self-sustaining information “islands”; and illuminates the central brokers in the network. Geocoding also reveals which editorial outlets are excluded from the hyperlinked exchange of information, and where these “news shadows” are located within a country. All in all, the hyperlinked network analysis approach employed here enables a “geography of associations” (Murdoch 1997, 321), combining the social practice of journalism with locations in the physical world presented in virtual space (cf. Adams 1998; Adams and Jansson 2012). News ecologies may be more or less conceptualised as world-level aspects of digital journalistic production, but the environments in which news is produced assume inherited geographic conditions, particularly as pertains to audience and advertising markets, thought to “disperse” as news ecologies become digital.

The Scandinavian Context

The pan-national context of this study allows for an analysis of digital news ecologies on a comparative level. The Scandinavian countries consisting of Denmark, Norway and Sweden are highly similar in cultural history, language and political system. Their media systems fall under Hallin and Mancini’s (2004) Democratic Corporative system, meaning strong journalistic professionalism, independent news institutions, public service broadcasting and systems of press support (Allern and Blach-Ørsten 2011; Lund and Berg 2009). Scandinavian countries have comparatively high levels of media use, a decentralised and diversified newspaper structure, and full digitalisation. Media ownership is primarily national in affiliation and regional in concentration, with some overlap between the countries. The Danish JP/Politikens Hus, the Norwegian Schibsted and the Swedish NWT Media are among the most prominent companies with ownership interests

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across Scandinavian borders. Ownership concentration for Scandinavia overall is most diversified at the local level (70 per cent of owners are at local level), and independent ownership mostly occurs at the local level (72 per cent). With similar ownership structures, a proximate number of newspapers, and strong one-headed state characteristics typical of small nations, Denmark, Norway and Sweden are comparable on a geographical and media ecological level.

Research Questions

Ascertaining the relational aspect through hyperlinks on a media systems level provides insights into how hyperlinking—both as a professional trait and as an economic aspect of online publishing—enables the kind of network centrality that render participation in the digital news ecology. The geographic and economic dimensions in turn illustrate the structural affordances that shape the digital news ecology in a linguistically and culturally connected region. Predictive analyses provide a basis for evaluating what main factors influence a news site's centrality within the networked ecology.

The study is guided by four research questions designed to facilitate an analysis of centrality within the Scandinavian hyperlink ecology:

RQ1: What is the network density of the Scandinavian digital news ecology, i.e. how interlinked are the news sites across regions and borders?

RQ2: Who are the brokers in the Scandinavian hyperlink network, i.e. who is in a position to facilitate the flow of links between other nodes in the network?

RQ3: What portion of the network is excluded from the hyperlink interaction?

RQ4: To what extent does ownership and geographic variables including country, publication level and distance to the capital predict network centrality in the Scandinavian digital news ecology?

The research questions are designed to enable a descriptive analysis of the Scandinavian networked news ecology (RQs 1–3), as well as offer predictive analyses of the structural factors influencing network centrality (RQ4).

Data and Method

Social network analysis is a multi-disciplinary method that features structural intuition, systematic empirical data, graphical imagery and the use of mathematical or computational models. Networks consist of nodes and edges. Nodes represent the finite set of actors in the network, in this case news outlets, while edges constitute the ties or links that describe the relationship between actors, here the hyperlinks that connect news websites. The object of analysis is the relationships between entities and their structure. Structural variables, such as ownership, distribution and geographic location, represent ties between actors (Martino and Spoto 2006). The advantage of the network analysis is thus that it moves beyond mere hierarchical rankings, allowing for analyses of social processes in the network (Guo 2012).

The first step in a network analysis is to collect data that describes the network according to a codebook (Guo 2012, 620). The codebook for this analysis contains the following variables: publication title; the latitude and longitude of the main editorial offices; place of

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publication (city, county and country); distribution reach (local/regional/national); ownership; distance to the capital; average hyperlink length, and the mean distance of links per outlet. The units of analysis are independent news outlets with an assigned editor and a unique physical location. We included all news organisations with a regularly updated website who adhere to professional codes of ethics and national editorial posters (detectable in the template), using databases kept by the national media authorities, and prior research (e.g. Høst 2017). To ensure that all relevant units were included, we also scanned web directories.

