Big Data and Political Social Networks: Introducing Audience Diversity and Communication Connector Bridging Measures in Social Network Theory

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Abstract
Social media have changed the way citizens, journalists, institutions, and activists communicate about social and political issues. However, questions remain about how information is diffused through these networks and the degree to which each of these actors is influential in communicating information. In this study, we introduce two novel social network measures of connection and information diffusion that help shed light on patterns of political communication online. The Audience Diversity Score assesses the diversity of a particular actor's followers and identifies which actors reach different publics with their messages. The Communication Connector Bridging Score highlights the most influential actors in the network who are potentially able to connect different spheres of communication through their information diffusion. We apply and discuss these measures using Twitter data from the discussion regarding the Transatlantic Trade Investment Partnership in Europe. Our results provide unique insights into the role various actors play in diffusing political information in online social networks.

Online social networks such as Twitter provide citizens increasing opportunities to get informed, discuss, and participate in politics (Yoo & Gil de Zúñiga, 2014). These social networks create new public spheres in which people from diverse cultural backgrounds and geographical locations can

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consume and share information about political topics and issues. Online social networks also have become a space where citizens, activists, politicians, news organizations, and institutions from across the globe can communicate about and engage in dialogue regarding transnational political matters, blurring geographical constraints (Bennett, 2012). These "networked publics" are defined by connections and social interactions between interested individuals and often arise around political issues in which network members have a vested interest, including social movements (Bennett & Segerberg, 2012). Thus, these networks are not limited to a particular geographical or cultural space and offer low-cost opportunities for citizens to join the discussion (Shirky, 2011). Twitter networks can be inclusive of multiple publics and connect seemingly disparate actors in a political debate (e.g., Maireder & Schwarzenegger, 2012). The impact of information and communication technologies, the internet, and social media in our lives, and particularly within the political context, has been under academic scrutiny for over a decade (see Farrell, 2012 for a review). In fact, some have argued that these digital technologies have diminished the power of traditional organizations in social movements and instead provided individuals an easier opportunity to connect and mobilize for political action (Bennett & Segerberg, 2012; Bimber, Flanagin, & Stohl, 2012) and opinion leaders within those networks can successfully encourage individuals to participate in political processes (Park, 2013).

However, from a purely communication perspective, many questions remain about the nature of these more globalized and individual-driven political communication networks (Castells, 2008). Some scholars have warned that digital media may fragment the public, as individuals are able to craft and control information environments that reflect their preexisting political dispositions (e.g., Bennett & Iyengar, 2008; Sunstein, 2007). Individuals may therefore not be exposed to information from other spheres but rather exist in information bubbles (Pariser, 2011). The extent to which online discussions of political issues incorporate multiple spheres and the connections between those spheres remain understudied. Although prior work has investigated the spread of information on Twitter, mostly through hashtags or retweets (e.g., Romero, Meeder, & Kleinberg, 2011; Starbird & Palen, 2012), little is known about the role various actors (e.g., activists, individuals, politicians, mass media, and organizations) play in connecting a diverse audience and diffusing information throughout the network. In other words, how influential are each of these key actors in forming links between subpublics and spreading information within online social networks?

In order to address these questions and identify the relative importance of different types of actors in the network, this study introduces two novel measures of communicative activity that offer new theoretical insights into the diffusion of information within an online transnational political network. We first introduce our measure of the Audience Diversity Score (ADS), which identifies the individual accounts in the Twitter network who are most likely to reach different and diverse publics with their messages. We next introduce our Communication Connector Bridging Score (CCBS), which highlights the accounts that bridge and connect different publics throughout the entire network and identifies the degree of influence actors have in diffusing information through the network. These measures expand on general approaches to network structures including centrality and segmentation by theoretically demonstrating which Twitter accounts communicate to and link different clusters in the network.

We employ and analyze our new measures in the context of the Twitter discussion of The Transatlantic Trade Investment Partnership (TTIP) in Europe, which was a contentious and protested issue throughout 2014. To better understand which actors hold influence in these networks, we utilized network analyses to examine the nature of the Twitter discussion of TTIP from July to September 2015. Using our two new measures, we next identified the 400 accounts that were most influential in forming connections in the network and spreading information. We then categorized the types of account to assess the degree to which activists, individuals, politicians, mass media, organizations, and others helped diffuse information through the network. Taken together, our two measures offer a

theoretical advancement on how transnational communication networks are structured and isolates the relative importance of each of these key actors in their potential to diffuse information.

