Between Fragmentation and Dialogue. Twitter Communities and Political Debate about the Swiss 'Nuclear Withdrawal Initiative'

1. Introduction

The emergence, use, and, in recent years, withdrawal from nuclear energy have stirred political controversies in numerous countries worldwide. These controversies have involved politicians, industry representatives, scientists, environmental organizations, and the wider public. Arguments promoting or criticizing nuclear energy ranged from the security of the energy supply over the technology's cost-effectiveness to concerns about global warming, health risks and terror threats.

Switzerland has witnessed similar debates in the past and is a particularly interesting case for analysis because it features a strong direct democracy that has given its citizens a direct say on the use of nuclear energy (Vatter, 2009). Since five nuclear power plants were commissioned in Switzerland between 1969 and 1984, several referenda were held on nuclear energy. In 1979 and 1984, initiatives aiming to prevent the construction of new nuclear plants were rejected. In 1990, following the Chernobyl accident, 55% of Swiss voters accepted a moratorium on the construction of further nuclear plants, although 53% were against a general withdrawal from the technology.[1] In 2003, the Swiss opted to lift the moratorium and new plants were discussed when the Fukushima accident occurred in March 2011. Immediately, Federal Councilor Doris Leuthard halted discussions about new plants, and, two months later, the Federal Council opted for a long-term phase-out according to which existing power plants will not be replaced after their operating periods end between 2019 and 2034 (Handelszeitung, 2011, May 25).

Since then, the focus of the Swiss political and public debate has shifted from *whether* to phase out nuclear power to the *terms and timeline* of such a phase-out. In 2015, the Swiss Green Party initiated the "Nuclear Withdrawal Initiative", targeting a rapid phase-out and a cut in the existing plants' operating times from 50 to 45 years. On November 2016, however, 54% of the electorate voted against the initiative - a surprising result, as experts and early

[1] All results on referenda on nuclear energy (18.02.1979, 23.09.1984, 23.09.1990, 18.05.2003, 27.11.2016) retrieved from https://www.admin.ch/ch/d/pore/va/vab_2_2_4_1.html by day of each referendum [19.04.2017].

polls had indicated a majority of the Swiss in favor of the initiative (Tagesanzeiger, 2016, October 21).

The debate in the run-up of the referendum was heated, particularly along two major cleavages: First, there was an *ideological polarization*. On the one side, the Green Party, the Social Democrats, the Green Liberal Party, civil society actors, and some experts positioned themselves as advocates for the initiative, while on the other hand, the Federal Council, the conservative People's Party, the Christian Democrats and the Liberals opposed it (fög, 2016). Second, there were strong *regional differences*. While support for the initiative was stronger in the French-speaking part of Switzerland, the German-speaking regions were more critical (fög, 2016).

In the article at hand, we analyze this debate, its characteristics and its development. We do so by analyzing social media, or more specifically, Twitter communication, as Twitter has become an important instrument for stakeholders' efforts to strategically disseminate their positions directly to the public, and to influence the agenda of legacy media (e.g., Broersma & Graham, 2012; Ceron, Curini, & Iacus, 2016; Metag & Rauchfleisch, 2017). And due to its pre-existing infrastructure and low cost, it "has become an important platform for eloquent and media-savvy people outside the traditional political, economic, or academic elites" (Rogstad, 2016, p. 142). We explore how Twitter communication surrounding the Nuclear Withdrawal Initiative was structured and to what extent it was polarized or enabled discussion between different camps. By doing so this paper contributes to previous research as it contradicts findings on a strong polarization on social media, but shows that there is substantial discussion regarding the controversial initiative both between and within different communities.

2. Conceptual Framework

Over the past decades, political scientists, sociologists, communication scholars and movement researchers, among others, have examined public debates about nuclear power, usually focusing either on stakeholders such as environmental NGOs or corporations, or on legacy media coverage in North America or Western European countries. They have analyzed, for example, which frames were used to portray nuclear power in US media between 1945 and 1986 (Gamson & Modigliani, 1989), how nuclear energy was strategically

reframed in the UK between 2005 and 2008 (Doyle, 2011), or how Fukushima has been instrumentalized in the media coverage across countries (Kepplinger & Lemke, 2016). Overall, however, the scholarship on public and media debates concerning nuclear power exhibits three desiderata that we want to tackle with our study.

2.1 Public Debates about Political Decisions: Shifting Away from the Analysis of Nuclear Accidents

A significant number of *studies have investigated the public discourse concerning nuclear power through the conceptual lens of risk and crisis communication*, mainly focusing on the accidents on *Three Mile Island* in 1979 (e.g., Friedman, 1981; Stephens & Edison, 1982), in *Chernobyl* in 1986 (e.g., Friedman, Gorney, & Egolf, 1992; Gale, 1987), and in *Fukushima* in 2011 (e.g., Binder, 2012; Kepplinger & Lemke, 2016; Li et al., 2016). Accordingly, many of them have limited themselves to an analysis of communication immediately after those events.

In contrast, studies analyzing nuclear energy debates as political debates, and against the background of national energy and climate policies, are rare. This is particularly problematic because the politics of nuclear energy have recently been debated in many countries as part of larger energy debates (e.g., Bickerstaff, Lorenzoni, Pidgeon, Poortinga, & Simmons, 2008), and as decisions surrounding (nuclear) energy policy are important.

The few existing analyses of media coverage about the building of new nuclear power plants, about the extension of existing plants' operating periods, or about the withdrawal of nuclear power have shown that such political debates about nuclear energy differ from times of accidents. During accidents and in their immediate aftermath, a "risk attention cycle" pattern appears which shifts debate away from political aspects and towards more immediate considerations of rescue missions, damages, victims and attributions of guilt (e.g. Kristiansen, 2017). In contrast, debates focusing on political decisions about nuclear energy focus on longer-term issues. Studies examining such periods found, for example, that nuclear power was framed as an instrument to combat climate change in the UK in an effort to legitimize new nuclear plants (Doyle, 2011; Teräväinen, 2011; Teräväinen, Lehtonen, & Martiskainen, 2011), or that the stability of energy supply and national energy independence were used as arguments in favor of extending the German plants' operating time (Arlt, 2013) and the building of new ones in other countries (Doyle, 2011; Teräväinen, 2011; Ylönen, Litmanen,

Kojo, & Lindell, 2017). Likely, public debate in the wake of the Swiss referendum would also center on long-term issues and objectives (e.g., the reduction of the proportion of fossil-based energy use, the expansion of the use of renewable energies, and intensification of energy efficiency) anchored in the Swiss National Energy Strategy 2050; which was finally accepted by 58% of the Swiss voters in a referendum held in May 2017.