To connect these sites in a network we wrote a small program (<https://github.com/eirik/GeoNewsNet>) that visited each site collecting all hyperlinks, mapping the entire site in the process. Internal links were stored to serve as an indicator of the size of the sites, while external links were stored in a separate database for analysis. The program was written to follow links (snowball sampling) n levels deep. The final data collection ran $n = 4$, collecting a “tip of the iceberg” sample of all sites. Samples range from 1 to 189,846 documents per site (avg. 5788, median 1622, SD 15,543). For smaller sites, this “tip” covers everything ever published, for larger sites it covers substantial, but not necessarily complete, hyperlink production. In total the program visited 3,889,614 documents (URLs) for the 658 sites combined, and the collection ran from 30 March 2016 to 1 May 2016. The data collection includes in total 79,112,851 external hyperlinks, where 22,861,013 hyperlinks (29 per cent of the total external link set) link between the 658 Scandinavian news sites. As such, the majority of hyperlinks (71 per cent) link outside the defined news domains—mainly to official information sites, advertising programs (such as AdSense) and social media sites (Facebook, Twitter and Google, for example, comprise more than 20 per cent of these hyperlinks). While these digital intermediaries (Nielsen and Ganter 2017) are highly integrated in the workings of the news industries (Lindskow 2016), third-party links are largely automatically generated by content management systems, whereas our interest is primarily in how established online news providers connect editorially to other news media in the network.

The remaining 22,861,013 hyperlinks, which comprise the data on which the network analysis was conducted, were distributed over 12,957 edges (existing links between nodes) in the final network. The analysis and its visualisation were conducted using the Gephi program (<https://gephi.org/>), with the geolayout plugin (<https://marketplace.gephi.org/plugin/geolayout/>) and the Python package Networkx (<https://networkx.github.io/>).

Results

The geocoding of the nodes in the network enables the generation of a geographic map of the Scandinavian news network (Figure 1). The colour coding visualizes the location of newspapers and their distribution reach. Newspapers are published where most people live—in the capitals, along the western coast of Norway, in the south of Sweden and around metropolitan areas in Denmark. A high number of links is generated into capital newsrooms, and between larger metropolitan centres, reflected in the size of the nodes at these locations. Connections between the countries occur between capital cities and along the borders where traffic (and hence commerce) is most prominent.

Network Density

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RQ1: What is the network density of the Scandinavian digital news ecology, i.e. how interlinked are the news sites across regions and borders?

The density of the Scandinavian hyperlink network gives an indication of the degree to which the digital news ecologies of the three countries are connected. The network density of each country indicates the degree to which the countries are comparable. It also establishes how connected the individual nodes are in the network. This is operationalized as the number of times a link is made from one site to another, constituting the weight (strength) of an edge, which renders a measure of connectedness. Density is calculated by dividing the sum of links by the number of possible links (Guo 2012, 625; Valente et al. 2008).

The average degree of the Scandinavian network is 39.3, meaning each news website has on average 39.3 connections to other news websites (links in and out summed). Norway has an average degree of 40.2 and Denmark has average degree of 37.2. Sweden has somewhat lower hyperlink network density of 29.5. Taking into account average weighted degree (the number of times the same news sites are linked; see Table 1), Denmark's network is densely connected, and the connection is high in frequency, reflecting the density of its subnetworks (see Figure 2). Norway's network connects to a greater variety of sites, which brings down the average frequency. Sweden's network is less interconnected, with a moderate frequency in the number of links between sites. There are clearly distinct national hyperlink ecologies present, while each ecology also displays attributes that point to structural differences reflected in the density of the networks.

To what Extent are the Countries Connected? Looking at the network overall (Figure 2), the national sub-networks are clearly visible. Hyperlinking between the countries also occurs. With no threshold for weight, 36.7 per cent of sites link across countries at least once, with nine per cent of edges crossing national borders. With a degree weight of 10 (cross-border edges that occur from one node more than nine times), 85 of 658 (13 per cent) of sites are connected beyond national borders. The "backbone" of the Scandinavian network (Figure 3) is revealed at a weight of >50, illustrating the nodes in the network that systematically link across borders (44 nodes with 75 edges).

The national barriers are clearly present. Eighty-seven per cent of sites do not link to a news site across any border more than 10 times. However, the Scandinavian news network is connected. An oddity that occurs in the data demonstrates what the organizational features facilitated by ownership entails for institutional linking practices. Edges between the countries (Table 2) show that news sites link mostly within their national news landscape. With regards to the number of individual hyperlinks within and between borders, in-country linking looks even stronger (Table 3). However, Table 3 also reveals a high amount of links from Sweden to Denmark—26.4 per cent of hyperlinks (but only 4.5 per cent of edges). 99.98 per cent of hyperlinks from Sweden to Denmark go to the Danish newspapers Ekstra Bladet and Politiken, predominantly from newspapers under the Swedish lokaltidningen.se umbrella. These newspapers share the same owner (JP/Politikens Hus), and are located at the opposite ends of the bridge connecting the Swedish city of Malmö to the Danish capital Copenhagen. Cross-border linking therefore is not random, but part of professional practice where commercial and navigational reasons for hyperlink traffic are present.

