5th International Conference on Advanced Research Methods and Analytics (CARMA2023)
Universidad de Sevilla, Sevilla, 2023
DOI: http://dx.doi.org/10.4995/CARMA2023.2023.16470

Exploring expert opinion on climate policy using Twitter

Enrico Bergamini[1], Ivan Savin[2], Jeroen van den Bergh[2,3,4]
[1]Department of Economics and Statistics "Cognetti de Martiis", Università di Torino, Italy, [2] Institute of Environmental Science and Technology, Universitat Autònoma de Barcelona, Spain, [3] ICREA, Barcelona, Spain, [4] School of Business and Economics & Institute for Environmental Studies, Vrije Universiteit Amsterdam, The Netherlands.

Abstract

We study online conversations about climate policy by building a novel dataset of around 100,000 tweets and tweet threads by climate policy scientists. This data is complemented with information about the scientific affiliation and production of scientists. We undertake an exploratory analysis of the content of tweets by means of Natural Language Processing. In addition, we study the relationship between tweet content and academic background. This indicates that economists and political scientists are the most active in discussing climate policy on Twitter. We further find that the policy instruments receiving most attention are cap-and-trade and carbon taxation.

Keywords: *climate policy; carbon price; scientometrics; social media; topic modelling.*

1. Introduction

Insights and views of scientists nowadays appear not only in academic publications and popular science but increasingly in social media. This also holds true for the theme of climate policy. In this study we examine conversations on Twitter, the most important platform for scientists, and match this to data on academic production. Scientists' presence and influence on social media has received considerable attention in recent years. Researchers have many incentives to use social media: getting informed or informing others about recent data, findings and publications, staying updated about planned conferences and workshops, debating topical issues in political reality or themes in their scientific field, and exchanging ideas with journalists, policymakers, environmental NGOs and the general public (Howoldt et al. 2023).

Many scientists choose Twitter over other social media, which affirms its role as a medium for experts, journalists and politicians to meet and engage in public conversation (Della Giusta et al.; Greetham 2021). For these reasons, Twitter has proven to be a good tool for exploring public and élite opinion about relevant phenomena (Bollen et al. 2011). Recent efforts have quantified behaviour and characteristics of scholars with social media data, raising opportunities for new instruments in scientometrics (Sugimoto et al. 2017a). Twitter has been used as a resource to study quantitatively the interaction between scientific production and social media uptake and engagement of academics (Howoldt et al. 2023). Next to promoting scientific work within the community and popularise it among a broader audience, scientists engage and learn from their communities and peers. An emerging literature is studying scientific sub-communities on Twitter. Côté and Darling (2018) found that most Twitter interactions by scientists are directed at other scientists. Della Giusta et al. (2021) compare the behaviour and communication of top economists vis-à-vis natural scientists. They find that the communities tend to behave in different ways: while economists explain more and engage less, natural scientists care more about communicating with the general public. Another study by Khandelwal and Tagat (2021) instead examines the communication of development researchers by combining Twitter and survey data. Bisbee et al. (2022) study the network of political scientists on Twitter with a focus on the United States. All these studies show that observing online networks and conversations can help provide evidence on knowledge diffusion as well as on different characteristics of scientific communication (Alperin et al. 2019; Howoldt et al. 2023).

However, an open challenge to studying scientific interactions on social media is a precise identification of accounts belonging to scholars. Recent work (Mongeon et al. 2022) addresses this gap, making a large-scale dataset of academics available. This allowed connecting academics from a large range of fields to their social media accounts. Researchers have employed Twitter data to track public opinion on a variety of climate issues: from polarization (Jang and Hart 2015) through misinformation (for a review see Treen et al. 2020) to social movements (Chen et al. 2022; Thorson and Wang 2020) and COP meetings (e.g.