2.2 Analyzing Social Media

Scholarship so far has largely focused on legacy news media and disregarded the growing relevance of social media in public debates concerning nuclear power. The vast majority of studies, even recent ones (e.g., Arlt & Wolling, 2016; Kepplinger & Lemke, 2016; Kristiansen, 2017; Teräväinen, 2011; Ylönen et al., 2017), examine public debates on nuclear energy by analyzing traditional news media such as television and newspapers.
Analyzing social media to complement these studies, however, is paramount. First, social media have generally become an important source of information for people in industrial countries around the world, including in Switzerland (e.g., Reuters Institute Digital News Report 2017). Second, they exhibit structural features which enable a different kind of communication. The open and interactive nature of online media provides "new opportunities for bottom-up communication, for the expression of public preferences, for participation in policy making, and for holding political actors accountable" and has "created new opportunities for countering the traditional top-down communication of existing print and broadcast media" (Esser, 2013, p. 173). As a result, stakeholders find a playing field online and in social media that differs from legacy media (e.g., Gavin, 2010, p. 461). Civil society groups and environmental NGOs in particular are very active in political debate around nuclear energy, but are often "weak" in terms of resources and have "fewer opportunities than established actors to gain a voice in traditional media" (Pfetsch & Adam 2013, p. 34). These groups may particularly benefit from the cost-effective communication enabled by social media, and as a result, a broader and more varied spectrum of stakeholders and political positions may be visible online. This importance of social media in debates around nuclear power, however, is not mirrored in scholarship. Only two studies have examined Twitter debate surrounding the Fukushima accident (Binder, 2012; Li et al., 2016), and one has examined how online resources were used in news media coverage in order to provide better information on the incident (Friedman, 2011). But again, these studies employ a risk and crisis communication perspective and do not focus on political decisions.

As a result, current scholarship is not yet able to assess whether the potential of social media to enable more pluralistic political debates around nuclear energy has been realized. Empirical evidence is missing which would allow scholars to assess the two competing conceptual perspectives existing on this question: On the one hand, some scholars fear that social media may function as "echo chambers" that facilitate networks among people who are similar to each other, have similar views and/or live in similar situations (e.g. McPherson, Smith-Lovin, & Cook, 2001). In social media, such homophily has mostly been studied in terms of shared ideological and political beliefs (Colleoni, Rozza, & Arvidsson, 2014; Garrett, 2009), and it has been argued that an increase in ideologically homogeneous communities on social media may lead to more intense, and problematic, political polarization and fragmentation of the public along ideological lines (Sunstein, 2009). Research supporting this perspective has found that social media communication, especially regarding controversial scientific and political issues, can exhibit "little conversation between [different] groups despite the fact that they are focused on the same topic. Polarized Crowds [..] are not arguing. They are ignoring one another" (Smith, Rainie, Shneiderman, & Himelboim, 2014, p. 2). Many of these studies, however, stem from Angloamerican countries. Jang and Hart (2015), for example, found that US debates about climate change on Twitter were strongly polarized between climate change believers and sceptics, and Williams, McMurray, Kurz, and Lambert (2015) came to similar results. Moreover, various studies have shown that Twitter (e.g., Barberá, Jost, Nagler, Tucker, & Bonneau, 2015; Himelboim, McCreery, Smith, 2013; Hong & Kim, 2015) and blog (e.g., Gilbert, Bergstrom, & Karahalios, 2009; Lawrence, Sides, & Farrell, 2010) communication is structured along political lines, and that users often interact within politically homogeneous clusters and are exposed to like-minded content. However, communication can also be structured along socialcultural lines (e.g., Rauchfleisch & Metag, 2016). Therefore, scholars gave posited that the social media may hinder than contribute to diverse and open debates.

This pessimistic perspective is contradicted, however, by scholars arguing that social media can also provide citizens with a wide range of ideologically different views, and may therefore enable interactions across ideological positions (Mutz & Mondak, 2006). Kim (2011), for example, demonstrated that social network sites expose individuals to challenging and thus cross-cutting political views. Similarly, Fletcher and Nielsen (2017) found that social media users consume news from more sources than non-users and, even more importantly,

that they “have a more politically diverse online news diet than those who do not use social media”.

Apart from studies those findings clearly support either the pessimistic or the optimistic position, there are also empirical results located between them which explored both “a clustering effect around shared political views among supporters of the same party” as well as “cross-ideological connections and exchanges, which may facilitate open, cross-party, and cross-ideological discourse” (Gruzd & Roy, 2014, p. 28; see also Barberá et al., 2015).

In sum, findings on the role of social media in political debates are mixed. While some studies confirm the pessimistic perspective showing that social media sites seem to facilitate segregation along ideological or sociocultural lines and thus a “non-debate” between groups holding opposing views, others support the optimistic perspective providing evidence that social media enable interactions between different people and thus support pluralistic debates.

2.3 Focusing on the Swiss Case

The third desideratum concerns the geographical focus of existing studies. *Most studies analyzing polarization on social media have analyzed English-language and, more specifically, US data – also those focusing on debates around nuclear energy*. In other words, they have focused on a country with a polarized political system in which power is divided between two main parties. Unless other countries are analyzed, the extent to which this structural and sociocultural polarization influences the polarization of social media debates remains unclear. Therefore, these analyses need to be supplemented by studies of structurally different cases. Switzerland represents an excellent test case for such a “most different” comparison. The country has been classified as a relatively pure consensus democracy (Lijphart, 2012, p. 7) in which the various parties in a multi-party system share executive power and have to find common ground on political issues (Lijphart, 2012, p. 33). Swiss political debates are usually not strongly polarized and disconnected between two ideological camps, but rather dialogical and consensus-oriented, as representatives from various political parties have to exchange positions and arguments to reach a common decision. Another argument to analyze social media debates in Switzerland is the country’s emphasis on direct-democratic instruments. In Germany (e.g., Arlt, 2013) and the UK (e.g., Doyle, 2011), decisions about the runtime or building of nuclear plants were taken on the national political level, with public discourse being less influential for these decisions. Switzerland, in contrast, allows for the direct participation of the population in political decision making (Vatter,

2009). Therefore, public discourse prior to referenda is highly relevant, since it may directly affect the outcome of referenda and have meaningful consequences for the future of Swiss energy policy.

2.4 Research Questions

The present paper addresses these three desiderata by exploring the political debate on Twitter concerning the Swiss Nuclear Withdrawal Initiative. It aims to assess the diversity of Twitter communication, its content and its fragmentation. Accordingly, it poses the following research questions:

RQ1: Which follower communities take part in the Twitter debate surrounding the Nuclear Withdrawal Initiative, and how can they be characterized in terms of their ideology, location, size and position towards the Initiative?

RQ2: How do these communities communicate, i.e. to what extent and with what content do they communicate?

RQ3: How pronounced is the fragmentation or polarization of the debate, i.e. to what extent are disconnected echo chambers or interactions across communities visible?

