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To cite this article: Alvin Zhou, Wenlin Liu & Aimei Yang (2024) Politicization of Science in COVID-19 Vaccine Communication: Comparing US Politicians, Medical Experts, and Government Agencies, Political Communication, 41:4, 649-671, DOI: [10.1080/10584609.2023.2201184](https://doi.org/10.1080/10584609.2023.2201184)

To link to this article: <https://doi.org/10.1080/10584609.2023.2201184>



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Politicization of Science in COVID-19 Vaccine Communication: Comparing US Politicians, Medical Experts, and Government Agencies

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ABSTRACT

We compare the social media discourses on COVID-19 vaccines constructed by U.S. politicians, medical experts, and government agencies, and investigate how various contextual factors influence the likelihood of government agencies politicizing the issue. Taking the political corpus and the medical corpus as two extremes, we propose a language-based definition of politicization of science and measure it on a continuous scale. By building a machine learning classifier that captures subtle linguistic indicators of politicization and applying it to two years of government agencies' Facebook posting history, we demonstrate that: 1) U.S. politicians heavily politicized COVID-19 vaccines, medical experts conveyed minimal politicization, and government agencies' discourse was a mix of the two, yet more closely resembled medical experts'; 2) increasing COVID-19 infection rates reduced government agencies' politicization tendencies; 3) government agencies in Democratic-leaning states were more likely to politicize COVID-19 vaccines than those in Republican-leaning states; and 4) the degree of politicization did not significantly differ across agencies' jurisdiction levels. We discuss the conceptualization of politicization of science, the incumbency effect, and government communication as an emerging area for political communication research.

KEYWORDS

Politicization of science;
COVID-19; social media;
government communication;
computational methods

Politicization of science is widely documented in news media, political speeches, and social media discourses on various scientific topics (Bolsen & Druckman, 2015; Chinn et al., 2020), with negative effects on the media ecosystem and the general public's understanding of scientific facts (Gauchat, 2012; Schmid-Petri, 2017). While much literature has examined its societal consequences (Druckman, 2017; Saulsberry et al., 2019), little research has focused on how various institutional communicators, such as government agencies, politicize science.

In this paper, we investigate institutional sources of politicization of science, propose a language-based definition and measurement strategy for politicization of science, and adopt a comparative perspective to examine social media discourses on COVID-19 vaccines during the global pandemic. More specifically, we consider whether, how, and to what

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 Supplemental data for this article can be accessed on the publisher's website at <https://doi.org/10.1080/10584609.2023.2201184>

degree this scientific issue has been politicized by various communicators, and use government agencies as a case study to investigate when and why they choose to politicize COVID-19 vaccines.

Focusing on three groups of institutional actors (i.e., U.S. politicians, medical experts, and government agencies) and analyzing nearly two years of their complete Facebook posting history related to COVID-19 vaccines, we document horizontal differences between institutions in Study 1. Next, in Study 2, we first construct a machine learning classifier to detect language patterns that signal politicization of science, making a methodological contribution to the literature. Then, we delve into government agencies, illustrating vertical differences within institutions by drawing insights from stakeholder theory and testing how three covariates – partisan leaning, jurisdiction levels, and COVID-19 infection rates – affect the level of politicization of COVID-19 vaccines among government agencies.

Our results reveal substantial disparities between U.S. politicians' and medical experts' social media discourses on COVID-19 vaccines, with politicians politicizing COVID-19 vaccines significantly more than the medical community. Government agencies, managing a nuanced balance between politics and medicine, constructed a mixed discourse which more closely resembled the medical corpus than the political counterpart. Our classifier achieves a relatively high accuracy in capturing subtle linguistic indicators of politicization, providing an alternative approach to quantifying politicization of sciences, content-analyzing large textual corpora, and understanding the landscape of politicization of sciences. Applying the classifier to the government communication corpus, we find that COVID-19 infection rates decreased government agencies' politicization of COVID-19 vaccines, government agencies in Democratic-leaning states were more likely to politicize COVID-19 vaccines than those in Republican-leaning states, and that jurisdiction levels did not significantly affect the level of politicization among various agencies.

Finally, we discuss 1) how the incumbency effect might have influenced our results, 2) how our computational approach to detecting politicization of science challenges existing conceptualizations and measurements of the phenomenon, and 3) how research on government communication – a less studied but extremely relevant area in political communication – can bring theoretical, methodological, and contextual diversity to the field.

Literature Review

Politicization of Science and COVID-19 Vaccines

The COVID-19 pandemic has claimed more than 6 million lives worldwide to date and brought significant changes to people's daily routines, work environments, and social realities (Giuntella et al., 2021). Since its onset in early 2020, the pandemic and the public discussion around its response policies have been characterized by sharp politicization and division along partisan lines (Arendt et al., 2022; Flores et al., 2022; Grossman et al., 2020; Shin et al., 2022; Zhou et al., 2022). It was thus not surprising that when COVID-19 vaccines were developed, the discourse about the vaccines also became highly politicized, which might have fueled vaccine hesitancy despite the growing scientific consensus on their efficacy (Bailard, 2022; Halpern, 2020; Hart et al., 2020).

Politicization of science capitalizes on the uncertainty and complexity surrounding scientific development and has detrimental downstream effects on various societal

outcomes (Bolsen & Druckman, 2015; Druckman, 2017). It is admittedly difficult to communicate science to the public when constituents' socioeconomic environments are political and polarized (Lupia, 2013). Some even contend that politicization of science is inherent in the process of public health administration (Goldberg, 2012). Politicization of science erodes general trust in science (de León et al., 2022; Gauchat, 2012), fuels misinformation and disinformation (Schmid-Petri, 2017), and undermines public perception of scientific consensus (Bolsen & Druckman, 2018). In the context of vaccine communication, politicization may directly decrease support for immunization programs (Fowler & Gollust, 2015; Saulsberry et al., 2019).

Scholars across many social science disciplines have investigated the politicization of science from various angles and proposed different conceptual frameworks and measurement strategies. For example, literature from political science and psychology examines doubt-mongering campaigns from malicious disinformation actors as contributors to the politicization of science (e.g., Druckman, 2022; Oreskes & Conway, 2011) and considers how emphasizing consensus among scientific experts can counter such efforts (e.g., Maibach & van der Linden, 2016). This line of research points to an *intention-based* definition of politicization of science: politicization happens when ill-intentioned organizations and individuals emphasize the inherent uncertainty of scientific development and coordinate to erode public trust in science (Bolsen & Druckman, 2015).

Another approach, signaled by empirical articles measuring politicization of science (e.g., Chen et al., 2022; Chinn et al., 2020), indicates an *actor-based* definition. It points to the unnecessary mentions of political actors in scientific and journalistic writing. Instead of highlighting scientists' work, this type of politicization of science emphasizes issues of governance, control, and ownership, and debates over expertise in decision-making, with most of these actors being elected officials or policymakers (Nisbet, 2009). Accordingly, studies following this approach code the presence of political actors to dichotomously classify text into "politicized" or "not politicized" (e.g., Hart et al., 2020).

