

Can Self-organized Criticality Theory help identify Political Mobilization on Social Media?

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Abstract: One of the challenges of monitoring political mobilization on social media is the setting of formalized mobilization criteria to identify early symptoms of political mobilization across different groups. We propose and test a tool for identifying groups that display a high level of political mobilization. This tool is based on the hypothesis that strong engagement of users in group activities and discussions is common to groups in a state of self-organized criticality (SOC). An attribute of SOC, known as pink noise, can be observed in time series. To test this hypothesis, we sourced data on activity in 200 Facebook groups in France and Germany.

Keywords: self-organized criticality, pink noise, social media, political mobilization

La théorie de la criticité auto-organisée aide-t-elle à identifier la mobilisation politique sur les réseaux sociaux ?

Résumé: L'une des difficultés de la surveillance de la mobilisation politique sur les réseaux sociaux consiste en la définition des critères de formalisation de ces mouvements afin d'identifier les premiers symptômes de mobilisation politique sur les réseaux sociaux. Nous proposons et testons un outil capable d'identifier des groupes qui affichent un fort taux de mobilisation politique. Cet outil repose sur l'hypothèse selon laquelle un fort niveau d'engagement des utilisateurs dans les activités et discussions du groupe est commun aux groupes dans un état de criticité auto-organisée (SOC). L'une des particularités de la SOC, connue sous le nom de *pink noise* (bruit rose), peut être observée dans les séries temporelles. Afin de tester cette hypothèse, nous avons récolté des statistiques dans 200 groupes Facebook en France et en Allemagne.

Mots-clés: criticité auto-organisée, bruit rose, réseaux sociaux, mobilisation politique

Introduction: Challenges, Objectives and Hypotheses

The monitoring of political mobilization on social media is challenging, due to the need to find countable mobilization criteria. In addition, there are difficulties with identifying the early symptoms of political mobilization across the wide array of groups forming the network. The objective of this study is to propose and test a convenient indicator to identify groups that demonstrate a high level of political mobilization.

We aimed to test the hypothesis that groups in a state of self-organized criticality (SOC) may be viewed as social communities with a high level of user engagement, since it is very likely that such groups will have higher level of mobilization.

For the purposes of this study, political mobilization is defined as a specific state of social media groups. This state has the following characteristics:

1. Group members display increased readiness to perceive and spread political messages on social media, and also to take action (both online and offline) driven by such messages;
2. Groups may generate information avalanches, i.e. major bursts of activity (involving rapid increases in the generation and diffusion of messages) driven by internal factors;
3. Group members demonstrate rather consistent opinions about current political situations and what needs to be done in the near future.

The SOC theory initially came into being to describe a wide array of scientific phenomena, but it has also proven useful in interdisciplinary social studies. One attribute of SOC is pink noise ($1/f$ noise), which is shown in time series. To test our hypothesis, we sourced daily activity data on 200 Facebook groups in France and Germany in the period between Jan 1, 2019 and June 30, 2019.

Pink noise (Figure 1A) is a fractal process with numerous minor oscillations, some medium-sized spikes and relatively few gigantic surges. On a chart, such process may look as a high wave interlaced with smaller waves, which are further interlaced with a small ripple, and so on. Pink noise is made of events of different size and force. The formal features of pink noise are described in Chapter 4 “Methods and techniques”.

1. Approaches

The state of SOC is similar to a time-extended bifurcation point where minor external or internal impulses are able to drastically change the evolution of the system. As a rule, systems cross bifurcation points rather quickly, and uncertainty is a short-lived state. However, self-organized critical systems (SOC-systems) are able to maintain dynamic equilibrium for a long time, owing to a combination of escalation and relaxation processes (Podlazov 2001).

SC systems are associated with a specific type of equilibrium called punctuated. This state can be described as alternating periods of relative rest and major sudden outbursts of activity. In some cases, systems can be extremely inert, displaying little to no reaction to strong and compelling impulses. However, from time to time, the stagnation gives way to an agitated state, when the system demonstrates violent reactions, up to self-destruction, to minor events and impulses. Stagnation and agitation make one concept – punctuated equilibrium.

Periods of relative rest in SC systems do not mean that the system has become static. Such systems may appear stable over a limited period of time, but essentially they aren't static. The same ongoing processes inside the system determine both the periods of inertia and outbursts of activity, which can have different sizes.

SOC may emerge in integral systems consisting of numerous communicating elements, and which contain causal loops. In SOC-systems, any events, even those that are local, short and weak, may trigger causal chains that do not damp out quickly and may thus span the entire system. This means that ordinary and simple micro-processes may affect complex and sometimes non-linear macro-level system behavior.