3. Data Collection and Network Description

To answer the research questions, we collected tweets on the Nuclear Withdrawal Initiative using keywords and hashtags related to the initiative in particular and to Swiss politics in general. We used German, French, and Italian keywords and hashtags to also cover the debate in the country's non-German-speaking regions. The keywords and hashtags were tracked on the Twitter stream API from November 2 to November 30, 2016; these four weeks cover the hot phase of the campaign before the voting day. As we also monitored general hashtags (e.g., #chvote), the final data set was filtered based on a list of issue-specific hashtags and keywords.[2] The final data set consisted of approximately 3000 unique users.[3] For all of them,

[2] We used the following issue-specific hashtags: "#aai", "#aai_nein", "#aai_ja", "#AAI2029", "#AAI2017", "#AtomausstiegJa", "#AtomausstiegNein", "#Ausstiegsinitiative", "#uscitadalnucleare", "#sortiedunucleaire", and "Ausstiegsinitiative". Addiditonally we considered tweets in which the French and Italian keywords "nuclaire" and "nucleari" appeared together with the general hastag #chvote for votes in Switzerland.

[3] In Switzerland Twitter is mainly an elite network (Rauchfleisch & Metag, 2016) whicthat has far less monthly active users than Facebook (Kovic et al., 2017).

we downloaded the list of Twitter accounts they were following in order to create a follower network. After cleansing[4] the data, the final network consisted of 2761 unique users who wrote 12,141 issue-related tweets (7998 [66%] retweets, 3312 [27%] normal tweets, and 831 [7%] replies). The network has a density of 0.014, which means that 1.4 percent of all possible connections actually exist within the network. The average path length, which serves as an indicator of the average number of jumps along the straightest paths for all possible user pairs in the network, is 2.94 and, therefore, the network can clearly be described as a "small-world" network. However, there is a visible gap between the German-speaking communities on the one hand and the French- and Italian-speaking community on the other. Geography and language seem to be stronger separators than political distance (see also Rauchfleisch & Metag, 2016). All analyses and visualizations were created in the R programming environment and using the open-source software Gephi.

4. Results

4.1 Follower Communities in the Twitter Debate and their Characteristics

To identify and characterize the follower communities taking part in the Twitter debate surrounding the Nuclear Withdrawal Initiative, we reconstructed a follower network for all users who posted at least one tweet or retweet containing a relevant keyword or hashtag. Using the Louvain algorithm for community detection (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008)[5], we identified seven distinct communities, which vary in size, composition, actor structure, ideological position, and opinion regarding the initiative (see Table 1).[6] These communities can be understood as "subgroups in a network in which nodes are substantially more connected to one another than to nodes outside that subgroup" (Himelboim, McCreery, & Smith, 2013, p. 159). One basic factor that affects membership of a certain group is homophily, since people are more likely to be embedded in homogeneous groups with regard

[4] In this network, we identified a group of Indian users who used the same hashtag as that for the referendum (#aai), but for a different purpose unrelated to the vote. We removed those users, as well as a few very small groups of users (mostly single bots that picked up a hashtag) who were not connected to the general Swiss Twitter population.

[5] Even though we have a densely connected follower network, we could identify meaningful structures with a modularity score above .3 (see also Newman, 2004).

[6] The density is an indicator of the degree of dyadic connections existing within a community. In our case, the density is the ratio of the number of connections that actually exist in the community dividing it by the total number of ties. The E-I index ranges from -1 (if all ties are internal) to +1 (if all ties are external). We also calculated the share of "yes" (ja) and "no" (nein) in the tweets of each community. For the Italian and French community, we used si, oui, non, and no. The percentage shows how many tweets have a yes out of all tweets mentioning either no or yes.divided by the number of all possible connections. The average path length provides information on the average number of steps it will take a community member to interact with a complete stranger/someone outside the community along the shortest path. The E-I (external-internal) index (Krackhardt & Stern, 1988) compares the number of ties within communities and between communities by subtracting the number of ties to internal community members from the number of ties to external people outside the community, and

to personal, political, or behavioral traits (McPherson, Smith-Lovin, & Cook, 2001). In first step, we compared our network to a "baseline" random graph with the same properties (Erdős-Rényi model; Erdős & Rény, 1959). We then compared the clustering coefficient mean distance, and degree of separation (see Kaiser, 2017). We created 100 random graphs and report the average score. The follower network has a considerably larger clustering coefficient (.234) than the random graphs (*M*=.028, *SD*=.0001). The average path length (2.94) is also considerably greater than in the random graphs (*M*=2.55, *SD*=.002). The degree of separation (Hu, Thulasiraman, and Verma, 2013) (128.48) is substantially larger than in the random graphs (M=.97, SD=.11).[7]

- The "*Conservative Mainstream*" community is the largest community (n=784). It holds a central position in the overall network, with almost all the other communities positioned around it (see Figure 1 in the Appendix). The community is the voice of the middle-class, conservative mainstream of German-speaking Switzerland, who generally oppose the Nuclear Withdrawal Initiative. Given that among the most relevant users, based on the number of direct connections, are various media outlets such as the NZZ, a conservative quality broadsheet, and the large German-language public-service broadcaster, SRF, this community is likely to have a considerable impact on the political debate on Twitter and beyond. The community has a comparatively low density of 0.036 and an average path length of 2.55. The community clearly opposes the initiative with a share of 81% "no".
- The major – and also quite large – counterpart of the Conservative Mainstream is the "*Green-Left*" community. It is the second largest community (n=621), representing the environmental and liberal camps of German-speaking Switzerland, and it contains various representatives of the Green Party, who initiated the Nuclear Withdrawal Initiative. The density of this community is 0.051 and the average path length is 2.38. This community clearly supports the initiative with a share of 87% "yes".
- The "*Energy-Environmentalist*" community, with a density of 0.024 and an average path length of 3.38, mainly consists of actors concerned with energy and environmental issues in general. Among the most relevant users are the Federal Department of Environment, Transport, Energy, and Communications, as well as

[7] If the 4 nodes with the highest betweenness centrality are excluded (mostly media), the polarization score is still substantially larger (57.60) than the score of the random network.

environmental organizations such as the WWF and Greenpeace, who clearly positioned themselves as supports of the initiative.

- In contrast, the "*Pro-Nuclear-Power*" community comprises a small group of issue-specific experts and pro-nuclear lobbyists who function as campaigners for nuclear energy and who thus oppose the initiative. One notable community member is the Energy for Humanity Foundation, a scientific-technical organization, which explicably aims to increase the acceptance of nuclear power among the public. The community has a density of 0.078 and an average path length of 2.49. Moreover, this community has a comparatively significantly negative E-I ratio of -0.46, which means that the community has far more internal than external ties and is therefore rather isolated from the other communities.
- The "*Basle Region*" community mainly consists of politicians from the Basle region, most likely because Basle historically positioned itself against nuclear power, and thus this community clearly supports the initiative. The community has a comparatively high density of 0.179 and an average path length of 1.92, which means that it takes members only about two steps to interact with members from other communities.
- The top users of the "*Green-Liberal*" community are mainly representatives of the Green-Liberal Party, which positioned itself as a supporter of the initiative. The community has a comparatively high density of 0.223, which means that 22.3 percent of all possible connections within the community actual existing. The average path length is 1.96.
- Finally, there is the "*French- and Italian-Speaking"* community, with a density of 0.032 and an average path length of 3.04, which represents political opinion leaders in the non-German-speaking parts of Switzerland, including Roger Nordmann and Adèle Thorens Goumaz, who are both representatives of the Canton of Vaud in the National Council of Switzerland. Although the French-speaking region of Switzerland supported the initiative (fög, 2016), there is a visible gap between the German-speaking communities and the non-German-speaking community, which means that language in terms of a sociocultural factor is a stronger separator than position regarding the initiative. Additionally, the negative E-I ratio of -0.36 indicates that the French- and Italian-speaking community is rather isolated from the other communities (see Table 1).