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Brokers

RQ2: Who are the brokers in the Scandinavian hyperlink network, i.e. who is in a position to facilitate the flow of links between other nodes in the network?

Because degrees in large networks follow the principle of preferential attachment (Kleinberg and Lawrence 2001), links attach preferably to already well-connected nodes (Himmelboim 2010, 376). The more ties a node has to other nodes, the more centrally it is located in the network. Hyperlink network analysis therefore facilitates analyses of information brokers—“bridges” (Verweij 2012), or hubs (Ding et al. 2004; Tremayne 2004) in the network. Brokers do not necessarily receive or send the most links in the network. Brokers instead function as bridges between other nodes, influencing the flow of information, connecting and facilitating the influence of other actors or clusters of actors. In that sense, brokers are nodes that tie the network closer together and, thus, wield power in the digital news ecology (Burt, Kilduff, and Tasselli 2013; Scott 1988).

The brokers in the network were identified by calculating betweenness centrality (the nodes that are most often included in the shortest path from any node to any other node; see, e.g. Valente et al. 2008), and by running the HITS algorithm (a link analysis algorithm that rates web pages according to the authority and hub properties of a website; see, e.g. Ding et al. 2004). In line with findings from previous research (Ramos et al. 2013), the largest omnibus newspapers in the three countries are all represented among the top brokers, as are the main state and commercial broadcasters (Figure 4). The largest brokers in Denmark are the newspapers Ekstra Bladet, Politiken,

Berlingske, Jyllands-Posten, and the commercial public service broadcaster TV 2. The largest brokers in Sweden are Aftonbladet, Expressen and Dagens Nyheter, as well as the public broadcaster Sveriges Radio. The top Norwegian brokers are Dagbladet, Verdens Gang, the commercial public service broadcaster TV 2 and Aftenposten. In each of these top lists of brokers, two newspapers share corporate affiliation – Ekstra Bladet and Politiken in Denmark (owned by JP/Politikens Hus); Expressen and Dagens Nyheter in Sweden (owned by Bonnier); and Verdens Gang and Aftenposten in Norway (owned by Schibsted, who is also the majority owner of the Swedish Aftonbladet). It seems likely, based on this, that corporate affiliation is a facilitator of broker positions in the Scandinavian countries’ digital news ecologies.

Network Shadows

RQ3: What portion of the network is excluded from the hyperlink interaction?

A substantial number of news outlets are excluded from the hyperlinked Scandinavian news ecology (Figure 5). Five per cent of sites are in essence isolated islands, not linking beyond internal structures. Of these 32 sites, 30 are local papers and two are regional papers. 21 are Danish, seven are Norwegian and four are Swedish. 25 of these “islands” are independently owned while 7 are corporately owned.¹ Isolation from the hyperlinked ecology is therefore characterised by independent ownership and local distribution.

About 30 per cent of all nodes in the network have 10 edges or less, illustrating the

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effect of preferential attachment in hyperlinked networks. These are newspapers with few editorial resources operating mainly as print-based media that rarely update their websites. 86 per cent of these are local newspapers, 55 per cent are independently owned. Among the 89 newspapers with degree 2 or less (Table 4), 67 per cent are independently owned, while 88 per cent are local distribution papers with low publication frequencies.

Local papers also score low on betweenness centrality—an indicator of a node's central position in the network. Of the 658 sites in the network, 234 sites—36 per cent – rank zero in betweenness centrality. Hence, one third of the actors are essentially disconnected from the networked ecology—newspapers that never function as the shortest distance between any of the other nodes, meaning they do not contribute to tie the network together into a digital news ecology. Of these, 197 sites are local papers (84 per cent).

These publications essentially do not take part in the networked structure of the digital news ecology. While local newspapers may share political, economic or cultural concerns topically, editors and journalists in local newspapers in Scandinavia do not create these connections via hyperlinks. This may be an effect of the non-substitutability of local news content. However, hyperlink flows also exceed traditional analogue news flow assumptions, as the digital ecology presumes hyperlink connections. By not participating in the hyperlinked practices that engender the online journalistic ecology, local newspapers fall on the “sidelines” of the digital news ecology in the Scandinavian hyperlink structure. As far as this tendency is the same in all three countries, digital isolation should be considered a trait of local newspapers, further characterised by independent ownership.