In causal loops, some cause and effect chains may be enhanced to a certain extent, while others are weakened to a different extent. Fluctuations of various durations emerging in the system form pink noise. (Figure 1A). Bak, one of the founders of SOC theory, described such processes (signals) as follows:

There are features of all sizes: rapid variations over minutes, and slow variations over years... The signal can be seen as a superposition of bumps of all sizes; it looks like a mountain landscape in time, rather than space. The signal can, equivalently, be seen as a superposition of periodic signals of all frequencies. This is another way of stating that there are features at all time scales. Just as Norway has fjords of all sizes, a $1/f$ signal has bumps of all durations (Bak, 1996, p. 21-22).

SOC systems are prone to causing avalanches, which involve an abrupt disequilibrium and breakdown of key system parameters. This is why pink noise is viewed as an indicator of disaster and drastic transformation. Such disasters and transformations are driven by the inner properties of SOC systems; trivial events, which over a long period of time have had no large-scale system implications, may thus provoke disastrous avalanches, which to an external observer appear to be

spontaneous and unexpected. The avalanche provokes a nonlinear effect: the cause and effect ratio is no longer commensurate.

Manifestations of pink noise are sometimes interpreted as punctuated equilibrium:

...This phenomenon is observed in the biological evolution and social and technical systems. It is a typical situation, when over a long period of time apparently nothing is happening, and then sudden and drastic changes occur in the system, and a revolution is around the corner, which certainly does not mean that all the small events, which were overlooked by us, did not happen (Malinetskii, 2014, p. 39).

A virtual environment in which numerous connections between a wide array of elements can be built up quickly and easily facilitates the manifestation of SOC effects. We may assume that social communities in the state of SOC are prone to self-organization. Such groups must have many channels of communication between their members and with the external environment. In the state of SOC, groups and their members must also have high level of reflexivity, defined here as the ability of people and a community to perceive numerous information impulses, respond to them, spread and replicate them. This ensures the higher readiness of SOC-groups to carry out social action and radical transformation.

We believe that identification of pink noise allows for the identification of true social groups, i.e. communities of highly engaged real people. Such groups are different from crowds of bots or users with low levels of engagement. SOC effects manifest themselves only in systems where members show a high reflection of each other's states and that of the group in general.

2. Literature

A series of theoretical papers and surveys (including the classical works of the founders of SOC theory) argue in favor of the applicability and heuristic efficiency of SOC theory for social studies, for example Bak (1996), Turcotte (Turcotte, 1999; Turcotte & Rundle, 2002), Buchanan (2000), Brunk (2001, 2002a, 2002b), Malinetskii (2014), Borodkin (2000, 2019), and Kron & Grund (2009).

Some authors have found a power law that suggests the manifestation of SOC in social processes (for example wars, strikes, rebellions, terror attacks and acts of extremists), such as Roberts and Turcotte (1998), Cederman (2003), Biggs (2005), Picoli, Castillo-Mussot, Ribeiro, Lenzi and Mendes (2014). Pink noise in social reality has also been demonstrated in the works of Shimada and Koyama (2015), Thietart (2016), Tadić, Dankulov and Melnik (2017), Zhukov, Kanishchev and Lyamin (2016, 2017). These studies demonstrate that the tools of SOC theory prove useful for the classification of social systems, and can help identify those systems that are prone to "spontaneous" outbursts of activity driven by minor internal

factors. In addition, changes in the type/color of the signal are markers that can help to identify the moment and direction of transformations in a social system.

The work by Tadić et al. (2017) was important for the design of our research, as these authors demonstrated the existence of SOC in online communities. Shimada and Koyama (2015) analyzed the outcomes of political elections in Japan in the second half of the 20th century. Researchers made an assumption that criticality identified in the time series studied may point at a potential for major disturbances in the electoral behavior:

...As indicated by the fallout from the Lehman collapse [crisis of 2008] and the severe deflationary economic downturn in Japan, the buildup of discrepancies in the basis of Japanese society is reaching an extreme level. In order to break free from this stagnant era and open up future prospects, new strategy for social change is needed. Currently, the country is approaching a dramatic transition from the state of social change that has existed up until now... to a state of real criticality, the most probable for social change. (Shimada & Koyama, 2015, p. 348).