Pearce et al. 2014; Hopke and Hestres 2018; Sanford et al. 2021). Jang and Hart (2015) study the polarization in climate change narratives among the general public by employing big data from Twitter. Cody et al. (2015) analysed public opinion about climate change, linked to events like climate disasters and legislation. Veltri and Atanasova (2017) studied the climate-change discourse on Twitter, mapping a sophisticated and complex information ecosystem around climate change, more nuanced than other studies would suggest. Another study investigates climate policy debates: Wei et al. (2021) explore the networks of accounts and conversations about the European Union's Emissions Trading System (EU-ETS), finding a prominent role of government officials and industry practitioners, and a focus on policies, legislations, prices and allocation.

While many scholars have put great effort in collecting (big) datasets (Effrosynidis et al. 2022) and studying climate change public opinion on Twitter, other studies have focused on specific subsets of users. Vu et al. (2020) studied the networks of climate NGOs on Twitter, highlighting the role of climate opinion leaders. They quantify the importance of network centrality in opinion leadership and suggest a strong Global North versus South division. Almironet al. (2022) study the network of think-tanks with contrarian stances on climate change in Europe, and their ties to the United States. Goritz et al. (2022) study the online presence in terms of climate policy of International Organizations, also employing Twitter data. Walteret al. (2019), instead, focus on scientists and climate change communication using network analysis on Tweets. They provide fascinating evidence on the varying communicative strategies of scientists when debating with different types of accounts (journalists, politicians, other scientists).

In this study, we focus the attention on opinions of scientists about climate policies. Earlier, Drews et al. (2023) and Savin et al. (2023) conducted an online survey among researchers who published on the topic of climate policies in the last five years finding that direct regulation is the most favoured type of instrument in a policy mix, while carbon tax and carbon market face more resistance from scientific field like political science, agriculture and sustainability transition. However, this study had a low response rate (less than 5%) and could not assure that all disciplines were properly covered. In the present paper we aim to expand this earlier work by analysing a much larger sample of scientific experts on climate policy, to verify previous conclusions and obtain additional insights about the main differences among scientists regarding opinions about climate policy.

We study the content of tweets using Natural Language Processing (NLP). To our knowledge, no study has comprehensively mapped scientific communication on social media specifically looking at climate policies. We fill this gap by collecting a large dataset of tweets about climate policies written by scientists. We add to two streams of literature: the one studying scientists' social media presence, and the other exploring climate discourse on social media. Our motivation stems from the importance of understanding scientific communication

and consensus as well as potential controversies about climate policies. Understanding expert opinions on climate policy may provide additional evidence for the support of decarbonisation policies (Drews and van den Bergh 2016). Furthermore, we add evidence and nuance by linking information about academic characteristics to tweets about climate policies.

2. Data and method

To answer the questions posed in the previous section, we build a novel database of Tweets around climate policies. We isolate specifically the subset of tweets made by scientists. We start by collecting from Tweets from the Twitter Academic API, corresponding to the keyword search based on Drews et al. (2023). This set of keywords identifies climate policy by focusing on a set of known instruments (carbon taxing, cap-and-trade, etc). The resulting database comprises 9.2 million tweets from 1.5 million accounts during the period 2007 to 2022. To assess which accounts belong to scientists, we rely on Mongeon et al. (2022) who created an algorithm to match known databases of scientists from all disciplines with Twitter accounts. This resulted in an open-access database of around 500,000 scientists matched with Twitter account ID's. In order to complement this information, we reconstruct the full database used in their paper by querying OpenAlex for information about scientists' main scientific field, affiliation, and academic performance metrics (e.g. number of publications and citations).

We merge the two databases, obtaining information about which tweets belonged to scientists in the Twitter database. This indicates they contributed to 4% of total tweets, namely 360,000 tweets out of 9.2 million tweets in total (i.e. corresponding to the search query). Note that this excludes non-English tweets, retweets and replies to other users from the sample. Threads are also a popular instrument on Twitter. They are chained tweets to overcome the character limit of a single tweet (280 characters). They allow for a more elaborate explanation of a scientific idea. Therefore, we include them and treat them as if they were single extended tweets. In terms of users, we find around 13,000 unique Twitter accounts belonging to scientists that we can match to the database of Mongeon et al. (2022).