Twitter Networks

Twitter provides individuals unique opportunities to form social connections and obtain and share information. Scholars have been examining the resulting networks and information diffusion in several important ways. First, retweet networks can be studied to show the diffusion of specific tweets from one user to another. In this case, the edges in the network show that Account A has retweeted a tweet of Account B. This offers insights into diffusion of individual tweets based on Twitter retweet function (Bruns, Highfield, & Burgess, 2013; Conover et al., 2011; Starbird & Palen, 2012). Researchers can also examine @reply networks, in which the edges are references of one account to another. The @reply networks demonstrate patterns of actual references between accounts within a certain discussion, often around a certain hashtag (Bruns & Burgess, 2012; Bruns et al., 2013) or between a fixed set of users over a long period of time (Ausserhofer & Maireder, 2013). Finally, researchers can investigate information diffusion and exposure on Twitter by analyzing the use of various hashtags over time (e.g., Romero et al., 2011) and by measuring user involvement based on the content of tweets and the users' profile information (Xu, Sang, Blasiola, & Park, 2014).

The final approach to studying Twitter networks, which we utilize in this study, does not examine user behavior but rather the networks of connections between accounts—the social graph. With this method, the edges in the network are follower relations. That is, this network allows for analyses of the accounts that individual users follow and are followed by. These networks are important because they help shape the information people are exposed to within Twitter and the diffusion of information on a particular topic or issue (Maireder & Schlögl, 2014). Following another account defines which messages turn up in individuals' news feeds. Hence, follower networks also show the potential of accounts in diffusing information to other accounts (González-Bailón, Borge-Holthoefer, & Moreno, 2013). An advantage of analyzing Twitter networks in this manner is that account networks are relatively stable, as people do not tend to dramatically alter their followers and followees on a daily basis. The present study examines these follower networks of users that participated in the TTIP discussion by writing tweets about the issue. Although this network only represents a small fraction of the overall follower network of Twitters 300 million accounts (Twitter, Inc., 2015), it provides important insights into the informational relationships between users interested and actively participating in a certain topic.

The Transatlantic Trade and Investment Partnership

The TTIP is a proposed trade agreement between the European Union (EU) and the United States that is intended to reduce barriers by lowering tariffs on goods and standardizing regulations (Traynor & Rice-Oxley, 2015). The partnership has been met with resistance in Europe, as citizens in countries across the continent expressed concerns that the deal would jeopardize consumer rights, quality of life, food safety, and health care, including privatization of the National Health Service in the United Kingdom (Traynor & Rice-Oxley, 2015). Negotiations over the deal were conducted in July 2014 in Brusselsand and were met with protests (Walker, 2014). During and following the negotiations, many individuals, journalists, and organizations from across Europe took to Twitter to debate the issue and voice their opinions.

Internationalization of Publics and Online Political Discussion

Information and communication technologies have helped facilitate an international public sphere in which news and information flow through global communication networks (Castells, 2008; Saldaña, McGregor, & Gil de Zúñiga, 2015; Volkmer, 2003). Political issues that were once local, regional, or national can now be discussed and debated at an international level. For example, Bennett (2012) notes how the occupy protests set off an international debate over income inequality. Other research indicates that digital protests are able to overcome geographical distances (e.g., Lynch, Freelon, & Aday, 2014). The debate over TTIP was international in scope, as it involved the United States and the 28-member states in the EU; Traynor & Rice- Oxley, 2015). This suggests that a transnational network of Twitter discussion should emerge on the issue.

Although these international public spaces for political discussion have developed, cultural and language considerations may still play an important role in the structure of an online, transnational protest network. For example, much news coverage within Europe continues to focus on national rather than international news (Bruggemann & Schulz-Forberg, 2009). Concerns about the implications of TTIP appeared to vary by country. For instance, many in France and Italy were concerned with changes in food quality, while concerns in Britain focused on threats to public health care (Traynor & Rice-Oxley, 2015). Each European country may therefore have its own political discussion sphere based on a sociocultural national identity or interest. This is not surprising given a long tradition of research on social identity theory indicating that people interact more frequently with others who are similar to them or whenever individuals perceive they will obtain useful information or benefit from that interaction (Gil de Zúñiga, 2012; Tajfel & Turner, 1979). Other research suggests that many people lack the skills and knowledge to effectively communicate with others from different cultures, suggesting people will prefer to discuss with others in their own language (e.g., Ting-Toomey, 1999). Based on this logic, we expect digital political discussion networks in Europe regarding TTIP to display clear clusters based on language and nationality. More formally:

> **Hypothesis 1:** The overall follower network of Twitter accounts discussing TTIP will consist of smaller clusters of spheres that are based on language and geo-identity characteristics.