Many works demonstrate that criticality is inherent to humans not only on the social, but also on the physiological level. Beggs and Timme (2012) explored the hypothesis that electrical activity of neural networks in the brain is critical. This article, composed as a classical dialogue, sets forth numerous pros and cons for this assumption. An earlier paper by Beggs (2008) also suggests that networks of neurons may be operating near a critical point. Hesse and Gross (2014) believe that the theory of Self-Organized Criticality offers the most accurate and promising explanation of criticality in human brain functions.

3. Material

The objects of this study were Facebook groups that were selected based on ratings by the Socialbakers social media analysis tool (<https://www.socialbakers.com/>) as of June 28, 2019. The list included 100 French and 100 German 'daily news' Facebook groups with the highest numbers of members in their respective countries.

The rationale behind the choice of objects was as follows. Firstly, as a rule, political mobilization is connected to a high level of engagement in the discussion of the political agenda that dominates newswires.

Secondly, Germany and France are convenient options for comparison. The mechanisms and indicators of political mobilization in these countries are likely to be rather similar, but the levels of mobilization over the studied period were different. In France, the Yellow Vests movement is an obvious manifestation of the higher level of political mobilization.

Group activity on social media generates several time series, such as the number of likes, views, visits etc. In this study, we decided to use daily reposting activity as

source material. Such series consist of numbers such as the total number of reposts made by users (both group members and other users) over a specific day. We took into account only reposts of messages published on the group page.

A repost is an elementary and basic act of reflection online, and is a sign that the message was perceived by a user and replicated to other users. By means of reposting, users create information channels that build group reflection. Reposting activity develops group beliefs, and at the same time allows groups to influence their members' opinions and behavior.

It follows from SOC theory that criticality is born out of the ability of numerous elements to influence each other, creating causal loops in the process. In terms of social media, this characteristic may be defined as reflexivity, where the most important act of reflexivity is a repost. We therefore believe that reposting activity produces time series that can be subjected to spectral analysis in order to identify the presence or absence of pink noise and criticality.

Reposting statistics obtained using the popsters.ru service are available online at <http://ineternum.ru/mobil-1/> (or supplementary file `initial-data.xlsx`). The data contained short gaps (90% of the gaps were between one and two days long), which were reconstructed using linear trends built over the previous five days. We chose not to reconstruct longer continuous gaps, as they did not impede the analysis of rather long series.

4. Methods and Techniques

To identify pink noise (and, consequently, to build a hypothesis about the presence of SOC in a system) we conducted spectral analysis of the time series. If a spectrogram (Figure 1B) shows a power trend, then the power law exponent allows the series/process/signal to be classified as pink noise. In the power trend equation (1), f is the frequency, S is the power, and α is the power law exponent:

$$S \sim \frac{1}{f^\alpha} \quad (1)$$

Bak showed that in the case of pink noise, α may be in the range 2 to 0 (Bak 1996, p. 22). As α approaches 2, the pink noise gradually transforms into red, and as it approaches 0 it hypothetically becomes white noise. The power law exponent therefore allows the precise identification of pink noise. Figure 1B depicts a pink noise spectrogram.

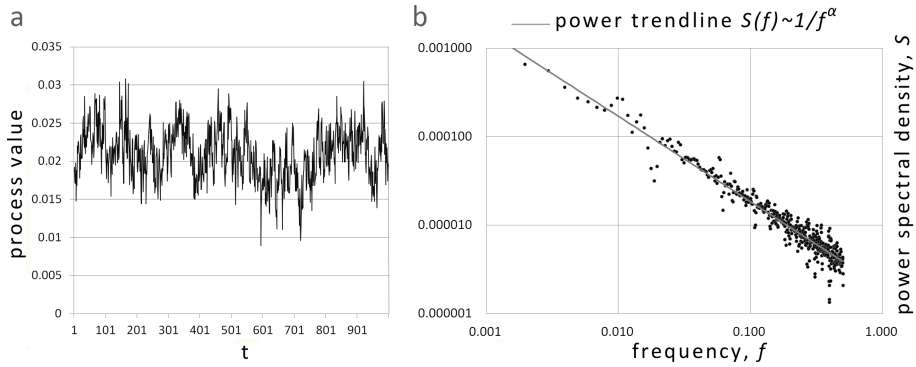


Figure 1. An example of pink noise (a) and its spectrogram in a logarithmic space (b)

The R^2 tool was used to verify the trend and the value of α . The closer R^2 is to 1, the more accurately the trend line approximates the data.

We conducted spectral analysis with help of Statistica 12 software (using the “Spectral (Fourier) analysis” module) with the following settings: pad length to power 2, subtract mean, detrend, no data smoothing.