The current study, as we detail later, proposes a *language-based* definition of politicization of science, considers how communicators (i.e., scientists, politicians, and third parties) frame the same issue differently, and uses the scientist-politician spectrum to measure the degree to which a piece of text is politicized. In doing so – in contrast to prior approaches (Bolsen & Druckman, 2015; Chinn et al., 2020) – we highlight that well-meaning individuals and organizations, such as scientists and research institutions, can also politicize science (unintentionally), and text mentioning political figures might not necessarily politicize science. We further review institutional sources of politicization of science below and use government agencies as a case study to illustrate our point.

Institutional Sources of Politicization of Science

A survey of existing literature on politicization of science shows that most studies have focused on its prevalence in news coverage (e.g., Chinn et al., 2020; Hart et al., 2020), its psychological and behavioral effects on the general public (e.g., Gauchat, 2012; Saulsberry et al., 2019), and its countermeasures and remedies (e.g., Bolsen & Druckman, 2015; van der Linden et al., 2018). The supply side of the equation – content producers who actively engage in the politicization process – remains under-studied and under-theorized. In other words, who is politicizing science (other than journalists)? Do they politicize science to the

same degree? If not, why do they employ politicization differently? Investigating these dynamics helps us understand its institutional sources and better design solutions to counteract those practices.

Indeed, there are reasons to believe that different institutions and actors, tailoring their content to various audiences, will employ politicization to varying degrees as a framing tool to report news, deliver messages, and persuade the public. In this study, we focus on three actors that are prominent in both COVID-19 pandemic responses and vaccine communication: political elites, medical experts, and government agencies.

Political elites, such as congresswomen and congressmen, dominated the online discourse around COVID-19 (Shin et al., 2022) and influenced public understanding of the pandemic (Flores et al., 2022). However, they also hold tremendous power in affecting partisans' collective behavior and vaccination intentions (Pink et al., 2021). With political polarization on the rise in the U.S. (Fiorina & Abrams, 2008) and most Americans lacking substantial domain knowledge to understand scientific breakthroughs, many constituents follow their partisan elites' messages to make sense of the pandemic and mRNA technologies. Many of these messages are highly politicized and lack scientific accuracy (A. Yang et al., 2021; Grossman et al., 2020; Mosleh & Rand, 2021).

Medical experts are essential sources of information in this public health crisis. They are the ones with expertise in vaccines. Studies have found that during the pandemic, most people perceive medical experts as trustworthy sources, and their messages about COVID-19 vaccines are persuasive (Flores et al., 2022). For instance, health institutions such as Johns Hopkins University and Mayo Clinic are highly regarded and trusted by the general public. These institutions are also among the first to establish COVID-19 dashboards, where they compile medical information to inform the public and brief policymakers (Santhanam, 2020). Medical experts, with scientific training and professional codes of conduct, are least likely to discuss political matters or politicize medical issues on social media (Halpern, 2020; Lupia, 2013).

Government agencies are pervasive communicators of COVID-related public policies and public health information. They routinely relay official information, connect with local communities, and provide guidelines and services related to COVID-19 vaccination. Government agencies consist of various organizations that bear distinct administrative responsibilities and directly affect residents' day-to-day lives (Park & Lee, 2018). Government communication is understudied in political communication literature. However, its effectiveness may directly affect millions of citizens' well-being (Canel & Sanders, 2012; Crozier, 2007; Horsley et al., 2010; Zhou et al., 2022). Since late 2020, government agencies have been tasked with persuading eligible citizens to get vaccinated against COVID-19. They present a variety of information to their audiences, ranging from national health providers' promotional messages, to local hospitals' instructions, to political and nonpolitical news about the pandemic. Research has shown that government agencies' messages can effectively influence risk perceptions and encourage protective behavior (Lee & VanDyke, 2015). In the current study, we pay special attention to government agencies and investigate their communication strategies regarding the politicization of science.

Focusing on these three entities – U.S. politicians, medical experts, and government agencies, we now consider why they might have communicated differently about COVID-19 vaccines. Specifically, we expect the three institutions to differ both horizontally

(between institutions) and vertically (among organizations of the same institution). Below we elaborate on these two major types of differences.

Horizontal Differences Between Institutions

All types of institutions are embedded in the larger cultural and power system, and they experience pressure to conform to the rules, traditions, and norms emanating from an organizational field (DiMaggio & Powell, 1983). An organizational field is a community of organizations that share a common meaning system (Scott, 1994). As DiMaggio and Powell (1983) argue, the convergence of practices occurs when organizations and actors are pressured to abide by laws or regulations (i.e., coercive isomorphism), mimic legitimate peers' behavior (i.e., mimetic isomorphism), or comply with the norms specific to the field (i.e., normative isomorphism). In our context, U.S. politicians are situated in the organizational field of politics, medical institutions are situated in the organizational field of science and health, and government agencies are situated in the organizational field of public administration and public affairs. They adhere to different rules, are evaluated against different standards, and exhibit different communication behavior.

A politician will communicate like other politicians who seek reelections through the system of electoral democracy. Thus, we expect politicians to frame events in political terms to seek political gains and win partisan support through their political rhetoric of public issues, pushing them toward one extreme of the "politicization of science" spectrum. Medical institutions' main objective is the physical well-being of the public (Schlesinger, 2002). The perseverance with professional standards would thus refrain them from discussing politics on social media and encourage them to use medical terms or even jargons to claim authority, pushing them toward the other end of the "politicization of science" spectrum. We propose the following hypothesis to test this difference:

H1: The discourse on COVID-19 vaccines exhibits significant divergence between U.S. politicians and medical experts.

Meanwhile, government agencies bridge the organizational fields of politics and medicine. Government agencies earn citizen trust through governance effectiveness (Feldman, 2015), and they have to manage a delicate balance between health and politics (Canel & Sanders, 2014). They are both accountable to democratic institutions and tax-paying constituents in spearheading the promotion of COVID-19 vaccines. On the one hand, as government agencies are often led by state or local politicians, their language on the pandemic might resemble that of elected officials. On the other hand, government agencies also implement health policies and are first responders of a health crisis, which necessitates the use of scientific language. To explore the extent to which government agencies mimic the discourse from the other two organizational fields, we further ask the following research question:

RQ1: Is government agencies' discourse on COVID-19 vaccines more similar to U.S. politicians' or medical experts'?

Central to the politicization of science literature is the investigation of language use in describing scientific discoveries and communicating science policies. As Gostin (2018) argued, “words have scientific meaning and social importance” and “word choices matter in public and policy discourse” (p. 541). What words are used by various actors to communicate science and how they signal various levels of politicization are essential in understanding and measuring politicization of science. However, existing approaches to the measurement of politicization of science leave room for improvement. For example, Hart et al. (2020) measured politicization of science by keyword-matching prominent political figures, an analytical strategy that could miss various signals of politicization. As such, we ask the following research question to advance our understanding of word choices in politicization of science:

RQ2: What word choices distinguish U.S. politicians’ and medical experts’ discourses on COVID-19 vaccines that signal politicization of science?