Connective Action and Online Protests

Social media and digital technologies have in many ways changed how social and political movements evolve. In many cases, these technologies have reduced the need for formal member-driven organizations by allowing individuals to organize, form groups, share information, and take action without the resources provided by these traditional organizations (Bimber et al., 2012). However, this does not mean that traditional issue advocacy and nongovernmental organizations (NGOs) no longer play a role in social movements. Bennett and Segerberg (2012) outline a three-part typology of political action networks that highlights the roles both social media and traditional organizations play in rallying citizens around a political issue. On one end of the spectrum, these action networks are technology driven. Their theory of connective action describes how fragmented individuals use social media to share personalized political messages and organize. In these instances, it is the communication technology rather than traditional organizations that bring people together (Bennett & Segerberg, 2012). They note several instances, including the Spanish *indignados* protests and the Arab Spring, in which networks of individuals independent of traditional organizations were able to connect and take action on a political issue. On the other end of the spectrum is collective action in which organizations remain fundamental to political action networks and use social media to form collective identities, coordinate resources, and connect individuals (Bennett & Segerberg, 2012). Finally, a hybrid model incorporates aspects of both connective and collective action. In particular,

in this model, traditional organizations encourage and coordinate the individual, personalized expression evident in the connective action network but do not play as prominent a role as they do in the collective action network (Chadwick, 2007). Tests of this hybrid model found that organizations were present and played a central role within online political action networks but served to facilitate individuals' messages rather than their own political agenda (Bennett & Segerberg, 2013).

The hybrid model of social and political movements suggests both organizations and individuals play important roles in the formation of an online discussion network. Advancing our understanding of who, where, and how information is disseminated online in a networked environment may be key in explaining today's citizens' complex informational and participatory behaviors (Brundidge, Garrett, Rojas, & Gil de Zúñiga, 2014; Valenzuela, 2013). Although prior research has identified some of the characteristics of influential accounts in online protest networks organizations and found that activist accounts can at times be as influential as larger media outlets (e.g., González-Bailón et al., 2013), this work has not fully isolated the importance of the multiple actors (i.e., activists, individuals, politicians, mass media, and organizations) in disseminating information in the network. What is needed theoretically and methodologically are measures that help identify exactly how these various actors are situated in the network and the role they play in facilitating information exposure. More precisely, better measures of the communication patterns of these different parties may help us understand how information is diffused through the network and who is influential in connecting the diverse constituents.

Network Measures

Although informative in a number of ways, existing general approaches to network structure on their own are unable to fully answer these questions. For instance, several measures demonstrate the position of individual nodes within the overall network, including degree centrality, closeness centrality, betweenness centrality, and others (Dubois & Gaffney, 2014; Rowley, 1997). These measures provide insights into the location of various actors and demonstrate a particular node's ability to disseminate information within the overall network (Wellman & Berkowitz, 1988). Other existing measures identify parts of the network where nodes are more closely connected to each other than in other parts. These cluster analyses offer a picture of the general segmentation of the network by allocating each node to a community of nodes. (Wasserman & Faust, 1994). Because we are interested in information diffusion between clusters (or "publics"), we created two new measures that combine these existing approaches and demonstrate which Twitter accounts connect different publics. These measures calculate the position of individual nodes relative to the segmentation of the network and take the general popularity of particular users into account. The first measure is the ADS, which identifies the Twitter accounts that are able to reach a diverse audience based on the location of their followers. We conceptualize diversity here as audiences who are not limited to or concentrated within a single public but rather include followers from several clusters in the network. In other words, an account with a high diversity score would be followed to a similar degree by other accounts in different clusters. The second measure, the Communication Connector Bridging Score, assesses an account's potential to diffuse information from one public to another. The potential to diffuse information is operationalized as the degree to which an account follows other accounts from different clusters than they are followed by. In other words, this measure identifies which accounts serve as the informational bridge between unique clusters. Taken together, these two novel measures demonstrate the accounts that are able to reach a diverse audience—in terms of publics—with their messages, as well as those that are influential in spreading information through the different parts of the network.

In order to better understand the nature of communication and information diffusion within a political Twitter network, we use these new measures to address the following research questions:

Research Question 1: Which actors in the network can reach the most diverse publics with their messages?

Research Question 2: Which actors in the network can serve as the most influential in terms of information diffusion and connecting different spheres of communication?