5. Results

Tables 1 and 2 show the values of α for the studied groups from Germany and France. We highlight the values that allow for the most accurate identification of pink noise. In these tables, the values of $\alpha > 0.7$ and $R^2 > 0.4$ are highlighted in gray. Examples of spectrograms can be found in Figure 2.

Table 1. Power law exponent in spectrograms (source data: reposting activity in Facebook groups, France)*

	Group	Members	URL: https://www.facebook.com /...	α	R^2
1	Le Monde	4 377 53 5	...lemonde.fr/	0.78 3	0.48 5
2	Le Parisien	3 214 95 3	...leparisien/	0.74	0.44 1
3	Le Figaro	3 161 81 0	...lefigaro/	0.59 2	0.50 4

	Group	Members	URL: https://www.facebook.com /...	α	R^2
4	20 Minutes	2 848 697	...20minutes/	1.083	0.71
5	L'Express	2 550 585	...LExpress/		
6	Epoch Times Paris	1 289 328	...EpochTimesParis/	0.841	0.613
7	BuzzFeed France	1 079 019	...BuzzFeedFrance/		
8	Mediapart	1 052 036	...Mediapart.fr/	0.751	0.598
9	Yahoo Actualités	1 050 506	...yahooactualites/	0.494	0.369
10	Le Monde diplomatique	1 045 344	...lemondediplo/	-0.04	0.009
11	Le HuffPost	1 024 134	...LeHuffPost/	1.234	0.660
12	Loopsider	894 575	...Loopsider/	0.127	0.024
13	Libération	887 546	...Liberation/	0.599	0.393
14	Oumma.com	874 561	...oummacom/	0.012	0.001
15	Les Echos	824 949	...lesechos/	0.538	0.399
16	l'Humanité	762 070	...humanite.fr/	0.321	0.169
17	NN	738 261	...NNoff/	-0.03	0.010
18	LA VDN par La Voix du Nord	663 301	...lavdn.lavoixdunord/	0.867	0.45
19	Ouest France	626 868	...ouestfrance/	0.735	0.458

	Group	Members	URL: https://www.facebook.com /...	α	R^2
20	La Provence	560 348	...laprovence/	0.94 5	0.44 8
21	Nice-Matin	424 715	...Page.NiceMatin/	0.21	0.3
22	SudOuest.fr	314 720	...journalsudouest/	1.03 4	0.78 3
23	Le Dauphiné Libéré	311 790	...ledauphinelibere/		
24	L'Internaute	268 193	...linternaute/	-0.21	0.08 5
25	Le Monde Politique	249 604	...lemonde.fr.politique/	0.55 2	0.37 2
26	Planet.fr	245 302	...planet.fr/	0.20 2	0.08 8
27	Var-Matin	235 403	...Page.VarMatin/	0.24 6	0.35 9
28	Le Progrès	230 559	...leprogres/	0.62 3	0.34 6
29	L'Est Républicain	229 373	...estrepublikain/	0.84 5	0.59 1
30	L'Union	219 155	...journal.lunionlardennais/	1.14 7	0.79 4
31	Le Télégramme	203 974	...letelegramme/		
32	Courrier picard	200 724	...lecourrierpicard/	0.63 1	0.40 3
33	Paris-Normandie	199 240	...parisnormandie/	0.47 7	0.23 7
34	Le saviez-vous?	186 998	...LSVInfo/		
35	Le Monde Afrique	182 313	...LeMondeAfrique/	0.37 1	0.20 4
36	Journal L'Alsace	181 148	...lalsace.fr/	0.96 3	0.60 6

	Group	Members	URL: https://www.facebook.com /...	α	R^2
37	Les Echos Start	180 828	...LesEchosStart/	0.29 2	0.15 1
38	Anadolu Agency- FR	177 107	...anadoluagencyfr/	0.47 1	0.33 5
39	LE REPUBLICAIN LORRAIN	174 821	...republicainlorrain/	0.49 4	0.33 8
40	Midi Libre	174 712	...midilibre/	0.38 2	0.34 9
41	La Dépêche du Midi	172 580	...ladepechedumidi/	-0.02	0.01 0
42	76 actu	169 634	...76actu/	0.56 6	0.27 2
43	Actu Toulouse	168 217	...actutoulouse/	0.68 6	0.43 4
44	Boulevard Voltaire	167 749	...bvoltaire.fr/	0.19 5	0.09 9
45	Le Parisien 75 - Paris	165 370	...Le.Parisien.75.Paris/	0.03 8	0.00 3
46	Charente Libre	164 223	...Charentelibre16/	0.35 2	0.28 7
47	Révolution Permanente	163 039	...RevolutionPermanente.fr/	0.31	0.13 7
48	La République du Centre	158 836	...republiqueducentre/	0.42 8	0.40 2
49	Météo Languedoc	140 639	...MeteoLanguedoc/	0.55 1	0.54 4
50	Le Journal du Siècle	131 011	...LeJournalduSiecle/	0.22 5	0.06 9
51	Le Monde Campus	126 095	...lemonde.fr.campus/	-0.05	0.00 9
52	Russia Beyond	117 653	...larussiedaujourhui/	0.37	0.37