Vertical Differences Within Institution

Institutions could also be understood as a set of relationships among groups that have a stake in the activities that make up the organization (Freeman, 1994). Stakeholders are defined as any individuals or organizations that “can affect, or are affected by, the achievement of the organization’s objectives” (Freeman, 1994, p. 25). Scholars further argue that every organization should identify relevant stakeholders, organizations have the responsibility to operate in the best interest of all stakeholders, and that the approval of stakeholder groups is critical especially during crises (Freeman & Dmytriiev, 2017).

In the U.S., government agencies from the federal to local levels undertake a broad spectrum of policy implementations and service delivery (Kerwin & Furlong, 2019). During these complex operations, they come in contact with a wide range of stakeholders of their policies, such as individual constituents, local communities, interest groups, and corporations. Managing stakeholder relationships and effectively engaging with these stakeholders play a crucial role in building up support for government policies and affecting the success of such policies (Liu & Xu, 2019). Based on this general principle, we believe two areas of stakeholder research are especially relevant to the current study: stakeholder differentiation and stakeholder expectation.

In the context of COVID-19 communication, we may expect government agencies to communicate COVID-19 vaccines differently based on their jurisdiction levels (federal vs. state vs. county vs. city) and their constituents’ partisan leanings (Democratic- vs. Republican-leaning). For federal- and state-level agencies, while in theory they are responsible to all U.S. citizens and the entire state population, their job performance appraisals are often done within the national political system (Feldman, 2015). In addition, for them to carry out policies and deliver services, gaining support from major political figures, committees, and coalitions is critical. Based on stakeholder differentiation, this reality may drive federal- and state-level agencies to consider political entities – instead of medical groups – to be their primary stakeholders. On

the contrary, county- and city-level government agencies directly deal with local constituents who wield more direct power on their operations. In addition, county- and city-level government agencies' performance during the pandemic is often evaluated based on results-oriented systems such as vaccination rates in a county. In other words, county- and city-level agencies, witnessing neighborhood communities' suffering and needs during the COVID-19 pandemic, are more likely to consider local constituents as their primary stakeholders (Horsley et al., 2010), feel pressured to communicate with them (Sanger, 2008), and refrain from "playing politics" that might hurt their approval rate. As such, we propose:

H2. Federal- and state-level government agencies employ more politicization of science in communicating COVID-19 vaccines than county- and city-level government agencies.

The same logic also applies to the partisan divide in the U.S. where polarization has become a prominent political reality (Fiorina & Abrams, 2008). At the start of the pandemic, the Trump administration repeatedly denied the existence or severity of the pandemic, and a staggering partisan difference between Republicans and Democrats has since emerged with respect to public policies surrounding COVID-19 (Gollust et al., 2020; Grossman et al., 2020). While Democrats promoted science-based pandemic interventions and generally adhere to recommendations ushered by public health institutions, Republicans have consistently challenged policies such as mask-wearing, social distancing, and vaccination (Pink et al., 2021; Shin et al., 2022), by amplifying elite voices that politicized the pandemic (Gostin, 2018; Halpern, 2020). Therefore, for government agencies whose primary stakeholders lean toward Democrats, it is likely they would focus on science-based messaging, while for government agencies that operate in red states, they may adapt communication strategies to the preference of their majority Republican constituents. We thus propose:

H3. Government agencies in Democratic-leaning states employ less politicization of science in communicating COVID-19 vaccines than those in Republican-leaning states.

At the same time, we note that organizations within the same institution may choose different communication strategies in accordance with changes in their stakeholders' expectations (Doh & Guay, 2006). One such varying factor during the COVID-19 pandemic is the local infection rate. When COVID-19 infection rates are high, it is likely that primary stakeholders (e.g., local communities and individual constituents) would expect effective medical interventions and demand that government agencies prioritize residents' health concerns over political debates. As such, we hypothesize that government agencies operating in areas with higher infection rates are more likely to focus their communication on scientific facts and vaccination guidelines, and less likely to politicize their messages, which might appear tone-deaf, antagonize primary stakeholders, and offend public opinion. Hence, we propose:

H4. Government agencies employ less politicization of science in communicating COVID-19 vaccines when the state-level infection rate increases.

Data and Methods

Data Collection

With access to Facebook data authorized by CrowdTangle, we identified three clusters of public accounts representing the three studied groups and collected their complete posting history related to COVID-19 vaccines from March 1, 2020 to December 31, 2021: U.S. Congress (e.g., Senator Ted Cruz; Account $n = 455$, Message $N = 17,913$), U.S. Departments and Agencies (e.g., City of Cleveland; Account $n = 2,837$, Message $N = 94,886$), and top health institutions (e.g., Mayo Clinic; Account $n = 1,897$, Message $N = 95,876$). Relevant search keywords are listed in our online Appendix. We use “political corpus,” “government communication corpus,” and “medical corpus” below to refer to the three datasets.

The three corpora underwent a series of text pre-processing, including the removal of punctuations, symbols, numbers, URLs, and stopwords. We also removed the search keywords “covid” and “vaccine” from the corpora since these two stems were universally present in every Facebook post. We removed additional custom stopwords such as “also,” “may,” “include,” “a.m.,” “p.m.,” and “can,” and conducted lemmatization, which reduced different forms of a word to their common base. After data cleaning, we created three document-feature matrices for our political, government communication, and medical corpora, each consisting of 18,592, 54888, and 45,123 features (Benoit et al., 2018). More methodological details are provided in our replication materials.

Research Design

Figure 1 summarizes our research design for easy reference. In Study 1, we tested the first hypothesis and answered the first research question by comparing the three corpora and identifying their similarities and differences in framing COVID-19 vaccines. To do so, we used both semantic network analysis and dictionary-based content analysis, with an additional structural topic modeling analysis provided in the Appendix.

In semantic networks, nodes are words and ties are two words’ strengths of co-appearance. Extracting semantic relations among frequently used words and representing them in a network form, semantic network analysis has been used to reveal linguistic patterns and provide descriptive accounts of how various groups frame public issues (Van Atteveldt, 2008). In the result section, we also highlighted top words that were exclusively used by one of the three clusters. In dictionary-based content analysis, researchers use a preset dictionary to calculate the frequency of terms used by certain documents. Referencing existing approaches (Chinn et al., 2020), we applied two dictionaries designed by Hart et al. (2020) to our textual corpus, which counted the number of times a piece of text mentioned Republican and Democratic political actors (e.g., Trump, Biden, McConnell) and scientists (e.g., Fauci, Birx).