Method

Data Collection

To test our measures of the ADS and CCBS, we used Twitter's Streaming API (Application Programming Interface) to gather all tweets that included "TTIP" between July 15 and September 14, 2014. This time frame was selected because negotiations over TTIP began in mid-July of 2014 and protests in Europe continued throughout the summer (Walker, 2014). We felt a 2-month time period would therefore capture much of the online debate and discussion surrounding the issue. A data quality check indicated that TTIP also referred to an Indonesian educational institution. Hence, prior to analysis we removed all tweets in Indonesian from the database. The resulting data set included 210,890 tweets written by 66,826 users. We next collected profile descriptions and follower connections for 66,612 of those users through Twitter's REST (Representational State Transfer) API on October 2, 2014. The remaining 214 users either had deleted their account or set their account to private in the time between when the tweets were collected and when we gathered profile data.

The network was next reduced to exclude all users with an indegree lower than 20 and those who had only written one tweet. This reduction resulted in 15,216 users for the final analyses. This reduction was necessary in part due to limited computational resource for the network analysis. However, the resulting network is theoretically beneficial in that it only includes accounts that demonstrate repeated participation and are relatively important compared to other users.

Following network reduction, we performed a cluster analysis using the built-in community identification algorithm of the network analysis software Gephi. This algorithm iteratively aggregates nodes to communities and communities to larger communities in order to optimize modularity or the quality measure for a given partition of a network. This algorithm was applied because it allows for scaling up to very large graphs with reasonable computational effort (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008).

We then calculated the distribution of languages used by the accounts and their geographical location, based on the accounts themselves as retrieved through Twitter's REST API. This allows us to describe clusters in the network in both geographical and language terms.

Measures

Audience Diversity Score. The ADS is a mere "broadcast" measurement. It seeks to capture the diversity of the audience (in terms of clusters, our publics) an account is tweeting to (the followers of this account). The higher the ADS, the more diverse its followers. It is based on Nepusz, Petroczi, Negyessy, and Bazso's (2008) concept of bridgeness. The ADS varies between 0 and 1, where 0 indicates that a node exclusively relates to others in its own community and 1 indicates that a node maintains relationships of the same extent to *all* of the existing communities in the network. We were especially interested in users whose audience is diverse and cosmopolitan in the sense that it is comprised of a variety of geo-identity publics (Gil de Zúñiga, 2012). We therefore only

considered the incoming links (i.e., followers) for the calculation of this metric. Based on Nepusz et al.'s (2008) argument that centrality should also be considered to distinguish "real bridges" from outliers, we multiplied the inlink-based bridgeness for each node with the logarithm of its indegree. The result of this calculation is the ADS. A high ADS indicates that a particular account has a large number of followers within the network from a diverse set of communities. Accounts with a high ADS are therefore in a position to widely spread information among those diverse communities and thus potentially set a common agenda.

Communication Connector Bridging Score. The CCBS identifies accounts that serve as connectors of one cluster or community to another. This occurs when a user follows accounts from a different cluster than it is followed by, which places the user in a position to diffuse information between two clusters. The fraction of edges a specific vertex has to vertices of clusters other than its own indicates how strongly a node is integrated into its own community. We refer to this as the inlink proportion, which can be calculated for incoming and outgoing edges (in directed networks) or the total neighborhood of a vertex. In the current Twitter network, the CCBS is low for accounts who hold several relationships to language- or country-specific clusters other than their own. We calculated the CCBS by taking the product of the absolute spread between the inverted inlink proportion for in and outlinks and the logarithms of the in- and outdegrees. The theoretical maximum score is the overall number of clusters minus 1 (the cluster the node is part of). The resulting measure is high for users with both relatively strong in- and outdegrees and follows more accounts that are part of other clusters than the users following them. Users high in the CCBS can be characterized as the bridges connecting one cluster to one or more other clusters. Both the ADS and the CCBS were calculated for all 15,216 accounts in the final network.

Coding Accounts by Type of User

To get a sense of the types of accounts high in ADS and CCBS, we next coded the 400 accounts that had the highest scores on each of the two measures. The accounts were coded in terms of their role in the political system. We distinguished between accounts if they appeared to be operated by individual users or collectives (e.g., companies, political parties, and organizations). In particular, we coded accounts into seven general categories including (1) media organizations and individual journalists; (2) political parties and governmental institutions, as well as individual politicians and officials; (3) NGOs and individual political activists; (4) companies and individual company executives; (5) research institutions and individual scholars; (6) cultural institutions and individual artists; and (7) other.[1] The coding was conducted by two independent coders. First, the coders worked together to establish the categories and the coding scheme, developing the system and resolving potential issues by mutual agreement. The coders then analyzed the remaining information corpus, compared their results and discussed and resolved all remaining disagreements. An intercoder reliability test was performed to ascertain the validity and reliability of the coded data (Krippendorff's $\alpha = .863$).

