COVID-19 Communication Management on Facebook Pages of Local Governments

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Abstract

We examine how Italian municipalities manage the COVID-19 communication on their official Facebook pages. For this purpose, we apply an automatic topic modelling procedure on a sample of 76,139 posts published on the official Facebook pages of 103 Italian provincial capital municipalities over the COVID-19 pandemic period from 1 March 2020 to 26 March 2021. We identify two topics related to COVID-19 consisting of COVID-19 restrictive measures and COVID-19 support measures.

Using regression models with municipality and year-week fixed effects, we find that the prevalence of the topic on COVID-19 restrictive measures negatively affects the tone of the communication, computed through a sentiment analysis procedure, and it is negatively associated with the number of COVID-19 positive cases in the municipal area. In contrast, the prevalence of the topic on COVID-19 support measures positively affects the tone of the communication and it is positively associated with the number of positive cases. These associations are moderated by ideology, age, and political incentives of incumbent mayors.

These results may reveal a strategic communication of municipalities to induce positive perceptions about the performance of municipal incumbents in responding to the pandemic and, therefore, enhance political consensus among voters. Finally, these findings may have practical implications for public regulators, public managers, and other followers of local governments' social media.

Keywords: social media; topic modelling; COVID-19 communication.

1 Introduction

Recent studies document an increase of the usage of social media (SoMe) by local governments for several purposes which include engaging citizens in public affairs, restoring confidence in the institutions, enhancing transparency and accountability, and improving public services (Bonsón et al., 2019; Guo et al., 2021; Haro-de-Rosario et al., 2018). In this regard, an additional purpose that is gaining ground is the management of disasters and crises (Chen et al., 2020; Guo et al., 2021; Tang et al., 2021). Indeed, in such delicate situations, SoMe may allow governments to effectively and timely enhance citizens' understanding and engagement, assess the evolving stages of the disaster, provide emotional support, reduce uncertainty, and control crisis rumours (Guo et al., 2021; Kaewkitipong et al., 2016; Mori et al., 2020).

The recent COVID-19 pandemic represents an unprecedented setting to assess how local governments have been managing their communication through SoMe to deal with the emergency. In this study, we initially seek to identify the COVID-19-related topics addressed by the main Italian municipalities on their official Facebook pages. Then, we aim to assess how these topics affect the tone of the communication and how their prevalence is adjusted to the severity of the pandemic expressed by the number of COVID-19 positive cases in the municipal area.

Among others, this information may allow inferring whether political incentives and, more specifically, the quest for political consensus play a role in the municipal COVID-19 communication through Facebook. In this regard, previous studies provide evidence of an opportunistic usage of Facebook by local governments of Western European countries for self-promotion and political marketing through a one-way communication (Agostino & Arnaboldi, 2016; Bonsón et al., 2017; Silva et al., 2019). These opportunistic aims may at least partially undermine the achievement of more desirable objectives such as engaging citizens in political and social issues and, more importantly in our study, effectively using Facebook to manage the pandemic (Löffler & Bovaird, 2019; Mori et al., 2020; Picazo-Vela et al., 2016; Zheng & Zheng, 2014).

Italy represents an interesting setting given that it is one of the first European countries to record one of the highest numbers of infections in the world. In addition, Italy is among the first countries to react positively to the pandemic (Mori et al., 2020). It should be noted that in Italy the communication through Facebook of public administrations is not mandatory and, therefore,

it could be considered as a form of voluntary e-disclosure[1]. Studies document the increase of Facebook popularity for the communication between local governments and citizens in Europe, Australia, and the US (Bonsón et al., 2016; Lev-On & Steinfeld, 2015; Omar et al., 2014). In this line, the usage of SoMe like Facebook by Italian municipalities has significantly grown in recent years (Gesuele, 2016; Guillamón et al., 2016) and it is recognized by several laws starting from Law 150/2000. This Law states that Italian public administrations can use a wide variety of suitable tools for their communication and information activities including digital media (Mori et al., 2020).

That said, to extract latent topics from posts published on Facebook, we apply an automatic topic modelling procedure called Latent Dirichlet Allocation (LDA) (Blei et al., 2003) on a sample of 76,139 posts published on the official Facebook pages of 103 Italian provincial capital municipalities over the COVID-19 pandemic period from 1 March 2020 to 26 March 2021. This analysis allows us to identify nine main topics of which two are related to COVID-19. More specifically, based on the most likely associated terms, we label the first COVID-19 topic as COVID-19 restrictive measures and the second as COVID-19 support measures. Using regression models including both municipality and year-week fixed effects (Angrist & Pischke, 2009), we find that the prevalence of the topic on COVID-19 restrictive measures negatively affects the tone of communication determined through a lexicon-based sentiment analysis procedure that considers contextual valence shifters in the polarity computation. In contrast, the prevalence of the topic on COVID-19 support measures positively affects the tone of communication.