3. Preliminary results

3.1 Descriptive statistics

The resulting dataset, cleaned for non-English tweets and replies, comprises 71620 tweets and 8565 threads, resulting in a total of 80185 unique observations, written by 13093 scientists. Table 1 shows the volume and percentage of Tweets by main academic discipline. The breakdown of disciplines follows that of OpenAlex which is based on Wikidata ontology (see also Mongeon et al. 2022).

The table shows that economists tweet relatively much compared to other scientists, accounting for a fifth of the total number of tweets. Economists also write relatively many threats.

Table 1. Distribution of tweets, accounts and threads by discipline

Field	**Tweets**		**Scientists**		**Threads**	
	volume	**%**	**number**	**%**	**volume**	**%**
Political science	15792	19.69	2445	18.63	1331	15.54
Economics	15697	19.58	1323	10.08	2164	25.27
Biology	15277	19.05	2900	22.10	1367	15.96
Non classified	8232	10.27	1153	8.79	963	11.24
Psychology	3405	4.25	681	5.19	528	6.16
Physics	2912	3.63	467	3.56	469	5.48
Computer science	2828	3.53	738	5.62	238	2.78
Business	2709	3.38	468	3.57	222	2.59
Environmental science	2390	2.98	350	2.67	289	3.37
Medicine	2358	2.94	729	5.55	160	1.87
Geology	2250	2.81	329	2.51	177	2.07
Engineering	1926	2.40	247	1.88	347	4.05
Geography	1561	1.95	382	2.91	84	0.98
Philosophy	760	0.95	189	1.44	98	1.14
Sociology	563	0.70	182	1.39	15	0.18
Mathematics	529	0.66	142	1.08	54	0.63
Chemistry	344	0.43	153	1.17	15	0.18
History	338	0.42	128	0.98	29	0.34
Art	250	0.31	87	0.66	8	0.09
Materials science	64	0.08	31	0.24	7	0.08

To explore the content of tweets, we perform a cleaning and pre-processing as is common in studies using NLP. In order to further explore the dataset, we analyse the content of tweets. We rely on BERT language models based on word embeddings, as proposed by Grootendorst (2022). Topic modelling uses word distributions across documents to extract latent topics for each document. We estimate a baseline topic model to cluster scientists' tweets about climate policies. Figure 1 shows a semantic map of the topics derived. Each tweet is a dot on the map, while the coloured clusters are topics. Although the total number of topics is 93, the figure depicts labels for the top 25 topics in terms of overall volume. Visual inspection indicates a prevalence of two instruments in the debate, namely carbon taxation and cap-and-trade. Due to a focus on English-only tweets, there is a bias towards national debates in Australia, Canada, and the United States. A specific cluster about EU climate policies and the EU's emissions trading system (ETS) appears as well, which is in line with the results presented by Wei et al. (2021). Fossil fuel subsidies (10) is also a large topic, as is the general debate on energy (13). Smaller topics include trade-offs between climate policy and

economic growth (15), climate policies for housing and cities (14), and policies linked to forests (17). The evidence provided in this paper is still preliminary. Nevertheless, our results show that it is possible to identify debates on social media by scientists using large data. In a next phase we will connect the novel dataset to information about scientists' academic characteristics and activities to explore topic heterogeneity. Further analysis could exploit Structural Topic Models in order to estimate covariates for topic prevalence and formation (e.g., in terms of academic field). Content, sentiment, network and psychometric analyses will provide further insights into climate policies communication.