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Table 1

Communities involved in the political debate on Twitter and their characterization

4.2 Intensity and Content of Twitter Communication

Over time, the Twitter communication concerning the Nuclear Withdrawal Initiative showed a slow increase typical for a pre-announced event (Lehmann et al., 2012). Within this timeline, three dates exhibit an increased level of communication. The first peak occurs on November 16, 2016, one day after the second SRG poll, which revealed the tight race between supporters and opponents, was published (gfs.bern, 2016, November 15). Both users and the media responded to this survey on Twitter, using it as an occasion to stress their arguments and further mobilize their supporters. The second, smaller peak occurred on November 21, 2016, one week prior to the vote, when Twitter was used for a final mobilization push. The third, sharp increase occurred on November 27, 2016, the day of the actual referendum, when the final mobilizations were made and the results discussed. As is typical for such an event, activity falls rapidly after the vote (Lehmann et al., 2012).

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Figure 2. Distribution of tweets per day and discourse community over time

Regarding the communicating activity of the identified communities, Figure 2 presents the distribution of their tweets per day and discourse community over time. The “Conservative Mainstream” and “Green-Left” communities provided the highest levels of daily activity in the Twitter debate, although their activity was proportionate to their overall size within the network (29% and 24%, respectively; see Table 1). Still, however, these communities are the ones most responsible for shaping the political debate in preparation for the referendum.

In addition, the “Energy-Environmental” community also generated a lot of activity and it was, in relation to its size, comparatively active in contributing to the debate on Twitter. In contrast, the “Pro-Nuclear-Power” community, which was rather small to begin with, was relatively inactive in comparison to its size, and it was accordingly less able to shape the debate. The other, smaller communities were represented rather weakly but still proportional to their size. The “French- and Italian-Speaking” community, in contrast, was proportionately under-represented on Twitter, with an average share of the daily total tweet volume of only

14%, which was also rather isolated from the other communities. This community's effect on the political debate was, therefore, likely limited, particularly in the German-speaking part of Switzerland where, in the end, the referendum was clearly rejected (Tagesanzeiger, 2016, November 27).

In addition to the (relative) activity of the different Twitter communities, the content of the communication of opponents and supporters of the Nuclear Withdrawal Initiative was assessed. Firstly, we grouped the communities into those opposing the referendum (i.e., the "Conservative Mainstream" and "Pro-Nuclear-Power" communities) and those supporting it (the "Green-Left", "Energy-Environmental", "Basle Region", and "Green-Liberal" communities) (see Table 1).[8] Secondly, we created two corpora (n=4383 tweets for the opponents and n=5986 tweets for the supporters) in order to examine similarities and differences in the over-representation of certain, meaningful words in the tweets of opponents and supporters. Thirdly, we cleaned each corpus (removing punctuation and non-graphic characters, changing all letters to lower case, etc.) and stemmed the words, thereby reducing the words to their base form. We did not remove numbers, since they are relevant in our case (e.g., providing information on dates and years). Fourthly, we calculated the total frequency of words as well as the relative frequency of words in each corpus. We then could divide for each word its relative frequency in the supporters' corpus by its relative frequency in the opponents' corpus in order to estimate the degree to which a given word was over-represented among the tweets of opponents or supporters. Finally, we log-transformed the score. A score of 0 indicates that a word is equally represented in each corpus, whereas a negative value indicates an over-representation in the tweets of opponents and a positive value indicates an over-representation in the tweets of supporters. In addition, we calculated the Chi-square for each word as an indicator, which words are not evenly distributed over the corpuses, and selected the 60 most frequently used words as well as the 60 words with the highest Chi-square values. As some of the most frequently used words also had one of the highest Chi-square scores, the visualization contains 92 unique words (see Figure 3).

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Figure 3. Over-representation of keywords used by opponents and supporters (the over-representation was normalized through a division by the absolute maximum number. The size of the words in the

[8] The "French- and Italian-Speaking" community was excluded for this analysis due to the difference in language.

figure indicates the overall frequency of each word in both corpuses. The color and position show the degree of over-representation by each camp)

Figure 3 shows that rather general hashtags such as #abst16 ("Abstimmung" = "vote") and #aai (the acronym of the German name of the referendum, "Atomausstiegsinitiative") were used equally often by opponents and supporters. The word "Nein" ("no") is obviously over-represented in the tweets of opponents, whereas "atomausstiegja" ("nuclear phase-out yes") mainly appears in supporters' tweets. It also becomes evident that opponents more frequently use vocabulary that describe the nuclear phase-out as blindfold in terms of being "überstürzt" ("rushed"), "überhastet" ("hasty"), and "chaotisch" ("chaotic"), and emphasize possible negative consequences like a "blackout" or the necessity to use more "kohlestrom" ("coalpower"), which is characterized as "dreckstrom" ("dirty electricity"). In contrast, supporters of a phase-out more frequently use the names of the operating nuclear power plants in Switzerland ("beznau" and "leibstadt"), as well as nuclear-power-related words ("atomstrom" and "akw"). Furthermore, words that point toward the problems of nuclear energy such as nuclear waste ("atommüll") and nuclear incidents ("Fukushima"), as well as to the alternatives such as renewable energies ("erneuerbare") are over-represented in tweets of the supporters.

4.3 Interactions Within and Across Communities

To examine the degree of interactions within and across the different communities, we used a reply network that reconstructs which of the identified users replied to whom and with what frequency (see Figure 4 in the Appendix). Thus, the reply network represents the active contributions of each community to the communicative exchange within the entire network.

Table 2 cross-tabulates the replies sent by the users of each community to users within the same community (internal replies) and to users in other communities (external replies). It clearly shows that Swiss Twitter users did not restrict their replies to users from their own communities. In all the communities, the number of "external" replies strongly outweighs the number of internal ones, with the "Conservative Mainstream" community having the highest proportion of internal replies (30%) and the "Pro-Nuclear-Power" community the lowest (5%). In other words, depending on the community, between 70% and 95% of replies went to users belonging to other communities.

The "Conservative Mainstream" community sent the most replies overall (n=406), 70% of which went to other communities, namely 33% to the "Energy-Environmental" community

and 26% to the “Green-Left” community, which were both supporting and, thus, ideologically different communities. A similar pattern can be observed in the 237 replies sent from the “Green-Left” community. Some 78% of them were external, with 43% being addressed to the “Conservative Mainstream” community and 21% to the “Energy-Environmental” community. The “Energy-Environmental” community also had a high proportion (74%) of external replies, with most of them being directed towards the “Conservative Mainstream” community (57%). In general, replies between these three communities were quite common, and they accounted for between 59% and 64% of all replies from these communities.