In addition, we find that when the number of COVID-19 positive cases grows in the municipal area, municipalities tend, on the one hand, to downplay negative information on COVID-19 restrictive measures and, on the other hand, to promote positive information on COVID-19 support measures relatively more on their Facebook pages, as indicated by the variations of the corresponding topic prevalence. This tendence may provide evidence of a strategic communication of municipalities aimed at fostering positive perceptions in their citizens about the performance of municipal incumbents in effectively dealing with the pandemic through suitable support measures. Furthermore, we find that this tendence is strengthened for municipalities led by right-wing mayors and older mayors. The role of political incentives is confirmed by an additional analysis revealing that the identified tendence is weaker for mayors with a stronger political position granted by a higher margin of victory in

[1]In Italy, the e-disclosure is mandatory and regulated only for municipal websites by Legislative Decrees 150/2009 and 33/2013.

the latest municipal elections. In contrast, the tendence is stronger for mayors in their first term of office that, unlike mayors in their second term, are allowed to run for re-election in the following elections.

Prior studies examine the increasing usage of SoMe by central and local governments and supranational entities (e.g., UN and WHO) to manage disasters and crises including the recent COVID-19 pandemic (Chen et al., 2020; Guo et al., 2021; Li et al., 2020; Mori et al., 2020; Tang et al., 2021). However, to the best of our knowledge, our study is the first to analyse how local governments strategically manage their COVID-19 communication on their official Facebook pages based on the association between COVID-19 topics, automatically extracted through the LDA algorithm, and the number of infections in the municipal area. We provide the first empirical evidence of political incentives that may affect this communication, consistent with studies that, in other contexts, identify political opportunism in the usage of Facebook by European local governments (Agostino & Arnaboldi, 2016; Bonsón et al., 2017; Silva et al., 2019).

Importantly, our results may raise some concerns regarding the opportunistic and biased communication of local governments through SoMe. Indeed, the opportunistic communication on SoMe by local governments for self-promotion and political marketing may hamper the effectiveness of SoMe as disaster management system as well as the proper usage of SoMe to enhance transparency and engage citizens in political and social issues. These concerns could be considered by public authorities engaged in developing guidance or regulations on the appropriate usage of SoMe by local governments.

The remainder of the paper proceeds as follows: section 2 undertakes the literature review and develops the main hypotheses; section 3 describes the sample data and the empirical strategy; section 4 presents the empirical results; and section 5 presents the conclusion.

2 Literature Review and Hypotheses

Recent studies show an increase in the usage of SoMe by governments and supranational entities (e.g., UN and WHO) to manage disasters and crises (Chen et al., 2020; Guo et al., 2021; Tang et al., 2021). For example, F. Liu and Xu (2018) examine the Facebook pages of three public officials responsible for managing three disasters occurred over the period 2013-2015. Using a thematic analysis, the authors find that public officials' posts can be grouped into four main categories: "official updates on the situation, recommendations for the local population, information regarding recovery procedures and methods, and replies to victims' queries and

needs". In this regard, Kaewkitipong et al. (2016) document that the prevalence of each topic posted on SoMe may be adapted to fit the knowledge sharing needs in each of the three phases (pre, during, and post) of the crisis.

In the very context of COVID-19 pandemic, Li et al. (2020) document the usage of Weibo—the largest short messaging SoMe platform in China—by Chinese government to mitigate information asymmetry with local governments and citizens. More specifically, Chinese central government used Weibo to coordinate its COVID-19 related actions and policies with local governments, collect timely information at the ground level, assist citizens, speed up relief efforts, and mobilize citizens and non-profit organizations to support its responses. In the same vein, Mori et al. (2020) examine the official Facebook page of the 11 Italian municipalities (capital cities of provinces) with the highest COVID-19-induced mortality rates from 31 January 2020 to 3 June 2020. The authors manually perform a qualitative content analysis and collect some quantitative indicators related to the number, frequency, and other features of the posts. They find that municipalities seem not to capitalize on the full potential of SoMe given that both quantity and frequency of published posts did not show significant changes during the pandemic. However, the content of municipal posts became richer and less formal, and it was rapidly adapted to the different circumstances and phases of the pandemic by revealing the absence of any structured communication strategy. In addition, the tone of communication varied from prescriptive—during the most critical phases—to informative as soon as the number of infections significantly declined. It should be noted that the authors do not analyse if the prevalence and the tone of COVID-19-related posts was strategically adapted to the severity of the COVID-19 spread.