	Group	Members	URL: https://www.facebook.com /...	α	R^2
	the Headlines FR, RUSSIA			7	9
53	JDD	116 632	...leJDD/	0.24 3	0.08 8
54	Le Populaire du Centre	107 088	...populaireducentre/	0.88 1	0.60 8
55	La Voix du Nord Arras	98 649	...lavoixdunord.arras/	0.44 8	0.42 4
56	Sudouest.fr Dordogne	91 517	...Sudouestfr-Dordogne- 250200455064681/	0.47 1	0.30 9
57	Kabyle.com	91 067	...kabylecom/		
58	Ouest France Etudiant	89 622	...OFEtudiant/	0.01 4	0.00 1
59	Journal La Croix	88 117	...lacroix.journal/	0.04 8	0.09 3
60	The Local France	80 705	...thelocalfrance/	0.31 1	0.16 6
61	BuzzFeed France News	80 611	...BuzzFeedFranceNews/		
62	Atlantico.fr	78 239	...atlantico.france/	0.42 4	0.19 3
63	Monkey	78 191	...Monkeyfr/		
64	Nord Littoral	75 880	...nordlittoralcalais/	0.75 1	0.47 1
65	Angers Info	74 841	...angersinfo/	0.15 3	0.07 9
66	Le Bien Public	74 023	...BienPublic21/	0.17 9	0.11 3
67	Ouest-France Rennes	66 552	...OuestFranceRennes/	0.77 6	0.49 4
68	La Nouvelle	66 068	...lanouvellerepublique/	0.71	0.47

	Group	Members	URL: https://www.facebook.com /...	α	R^2
	République			1	5
69	Investir	65 538	...Investir.fr/	0.21 8	0.1
70	Contrepoints	58 359	...Contrepoints/	0.09 6	0.01 8
71	Le Muslim Post	57 603	...LeMuslimPost/	-0.16	0.04 8
72	Ouest-France Vannes	56 585	...OuestFranceVannes/	0.00 6	0.00 2
73	Vosges Matin	56 035	...vosgesmatin/	0.95 7	0.48
74	Sudouest.fr Charente- Maritime	55 543	...SOCharenteMaritime/	0.46 7	0.30 1
75	Sudouest.fr Bordeaux	54 167	...sobordeaux/	0.36 7	0.30 6
76	La Voix du Nord Valenciennes – Denain	53 356	...VDNvalenciennes/	0.66 7	0.51 4
77	La Nouvelle République Indre- et-Loire	49 158	...lanouvellerepubliqueindre etloire/	0.17 4	0.07 4
78	Le Maine Libre	47 664	...lemainelibre/	0.52	0.34 6
79	La Voix du Nord Dunkerque	47 266	...lavoixdunord.dunkerque/	0.20 7	0.15
80	Ouest-France Caen	46 889	...ouestfrance.caen/	0.36 7	0.21 8
81	La Voix du Nord Lens	46 458	...lavoixdunord.lens/	0.37 2	0.23 8
82	La Voix du Nord Lille	45 883	...lavoixdunord.lille/	-0.15	0.08 4

	Group	Members	URL: https://www.facebook.com /...	α	R^2
83	Le Courrier de l'Ouest	45 837	...courrierdelouest/	0.57 4	0.40 3
84	La Voix du Nord Boulogne	43 499	...lavoixdunord.boulogne/	0.10 2	0.01 4
85	Ouest-France Nantes	41 656	...ouestfrancenantes/	0.07 4	0.00 7
86	Sudouest.fr Pays Basque	39 974	...sudouest.paysbasque/	0.14 1	0.02 6
87	La Nouvelle République Loir-et-Cher	37 654	...lanouvellerepubliqueloiretcher/	0.50 8	0.24 4
88	La Voix du Nord Douai	37 483	...lavoixdunord.douai/	0.31 1	0.14 3
89	SudOuest.fr Landes	35 848	...sudouest.landes/	0.24 2	0.10 7
90	Les Echos Executives	34 403	...ExecutivesLesEchos/	0.17 4	0.06 5
91	La Voix du Nord rédaction Cambrai	32 586	...lavoixdunord.cambrai/	0.34	0.22 7
92	La Nouvelle République Vienne	32 533	...lanouvellerepubliquevienn e/	0.34 4	0.14 6
93	swissinfo.ch en français	31 998	...swissinfochenfrancais/	0.03 1	0.00 2
94	Ouest-France Brest	31 632	...ouestfrancebrest/	0.43 2	0.26 1
95	Les Echos Entrepreneurs	31 473	...LesEchosEntrepreneurs/	0.20 5	0.06 2
96	La Voix du Nord Saint-Omer	31 241	...lavoixdunord.saintomer/	0.64 4	0.52 3
97	Presse Océan	31 052	...PresseOcean/	0.50 3	0.29 7