The other communities also sent a large share of replies to different communities, thereby exhibiting a similar pattern. Most of these replies were directed toward the three large communities mentioned above, with the remainder being proportionately distributed among the smaller communities. The only exception was the “Green-Liberal” community, which very frequently replied to the “Pro-Nuclear-Power” community. But, in general, the number of cases was very low.

Our findings indicate that the Swiss Twitter debate concerning the Nuclear Withdrawal Initiative was not limited to an individual’s community. Instead, users were actively engaging with members of other communities. The communication between communities is still on average higher over time when we compare the group of communities opposing the referendum with the group supporting the referendum (the groups from the prior section: see Figure 5).

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Figure 5

Figure 5. Communication (replies) between and within communities over time

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Table 2

Cross-tabulation of internal and external replies to tweets posted by each discourse community

5. Discussion and Conclusion

Although analyses of public debates concerning nuclear power are well established in communication studies, yet previous research displays three desiderata: First, existing studies mostly focused on disasters such as Three Mile Island, Chernobyl, or Fukushima, and hence they have explored the nuclear issue in the context of risk and crisis communication. Second, despite their rapidly growing importance of social media in changing media landscapes worldwide, previous research mostly neglected the role of social media in public debates concerning nuclear power. Third, existing studies that examine the role of social media in public controversies (e.g., climate change) mostly focused on the USA, where public debate may exhibit different discursive patterns from those in other countries. In particular, countries in which public debates are of particular relevance due to the public having a say in energy politics via direct, national referenda have not yet been studied (see Vatter, 2009).

In light of these desiderata, we analyze Twitter discourse in the wake of a Swiss referendum concerning the withdrawal from nuclear energy. We identified and characterized different communities debating the referendum, examined how frequently and with what content they communicated about the issue, and explored the interactions within and between these communities in order to assess in how fare the debate was polarized or connected.

The findings of this study are particularly significant, because they run counter to the results of many other studies that explore social media communication on environmental issues. Instead of two large, ideological separated groups, like climate skeptics and advocates in the case of global warming, we identified seven communities based on the follower relationships, which are rather stable over time (e.g., Bruns, 2012). Moreover, our findings show that these communities differ in terms of their size, ideological position, communicative activity, and the way they communicate about the initiative (see Table 1, Figure 2 and 3). The "Conservative Mainstream" community was the largest of these communities, representing the majority of the conservative mainstream in the German-speaking part of Switzerland. Its largest challengers were the "Green-Left" community, representing the initiators of the

nuclear phase-out initiative, among others, and the "Energy-Environmentalist" community, which included activists and environmental NGOs. Three smaller communities and one mostly comprising representatives of the French- and Italian-speaking parts of the country completed the set of communities. The two communities in our network that are clearly geographical allocatable both supported the initiative, but for different reasons. In the case of the "Basle Region" community, the successful protests in the 1970ies and 1980ies against the construction of a nuclear power plant near Basle and the proximity to France's oldest nuclear power plant in Fessenheim explain the support for the initiative. However, in case of the "French- and Italian-Speaking" community rather the distance to the Swiss nuclear power plants, which are all located in the German-speaking part of Switzerland possibly, seems to explain the support for the initiative (e.g., Frantál, Malý, Ouředníček, & Nemeškal, 2016).

The activity of these communities varied over time, with peaks around the publication of national polls, during intense mobilization efforts and on the day of the referendum itself. This activity varied between communities, with larger communities displaying disproportionately high levels of activity. Depending on their position towards the referendum, the communities emphasized different content. Our analysis of the over-represented words exchanged between supporters and opponents of the initiative revealed some shared nomenclature, but also some clear differences in the wording and, even though we cannot show this in detail, framing of the issue.

However, although we found seven rather diverse communities, with respect to their communicative interactions, our results revealed an active exchange both within and, more importantly, across communities. Our findings revealed a lively exchange between the "Conservative Mainstream", the "Green-Left", the "Energy-Environmental", and the "Pro-Nuclear-Power" communities, even though they were positioned differently toward the initiative. Moreover, findings show that not only politicians were involved in the debate, but also journalists, environmental organizations, representatives from the energy sector, and scientists. Yet, although the Swiss Twitter debate has to be characterized as an elite discourse dominated by stakeholders from the German-speaking part of Switzerland, still our findings support the potential of Twitter to enable a pluralistic and cross-ideological debate including various types of actors and positions (see Tables 1 and 2). Therefore, our findings run contrary to analyses of social media debates on other issues in other countries. In contrast to Williams et al.'s (2015) analysis of Twitter communication regarding global warming, for

example, we do not find pronounced echo chambers. Instead, our study showed a rather pluralistic and internally connected debate characterized by active exchanges both within and across communities. Moreover, our findings confirm our earlier argumentation that due to the consensus democracy and multi-party system of Switzerland, Swiss political debate are in general less polarized, but more strongly dialogical and consensus-oriented between various political actors. These findings were also confirmed in a follow-up study analyzing the Twitter communication during the referendum campaign of the Swiss National Energy Strategy 2050 in May 2017 (Vogler & Rauchfleisch, 2017).

In sum, our study finds pronounced diversity in the communities we reconstructed. In these stable follower relationships (Bruns, 2012), which have sedimented over time, we find a broad ideological and socio-cultural spectrum. However, this does not simultaneously mean that the communication between these communities is fragmented; there is a considerable amount of communication both across communities and across different positions towards the nuclear withdrawal initiative. In other words, we do find the chambers, but not the echo – at least not in the Swiss context which differs considerably from that in the US.

To conclude, our study reiterated that social media sites represent important arenas for political discourse concerning nuclear power. The extent to which this is due to the unique case of the Swiss referendum on nuclear power remains to be seen, while determining how far this can be generalized to public debates beyond Twitter is an issue for future research. Thus, more comparative research on political discourse conducted on social media is needed in order to explore which national, political, media, and issue-specific characteristics lead to which discursive patterns on social media.

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Appendix

Insert here

Figure 1. With k-core decomposition filtered[9] follower network visualized with force atlas 2 (green: Conservative Mainstream; pink: Green-Left; grey: Energy-Environmentalist; orange: Pro-Nuclear-Power; blue: Basle Region; dark grey: Green-Liberal; violet: French- and Italian-Speaking)[10]

Insert here

Figure 4. Reply network with the same node layout and colors as in Figure

[9] Borge-Holthoefer, J., & Gonzlez-Bailn, S. (2017). Scale, Time, and Activity Patterns: Advanced Methods for the Analysis of Online Networks. In N. G. Fielding, R. M. Lee, & G. Blank (Eds.), The SAGE Handbook of Online Research Methods (pp. 259–276). London: SAGE Publications.