The usage of Facebook by Italian municipalities to inform on COVID-19 is consistent with previous studies finding that local governments of Western European countries mostly use SoMe to provide useful information to citizens through a one-way communication (Agostino & Arnaboldi, 2016; Bonsón et al., 2017). In this one-way communication, the purposes of self-promotion and political marketing may tend to prevail over the more desirable objective of engaging citizens in political and social issues through an interactive two-way dialogue (Löffler & Bovaird, 2019; Picazo-Vela et al., 2016; Zheng & Zheng, 2014). Based on previous studies on the usage of SoMe by governments to manage disasters (Chen et al., 2020; Kaewkitipong et al., 2016; F. Liu & Xu, 2018), we expect COVID-19 topics on Facebook of Italian municipalities to mostly deal with restrictive measures to contain the pandemic and support measures for citizens. Due to the previously found lack of a structured communication strategy through Facebook by Italian municipalities (Mori et al., 2020), the tone of posts more focused

on restrictive measures might be more prescriptive and, therefore, more negative. Conversely, the tone of posts more focused on support measures might be more supportive and, therefore, more positive. Hence, the first hypothesis of our study is the following:

H1: The tone of posts on municipal Facebook pages is negatively associated with the prevalence of the topic on COVID-19 restrictive measures and positively associated with the prevalence of the topic on COVID-19 support measures.

Previous studies show that local governments tend to minimize or avoid reporting negative information that may signal their incapacity to effectively deal with crises. This negative information may compromise promotion opportunities for public officials and re-election opportunities for local incumbents (CAI, 2004; Li et al., 2020). Indeed, natural disasters such as COVID-19 could be an opportunity for the citizens to assess competences and performance of the incumbents based on the quality of the politicians' response to the disaster (Ashworth et al., 2018; Masiero & Santarossa, 2021)**.** More specifically, based on the retrospective voting theory (Achen & Bartels, 2018), voters will reward the incumbents in the next elections if they perceive the response of the incumbents as adequate to alleviate the negative effects of the disaster on the public welfare. Conversely, voters will punish the incumbents if they perceive them as unable to manage the disaster promptly and effectively. However, incumbents may manage to influence the perception of their voters about their performance in managing the disaster through an opportunistic communication strategy on SoMe. Indeed, previous studies show that voters may be emotional, not adequately informed about reality and, therefore, prone to be manipulated by demagogical or populist politicians though biased political communication (Achen & Bartels, 2018; Cole et al., 2012).

Studies show that, following a disaster, the ability of incumbents to support citizens through adequate relief spending is the main booster for political consensus among voters. For example, electoral returns for incumbents arose from the allocation of relief spending in Colombia following the disaster caused by the 2010–2011 rainy season (Gallego, 2018), in Germany following the 2002 Elbe flooding (Bechtel & Hainmueller, 2011), and in Italy following destructive earthquakes between 1993 and 2015 (Masiero & Santarossa, 2021).

However, prior research documents that the effectiveness of governments' disaster relief programmes in forging political consensus can be amplified by a strategic political communication through traditional media and SoMe aimed at promoting public spending for disaster support (Klomp, 2020; Masiero & Santarossa, 2021). This strategic promotion of

disaster reliefs may be more likely in disasters like COVID-19 that find politicians unprepared and with insufficient resources and experience to effectively manage the disaster (DellaVigna & Kaplan, 2007; Masiero & Santarossa, 2021).

In addition, Facebook posts on support measures regarding COVID-19 disaster may entail a positive emotional tone. In this vein, some studies find that posting on positive topics may enhance citizen engagement, political consensus and attract voters (Nave et al., 2018; Stieglitz & Dang-Xuan, 2013). For example, Gerbaudo et al. (2019) find that, in the 2017 UK general elections, the posting strategy focused on topics with positive emotional tone adopted by Labour party and its leader on their official Facebook pages attracted voters by engaging users. Positive posting mostly relied on more optimistic content such as promises of improvement of welfare and public services rather than stressing fear-inducing issues of national security, terrorism, and immigration. In the same line, Ceron and D'Adda (2016) document that a positive political campaign focused on distributive promises through the official Twitter accounts of Italian parties enhanced voting intentions expressed on Twitter in the 2013 Italian general elections. Using a systematic random sample of 125 U.S. cities, Zavattaro et al. (2015) find that local governments that adopt a positive sentiment tone in their communication through Twitter are more likely to engage citizens and encourage their participation than cities that simply share information in a push manner.