Study 2 answered our second research question, moved beyond simple descriptions, and made a methodological contribution by constructing a classifier that could identify the degree to which a message on COVID-19 vaccines was politicized. Prior approaches with parsimonious dictionaries of political actors, such as the one used by Hart et al. (2020), do not consider other words with subtle signals of politicization of science, such as “fund,” “American,” and “president.” Neither do they

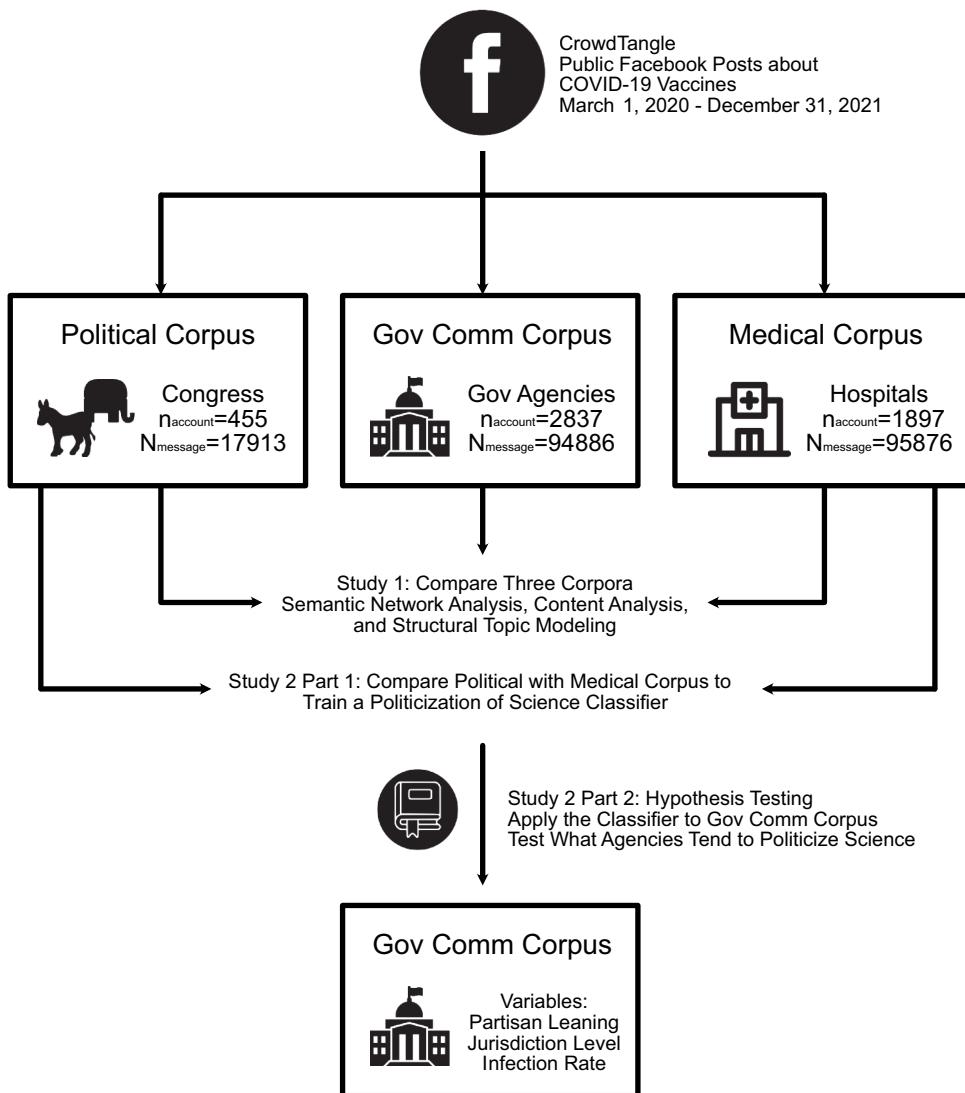


Figure 1. Research design.

distinguish words' various levels of politicization of science, a problem commonly known as "feature evaluation" (Monroe et al., 2008). For example, the word "biden" in our context arguably signals more politicization of science than the word "fund," and the content analysis method – counting the frequency of political actors in textual corpora – misses such nuance. To fill this gap, we employed computational linguistics through *scikit-learn*, a supervised machine learning package in Python, to train a classifier that can assess whether a message is more likely to come from our political corpus or our medical corpus. More specifically, we randomly sampled 6,000 posts from each of our political corpus and medical corpus, and trained a logistic regression classifier on the balanced dataset's language features (including

unigram, part of speech tagging, sentiment, and other common message features such as number of characters and post length) with L1 penalty (Pedregosa et al., 2011). Ten-fold cross validation showed an average accuracy of 82.8%. The model and relevant scripts are provided in the replication materials.¹

In the second part of Study 2, we applied this classifier to the government communication corpus ($N = 89,002$ messages containing text), and generated two (dependent) variables that quantified the degree to which government agencies politicized messages about COVID-19 vaccines: the first one was a dichotomous variable indicating whether a specific government communication post resembled our political corpus more (1) or our medical corpus more (0); and the second one was a continuous variable ranging from 0 to 1 indicating the probability that the post's language features resembled those from the political corpus.

As hypothesized earlier, we focused on three covariates – jurisdiction level, partisan leaning, and infection rate. Employing a dataset on all county names across the U.S., we used both computer-assisted keyword matching and manual content analysis. For agencies with page names that corresponded to only one state or one county, we automatically labeled those agencies with the matched jurisdiction levels and state names. For agencies with page names that corresponded to multiple states or counties, the research team visited each account's homepage and manually coded their state names and jurisdiction levels by hand. We identified one federal agency (message $N = 965$, 1.08% of total messages, i.e., CDC), 73 state-level agencies (message $N = 17,330$, 19.47% of total messages, e.g., "Florida Department of Transportation"), 1,363 county-level agencies (message $N = 56,189$, 63.13% of total messages, e.g., "Lancaster County Government"), and 1,398 city-level agencies (message $N = 14,518$, 16.31% of total messages, e.g., "City of Canton GA").

To measure the state-level partisan leaning for H3, we developed three measures. The first measure utilized an NCSL dataset on the partisan composition of state legislatures² which calculated the percentage of state legislators that were Democrats as of February 1, 2021 (e.g., for agencies in Arkansas/California, the variable is 0.215/0.75). The second and third measures used the result of the 2020 presidential election to indicate if a state should be considered a Democratic- or Republican-leaning state. The second measure was the percentage of a state's popular vote that went to Joe Biden in the election (e.g., for agencies in Arkansas/California, the variable is 0.348/0.635). The third measure was a dummy variable indicating if a state was won by Joe Biden (e.g., for agencies in Arkansas/California, the variable is 0/1). Messages published by federal-level agencies and agencies in Washington DC were omitted from H3 analysis. To obtain state-level infection rates for H4, we utilized an ongoing New York Times repository on coronavirus cases.³ We identified the publication date of each Facebook post, calculated the number of new infections in the state from seven days prior to the date of the post, and used its logarithmic form as a proxy measure of infection severity. This measure did not apply to the federal-level account (i.e., CDC).

Results

Study 1: Comparing Politicization of COVID-19 Vaccines Across Three Corpora

Figure 2 shows the result for Study 1. We focus on the comparison between the political corpus (Panel A1 and A2) and the medical corpus (Panel C1 and C2) for our H1.