	Group	Members	URL: https://www.facebook.com/ /...	α	R^2
98	La Voix du Nord Béthune	30 826	...lavoixdunord.bethune/	-0.01	0.00 1
99	Courrier Picard - édition de Haute- Somme	30 429	...CourrierPicardHautePicar die/	0.23 3	0.12 1
100	La Voix du Nord Maubeuge	30 321	...lavoixdunord.maubeuge/	0.33 5	0.22 7

* *Note:* in Tables 1 and 2, some groups were excluded from the analysis due to significant gaps in the daily data (over two thirds of the studied period).

Table 2. Power law exponent in spectrograms (source data: reposting activity in Facebook groups, Germany)

	Group	Members	URL: https://www.facebook.com/ ...	α	R^2
1	Der Postillon	2 854 481	...DerPostillon/	0.107	0.016
2	Bild	2 509 210	...bild/	0.849	0.454
3	DW News	2 232 676	...deutschewellenews/	-0.12	0.195
4	SPIEGEL ONLINE	1 584 147	...spiegelonline/	0.485	0.384
5	WELT	997 676	...welt/	0.286	0.263
6	ZEIT ONLINE	885 797	...zeitonline/	0.607	0.422
7	FOCUS Online	815 564	...focus.de/	0.533	0.801
8	WetterOnline	761 231	...wetteronline/	0.36	0.146
9	Süddeutsche Zeitung	752 437	...ihre.sz/	0.247	0.192
10	Stern	747 702	...stern/	0.371	0.224
11	Gut für Mich	630 885	...GutFuerMich/	0.08	0.054

	Group	Members	URL: https://www.facebook.com/ ...	α	R^2
12	Deutschland.de	574 322	...deutschland.de/	-0.02	0.001
13	Frankfurter Allgemeine Zeitung	537 534	...faz/	0.3	0.314
14	FOCUS Online Politik	533 251	...FOCUSOnlinePolitik/	0.453	0.260
15	BuzzFeed Deutschland	477 006	...BuzzFeedDeutschland/	-0.06	0.015
16	DIE ZEIT	475 980	...diezeit/	0.026	0.002
17	DER SPIEGEL	462 456	...DerSpiegel/	0.45	0.265
18	BILD News	460 117	...BILDnews/	0.65	0.339
19	t-online.de	366 205	...tonline.de/	0.573	0.499
20	FOCUS Online Finanzen	356 846	...FOCUSOnlineFinanzen/	0.299	0.194
21	SPIEGEL International	315 596	...spiegelinternational/		
22	Business Insider Deutschland	306 001	...Business.Insider.Deutschland/	0.144	0.103
23	taz	288 564	...taz.kommune/	0.204	0.124
24	wetter.de	278 660	...wetter.de/	0.314	0.092
25	Berliner Morgenpost	261 493	...morgenpost/	0.641	0.287
26	Handelsblatt	240 037	...handelsblatt/	0.239	0.302
27	EXPRESS	240 014	...EXPRESS.Koeln/	0.254	0.159
28	inFranken.de	231 867	...inFranken/	0.713	0.601
29	Berliner Zeitung	200 524	...berlinerzeitung/	0.428	0.288
30	FOCUS Online Digital	192 283	...FOCUSOnlineDigital/	0.393	0.315
31	t-online.de	176 146	...tonline.wetter/	0.131	0.032