Structural Predictors

RQ4: To what extent do ownership and geographic variables including country, publication level and distance to the capital predict network centrality in the Scandinavian digital news ecology?

A multiple linear regression analysis was performed to test four nested models explaining network centrality, operationalised as weighted in-degree (recoded to a logarithmic scale) and serving as the dependent variable. The independent variables include country (dummies: Sweden as reference); level of publication (dummies Local, Regional and National, the first as reference); ownership (dummy: owned by corporation = 1); distance to the capital; average hyperlink length, and the mean distance of links per outlet (kilometres). All variables/models satisfied normal distribution and collinearity tolerance, indicating there were no problems with the model.

The final model explains 10 per cent of the variance in network centrality in the Scandinavian network overall (Table 5). Geographic distances are insignificant to news outlets' position in the network after controlling for publication level and ownership. While Denmark stands out because of its short distances, national distribution and corporate ownership are better predictors of centrality in the Scandinavian digital news ecology.

Discussion

The rationale for analysing the network density of the hyperlink structure of the Scandinavian online news sites is that news ecologies are increasingly referred to as digital environments (cf.

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Anderson 2016). However, insights from this hyperlink network analysis show that local newspapers in Scandinavia are largely disconnected from this ecology. While Scandinavian media systems are still able to support local newspaper structures, these seem to exist in their own disconnected ecologies, unable to link onto the national hyperlinked networks that remain dominated by corporate, resourceful media organisations. Hence, not only has digitalisation not been able to break up the power of well-established legacy media, networked technology does not surpass ownership ties and geographic boundaries to ideally strengthen the diversity of online media ecologies in Scandinavia.

What we instead find from studying the hyperlinked digital news ecology in Scandinavia is that there are clear patterns of preferential attachment in the network (cf. Barabasi and Albert 1999). Reasons for preference may vary (Tremayne 2004), but attachment is clearly an indication of the importance of staying connected to central nodes. As news media deal in information, hyperlink patterns are taken as indicators of flow of information (Himmelboim 2010; Ryfe, Mensing, and Kelley 2016). Because resourceful media organisations attract more connections (cf. Fu 2016), intra-organisational affinity and centralised locations matter for the power dynamics of digital media ecologies. The brokers in the network are therefore the same—elite media, prominent national newspapers or television—as in the analogue context (Skogerbo and Krumsvik 2015). Thus, there is a clear centre/periphery dimension where independently owned, local outlets assume weaker positions. Instead, corporately owned, national, legacy newspapers facilitate the hyperlink connectivity between subsequent players, shaping the structures of the digital news ecology.

Local media have been described as the “backbone” of national media structures (Mathisen 2010), acting as a social “glue” (Espeland 2006) that serve important functions in getting local stories that otherwise might be overlooked into the public domain (Nielsen 2015, 51). This “backbone” function that local newspapers serve, however, is not reflected in the Scandinavian digital news ecologies. While audience news habits are moving online, shifting news diets from the local to the national (Wadbring and Bergström 2017), local stories do not climb the digital news ladder to reach online news agenda prominence (cf. Chyi and Lewis 2009; Rosse 1975). This likely has economic explanations, the primary being that the simple practice of hyperlinking does not yet fall within the realm of economically rational local journalistic practice.

As was evident in the early days of media digitalisation, migration to online-driven journalism requires resources in the form of time, money and know-how. These are resources that are more easily mobilised within corporate structures. Content produced by well-resourced, centrally located media organisations have always penetrated local markets more than the other way around, while local content tends to predominantly satisfy local preferences (Wildman 1995). While research shows that online local news can attain dual-geographic markets, predominantly by reaching long-distance readers (Chyi and Sylvie 2010), corporate structures seem to prevent changes in news flow dynamics characteristic of the analogue era. Future inclusion of local newspapers in the digital news ecology will therefore likely be contingent on the fact that corporatisation is seen as increasingly important for surviving the digital shift in Scandinavia (Borgen 2017).

While these results can be expected in the light of previous research, they suggest that the methodological approach—a network analysis accounting for geographical dimensions—can be a useful addition to the toolbox of digital journalism research. Not least in view of the fact that most

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previous studies are small (Shaw and Sparrow 1999) and our approach allows for monitoring hundreds, if not thousands, of websites and millions of hyperlinks. Furthermore, a network analysis enables a “geography of associations” (Murdoch 1997, 321) approach which is useful in including players beyond the frontlines of digital development in media ecology analysis. Here, the “geography of associations” is largely identical to “associations of ownership”—a connection that would be difficult to chart to the same extent without the use of network analysis. Hence, mapping all news organisations in a geographic context that could link to each other, rather than all news organisation that actually link to each other, better allows to investigate inequalities in the journalistic field. This raises the question of how various forms of journalism will develop given the highly heterogeneous, and tentatively—increasing structural—differences between them.