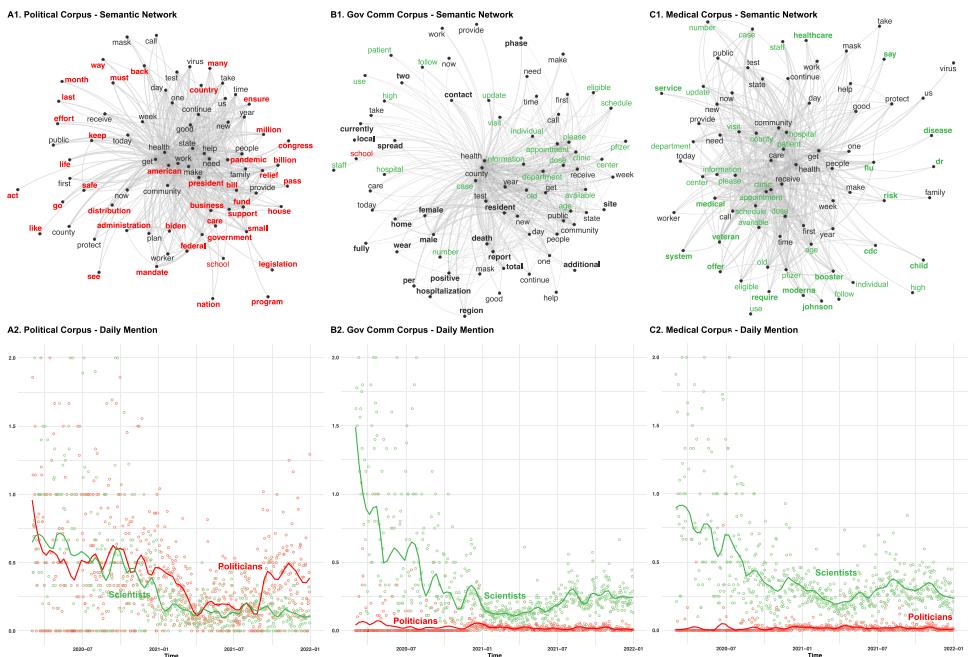


Figure 2. Comparing U.S. politicians', government agencies', and medical experts' communication on COVID-19 vaccines. Note: Panel A1, B1, and C1 respectively show the semantic networks of U.S. politicians', government agencies', and medical experts' communication on COVID-19 vaccines, visualizing the top 75 words in terms of degree centralities in each corpus. In Panel A1, words that are unique to the political corpus and not found in the other two semantic networks are marked red and bold (e.g., "billion," "biden," "american," "fund"), while words that are found in both the politician corpus and the government communication corpus are marked red ("school"). In Panel C1, words that are unique to the medical corpus and not found in the other two semantic networks are marked green and bold (e.g., "dr," "moderna," "healthcare," "booster"), while words that are found in both the medical corpus and the government communication corpus are marked green (e.g., "staff," "eligible," "patient," "dose"). In Panel B1, words from the political corpus are marked red, with words from the medical corpus marked green. Words unique to the government communication corpus are marked bold. All visualizations excluded the search keywords ("covid" and "vaccine"). U.S. politicians' (Panel A1) and medical experts' (Panel C1) communication on COVID-19 vaccines show huge disparities, while government agencies' (Panel B1) communication shows a mix of the two but aligns more closely with medical experts'. Panel A2, B2, and C2 apply the politician and scientist dictionary developed by Hart et al. (2020) to our dataset, show the temporal trend of daily mentions of prominent politicians and scientists in the three corpora, and confirms our findings from semantic network analysis.

Using semantic network analysis, we visualized the top 75 words in terms of degree centrality in the three corpora. Words signaling national identities and reflecting political, legislative, and economic processes rose to the top in the political semantic network, with tokens such as "American," "president," "bill," "business," "fund," "country," "relief," and "billion" occupying the center of the network. Among the 75 top words, 40 words exclusively existed in the political corpus and did not emerge as top words in the medical corpus, which we highlighted in bold text in Panel A1.

In comparison, the hub of the medical corpus's semantic network consisted of health-related words such as "schedule," "dose," "clinic," "veteran," and "patient." It is also characterized by professional and public health terms such as "Dr.," "Moderna," "CDC," "healthcare," and "booster." More description of the comparison is provided in the figure note.

Applying the COVID-19 politicization of science dictionary developed by Hart et al. (2020) to our datasets, we measured the frequency of the three Facebook corpora mentioning science- or politics-centered keywords throughout the pandemic. In the second-row panels, the measure was the number of daily mentions of scientists/politicians divided by the number of Facebook posts in the datasets per day. Once again, the political corpus and the medical corpus exhibited considerable disparities. While the medical community rarely mentioned political keywords (e.g., "Biden," "Democrat," "Trump," "Republican," "McConnell," "White House," etc.), the political corpus mentioned them as frequently as, if not more frequently than, scientific keywords (e.g., "research," "professor," "doctor," "expert," "Fauci," and "Johns Hopkins," etc.) from early 2020 to the end of 2021.

To answer RQ1, we shift focus to the government communication corpus. Figure 2 Panel B1 shows its semantic network, with words stemming from the political corpus colored red and words stemming from the medical corpus colored green. The language employed by government agencies resembled the medical community more than the political actors. Government communication and medical experts shared common words such as "eligible," "dose," "Pfizer," "visit," and "hospital" that occupied the network hub, and "school" was the only word that government communication's semantic network shared with the political corpus. Additionally, we identified words that were unique in the government communication corpus and reflected administrative governance, such as "spread," "local," "wear," "hospitalization," and "resident." Figure 2 Panel B2 provides further evidence to support our finding, as it suggested that the trend and frequency of scientist/politician mentions by government communication resembled the medical corpus more. Using the simple measure of cosine similarity which quantifies the similarity between two corpora based on the number of times each word is used (Grimmer et al., 2022), we found that the government communication corpus was overall more similar to the medical corpus ($\text{cosine} = .865$) compared to the political corpus ($\text{cosine} = .705$).

In conclusion, we found that the discourse on COVID-19 vaccines exhibited significant divergence between U.S. politicians and the medical community, supporting H1, and that government communication was more similar to medical experts than to U.S. politicians, answering RQ1. In the online Appendix, we provided additional results using structural topic modeling, which further confirmed our findings.

Study 2 Part 1: Classifying Politicization of Science with Computational Linguistics

Using posts from the political corpus as positive and posts from the medical corpus as negative, we trained a logistic regression classifier with L1 penalty using various language features. Figure 3 shows our conceptualization of the spectrum of politicization of science, along with some sample posts from the government communication corpus where various agencies more or less politicized their communication on COVID-19 vaccines. For example, the Louisiana Department of Health's post, reporting on Biden's new policies and demonstrating institutional support for the President's actions, showed a 0.874 possibility of politicizing science and was classified as positive. In contrast, the