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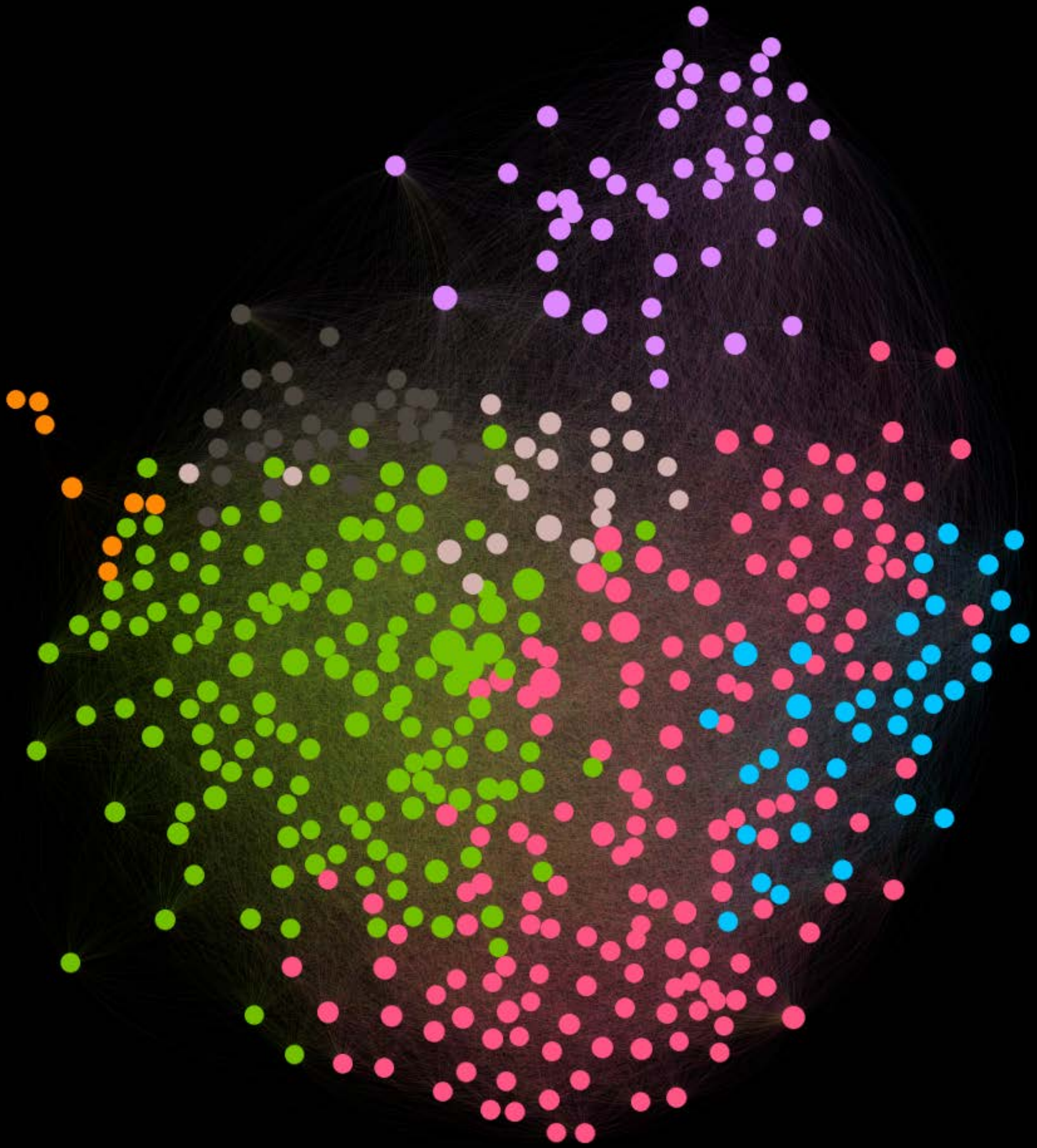
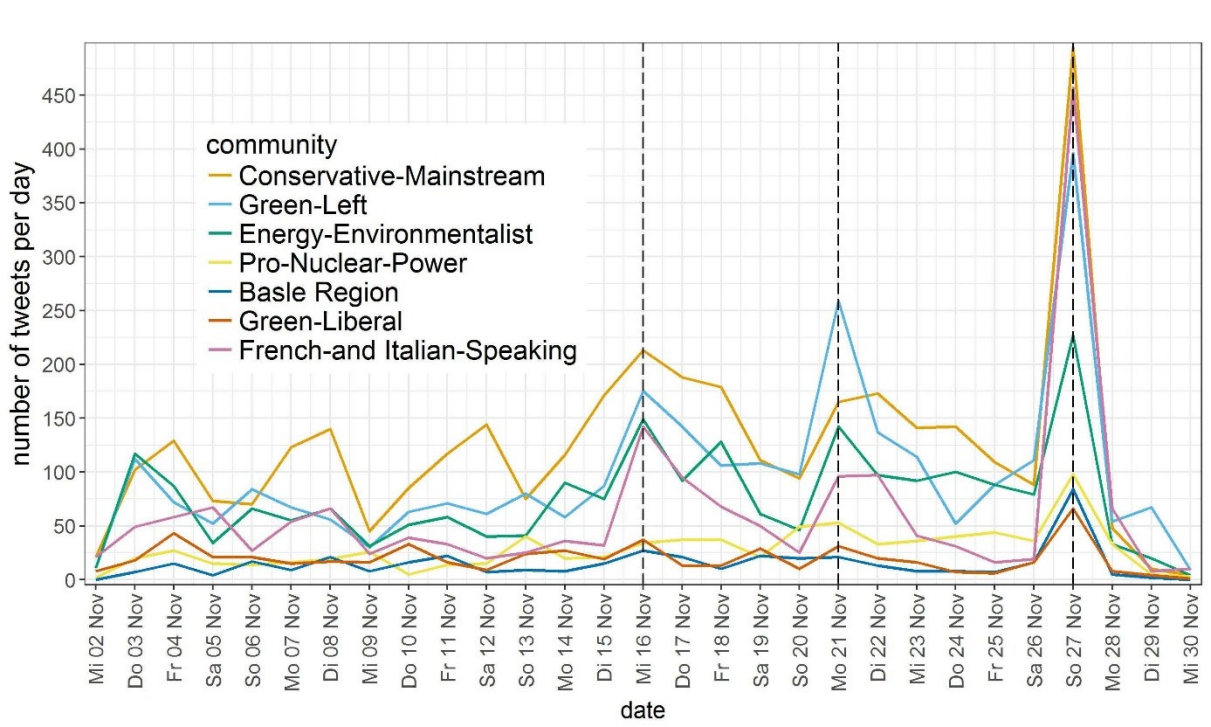
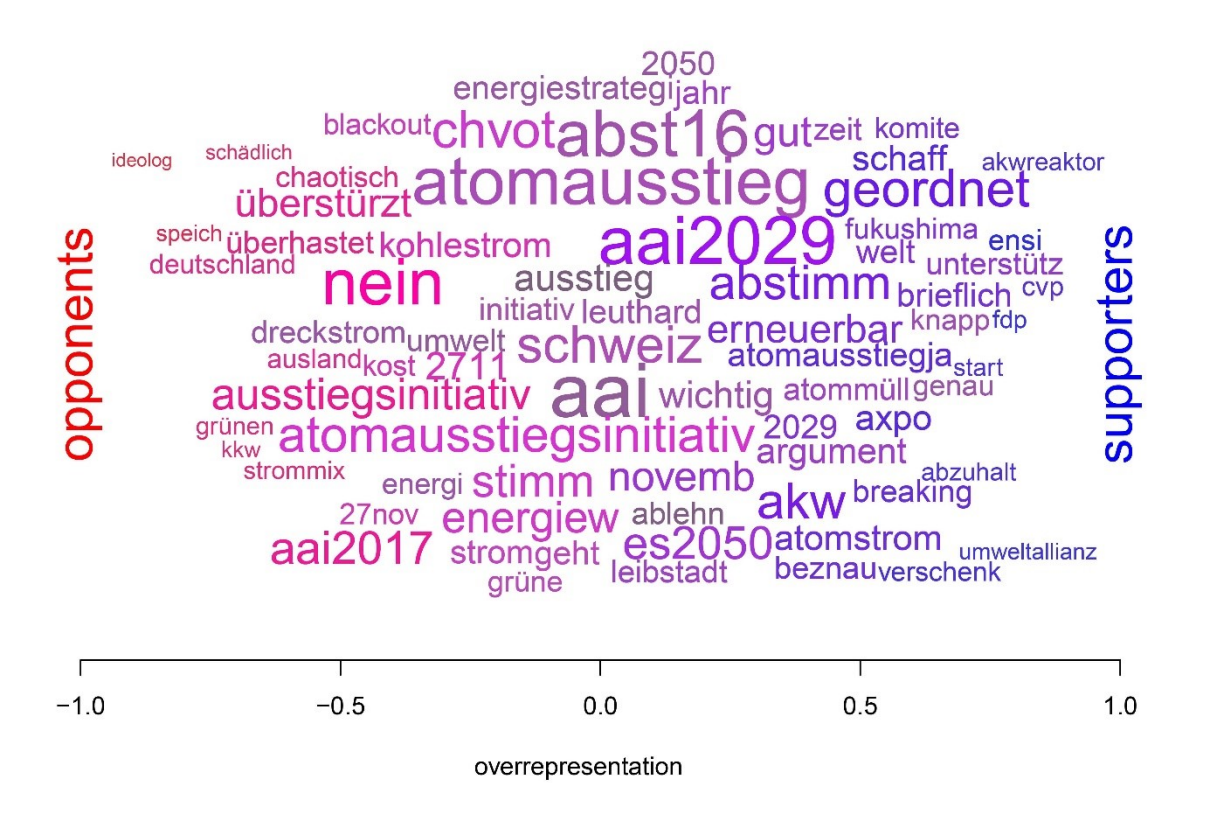