That said, prior evidence on the opportunistic usage of Facebook by European local governments for self-promotion and political marketing through a one-way communication (Agostino & Arnaboldi, 2016; Bonsón et al., 2017; Silva et al., 2019) may support the tendence of Italian municipalities to post more on positive topics while minimizing posts on negative topics. In this regard, when the severity of the pandemic—measured by the number of COVID-19 positive cases—grows, citizens may fear the negative effects on their personal lives of the tightening of COVID-19 restrictions. Therefore, municipalities may post less or, at least, avoid posting more on COVID-19 restrictive measures given that the communication regarding these measures may be perceived more prescriptive by citizens and, therefore, more emotionally negative (Mori et al., 2020). These negative emotions may erode the political support for municipal incumbents that may be perceived as incapable of effectively dealing with the pandemic. On the other hand, a higher number of positive cases may lead municipalities to post more on COVID-19 support measures even to enhance the citizens' perception about their effective response to the pandemic through a strategic positive communication (Gallego, 2018; Masiero & Santarossa, 2021). Hence, two more hypotheses of our study are the following:

H2: On municipal Facebook pages, the prevalence of the topic on COVID-19 restrictive measures is not positively associated with the number of positive cases in the municipal area.

H3: On municipal Facebook pages, the prevalence of the topic on COVID-19 support measures is positively associated with the number of positive cases in the municipal area.

Based on the municipal electoral system in Italy, voters can express a direct choice for the mayoral candidate or the coalition of parties supporting the mayoral candidate[2]. The electoral system attributes great importance to the candidate mayor and, ultimately, guarantees the majority of seats to the parties supporting the elected mayor. Therefore, the mayor is likely to have a significant influence on the communication strategy of the municipality through SoMe (Larsson & Skogerbø, 2018; Silva et al., 2019). To account for this influence, we test whether ideology, age and gender of the mayor affect the previously hypothesized associations between the prevalence of COVID-19-related topics on municipal Facebook pages and the number of positive cases in the municipal area.

Regarding mayor's ideology[3], by examining political Facebook posts by Israeli political actors during the campaign of the 2015 Israeli election, Nave et al. (2018) provide further evidence on the more positive content of left-wing candidates' successful posts relative to right-wing candidates. More specifically, positive feelings based on humour, optimism and hope are more typical of successful left-wing posts given that these feelings are more consistent with values of leftists and their perceived identities compared to rightists (Caprara et al., 2006). Based on a panel of 90 democratic countries between 1985 and 2013, Klomp (2019) shows that left-wing governments allocate more public support spending in the aftermath of a disaster than right-wing governments do. The author explains his results based on the partisan theory stating that left-wing governments are more committed to fiscal policies aiming at fighting poverty or inequality given that their constituency mostly consists of the working class and low-income citizens (Potrafke, 2017). However, more generally and regardless of the right-wing differences, political parties may be more willing to provide public support if their constituency is especially vulnerable to a specific disaster (Klomp, 2019). In Italy, COVID-19 has significantly affected small and medium-sized businesses and self-employed workers that may mostly support right-wing parties. We expect the relevance attached to COVID-19 public

[2]In Italy, the election of the mayor and the municipal council in municipalities with up to 15,000 inhabitants is regulated by the Legislative Decree n. 267 of 18 August 2000.

[3]We infer the political ideology of the mayor based on the dominant political orientation of the parties supporting her/him as well as her/his political and professional trajectory usually published on Wikipedia.

support by incumbents to be reflected in the prevalence of the related topic in their Facebook communication. However, because of our previous conflicting arguments, we do not make any prediction regarding the moderating effect of mayor's ideology on the relation between COVID-19 support topic and COVID-19 positive cases and formulate the following null hypothesis:

H4: Mayor's political ideology does not moderate the relation between the prevalence of the topic regarding COVID-19 support measures on municipal Facebook pages and the number of positive cases in the municipal area.

Previous social psychological research finds that, relative to progressives, conservatives tend to show greater sensitivity to several threats, including disease threat, and perceive the world as more dangerous (Conway et al., 2020; Jost, 2017; Jost & Amodio, 2012; Perry et al., 2013)**.** Specifically, Jost et al. (2003) show that core values of political conservatism such as traditionalism and acceptance of social inequalities are associated with desires to manage uncertainty and stronger perception of threats.

However, partisan media coverage may manipulate the public perception of specific threats and make conservatives less sensitive to those threats than progressives. For example, in the US, partisan media coverage may be responsible for the higher sensitivity to the threat of climate change of progressive Democrats relative to conservative Republicans (Carmichael et al., 2017)**.** Similarly, Calvillo et al. (2020) attribute the lower perception of COVID-19 threat by conservatives than progressives in the US to partisan media coverage, polarization induced by political leadership, and less accurate discernment between real and fake news of conservatives. In this regard, Havey (2020) finds that political conservatives predominate the misinformation discourse and conspiracy theories regarding COVID-19 on Twitter. On the other hand, Conway et al. (2020) argue that American conservatives are less concerned about COVID-19 and, therefore, less likely to follow government recommendations (van Holm et al., 2020) because they feel that the effects of the pandemic and related public interventions such as government restrictions will hurt their ideological ends. Therefore, the authors suggest that the match between ideological ends and the outcomes of the pandemic may help predicting public perceptions about the pandemic. The authors acknowledge that, in other socio-cultural contexts, conservatives may not share American conservatives' strong dislike of public interventions related to COVID-19. In these contexts, the relationship between ideology and perceived threat would not be affected by this match mechanism.