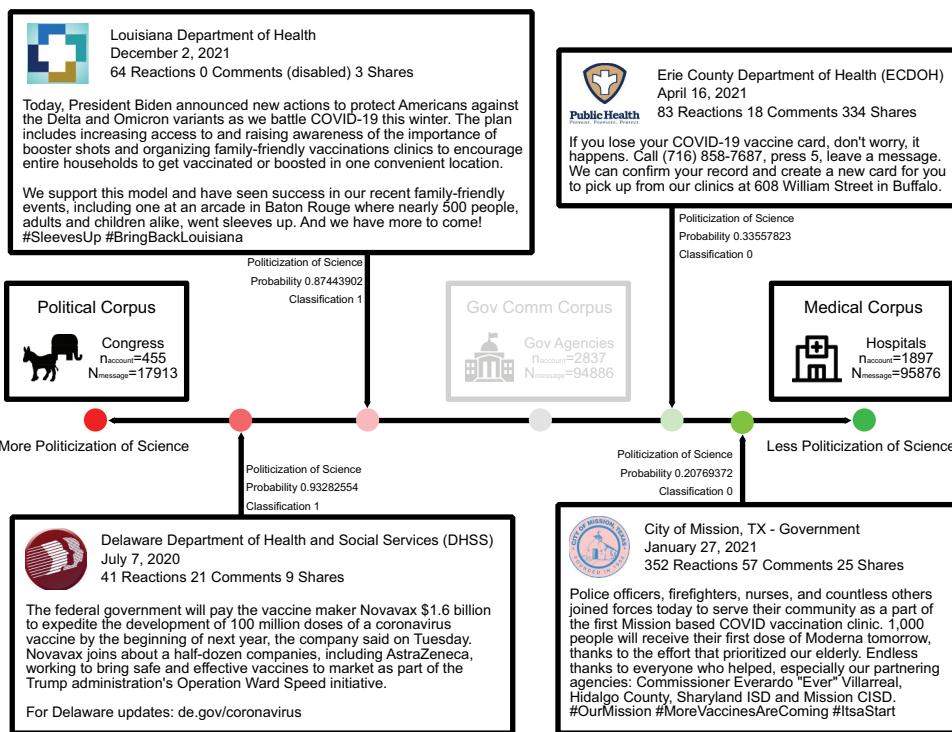


Figure 3. The spectrum of politicization of science and examples of Facebook posts with more or less politicization of science in the government communication corpus. Note: Distances in the figure are for illustrative purposes and indicative of cosine similarities between corpora and machine learning classification results. The government communication corpus overall is more similar to the medical corpus (cosine 0.865) than to the political corpus (cosine 0.705). Louisiana Department of Health's (cosine 0.167 with political and 0.110 with medical) and Delaware Department of Health and Social Services' (cosine 0.369 with political and 0.281 with medical) posts contain more politicization of science than the average government communication post as detected by the classifier and are dichotomously classified as 1 for politicization of science. City of Mission's (cosine 0.071 with political and 0.113 with medical) and Erie County Department of Health's (cosine 0.118 with political and 0.227 with medical) posts contain less politicization of science than the average government communication post as detected by the classifier and are dichotomously classified as 0 for politicization of science.

City of Mission's post, expressing gratitude to its local community for helping set up a vaccination clinic, showed a 0.208 possibility of politicizing science and was classified as negative.

Table 1 shows the top words and their coefficients in our politicization of science classifier. As expected, words related to the two administrations (e.g., “Biden,” “Trump,” “Congress”), policy enforcement (e.g., “mandate,” “must,” “distribution”), and money (e.g., “fund,” “business,” “economy”) emerged as key indicators of “playing politics,” while words related to the scientific literature (e.g., “effect,” “explain,” “MD”) and medical procedures (e.g., “hospital,” “patient,” “schedule”) emerged as key indicators of “straight talk of science.”

Answering RQ2, we concluded that word choices signaling politicization of science were likely to go beyond simple mentions of politicians as employed by prior methods (Hart

Table 1. Words with highest and lowest coefficients for the politicization of science classifier.

| Higher Politicization of Science | | | | Lower Politicization of Science | | | |
|----------------------------------|--------------|-----------|--------------|---------------------------------|--------------|-----------|--------------|
| Words | Coefficients | Words | Coefficients | Words | Coefficients | Words | Coefficients |
| american | 0.38900842 | news | 0.11762613 | hospital | -0.2585766 | share | -0.1037717 |
| mandate | 0.33372027 | must | 0.11451771 | clinic | -0.2448771 | say | -0.0887825 |
| Biden | 0.30116366 | attention | 0.11120367 | patient | -0.2393779 | available | -0.0841672 |
| fund | 0.17947842 | I'm | 0.11103081 | learn | -0.2022654 | please | -0.0734432 |
| great | 0.15889627 | business | 0.10969218 | MD | -0.1912435 | disease | -0.0697151 |
| Trump | 0.15873497 | senior | 0.09523522 | Dr | -0.1624164 | dose | -0.0673057 |
| distribution | 0.14661215 | economy | 0.0936997 | team | -0.1493825 | hand | -0.0661975 |
| town | 0.14040519 | free | 0.0921181 | flu | -0.1235296 | update | -0.0658881 |
| Congress | 0.12280803 | speed | 0.08744835 | moderna | -0.1135099 | other | -0.0638241 |
| government | 0.12236181 | work | 0.08723146 | schedule | -0.1106562 | ask | -0.0627596 |
| crisis | 0.1216144 | House | 0.08646281 | effect | -0.1090484 | explain | -0.0612517 |

et al., 2020). Many words frequently used by politicians were not *names* of politicians, but words that subtly communicated COVID-19 vaccines under political frames, ranging from economic terms (“fund” and “economy”) to adjectives of self-promotion (“speed” and “great”) and to partisan and national identities (“American” and “Congress”). We applied this classifier to the government communication corpus and used both the dichotomous and continuous outcomes as dependent variables for the next analysis.⁴

Study 2 Part 2: Politicization of Science in Government Communication

Jurisdiction Levels

Our continuous measure showed that the posts published by the federal level agency (i.e., CDC) had a low-to-median level of politicization of science ($M = .350$, $Md = 0.329$, $SD = .198$), and the dichotomous variable showed that 23.8% ($N = 230$) of its 965 posts were classified positive for politicization of science. State-level agencies had a slightly higher level of politicization of science ($M = .379$, $Md = 0.386$, $SD = .205$), and the dichotomous measure indicated that 28.4% ($N = 4,929$) of its 17,330 posts were classified as politicizing science. County-level agencies, compared to state-level agencies, had lower levels of politicization of science ($M = .331$, $Md = 0.332$, $SD = .231$), and the dichotomous measure suggested that 25.0% ($N = 14,020$) of its 56,189 posts were politicizing science. City-level agencies had higher politicization of science ($M = .382$, $Md = 0.390$, $SD = .239$) than county-level agencies, with 33.2% ($N = 4,826$) of their posts politicizing science.

Testing H2, we conducted a non-parametric two-tailed Mann-Whitney test comparing the federal- and state-level agencies versus county- and city-level agencies in terms of their posts’ politicization of science scores. We found that posts from federal- and state-level agencies ($M = .377$, $Md = 0.382$, $SD = .205$) politicized COVID-19 vaccines more than those from county- and city-level agencies ($M = .341$, $Md = 0.342$, $SD = .234$) ($p < .001$). However, the effect was mostly driven by the huge number of highly politicized posts published by state-level agencies. If we used Facebook account as the unit of analysis and assigned each Facebook account one score as its posts’ average politicization scores, the effect became statistically insignificant ($p = .117$). Regressing the continuous score on those accounts’ jurisdiction levels with OLS while including random effects around Facebook account IDs, we confirmed our finding that local (i.e., county- and city-level)

Table 2. OLS regressions of posts' politicization of science scores on agency covariates.