Results

The first hypothesis predicted that the larger network of Twitter discussion about TTIP would consist of smaller clusters of discussion spheres based on language and geographical location. The cluster analysis of the network of users identified 10 distinct communities. Two of those communities consisted of a very small number of accounts (6 and 10) that were not connected to any of the other clusters. We identified those clusters as spam bots that were retweeting messages containing our keyword and were subsequently removed from analysis. The remaining eight clusters included 15,200 accounts (modularity $= .626$) and were clearly separated by language and geo-identity

Table 1. Account Distribution by Language and Geographical Location.

Name	Indicators	Number of Nodes	Mean Number of TTIP Tweets by Account
English sphere	94% English language, mainly cities located in England	3,804	9.83
German sphere	85% German language, mainly German and Austrian cities	3,090	12.06
Central European sphere	67% English and 22% French language, many accounts located in Belgium, some in France and the Netherlands	2715	9.32
Spanish sphere	87% Spanish and 7% Catalan language, Spanish cities	1,812	7.77
Scottish sphere	93% English language, locations in Scotland	1,561	6.74
International sphere	95% English, accounts from different parts of the world, including the United States, Russia, and smaller European countries	1,520	8.49
Italian sphere	88% Italian language	459	5.53
UKIP sphere	91% English language, a large share of accounts with reference to the UKIP in their profile description	239	6.21
		15,200 (Total)	

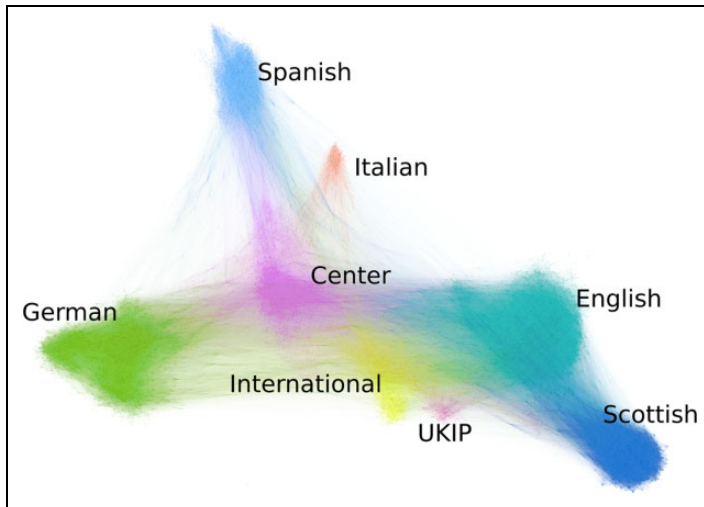*Note.* UKIP = United Kingdom Independence party.

Figure 1. Visual depiction of TTIP Twitter network. Cluster algorithm: Blondel et al., 2008; Layout algorithm: Force Atlas 2; modularity = .626; colored by cluster; only nodes with indegree > 100 visible; 15,200 nodes (6,335 visible) and 1,476,323 edges (851,654 visible). A permanent link to a full color figure has been placed at http://phaidra.univie.ac.at/o:408005.

features (see Table 1). It is clear from Figure 1 that the network is not divided by a single factor but a combination of factors including language, geo-identity, and political orientation. In particular, three clusters represent different language communities, as there are clear and distinct clusters for German, Italian, and Spanish languages.

Table 2. Categories of Accounts in the Top 400 for the ADS.

ADS	Organizations	Individuals	Total
Media	26 (6.5%)	8 (2%)	34 (8.5%)
Politics	36 (9%)	49 (12.25%)	85 (21.25%)
Research	9 (2.25%)	17 (4.25%)	26 (6.5%)
Economy	4 (1%)	7 (1.75%)	11 (2.75%)
Culture	0	23 (5.75%)	23 (5.75%)
NGOs and activism	108 (27%)	66 (16.5%)	174 (43.5%)
Sum	183 (45.75%)	170 (42.5%)	353 (88.25%)
Other	47 (11.75%)		47 (11.75%)
Sum	400		

Note. Percentages are based on the total of 400 accounts coded. Reading example: 26% or 6.5% of the top 400 accounts by ADS are media organizations. ADS = Audience Diversity Score; NGO = nongovernmental organization.

The German sphere is the second largest in the network and features the most active users, with a mean of 12.06 tweets by accounts. It is the only sphere with a notable activity of mainstream news media. Twitter handles of news websites are also the most influential (measured by indegree centrality within the cluster) in the cluster. Top users in the considerably smaller Spanish and Italian spheres feature accounts of social movements, political activists, and experts.