Studies find a relatively high level of acceptance among the Italian population of the restrictive measures to contain the virus that Italian government started adopting on 23 February 2020, just a few days after the first case of COVID-19 contracted in Italy was diagnosed (Ceccato et al., 2020; Motta Zanin et al., 2020). In addition, at the beginning of the pandemic, Italian government through the Ministry of Health and public health authorities engaged in a digital communication strategy through SoMe to inform citizens and counteract misinformation on COVID-19 (Lovari, 2020). Therefore, in Italy, the political leadership does not induce the same level of political polarization of COVID-19 topic as in the US.

On the one hand, within the Italian socio-political context, the traditional tendance of rightists to show greater sensitivity to COVID-19 threat than leftists (Jost et al., 2003) may not to be moderated by partisan media coverage or political polarization at the same level as in the US. Hence, Italian rightists may accept restrictive measures to contain the pandemic threat. On the other hand, COVID-19 restrictive measures may more negatively affect interests and ideological ends of constituency of right-wing parties including small and medium-sized businesses and self-employed workers. Therefore, we are unable to make any prediction regarding the moderating effect of mayor's ideology on the relation between COVID-19 restrictive measures and COVID-19 positive cases and we address this issue empirically through the following null hypothesis:

H5: Mayor's political ideology does not moderate the relation between the prevalence of the topic regarding COVID-19 restrictive measures on municipal Facebook pages and the number of positive cases in the municipal area.

Regarding mayor's age, studies carried out in different countries using questionnaires find that older adults show higher perception of COVID-19 risk than younger adults (Barber & Kim, 2021; Bruine de Bruin, 2021). This may also arise from the fact that the case fatality rate of COVID-19 significantly increases with age (Remuzzi & Remuzzi, 2020; Wu & McGoogan, 2020). However, higher COVID-19 risk perception is not always associated with greater concerns and consequent behavioural changes. For example, Barber and Kim (2021) find that, in the US, older men are less concerned than younger counterparts and implement fewer behavioural changes as precautions against COVID-19. On the other hand, using a survey, Ceccato et al. (2020) find that in Italy older adults show more positive attitudes and lower negative emotions towards COVID-19 than younger adults. However, older adults are more favourable about restrictive measures, more confident about COVID-19-related information

received from the media and official sources, and they estimate longer time for the solution of the emergency.

More positive attitudes of older mayors towards COVID-19 and their higher reliance on official COVID-19-related information may lead them to perceive the COVID-19 topics as less negative than younger mayors and, therefore, inform relatively more on COVID-19 and related support measures through Facebook when the number of positive cases increases. Conversely, older mayors may implement fewer behavioural changes and may have a more negative perception about the socio-economic effects of restrictive measures (Barber & Kim, 2021). These factors may induce older mayors to promote COVID-19 restrictive measures relatively less through Facebook when the number of infections grows. Hence, our sixth hypothesis is the following:

H6: When the number of positive cases grows, municipal governments led by older mayors tend to post less on COVID-19 restrictive measures and more on COVID-19 support measures on their Facebook pages than municipal governments led by younger mayors.

Regarding mayor's gender, studies conducted in several OECD countries find that, despite higher fatality rates of COVID-19 for males than females, females present a higher perception of COVID-19 risks than males (Rana et al., 2021). Therefore, females are more likely to see COVID-19 as a very serious problem, take precautionary measures and agree with restrictive public policy measures (Abdulmuhsin et al., 2021; Bostan et al., 2020; Galasso et al., 2020; Rodriguez-Besteiro et al., 2021). In addition, females show higher prevalence and severity of COVID-19-related anxiety, depression, and stress symptoms (N. Liu et al., 2020). These difference in risk perception between males and females are also reflected in behavioural differences between male and female leaders. For example, countries led by female rulers (e.g., New Zealand, Germany, Iceland) have shown greater effectiveness and adopted clearer communication strategies to tackle the pandemic than countries led by male rulers (e.g., US, UK, Brazil) (Garikipati & Kambhampati, 2020).