Conclusions

Hyperlinking is related to, for the purpose of this study, two oppositional forces—a professional practice of courtesy/citation, and a financial metric that can be sold to advertisers (Ryfe, Mensing, and Kelley 2016). The density of the network and the characteristics of density patterns can therefore shed light on what it means to be part of, central to, or excluded from the hyperlinked ecology. What is obvious from this study is that the power distribution in the network is, to some extent, guided by commercial considerations, particularly by corporate ownership (e.g. Barnett et al. 2017). This raises an important issue that can only be answered by further and longitudinal research. The question, then, drawing on Fu’s (2016, 300) proposition, “that network analysis can explain and predict emergent patterns of media structures”, is whether commercial intra-conglomerate linking practices, coupled with the de-staffing of newsrooms, is bad news for local journalism in the Nordic region. The implications of this research therefore lie in the insight it yields as to the future effects of corporatisation, particularly of local newspapers, and the extent to which the Scandinavian digital news ecologies—characterised by geographically dispersed news environments—maintain news flow properties shaped by the analogue era. With the influence of Google and social media, providing platform infrastructures with partially editorial inclinations, the ecological context beyond the newsroom increases in significance, characterised by the networked conditions that hyperlinks entail.

Limitations and Further Research

It is important to note that our study is limited to the Scandinavian region, and to legacy media. Further research should include other countries and regions, as well as other players in the digital information ecology, such as technology companies and other third party intermediaries. Hyperlinking is but one aspect of relatedness between news media outlets. Network analysis could therefore be combined with more traditional approaches (such as institutional, organisational or newsroom studies) to evaluate the significance of hyperlinking for the news media ecology. On the other hand, external hyperlinks also measure actual, institutionalised behaviours in creating and maintaining links between news organisation. Adding automatic content analysis methods to analyse the thematic scope of hyperlink traffic, combined with time series analysis to ascertain changes in broker positions over time, would also help inform theories of journalism on the digital platform.

Studying hyperlinks comes with its own set of limitations. External hyperlinks do not

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encompass the range of expressions of news media relationships relevant for the study of digital journalism. Indeed, as our data shows, the majority of hyperlinks from news sites link to sources beyond the digital news ecology. Further studies should therefore expand the scope beyond the journalistic discourse into the wider digital communication ecology to also include sources such as social media sites, blogs, public information sites, organisations and NGOs, political parties, information aggregators and other brokers of information. Further expansion of the network could reveal new sources of centrality, additional shadows, as well as other predictors of prominence in the digital communication ecology. This approach would also allow for assessing how the historically central role of news media in society holds up in the digital environment.

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Note

1. Isolated islands in the network include: In Denmark Farsø Avis, Midtvedssyssel Avis, Gråsten Avis/Bov Avis, Fjends Folkeblad, Vesthimmerlands Avis, Ugeavisen Karup, Salling Avis, Dragør Nyt, Vamdrup Ugeblad, Brønshøj-Husum Avis, Vanløse Bladet, Nordjyske Stiftstidende, Midthimmerlands Folkeblad—Folkebladet Støvring, Lyngposten, Gladsaxe Bladet, Gudenådalens Avis, Galten og Omegns Folkeblad, Østerbro Avis, Østhimmerlands Folkeblad, Sydsjællandske Tidende, and Folkebladet for Glostrup, Brøndby og Vallensbæk; in Norway Vestnesavisa, Vestavind, Hordaland Folkeblad, Vaksdalsposten, Øy-blikk, Sydvesten, Meløyavisa; and in Sweden Blekingeposten, Kalmar Läns Tidning, Alingsås Kuririen.

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Tables and figures

Table 1. Network density

Degree	Scandinavia	Denmark	Norway	Sweden
Average degree	39.9	37.2	40.2	29.5
Average weighted degree	33,371	64,340	5,160	21,268

Note. Average degree (average number of connections one site has to other sites in the network) and average weighted degree (the average number of times the same news sites are linked, or raw link count).

Table 2. National barriers

	Denmark	Norway	Sweden	Sum
Denmark	4,284 (94%)	106 (2%)	154 (3%)	4,544 (100%)
Norway	228 (5%)	4,425 (88%)	394 (8%)	5,047 (100%)
Sweden	149 (4%)	145 (4%)	3,072 (91%)	3,366 (100%)

Note. Connectedness between edges (existing links between nodes) in the network.