Three clusters consist of British accounts, which are further distinguished by geographical location and political orientation. One cluster represents users in England, a second consists of mainly Scottish accounts, and the final cluster includes accounts that reference the United Kingdom Independence Party. The latter is the only major cluster clearly separated by ideology rather than geography or language. The most important accounts in the English sphere are accounts of small political parties (Green party and NHA [National Health Action] Party), health-related political activists, and labor activists as well as journalists. The Scottish sphere is led by MPs and Scottish news media.

One of the final two clusters consists mostly of accounts connected to the EU and its institutions like members of the European Parliament (MEPs), EU agencies and officials, EU-related special interest media, and EU correspondents as well as lobbyists. Those accounts use different languages (e.g., English and French) and are located near one another geographically (e.g., France, Belgium, and Netherlands). At the center of this cluster are the accounts of the European Commission and the EU TTIP team, negotiating team. The last cluster includes more international accounts, including those from the United States, Canada, Russia, Australia, and smaller European countries. Wikileaks, Russian television, and the HuffPost Green are among the most important accounts. Taken together, these eight distinct clusters based on language and geo-identity features provide strong support for Hypothesis 1.

The first research question sought to identify which types of actors in the network were able to reach the most diverse publics with their messages. Here we applied the ADS, which measures the degree to which an account is followed by accounts from diverse clusters *other* than its own.

Overall, both organizations and individuals were equally likely to make the ADS top 400, as 45.75% ($n = 183$) of the accounts were run by organizations and 42.5% ($n = 170$) were run by individuals (see Table 2). Importantly, the results indicate that NGO and activist accounts were most likely to have a diverse audience from multiple clusters. A total of 174 (43.5% of top 400) NGO and activist accounts were in the top 400 for the ADS, and of those accounts, 108 were maintained by organizations (27% of top 400), while 66 (16.5% of top 400) were run by individual. This indicates that NGOs and activists, more than any other category of accounts, were followed by other accounts from a diverse set of subclusters.

Given that NGOS and activists had the most accounts in the top 400 of the ADS, we next took a closer look at the types of accounts within that category. In Table 2, we see that of the 174 NGO and

Table 3. Categories of Accounts in the Top 400 for the Communication Connector.

CCBS	Organizations	Individuals	Total
Media	29 (7.25%)	30 (7.5%)	59 (14.75%)
Politics	39 (9.75%)	62 (15.5%)	101 (25.5%)
Research	8 (2%)	22 (5.5%)	30 (7.5%)
Economy	1 (.25%)	11 (2.75%)	12 (3%)
Culture	0	18 (4.5%)	18 (4.5%)
NGOs and activism	63 (15.75%)	80 (20%)	143 (35.75%)
Sum	140 (35%)	223 (55.75%)	363 (90.75%)
Other	37 (9.25%)		37 (9.25%)
Sum	400 (100%)		

Note. Percentages are based on the total of 400 accounts coded. Reading example: 29 or 7.25% of the top 400 accounts by CCBS are media organizations. NGO = nongovernmental organization; CCBS = Communication Connector Bridging Score.

activist accounts in the top 400, activist groups (42% of category) maintained the most accounts on the list, followed by individuals without affiliation and NGOs (both 20.1% of category) and individuals with an affiliation. Taken together, activists groups and unaffiliated individuals were more likely to have diverse audiences than NGOs or affiliated individual accounts.

The category with the second most number of accounts in the top 400 on the ADS was political parties and politicians, which accounted for 21.25% ($n = 85$) of the 400 accounts. Within the political category, only 36 (9%) were run by organizations and 49 (12.25%) were individual accounts. Interestingly, the results suggest that media organizations and individual journalists played a minor role in TTIP. Only 34 (8.5%) media accounts made the top 400, which demonstrates that news organizations and journalists were not reaching a diverse, transnational public with their messages about TTIP, at least on Twitter. This finding is in contrast to other studies on Twitter discussion networks in Europe, which report that news organizations were central to the network (e.g., Maireder & Schlögl, 2014). No other category reached 7% of the top 400 accounts.

The second research question was posed in order to highlight which actors in the TTIP Twitter network were potentially most influential in diffusing information and connecting different clusters within the larger network. In other words, which accounts' communication could have helped spread information about TTIP throughout the network?

To answer this question we applied our CCBS to all accounts in the network and once again identified the 400 accounts with the highest CCBS. The results indicate that the top 400 accounts on the CCBS included more individual accounts (55.75%) than organizational accounts (35%). As with the ADS, NGOs and activists had the greatest number of accounts in the top 400 (35.75%), with 80 (20%) individual accounts and 63 (15.75%) organizational accounts making the list (Table 3). This suggests that NGOs and activists were most likely to diffuse information through the network.