That said, we expect female mayors to show higher sensitivity to COVID-19 than male mayors. This higher sensitivity may be reflected in a communication through Facebook less opportunistic, more supportive, more transparent and in line with the evolution of the pandemic. Therefore, our seventh related hypothesis is the following:

H7: When the number of positive cases grows, municipal governments led by female mayors tend to post more on COVID-19 restrictive measures and COVID-19 support measures on their Facebook pages than municipal governments led by male mayors.

3 Data and Empirical Strategy

3.1 Data and Sample Selection

Our sample consists of the official Facebook pages of the capital municipalities of the 107 Italian provinces[4]. As in prior studies (Agostino & Arnaboldi, 2016; Bonsón et al., 2017), we search for the Facebook page link on the institutional websites of the capital municipalities[5]. If no Facebook page link is displayed on the municipal website, we directly search for the municipality's page on Facebook. If we find the page, we consider it as official if it refers to the municipality's website and/or its official email address. Out of 111 provincial capital municipalities, we find 103 with an active Facebook page in March 2021 at the time of our search. We input the numeric ID of each municipal Facebook page[6] into a Python Facebook scraper (Zúñiga, 2020) that allows us to download, on 26 March 2021, all the posts and related metadata published on the municipal Facebook pages since 1 March 2020. We start our analysis from March 2020 as it is the month when the emergency of COVID-19 acquires relevant proportions in Italy because of the WHO pandemic declaration and the unprecedented restrictive measures adopted by the Italian Government, following the sharp increase of diagnosed COVID-19 cases across the Italian territory (Ceccato et al., 2020; Motta Zanin et al., 2020).

The Python Facebook scraper retrieves 76,139 posts published on the 103 municipal Facebook pages during the examined period of about 13 months. These posts represent the documents of our corpus that we use to extract the main topics through a topic modelling algorithm.

3.2 Variables and Baseline Regression Models

To test our hypotheses, we build two main dependent variables for our baseline regression models. The first dependent variable is the prevalence (proportion) of COVID-19-related topics

[4]Italian territory consists of 20 regions representing the first-level administrative entities of the Italian Republic regulated in the Italian Constitution. Each region is subdivided into smaller areas called provinces and each province is subdivided into municipalities. Each province has its corresponding capital municipality.

[5]The institutional websites of Italian municipalities are available on https://www.tuttitalia.it/comuni/.

[6]We obtain the numeric ID of each municipal Facebook page by using the website https://www.duplichecker.com/find-facebook-id.php.

(*TOPIC_COVID*) within each post published on the municipal Facebook pages during our study period. To estimate the variable *TOPIC_COVID*, we adopt a topic modelling algorithm called Latent Dirichlet Allocation (LDA) initially proposed by (Blei et al., 2003). Topic modelling algorithms aim at uncovering latent topics in large corpora of documents by identifying clusters of words co-occurring within the documents and assumed to refer to the same semantically interpretable topic (Roberts et al., 2014). In natural language processing, LDA is a largely used topic modelling technique that belongs to the family of unsupervised machine learning algorithms. More specifically, LDA is a two-step generative probabilistic model assuming that each document of the corpus is a Dirichlet probability distribution of a predefined number of topics and each topic is a Dirichlet probability distribution of a vocabulary of words (Blei et al., 2003). Therefore, the input of the LDA estimation consists of a document-term matrix, whose elements include the frequency of each term (column) for each document (row), and a predefined number of expected topics. The output of the LDA estimation consists of two main matrixes. Specifically, the document-topic matrix shows the probability (prevalence) of each topic (column) for each document (row), whereas the topic-term matrix shows the probability of each term (column) referring to each topic (row). The topic-term matrix is used by the researcher to assign a descriptive label to each topic by interpreting the most probable terms for each topic based on previous theory and contextual knowledge (Humphreys & Wang, 2018)[7]. Relative to manual text analysis procedures, LDA allows to efficiently process massive collections of documents through a more reliable, objective, and replicable procedure not requiring the subjective predefinition of categories or keywords that is typical of manual coding or dictionary methods (Huang et al., 2018). In addition, whereas manual text analysis procedures commonly assign one main topical category to each document, LDA allows identifying various topics with their respective prevalence within each document.

The second dependent variable for our baseline regression models is the polarity score (tone) of municipal Facebook posts (*TONE*) during the examined pandemic period. To compute the polarity tone of Facebook posts we adopt a lexicon-based sentiment analysis procedure (Kearney & Liu, 2014). Specifically, we count the words of each post included in an Italian word list that assigns a negative or positive sentiment (tone) to each word based on an interval ranging from -1 (most negative) to +1 (most positive). Posts with a relatively higher frequency of positive words are assumed to be optimistic. Conversely, posts with a relatively higher frequency of negative words are assumed to be pessimistic.

[7]In LDA each word of the vocabulary can occur in several topics with different probability and neighbouring words.