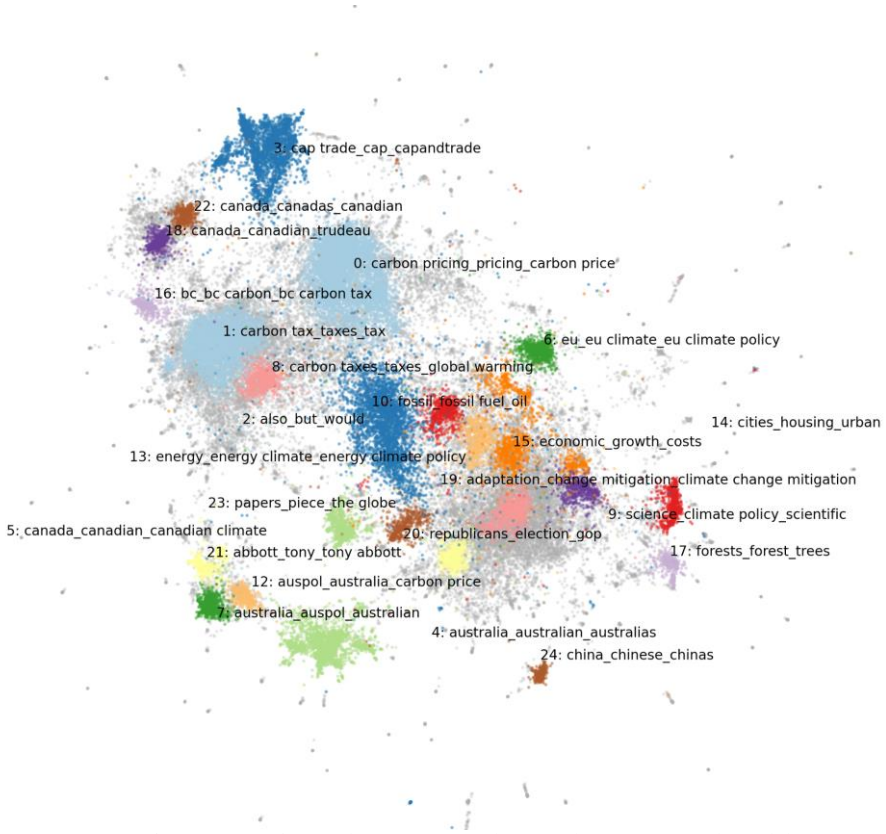

Figure 1. A semantic map of main topics of tweets by scientists on climate policy. Source: Authors elaboration

References

Almiron, N., Moreno, J. A., & Farrell, J. (2022). Climate change contrarian think tanks in Europe: A network analysis. *Public Understanding of Science*, 09636625221137815.

Alperin, J. P., Gomez, C. J., & Haustein, S. (2019). Identifying diffusion patterns of research articles on Twitter: A case study of online engagement with open access articles. *Public Understanding of Science*, 28(1), 2-18.

Bisbee, J., Larson, J., & Munger, K. (2022). #Polisci Twitter: A descriptive analysis of how political scientists use Twitter in 2019. *Perspectives on Politics*, 20(3), 879-900.

Bollen, J., Mao, H., & Pepe, A. (2011). Modeling public mood and emotion: Twitter sentiment and socio-economic phenomena. *In Proceedings of the International AAAI Conference on Web and Social Media*, 5, 450-453.

Chen, K., Molder, A. L., Duan, Z., Boulianne, S., Eckart, C., Mallari, P., & Yang, D. (2022). How climate movement actors and news media frame climate change and strike: Evidence from analyzing Twitter and news media discourse from 2018 to 2021. *The International Journal of Press/Politics*, 19401612221106405.

Cody, E. M., Reagan, A. J., Mitchell, L., Dodds, P. S., & Danforth, C. M. (2015). Climate change sentiment on Twitter: An unsolicited public opinion poll. *PloS One*, 10(8), e0136092.

Côté, I. M., & Darling, E. S. (2018). Scientists on Twitter: Preaching to the choir or singing from the rooftops? *Facets*, 3(1), 682-694.

Della Giusta, M., Jaworska, S., & Vukadinović Greetham, D. (2021). Expert communication on Twitter: Comparing economists' and scientists' social networks, topics, and communicative styles. *Public Understanding of Science*, 30(1), 75-90.

Drews, S., Savin, I., & van den Bergh, J. C. (2023). A Global Survey of Scientific Consensus and Controversy on Climate Policy (*mimeo*)

Drews, S., & van den Bergh, J. C. (2016). What explains public support for climate policies? A review of empirical and experimental studies. *Climate Policy*, 16(7), 855-876.