Table 3. In-country linking

	Denmark	Norway	Sweden	Sum
Denmark	14,798,218 (100%)	994 (0%)	1,295 (0%)	14,800,507 (100%)
Norway	1,173 (0%)	1,135,326 (99%)	6,236 (1%)	1,142,735 (100%)
Sweden	1,590,476 (26%)	741 (0%)	4,423,901 (74%)	6,015,118 (100%)

Note. Weight, raw numbers. Hyperlinks that travel within and between countries.

Table 4. Network shadows

	Degree 2 or less (n=89)	
Denmark	39 titles	17% of sites
Norway	24 titles	11% of sites
Sweden	26 titles	13% of sites
	Zero betweenness centrality (n=233)	
Denmark	121 titles	53% of sites
Norway	50 titles	23% of sites
Sweden	62 titles	30% of sites

Note. The portion of sites in each country that have a degree of two edges or less, and the portion of sites that score zero in betweenness centrality.

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Table 5. Predictors of network centrality in the Scandinavian digital news network by weighted in-degree. Multiple linear regression analysis.

Variables	β	SE	Sig.	R square	Adjusted R Square
<i>Model 1 Distance</i>				.016	.010
(Constant)		13211.800	.000		
Distance to the capital	-.052**	.039	.006		
Distance of links	.062	.053	.257		
Mean distance of links per outlet	-.004*	.034	.027		
<i>Model 2 Country</i>				.060	.050
(Constant)		17454.839	.295		
Distance to the capital	-.098	.039	.073		
Distance of links	.131*	.054	.020		
Mean distance of links per outlet	.001	.033	.990		
Country Sweden (ref.)					
Country Denmark	.196***	18350.750	.000		
Country Norway	-.066	18470.522	.199		
<i>Model 3 Publication level</i>				.099	.087
(Constant)		17389.975	.423		
Distance to the capital	-.014	.042	.811		
Distance of links	.083	.057	.162		
Mean distance of links per outlet	-.040	.033	.360		
Country Denmark	.192***	18011.403	.000		
Country Norway	-.068	18188.037	.176		
Level Local (ref.)					
Level Regional	-.059	19675.699	.190		
Level National	.199***	28265.757	.000		
<i>Model 4 Ownership</i>				.116	.102
(Constant)		24011.289	.126		
Distance to the capital	.001	.041	.980		
Distance of links	.064	.057	.279		
Mean distance of links per outlet	-.046	.033	.293		
Country Denmark	.193***	17864.832	.000		
Country Norway	-.054	18119.047	.282		
Level Regional	-.065	19531.232	.149		
Level National	.222***	28392.233	.000		
Owner Corporation	.131**	19589.802	.003		

N = 505. Network centrality according to country, level of publication, ownership and distance to the capital.

* $p < .05$

** $p < .01$

*** $p < .001$

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Figure captions

Figure 1. The nodes in the network correspond to the geographical location of the newsrooms, superimposed on a Google map. Purple nodes represent local newspaper websites, green nodes represent regional newspaper sites and blue nodes represent national news sites. Node size reflects the amount of links coming into the newsroom. The bigger the node, the more hyperlinks the news site receives. Edges are coloured according to outgoing node. Edges going out of frame arrive at news sites located in Greenland (Denmark) and Svalbard (Norway).

Figure 2. Yifan Hu Proportional layout. Sweden (yellow), Denmark (red) and Norway (blue). Nodes are strongly connected within each country. Strong subnetworks exist in Sweden (the lokaltidningen.se domain) and Denmark (the lokalavisen.dk domain). There is also a fair amount of transnational hyperlinking.

Figure 3. Systematic cross-border linkers. N=44 nodes (with 75 edges), weight >50 (cross-border edges occur from one node more than 50 times). Node size reflects number of outgoing cross-border links. The Danish (red nodes) Ekstra Bladet and Politiken link systematically to the Swedish (yellow nodes) lokaltidningen.se cluster. The Norwegian sites (blue nodes) link more frequently to Swedish sites than Danish sites, where the Swedish Expressen is particularly well connected to the largest Norwegian cross borderlinkers.

Figure 4. HITS algorithm. Top 5% of the network according to broker properties. The larger the node the more the site is considered a broker. N=31. Label adjusted.

Figure 5. Distribution per degree. Brokers are located on the right, isolated sites on the left. Very few sites have more than 150 connections to other news sites, while many sites have between 50 and 100 connections. A fair number of sites have less than 10 connections, indicating exclusion from the network. N=658.