Previous studies adopt several English lexicons for sentiment analysis that are specifically tailored to certain research areas such as sociology, psychology, accounting, finance, etc. (Davis et al., 2015; Loughran & Mcdonald, 2016). Indeed, some words could have positive or negative meaning depending on the setting or area in which they are used (Lewis & Young, 2019). As we examine a non-specialized Facebook communication in Italian, we use a generic Italian lexicon for sentiment analysis called *Sentix* (Sentiment Italian Lexicon)[8]. *Sentix* lexicon is developed by aligning other resources such as *Multiwordnet* (Pianta et al., 2002) and *SentiWordnet* (Baccianella et al., 2010). An entry in *Sentix* includes an Italian lemma with its part-of-speech (POS) and polarity score ranging from -1 (totally negative) to +1 (totally positive)[9], among others.

Using programming languages like Python and R, several sentiment analysis packages have been developed that include standard lexicons (Naldi, 2019). We use the R package *udpipe* (Wijffels, 2021) to compute the aggregate sentiment polarity score for each Facebook post based on the the *Sentix* lexicon. In particular, we first tokenise and lemmatise each post using the *PoSTWITA-UD* treebank collection of Italian tweets annotated in Universal Dependencies (Sanguinetti et al., 2018). This treebank is particularly suitable for textual analysis of SoMe. The lexicon-based sentiment analysis procedure is referred as a 'bag of words' model as both the order and the context of the words are ignored (Huang et al., 2014). To partially overcome this limitation, we exploit the ability of *udpipe* sentiment analysis function[10] to consider contextual valence shifters (Mehta & Chandra, 2019; Polanyi & Zaenen, 2006) in the polarity computation. Valence shifters are specific words that modify the degree of positivity or negativity of the term that they closely precede or follow. More specifically, we include negators (e.g. not, never, etc.) and adversative conjunctions (e.g. but, however, etc.) that, if occurring in the neighbourhood of the word (between 4 words before and 2 words after), invert the sign of the word polarity. In addition, we include amplifiers (deamplifiers)[11] that, if occurring in the neighbourhood of the word, amplify (deamplify) the word sentiment polarity by multiplying it by 1.8 (0.2). Finally, we constrain the aggregated sentiment scores between -

[8]*Sentix* can be freely downloaded from: http://valeriobasile.github.io/twita/downloads.html.
[9]Details on Sentix and the polarity computation for each Italian lemma are available on the project webpage: http://valeriobasile.github.io/twita/sentix.html.
[10]We use the function *txt_sentiment* whose details are available on the webpage: https://rdrr.io/cran/udpipe/man/txt_sentiment.html.
[11]Some examples of English amplifiers are 'really', 'exceptionally', 'extremely', 'very', 'totally'. Conversely, some examples of English deamplifiers are 'slightly', 'somewhat', 'barely', 'little', 'partly'. The list of Italian amplifiers/deamplifiers used in this study is available on request.

1 and +1 by using the related option of the *udpipe* sentiment function that exploits the properties of the standard logistic function.

We run our regression estimations for average weekly values of all variables at the municipal level. Therefore, we have an observation for each municipality and week included in our sample. This specification may produce benefits in terms of robustness and simplification of the models. Indeed, it allows the inclusion in the regression models of municipality and time (year-week) fixed effects to respectively account for time-invariant unobserved variables at the municipality level and macro contextual factors that could equally affect the capital municipalities in each week of the year. These macro contextual factors may include legal restrictive or support measures at national level, macroeconomic factors, and the changing psychological perception of citizens about the severity of the pandemic.

Hence, to test our hypothesis H1, we estimate the following Eq. (1) regression using a Tobit model (Cameron & Trivedi, 2010) given that the sentiment polarity dependent variable is censored between -1 and +1:

$$TONE_{it} = \beta_0 + \beta_1\, COVID\_TP1_{it} + \beta_2\, COVID\_TP2_{it} + \sum_k \beta_k\, CTRLS^k_{it} + m_i + w_t + e_{it} \qquad (1)$$

where for municipality i in year-week t over the study period, *TONE* is the previously defined sentiment polarity of Facebook posts; *COVID_TP1* is the prevalence of the topic on COVID-19 restrictive measures; *COVID_TP2* is the prevalence of the topic on COVID-19 support measures; $CTRLS^k$ is a set of k control variables; m_i denotes unobserved time-invariant municipality fixed effects; w_t denotes municipality-invariant year-week fixed effects; and e_{it} is the standard error term.

Within the control variables ($CTRLS^k$), we include topic prevalence variables for the other topics identified in the LDA estimation described in the next section, the natural logarithm of the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level (*CASES_COVID*)[12], and the natural logarithm of the number of weekly posts on each municipal Facebook page (*N_POSTS*).