Effrosynidis, D., Karasakalidis, A. I., Sylaios, G., & Arampatzis, A. (2022). The climate change Twitter dataset. *Expert Systems with Applications*, 204, 117541.

Goritz, A., Schuster, J., Jörgens, H., & Kolleck, N. (2022). International public administrations on Twitter: A comparison of digital authority in global climate policy. *Journal of Comparative Policy Analysis: Research and Practice*, 24(3), 271-295.

Grootendorst, M. (2022). BERTopic: Neural topic modeling with a class-based TF-IDF procedure. *arXiv preprint* arXiv:2203.05794.

Hopke, J. E., & Hestres, L. E. (2018). Visualizing the Paris Climate Talks on Twitter: Media and climate stakeholder visual social media during COP21. *Social Media*

Howoldt, D., Kroll, H., Neuhäusler, P., & Feidenheimer, A. (2023). Understanding researchers' Twitter uptake, activity and popularity—an analysis of applied research in Germany. *Scientometrics*, 128(1), 325-344.

Ivanova, A., Schäfer, M. S., Schlichting, I., & Schmidt, A. (2013). Is there a medialization of climate science? Results from a survey of German climate scientists. *Science Communication*, 35(5), 626-653.

Jang, S. M., & Hart, P. S. (2015). Polarized frames on 'climate change' and 'global warming' across countries and states: Evidence from Twitter big data. *Global Environmental Change*, 32, 11-17.

Khandelwal, A., & Tagat, A. (2021). #DevResearch: Exploring development researchers' Twitter use for research dissemination. *Scholarly and Research Communication*, 12(1), 23-pp.

Mongeon, P., Bowman, T. D., & Costas, R. (2022). An open dataset of scholars on Twitter. *arXiv preprint* arXiv:2208.11065.

Pearce, W., Holmberg, K., Hellsten, I., & Nerlich, B. (2014). Climate change on Twitter: Topics, communities and conversations about the 2013 IPCC Working Group 1 report. *PloS One*, 9(4), e94785

Sanford, M., Painter, J., Yasseri, T., & Lorimer, J. (2021). Controversy around climate change reports: A case study of Twitter responses to the 2019 IPCC report on land. *Climatic Change*, 167(3-4), 59.

Savin, I., Drews, S., & van den Bergh, J. C. (2023). Carbon Pricing: Perceived Strengths, Weaknesses and Knowledge Gaps according to a Global Expert Survey. (*mimeo*)

Sugimoto, C. R., Work, S., Larivière, V., & Haustein, S. (2017). Scholarly use of social media and altmetrics: A review of the literature. *Journal of the Association for Information Science and Technology*, 68(9), 2037-2062.

Thorson, K., & Wang, L. (2020). Committed participation or flashes of action? Mobilizing public attention to climate on Twitter, 2011–2015. *Environmental Communication*, 14(3), 347-363.

Treen, K. M. d'I., Williams, H. T. P., & O'Neill, S. J. (2020). Online misinformation about climate change. *Wiley Interdisciplinary Reviews: Climate Change*, 11(5), e665.

Veltri, G. A., & Atanasova, D. (2017). Climate change on Twitter: Content, media ecology and information sharing behaviour. *Public Understanding of Science*, 26(6), 721-737.

Vu, H. T., Do, H. V., Seo, H., & Liu, Y. (2020). Who leads the conversation on climate change?: A study of a global network of NGOs on Twitter. *Environmental Communication*, 14(4), 450-464.

Walter, S., Lörcher, I., & Brüggemann, M. (2019). Scientific Networks on Twitter: Analyzing Scientists' Interactions in the Climate Change Debate. *Public Understanding of Science*, 28(6), 696–712.

Wei, Y., Gong, P., Zhang, J., & Wang, L. (2021). Exploring Public Opinions on Climate Change Policy in "Big Data Era"—a Case Study of the European Union Emission Trading System (EU-ETS) Based on Twitter. *Energy Policy*, 158, 112559.