	Group	Members	URL: https://www.facebook.com/ ...	α	R^2
	Wetter				
32	Hamburger Morgenpost	171 861	...hamburgermorgenpost/	0.4	0.465
33	RP ONLINE	163 071	...rponline/	0.645	0.461
34	Deutscher Wetterdienst	162 962	...DeutscherWetterdienst/	0.242	0.160
35	BILD am SONNTAG	162 240	...BamS/	0.034	0.008
36	Tagesspiegel	150 910	...Tagesspiegel/	0.518	0.324
37	KSTA	146 666	...ksta.fb/	0.889	0.648
38	JUNGE FREIHEIT	135 184	...jungefreiheit/	0.3	0.128
39	BILD Mallorca	135 108	...BILD.Mallorca/	-0.06	0.004
40	der Freitag	132 751	...derfreitag/	0.302	0.193
41	WAZ	132 144	...waz/	0.518	0.382
42	B.Z.	127 839	...B.Z.Berlin/	0.444	0.506
43	Hamburger Abendblatt	124 107	...abendblatt/	0.456	0.32
44	Mitteldeutsche Zeitung	120 342	...mzwebde/	0.599	0.389
45	Nürnbergischer Nachrichten	119 453	...Nuernberger.Nachrichten. Online/	0.676	0.545
46	Thüringen24	116 378	...thueringen24/	0.185	0.089
47	BILD Hamburg	114 104	...bild.hamburg/	0.293	0.237
48	The Local	113 224	...TheLocalGermany/	0.163	0.053
49	Augsburger Allgemeine	112 061	...AugsburgerAllgemeine/	0.162	0.048
50	Freie Presse	107 915	...freiepresse/	0.17	0.204
51	TAG24 Dresden	105 674	...tag24.dresden/		

	Group	Members	URL: https://www.facebook.com/ ...	α	R^2
52	news38.de	105 340	...news38.de.funke/	0.29	0.117
53	LVZ Leipziger Volkszeitung	103 991	...lvz.de/	1.143	0.555
54	Nachrichten aus Schleswig- Holstein	101 963	...shzonline/	0.362	0.27
55	stuttgarter- nachrichten.de	100 663	...stuttgarternachrichten/	0.844	0.586
56	Ostsee-Zeitung	99 687	...Ostseezeitung/	0.872	0.464
57	Deutsche Wirtschafts Nachrichten	97 846	...DeutscheWirtschaftsNachrichten/		
58	Frankfurter Rundschau	92 554	...FrankfurterRundschau/	0.404	0.183
59	HNA	91 848	...HNA/	-0.02	0.002
60	stuttgarter- zeitung.de	91 758	...stuttgarterzeitung/	0.639	0.384
61	ISPO	90 123	...ispo.acceleratingsports/	0.04	0.004
62	Badische Zeitung	89 095	...badischezeitung.de/	0.052	0.012
63	Mein München	80 554	...focusmuenchen/	-0.05	0.007
64	Lübecker Nachrichten Online	78 832	...LNOnline/	0.773	0.5
65	Nürnberger Zeitung	78 602	...nuernberger.zeitung/	0.927	0.57
66	WELT KOMPAKT	78 216	...weltkompakt/		
67	Westfälische Nachrichten	76 256	...wnonline/	0.564	0.411
68	Heilbronner	75 243	...HeilbronnerStimme/	0.759	0.548

	Group	Members	URL: https://www.facebook.com/ ...	α	R^2
	Stimme				
69	Mannheimer Morgen	74 673	...mannheimer.morgen/	0.295	0.166
70	Sächsische.de	74 104	...saechsische.de/	0.189	0.068
71	Berliner Kurier	73 916	...bkurier/	0.375	0.278
72	TA Thüringer Allgemeine	72 573	...thueringerallgemeine/		
73	Mallorca Zeitung SPAIN,	70 290	...MallorcaZeitung/	0.536	0.305
74	RUHR24 Dortmund	67 816	...RUHR24.Dortmund/	0.454	0.296
75	rosenheim24	66 469	...rosenheim24/	0.32	0.178
76	WESER-KURIER	65 252	...WESER.KURIER/	0.407	0.277
77	Ruhr Nachrichten	65 080	...RuhrNachrichten/	0.276	0.124
78	General-Anzeiger Bonn	64 907	...gaonline/	0.731	0.455
79	Neues Deutschland	63 965	...neuesdeutschland/	0.203	0.124
80	DIE RHEINPFALZ	63 356	...rheinpfalz/	0.026	0.027
81	svz.de - Nachrichten aus Mecklenburg-Vorpommern	62 950	...svzonline/	0.353	0.156
82	Merkur.de	62 501	...merkuronline/	0.606	0.422
83	Saarbrücker Zeitung	62 166	...saarbrueckerzeitung/	0.337	0.142
84	Nordkurier	61 720	...Nordkurier/	0.652	0.472
85	Kieler	61 390	...kielernachrichten/	0.607	0.635