community
Conservative-Mainstream
Green-Left
Energy-Environmentalist
Pro-Nuclear-Power
Basle Region
Green-Liberal
French-and Italian-Speaking
number of tweets per day
0
50
100
150
200
250
300
350
400
450
Mi 02 Nov
Do 03 Nov
Fr 04 Nov
Sa 05 Nov
So 06 Nov
Mo 07 Nov
Di 08 Nov
Mi 09 Nov
Do 10 Nov
Fr 11 Nov
Sa 12 Nov
So 13 Nov
Mo 14 Nov
Di 15 Nov
Mi 16 Nov
Do 17 Nov
Fr 18 Nov
Sa 19 Nov
So 20 Nov
Mo 21 Nov
Di 22 Nov
Mi 23 Nov
Do 24 Nov
Fr 25 Nov
Sa 26 Nov
So 27 Nov
Mo 28 Nov
Di 29 Nov
Mi 30 Nov
date


opponents
supporters
2050
energiestrategi
jahr
blackout
chvot
abst16
gutzeit
komite
ideolog
schädlich
schaff
akwreaktor
chaotisch
atomausstieg
geordnet
überstürzt
speich
überhastet
kohlestrom
aai2029
fukushima
ensi
deutschland
nein
ausstieg
welt
unterstütz
abstimm
brieflich
cvp
initiativ
leuthard
dreckstrom
umwelt
schweiz
erneuerbar
knapp
fdp
ausland
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ausstiegsinitiativ
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wichtig
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breaking
27nov
energiew
ablehn
aai2017
stromgeht
es2050
atomstrom
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−1.0
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overrepresentation

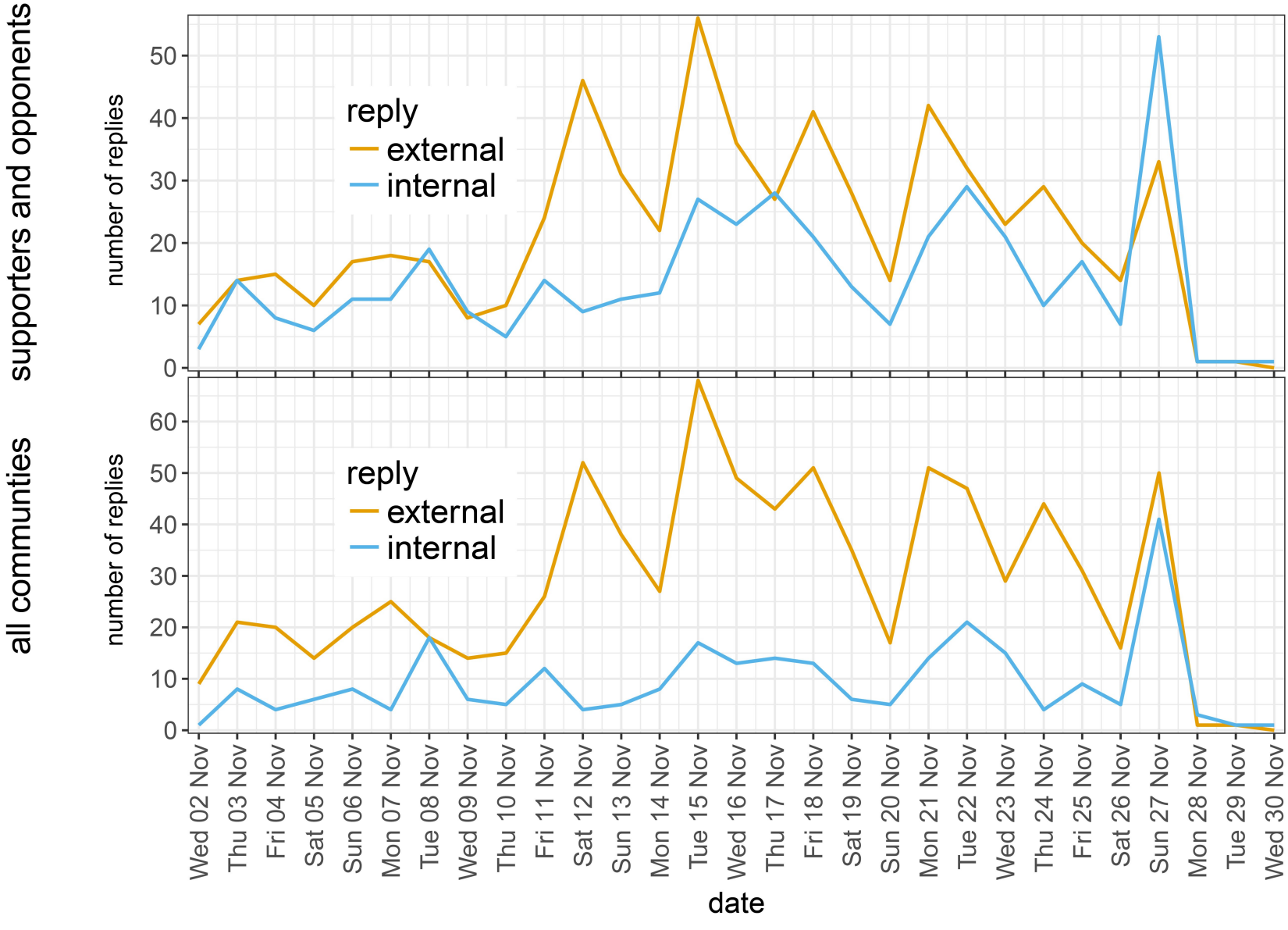
supporters and opponents
all communties
number of replies
reply
external
internal
0
10
20
30
40
50
60
Wed 02 Nov
Thu 03 Nov
Fri 04 Nov
Sat 05 Nov
Sun 06 Nov
Mon 07 Nov
Tue 08 Nov
Wed 09 Nov
Thu 10 Nov
Fri 11 Nov
Sat 12 Nov
Sun 13 Nov
Mon 14 Nov
Tue 15 Nov
Wed 16 Nov
Thu 17 Nov
Fri 18 Nov
Sat 19 Nov
Sun 20 Nov
Mon 21 Nov
Tue 22 Nov
Wed 23 Nov
Thu 24 Nov
Fri 25 Nov
Sat 26 Nov
Sun 27 Nov
Mon 28 Nov
Tue 29 Nov
Wed 30 Nov
date