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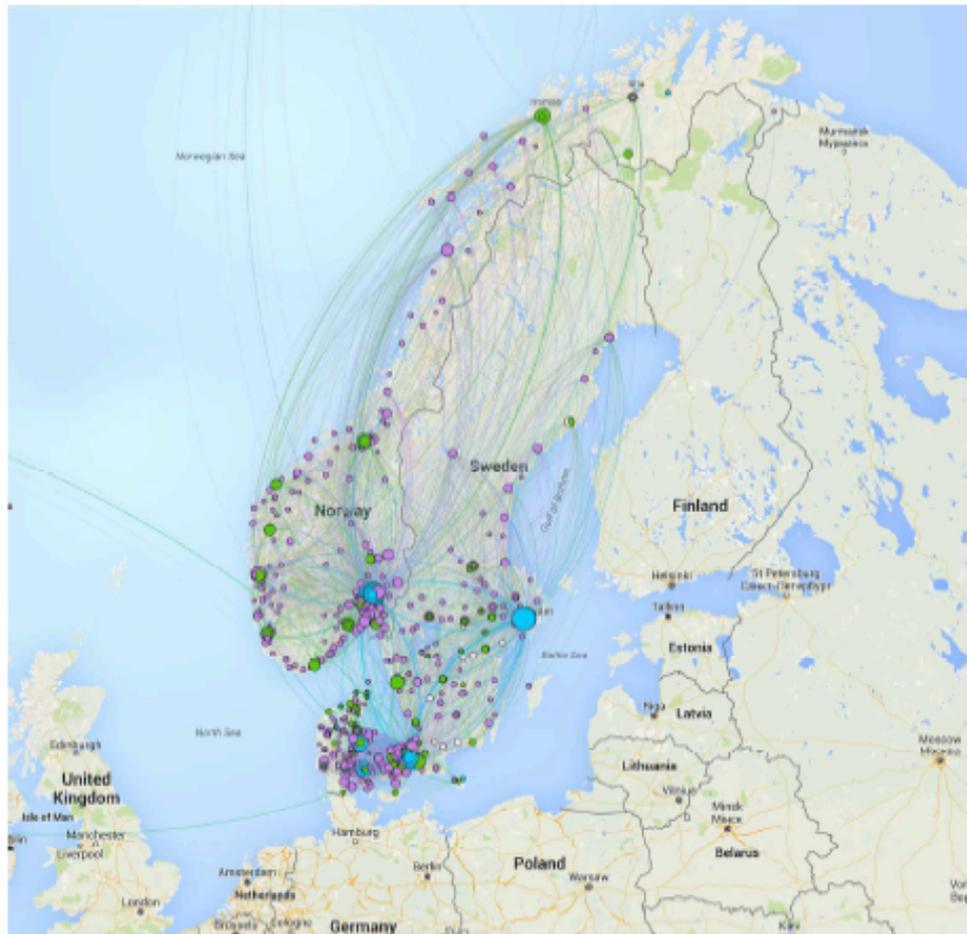


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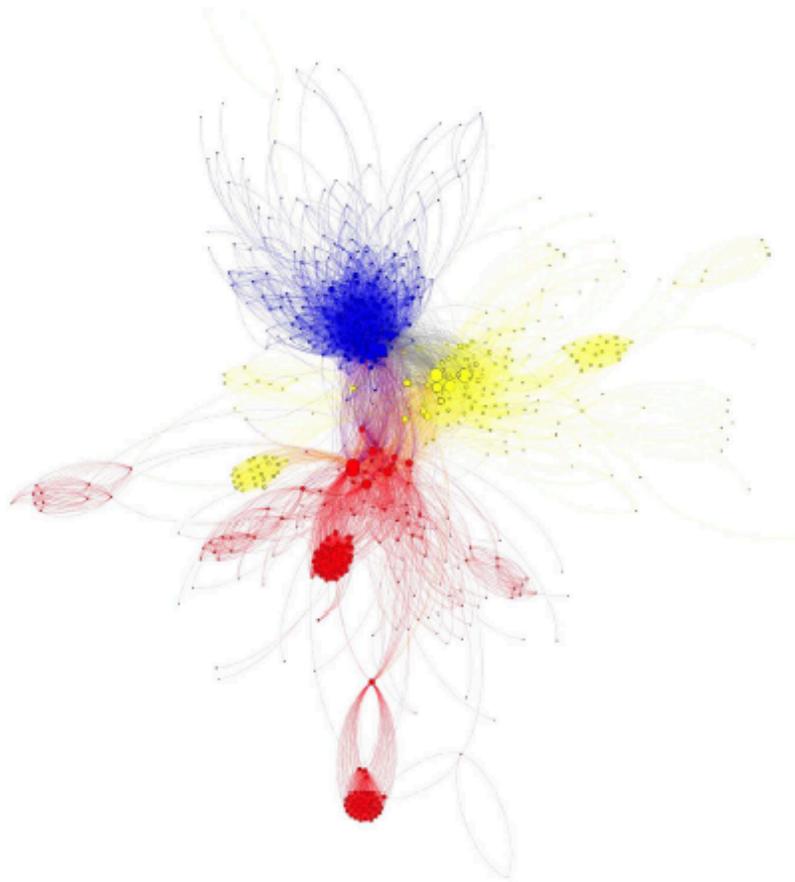