	Group	Members	URL: https://www.facebook.com/ ...	α	R^2
	Nachrichten				
86	Mannheim24	61 089	...mannheim24/	0.127	0.044
87	Allgemeine Zeitung	61 059	...allgemeinezeitung/	0.352	0.349
88	Neue Westfälische	61 047	...NeueWestfaelische/	0.55	0.578
89	NWZonline	59 886	...nwzonline/	0.209	0.088
90	Abendzeitung München	59 849	...abendzeitung.muenchen/	0.035	0.013
91	Mittelbayerische	59 833	...mittelbayerische/	0.084	0.016
92	Heidelberg24	58 885	...heidelberg24/	0.086	0.016
93	tz München	57 754	...tzmuenchen/	0.427	0.27
94	Schwäbische	55 729	...schwaebische.de/	0.188	0.301
95	ka-news.de	55 642	...kanews.de/	0.113	0.018
96	BILD Politik	54 110	...BILDpolitik/	0.697	0.455
97	Rhein-Zeitung	53 686	...rheinzeitung/	0.129	0.086
98	BILD Dresden	53 078	...dresdenbild/	0.089	0.03
99	lokal.de	51 543	...lokal.de/	0.422	0.343
100	Rhein-Neckar-Zeitung	49 404	...RheinNeckarZeitung/	0.003	0.001

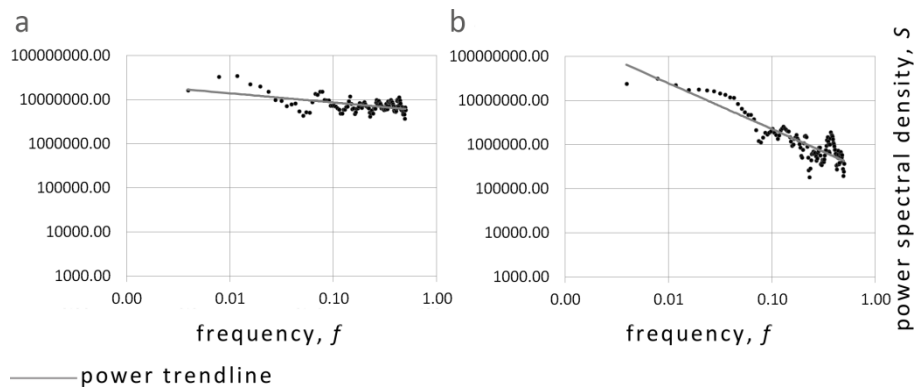


Figure 2. Spectrograms of reposting activity in Facebook groups between 02.01.2019 and 30.06.2019. (a) *Nice-Matin*, $\alpha = 0.21$, $R^2 = 0.2995$; (b) *SudOuest.fr*, $\alpha = 1.034$, $R^2 = 0.7829$.

6. Discussion

The top positions in Tables 1 and 2 are mainly taken by Facebook groups run by major national news agencies; followers of such groups are focused on nationwide agendas. The top of the French list is dominated by groups that display strong signs of pink noise. This is as expected, as the Yellow Vests movement continued their actions in France over the studied period, despite a certain slowdown. Large-scale protest activities are accompanied by massive political mobilization, including the increased willingness by citizens to discuss nationwide problems.

In Germany, only one group from the top of the list demonstrated pink noise (Table 2).

The middle and bottom parts of the list contain a significant number of local news agencies, which have fewer members. In the German list, pink noise is only found in regional groups, with one exception. This indicates that members of these groups are more engaged in discussion around regional issues, or tend to use local platforms to exchange opinions on a wide range of issues. We can assume that political mobilization in Germany primarily drives regional-level activism.

Conclusion

Our findings suggest the following. A significant number of Facebook groups dedicated to the nationwide agenda in France generated pink noise, and apparently were in a state of SOC in the first six months of 2019. This is most likely to be related to a high level of political mobilization within French society. Over the same period, pink noise was also demonstrated in Germany, with the exception of groups focused on regional information.

A description of an SOC-system in SOC theory can be interpreted as a set of features of a social group with a high level of engagement from its members. This is an essential characteristic of political mobilization. Of course, users may also show high engagement when discussing movies or football, but we studied social media groups in which the debate was likely to be focused on the political agenda. We therefore believe that the presence of pink noise in such groups may flag a high level of political mobilization.

SOC theory is an efficient tool to monitor political mobilization on social media, and also a very convenient tool. The key indicator of mobilization is α , and its value can be calculated exactly based on publicly available statistics for different periods of time.

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Supplementary Material

The replication files are available at <http://ineternum.ru/mobil-1/> (or supplementary file initial-data.xlsx).

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