| | H2 Model1 | H2 Model2 | H3 Model1 | H3 Model2 | H3 Model3 | H4 |
|--------------------------|--------------------|-------------------|---------------------|---------------------|---------------------|----------------------|
| Level: Local Agencies | -0.025+ (0.014) | | | | | |
| Level: State | | 0.029 (0.102) | | | | |
| Level: County | | -0.023 (0.101) | | | | |
| Level: City | | 0.041 (0.101) | | | | |
| State Legislator Dem% | | | 0.092*** (0.014) | | | |
| Biden Vote% | | | | 0.177*** (0.028) | | |
| Biden Win | | | | | 0.018*** (0.005) | |
| Past Week Infection Rate | | | | | | -0.012*** (0.001) |
| Num.Obs. | 89002 | 89002 | 87836 | 87836 | 88037 | 87909 |
| R2 Marg. | 0.002 | 0.014 | 0.005 | 0.005 | 0.001 | 0.005 |
| R2 Cond. | 0.207 | 0.204 | 0.207 | 0.207 | 0.206 | 0.217 |

+p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001

All models include random effects around Facebook IDs. Local agencies in the first column refer to county- and city-level agencies.

agencies politicized COVID-19 vaccines less with a marginally (in)significant effect ($b = -0.025, se = 0.014, p = .066$), shown in the first two columns in [Table 2](#). We visualize our result in [Figure 4](#) Panel A. We thus did not find conclusive evidence for H2, but instead showed that government agencies' politicization tendencies did not vary much across jurisdiction levels, and that state-level agencies seemed to politicize COVID-19 vaccines more than other agencies.

State-Level Partisan Leaning

By regressing the continuous score on government agencies' state-level partisan leanings – quantified as each state's legislative composition, vote share, and election outcome from the 2020 presidential election – using OLS with random effects around Facebook account IDs, we found evidence that agencies in Democratic-leaning states were actually more likely to politicize COVID-19 vaccine communication than those in Republican-leaning states (using partisan composition among state legislators, $b = .092, se = .014, p < .001$), with results shown in [Table 2](#) and [Figure 4](#) Panel B.

Infection Rate

Similarly, we regressed the continuous score on the infection rate (the number of new positive state-wide COVID-19 cases in the past seven days, log transformed) using OLS, with random effects around Facebook account IDs. We found evidence that agencies did politicize COVID-19 less when the pandemic got more severe ($b = -.012, se = .001, p < .001$), with results shown in [Table 2](#) and [Figure 4](#) Panel C. We confirm that the effect persisted ($b = -.003, se = .001, p < .01$) if we additionally included random effects around posts' publication dates.

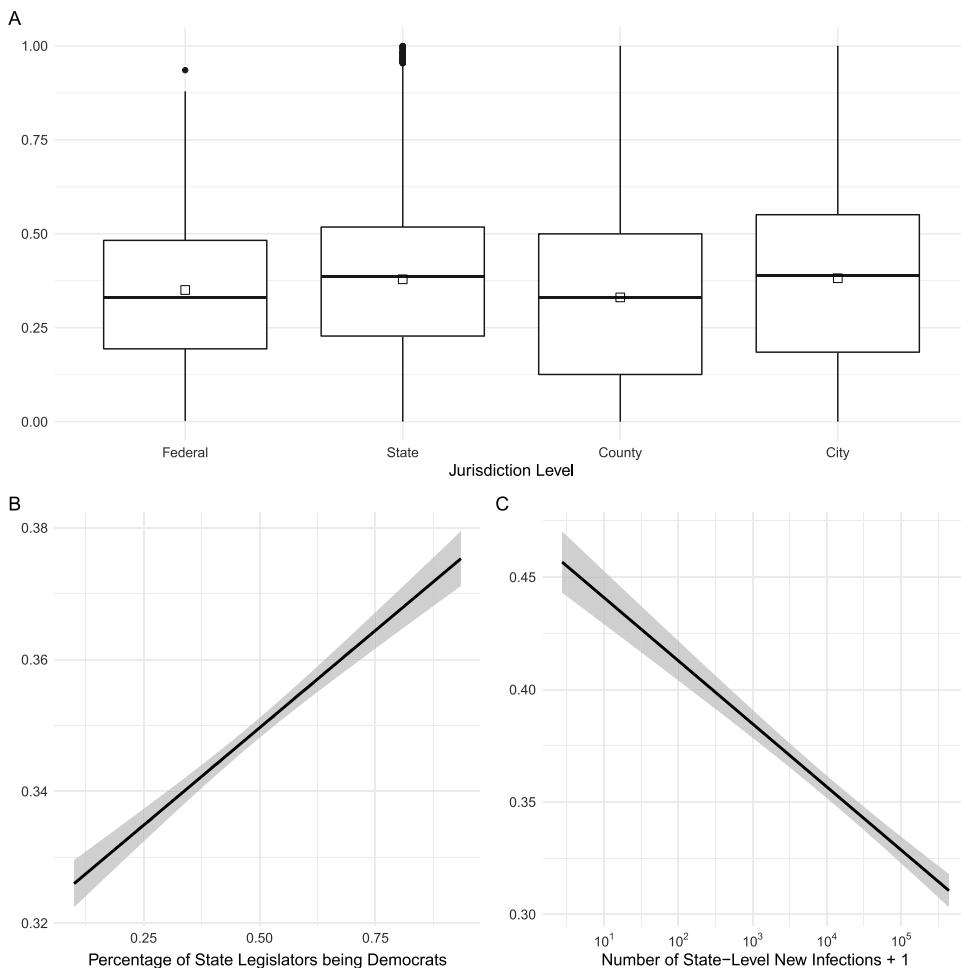


Figure 4. How government agency covariates predict politicization of science scores. Note: The three panels visualize how government agency covariates predict their tendencies to politicize COVID-19 vaccines on social media (a continuous outcome variable ranging from 0 to 1). Panel A shows the boxplot of agencies' politicization scores across jurisdiction levels, with mean values marked by squares. Panel B shows the linear effect of state-level partisan leaning on agencies' politicization scores. Panel C shows the marginal effect of state-level infection rate on agencies' politicization scores. All three panels use Facebook posts as the unit of analysis. Regression models used for Panel B and Panel C include random effects around Facebook IDs.

Discussion

Overall, this paper contributes to our understanding of the politicization of science in the context of the COVID-19 pandemic. It highlights the divergent discourses on COVID-19 vaccines between politicians and medical experts, as well as the nuanced balance that government agencies strike between the two. Additionally, the paper provides evidence that the politicization of COVID-19 vaccines is dampened when infection rates are high, and that agencies in Democratic-leaning states are more likely to politicize their communication on COVID-19 vaccines.

However, there are some inconsistencies with the initial predictions, particularly in relation to the role of jurisdiction levels and partisan leanings. The evidence suggests that the tendency to politicize COVID-19 vaccines does not vary much across jurisdiction levels, and that state-level agencies are more likely to politicize COVID-19 vaccines than other agencies. Additionally, the paper finds that agencies in Democratic-leaning states are more likely to politicize their communication on COVID-19 vaccines, which is contrary to the initial prediction.

The findings of our study highlight the importance of understanding the ways in which institutional norms and stakeholder influence can shape the politicization of science. Given that government agencies provide services and messages that affect the lives of millions of citizens, their role in the politicization of science should not be overlooked. Instead, they should be viewed as important allies in efforts to promote scientific information, and the collaboration between government agencies should be informed by a solid understanding of their institutional norms and stakeholder expectations. Future research should aim to further investigate the mechanisms through which institutional factors influence the politicization of science within and between different types of organizations.