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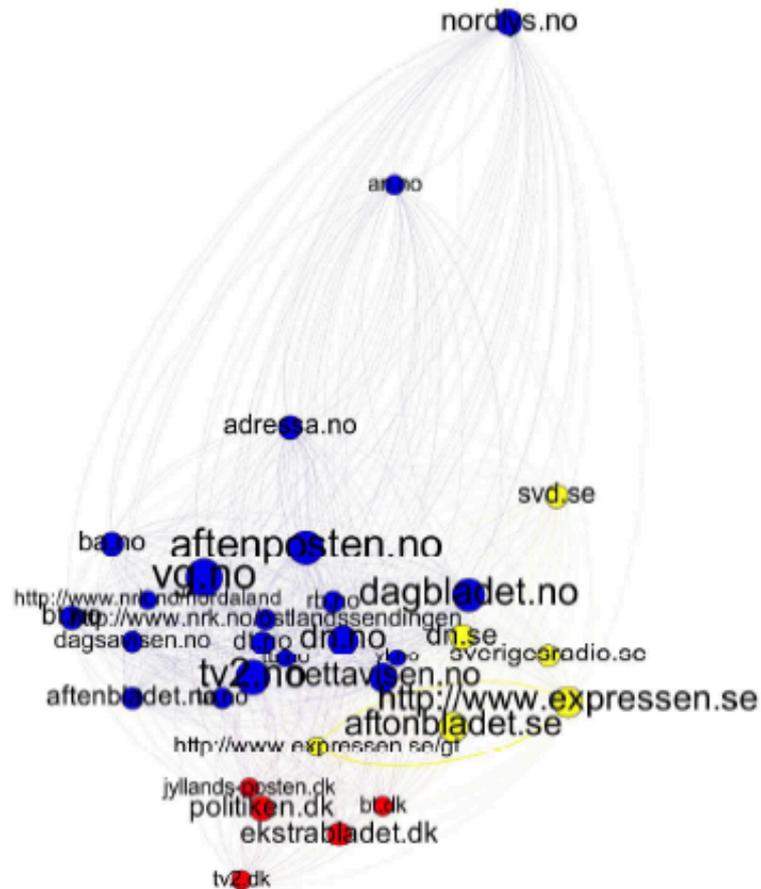


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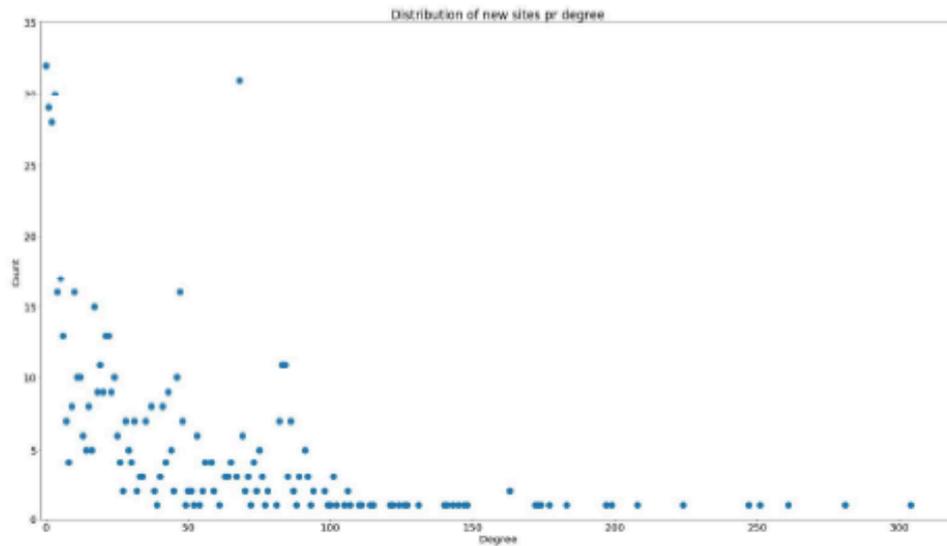


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