Table 1

Communities involved in the political debate on Twitter and their characterization

Community[1]	**Dominant position of community initiative**[2]	**Yes share in tweets**	**Relevant users in the community**	**Type of relevant users**	**Language region**	**Size (n/% of all users)**	**Average share of the daily total volume**	**Density**	**Average path length**	**E-I index**
Conservative Mainstream	Opponents, e.g., FDP, SVP, and NZZ	19%	**NZZ** (conservative quality newspaper), **srfnews** (mainstream Swiss public broadcaster), **cwasi** (FDP. The Liberal politician), **FDP_Liberalen** (political party FDP. The Liberals)	Media, politicians	German-speaking Switzerland	784 (28%)	29%	0.036	2.55	-0.28
Green-Left	Supporters, e.g., Green Party	84%	**Bglaettli** (Green Party politician), **watson_news** (left online news portal), **bastiengirod** (Green Party politician and environmental scientist)	Media, politicians	German-speaking Switzerland	621 (23%)	24%	0.051	2.38	-0.14
Energy-Environmentalist	Supporters, e.g., environmental organizations	62%	**WWF_Schweiz** (Swiss affiliation of the environmental organization WWF), **greenpeace_ch** (Swiss affiliation of the environmental organization Greenpeace)	Civil society, environmental organizations	German-speaking Switzerland	426 (15%)	18%	0.024	3.38	0.08
Pro-Nuclear-Power	Opponents, e.g., nuclear energy lobbyists	12%	**UrsBolt** (Director of the Swiss pro-nuclear Energy for Humanity Foundation), **EfH_CH** (pro-nuclear Energy for Humanity Foundation), **KernenergieNews** (Swiss nuclear forum)	Nuclear industry, experts, science and technology	German-speaking Switzerland	133 (5%)	7%	0.078	2.49	-0.46
Basle Region	Supporters, e.g., Social Democratic Party, Green Party in Basle region	79%	**SusanneSlo, enussbi** (Social Democratic Party politicians), **nr_mayagraf** (Green Party politician)	Politicians	German-speaking Switzerland	118 (4%)	3%	0.179	1.92	0.21
Green-Liberal	Supporters, e.g., Green-Liberal Party	87%	**Grunliberale** (Green-Liberal Party), **beatflach, huberfe** (Green-Liberal Party politicians)	Politicians	German-speaking Switzerland	97 (4%)	5%	0.223	1.96	0.31
French- and Italian-Speaking	Supporters, e.g., Social Democratic Party, Green Party, Romandy	89%	**BR_Sprecher** (spokesman for the Swiss Federal Council), **NordmannRoger** (Social Democratic Party politician), **adelethorens** (Green Party politician)	Politicians	French- and Italian-speaking Switzerland	582 (21%)	14%	0.032	3.04	-0.36

Notes: [1]In an analysis of the Twitter debate concerning the nuclear phase-out initiative on Twitter prior to the referendum, the Swiss research institute gfs.bern identified similar communities (SRF, 2016, October 20); [2]See also fög (2016) for the positioning of the actors.

Table 2

Cross-tabulation of internal and external replies to tweets posted by each discourse community

		Community sending a reply							
	Community posting a tweet (sender)	**Conservative Mainstream**	**Green-Left**	**Energy-Environmentalist**	**Pro-Nuclear-Power**	**Basle Region**	**Green-Liberal**	**French- and Italian-Speaking**	
	Number of replies to posts from sender (n)	406	237	262	76	71	16	35	Number of replies received
Community receiving a reply	Conservative Mainstream	30% (+2%)	43% (+15%)	57% (+29%)	33% (+5%)	46% (+18%)	56% (+28%)	51% (+23%)	426
	Green-Left	26% (+3%)	22% (-1%)	6% (-17%)	37% (+14%)	10% (-13%)	13% (-13%)	9% (-14%)	206
	Energy-Environmentalist	33% (+18%)	21% (+6%)	26% (+11%)	17% (+2%)	14% (-1%)	0% (-15%)	17% (+2%)	272
	Pro-Nuclear-Power	3% (-2%)	5% (0%)	6% (+1%)	5% (0%)	3% (-2%)	19% (+14%)	3% (-2%)	45
	Basle Region	2% (-2%)	4% (0%)	2% (-2%)	1% (-3%)	21% (+17%)	6% (+2)	0% (+4%)	25
	Green-Liberal	5% (+1)	4% (0%)	1% (-3%)	3% (-1%)	1% (-3%)	6% (+2%)	0% (-4%)	34
	French- and Italian-Speaking	1% (-20%)	0% (-21%)	3% (-18%)	4% (-17%)	4% (-17%)	0% (-21%)	20% (-1%)	24

Notes: The grey background represents internal replies within one community, while the white background represents external replies from other communities. χ^2 (36, n = 744) = 479.2, $p < .001$. In brackets the difference to the n/% of all users in the receiving community as baseline.