It is necessary to note that although we provided some reasonable explanations to account for the observed horizontal and vertical differences between and within institutions, given the complexity involved with such a large sample of organizations, many other factors/mechanisms may also play significant roles. Systematic future studies are needed to develop comprehensive theories to explain politicization between and within institutions.

Below, we further our discussion on the measurement and conceptualization of politicization of science, the counter-intuitive findings regarding partisan leanings, and the role of government communication in political communication.

By constructing a classifier to provide a non-dichotomous examination of politicization of science, the current study creates new avenues for political communication scholarship to reconsider what politicization of science is and how we should measure it. Comparing our classifier results from [Table 1](#) with the dictionary of Hart et al. (2020), it is evident that both approaches tap into the issue of politicization of science but measure it in different ways. We defend our methodological approach as it reflects more nuances around the political framing of scientific events, captures subtle signals of politicization, and moves beyond a dichotomous and frequency-based evaluation of the phenomenon. In fact, the most politicized example in [Figure 3](#), published by the Delaware Department of Health and Social Services and scoring 0.932 with our classifier, would not be considered politicization of science by the existing toolkit. This demonstrates the greater sensitivity of our approach in quantifying politicization.

Improved measurement strategies, especially those associated with the development of computational social science, can challenge theoretical understanding of communication phenomena (González-Bailón, 2017; Theocharis & Jungherr, 2021). In this sense, our method reflects a *language-based* definition of politicization of science that emphasizes how communicators (e.g., politicians, scientists, etc.) carefully and strategically frame scientific issues to achieve their goals. It advocates the idea that word choices constitute a framing technique that can subtly politicize science-related messages without using explicitly political terms. Our research design conceptualizes politicization of science as a continuous spectrum where the two extremes are defined by politicians' rhetoric and scientists' rhetoric. It deviates from the prior *actor-based* definition of politicization of

science (Hart et al., 2020), where the signal of politicization is captured by explicit mentions of political actors. It also deviates from the *intention-based* definition of politicization of science (Bolsen & Druckman, 2015), where the signal of politicization is assessed by (political and nonpolitical) agents' intentional emphasis on scientific uncertainty. Comparing these three conceptual and methodological approaches is beyond the scope of this empirical paper. We invite further scholarly debates in this area to advance our understanding of what politicization of science is and how we should measure it.

The surprising finding on the association between politicization and partisan leaning – that agencies in Democratic-leaning states are more likely to politicize COVID-19 vaccines – may indicate an incumbency effect. During most of the studied period, Democrats had an incumbent advantage over Republicans, with President Biden in the White House and Dr. Fauci as the de facto public health spokesperson in managing the COVID-19 pandemic. Despite never endorsing any political candidate, Dr. Fauci was constantly pitted against the Trump administration and considered a Democratic ally by the press (Collins, 2020). Government communication managers in Democratic-leaning states, such as those serving Los Angeles County and New York City, might thus consider politicians as in-group members. They might align their framing of COVID-19 vaccines closer to political incumbents and echo with these Democratic officials linguistically. For example, in Figure 3, the post from Louisiana Department of Health was essentially publicity for the Biden administration, suggesting the possibility of incumbency bias in government communication.

In contrast, for agencies in Republican-leaning states without this incumbent advantage, communication managers might strategically dissociate themselves from politics and intentionally avoid political terms, fearing reminding constituents of their political disadvantage in national politics. We argue that our Study 2—revealing government agencies' communication conundrum between “conforming to institutional norms” and “catering to stakeholder interests”—presents an interesting case where a theoretical tension between institutional theory and stakeholder theory emerges: When institutional pressure and stakeholder expectations diverge, how do organizations communicate, and whose side will they take? Additionally, we contend that this unexpected finding also sheds light on the lack of literature on government communication, a central but largely neglected area of political communication, that deserves more scholarly attention, as we discuss below.

Canel and Sanders (2012) argued that government communication is an emerging field in political communication research that offers a vantage point where scholars can 1) deviate from the U.S.-centric focus on partisan competitions, 2) expand the definition of political communication to truly incorporate all communication programs, and 3) incorporate multidisciplinary knowledge to diversify available theoretical frameworks. Ten years later, there are still significant literature gaps on why government agencies communicate in certain ways and what effects their communication has on everyday citizens. Political communication scholars might continue to have this knowledge lacuna in the coming years, with research efforts recently poured into other important areas such as misinformation, polarization, and news engagement – which focus on either individual citizen's or political elites' media behavior instead of institutional communication in political processes (Sanders et al., 2011). We contend that government communication is an understudied yet promising area of political communication research that has the potential to bridge various disciplines, such as organizational communication (e.g., Lee & VanDyke, 2015), public administration (e.g.,

Feldman, 2015), political science (e.g., Börzel & Risse, 2021), public policy (e.g., Crozier, 2007), public relations (e.g., Horsley et al., 2010), and science/health/risk communication (e.g., Park & Lee, 2018). Moreover, it brings methodological diversity to the field with archival, critical, qualitative, and computational approaches (cf., Windsor, 2021) and provides a window to examine non-Western political communication processes (e.g., S. -U. Yang, 2018). Government communication is central to the effective governance of citizens and the stability of electoral democracies (Rothstein, 2009), and we encourage scholars to continue examining this area of research to broaden the scope of political communication.

Notes

1. We opted for logistic regressions over other methods to provide a more accessible model for the wider social scientific and public communities (Theocharis & Jungherr, 2021). The classifier puts different weights (as coefficients) on different words (tokens), constitutes a transparent and interpretable algorithm, and provides more granularity than the keyword-matching method employed by prior studies. Other methods, such as SVM and BERT, produce more black-box models that are hard to interpret (Molnar, 2019). Our goal is not to compare the accuracy rates of different classifiers, but to demonstrate the utility of measuring politicization of science from a linguistic perspective on a continuous scale from 0 to 1, for which logistic regressions are the best fit.
2. <https://www.ncsl.org/research/about-state-legislatures/partisan-composition.aspx>.
3. <https://github.com/nytimes/covid-19-data> Few states changed their reporting protocols during the COVID-19 pandemic, which led the state's cumulative number of positive cases to reduce in some weeks. We excluded observations with negative numbers of weekly new cases from our regression models.
4. We provided this classifier in our replication materials, however, it should be noted that the classifier was trained for the specific context of COVID-19 vaccine communication. Researchers are advised to adjust our script to re-train classifiers for their own studies.

Acknowledgments

We are grateful to editors, anonymous reviewers, Kaiping Chen, Kokil Jaidka, Yphtach Lelkes, Erik Nisbet, Michael Xenos, Tian Yang, as well as seminar participants at MPSA and the University of Pennsylvania's Democracy & Information Group (DIG). All remaining errors are our own. Replication materials associated with the analyses have been deposited onto Open Science Framework at <https://doi.org/10.17605/OSF.IO/RMBGK><https://doi.org/10.17605/OSF.IO/RMBGK>

Disclosure statement

No potential conflict of interest was reported by the author(s).

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