Taking a closer look at the types of accounts within the NGO and activist category, we see that individual activists were the most influential in terms of information spread, as nearly 40% of the accounts within the category were individuals without an affiliation (see Table 4). Activist groups were also important, comprising 28.7% of accounts within the category. Importantly, NGOs and affiliated individuals combined comprised only 31.5% of the category, suggesting that their role in the network was less influential than activist groups and unaffiliated individual accounts.

Returning to the general list of top 400 accounts on the CCBS, politicians, and political groups accounted for about a quarter of the list (25.5%), while accounts stemming from media organizations and individual journalists only made up 14.75% of the list. As with the ADS, it appears the media played a minor role in diffusing information about TTIP through the network. The remainder of the top 400 accounts included researchers (7.5%), cultural accounts (4.5%), and corporate accounts (3%).

Table 4. Types of Accounts Within NGO and Activism Category in the Top 400.

NGO and activism detail	ADS	CCBS
All	174	143
NGO	35 (20.1%)	22 (15.4%)
Activist group	73 (42%)	41 (28.7%)
Individual with affiliation	31 (17.8%)	23 (16.1%)
Individual without affiliation	35 (20.1%)	57 (39.9%)

Note. NGO = nongovernmental organization; CCBS = Communication Connector Bridging Score; ADS = Audience Diversity Score.

Key Trends in Results

Our analyses provide unique insights into the potential of information diffusion about TTIP in the Twitter network. In particular, the results highlight three key trends that further our understanding of online political discussion networks. First, the results demonstrate that individuals played a critical role in spreading information within the network. In terms of audience diversity, individual accounts were just as likely as organizational accounts to make the top 400 list. This means that many individual accounts were being followed by a diverse set of followers from multiple subspheres or geoidentity clusters in the network.

Individuals were also more influential than organizations in connecting and bridging different clusters in the network. The top 400 accounts on the CCBS contained over 80 more individual accounts than organizational accounts. Here, individuals are more likely to receive information from another cluster of the network than the clusters they are followed by. This indicates that individuals, more than organizations, are the bridges between unique clusters. The individuals therefore have the potential to spread diverse information through the network. This is not to say organizations, in particular NGOs, did not impact the network, but rather individuals were more important in diffusing information about TTIP between clusters. This finding is consistent with Bennett and Segerberg's (2012) hybrid model of connective action in which traditional organizations play a role but are less instrumental to the network. Instead, the network relies on communication between individuals to make the critical connections across various spheres.

The large presence of activists groups in top 400 for the ADS also indicates that these groups were successful at reaching out to different audiences regarding TTIP. The activists in this discussion had several different agendas related to the TTIP debate including workers' rights, the effects of the agreement on the environment, digital rights, and the consequences for the health-care system. All of these issues have been raised by opponents of TTIP and the importance of activists in this discussion indicates that many people across Europe were interested in what activists had to say about the issue.

Finally, part of the reason activists and individuals were so influential in the TTIP network may be due to the relative silence of media organizations, journalists, and politicians. Media contributed only 8.5% of the top 400 accounts for the ADS and 14.75% of the CCBS. This is somewhat surprising given that media likely have the greatest ability to "broadcast" transnationally. That is, given their international recognition, media organizations might be expected to be followed by individual accounts from diverse clusters and serve to connect various clusters, as other studies have demonstrated (e.g., Maireder & Schlögl, 2014), or at the very least contributing to set an internetwork agenda (Vargo, Guo, McCombs, & Shaw, 2014). This was not evident in the follower network, however. The media did not give TTIP much attention until after protests emerged in Europe, suggesting the issue was driven by non-media accounts. Although more influential than the media, politicians also took a back seat to individuals, activists, and NGOs. TTIP is a potentially sensitive topic

politically and it is possible that politicians did not want to join the conversation until absolutely necessary. It is also possible that TTIP was not on many politicians' agendas. Whatever the reason, traditional political actors, as well as media organizations, potentially played a relatively less essential role in the diffusion of information about TTIP.

Discussion

This study makes two important contributions to our understanding of information diffusion of political content within online social networks. First, the paper offers a methodological advancement to the study of communication within online social networks by introducing two new measures that assess how information can diffuse between different Twitter spheres. Second, we provide new insights into how diffusion networks are structured within the context of protest networks by demonstrating the relative importance of individuals and activists in these networks.

The ADS and the CCBS introduced in this study build off existing network measures, including centrality and segmentation, but more precisely examine patterns of communication. Network analysis is often used to study network publics but there existed a clear need to develop methodological concepts and analytical approaches that operationalize network features of public communication. By examining follower networks, these two measures demonstrate what types of audiences an individual Twitter user reaches with their messages, as well as their relative influence in connecting different spheres within the network through their information diffusion. In doing so, this article also illustrates the relevance of research into follower networks for the study of the contemporary public sphere. The structure of these follower networks show macrosociological patterns of media repertoires and can identify subpublics of discussion based on common followees. As citizens increasingly turn to social media for political purposes, it is important to understand the dynamics of public opinion formation in networked, multi-medial, and multi-level media environments. The measures offered in this article represent an advancement in that direction.

The second contribution of this article relates to the structure of online, networked protest movements. We find support for Bennett and Segerberg's (2012) hybrid model of connective action, as individuals, activists, and NGOs were all potentially influential in spreading information. Despite some presence of NGOs and other organizations, individuals were critical in communication information about TTIP. This is perhaps not surprising, as protest movements online frequently are highly individualized (Bennett & Segerberg, 2013), and online social networks, including Twitter, provide an opportunity for individuals to express their self-identity (Papacharissi, 2012). Importantly, we also find that with the exception of the German subsphere, media organizations and journalists played a minor role in diffusing information about TTIP. This movement and protest coalition was formed and accelerated by individuals and interested NGOs (e.g., labor groups, digital rights groups, and environmental groups) rather than traditional media outlets. This suggests that digital protests may emerge without a strong presence of mainstream media outlets within these social networks and supports work indicating that activists can be as (or more) influential than established media organizations (González-Bailón et al., 2013). Yet, large-scale online protests can also spur mainstream media attention to the causes, which may ultimately enhance their success (Bennett & Segerberg, 2013; Howard & Hussain, 2011). Thus, more research on the symbiotic relationship between digital protests and mainstream media coverage is needed before strong conclusions can be drawn.

While this study offers a methodological advancement to the study of communication patterns within online social networks, there are a few limitations of note. First, we did not analyze the content of the tweets so we are not able to offer insights on the types of messages spread throughout the network. Future studies could combine our measures of ADS and CCBS with content analyses to determine if accounts high on those measures produce different messages than those low on the measures. This would perhaps help explain why certain accounts have diverse audiences and are

influential in the network. Nonetheless, future work should combine our measures with analyses of the content of the tweets to better understand how these two factors interact in the spread of information in these networks. Second, we did not include tweets that used the hashtag "TAFTA," which is the French abbreviation for TTIP. This may account for the relatively small number of French accounts in the network and why a large subcluster did not emerge for the French language, as they did for English, German, Italian, and Spanish. We chose not to include the tweets on Transatlantic Free Trade Area (TAFTA) because it is a larger and more general concept related to trade between the United States and the EU, whereas TTIP is a specific (and controversial) proposal under the larger umbrella of TAFTA. We were interested in the current political debate and discussion regarding TTIP and were concerned that including TAFTA tweets would draw in unrelated tweets and create unwanted noise in our data. Finally, we must acknowledge that our analyses here are limited to a single issue in Europe. Moving forward it will be important for future research to apply our measures to different topics and contexts.

Nonetheless, this study demonstrates the importance of introducing specific, communication-relevant measures to the study of information diffusion in online social networks. Our novel measures better highlight how information can spread through these networks and represent a better picture of networked, public communication.

Declaration of Conflicting Interests

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Notes

1. Definition of the account categories and examples. Please note that the coding is based on the information provided in the "description" field of the Twitter profiles.
    1. Media organizations (broadcasters, newspapers, special-interest media, and blogs, e.g., Zeit online and European Voice) and individual journalists (stating their profession or their workplace).
    2. Political parties (European, national, and regional parties, e.g., British Labour and European Greens) and governmental institutions (European, national, and regional executive bodies and agencies, e.g., the European Commission), as well as individual politicians and officials (Ministers, MEPs, MPs, commissioners, and party officials, e.g., Carl Bildt and Ska Keller).
    3. Nongovernmental organizations (NPOs [Non Profit Organisations], political advocacy groups, and unions, e.g., ATTAC [Action for a Tobin Tax to Assist the Citizen] and Corporate Europe) and individual political activists (individuals who present themselves with a political mission, often affiliated to NPOs and activists groups).
    4. Companies (for-profit firms) and individual company executives.
    5. Research institutions (universities, research departments, think tanks, etc.) and individual scholars (individuals working at research institutions and presenting themselves as researchers).
    6. Cultural institutions (festivals, museums, etc.) and individual artists (musicians, comedians, etc.).
    7. Other.

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