[12]The positive cases include both hospitalised patients and home confined people. Updated data about COVID-19 in Italy are publicly available on the official website of the Italian Ministry of Health https://www.salute.gov.it/portale/home.html. COVID-19 data can be downloaded in CSV/JSON format from the repository https://github.com/pcm-dpc/COVID-19.

To test our hypotheses H2 and H3, we estimate the following Eq. (2) regression using a Beta model with logit link (Smithson & Verkuilen, 2006)[13] given that the topic prevalence dependent variable is a proportion taking values greater than 0 and less than 1:

$$TOPIC\_COVID_{it} = \beta_0 + \beta_1\, CASES\_COVID_{it} + \sum_k \beta_k\, CTRLS^k_{it} + m_i + w_t + e_{it} \quad (2)$$

where for municipality i in year-week t over the study period, *TOPIC_COVID* is either the prevalence of the topic on COVID-19 restrictive measures, to test the hypothesis H2, or the prevalence of the topic on COVID-19 support measures, to test the hypothesis H3; *CASES_COVID* is the independent variable of interest defined as in the Eq. (1); $CTRLS^k$ is a set of k control variables including topic prevalence variables for the other topics identified in the LDA estimation and the variable *N_POSTS* as defined in the Eq. (1). The rest of variables are defined as in the Eq. (1).

Finally, to test the remaining hypotheses, we estimate the following Eq. (3) regression using a Beta model with logit link (Smithson & Verkuilen, 2006):

$$TOPIC\_COVID_{it} = \beta_0 + \beta_1\, CASES\_COVID_{it} + \beta_2\, CASES\_COVID_{it} \times MODER_{it} + \sum_k \beta_k\, CTRLS^k_{it} + m_i + w_t + e_{it} \quad (3)$$

where for municipality i in year-week t over the study period, *MODER* is the moderating variable corresponding to each hypothesis[14] and the rest of variables are defined as in the Eq. (2). The moderating variables that we use for the estimations are an indicator variable for left-wing mayors (*LEFT_MR*), a continuous variable for mayor's age in years (*AGE_MR*), and an indicator variable for female mayors (*FEM_MR*).

4 Empirical Results and Analysis

4.1 Topic Model Estimation and Interpretation

Before estimating the LDA topic model, we conduct several pre-processing steps to the corpus of Facebook posts for text cleaning and transforming (Banks et al., 2018)[15]. These steps involve converting all uppercase letters into lowercase and removing punctuation, accents,

[13]We use the STATA 15 command *betareg* for the Beta model estimation.

[14]Variable *MODER* does not appear uninteracted in the model as it is time-invariant at the municipality level and, therefore, it is absorbed by municipality fixed effects.

[15]We use the R package *quanteda* (Benoit et al., 2018) to perform most of the pre-processing steps.

apostrophes, symbols[16], numbers, URLs beginning with http(s), words with less than three characters, and standard Italian stopwords. Stopwords are high-frequency words, commonly consisting of specific parts of speech, which do not provide additional insights for the interpretation of the latent topic (e.g. articles, pronouns, conjunctions, prepositions, etc.). To enhance consistency and relieve computational load (Hoffman et al., 2010), we also include in the stopwords other semantically irrelevant words that appear frequently in our corpus (frequency > 200) such as names of months, days of the week, Italian regions, towns, and first names. In addition, we remove sparse terms appearing in less than 0.025% of the 76,138 posts and frequent terms appearing in more than 80% of the 76,138 posts (Banks et al., 2018) that enhance the computational complexity without significantly contributing to the identification and interpretability of the topics (Roberts et al., 2014). Finally, we avoid performing other popular text pre-processing steps like stemming and lemmatisation given that studies show that, in large corpora, their impact on the performance of topic modelling is insignificant or even negative (Schofield & Mimno, 2016). Indeed, they may remove word distinctions that are often informative (Kern et al., 2016).

We use the pre-processed corpus to generate the document-term matrix, the first input of the LDA estimation, by using the tokenisation and document-feature matrix functions of R package *quanteda* (Benoit et al., 2018). Importantly, we include concatenated bigram terms (sequence of two adjacent terms) as well as individual terms (unigrams) in the LDA estimation. Indeed, frequent bigram terms (e.g. big_data) could be more semantically meaningful than the corresponding individual terms (big and data) and, therefore, help the topic interpretation (Kern et al., 2016).

The second input of the LDA estimation is the number of expected topics. Studies recommend using a combination of statistical methods and human judgment to select the best number of topics (Roberts et al., 2014, 2016). An increase in the number of topics tend to improve the model fit and the human interpretability of resulting topics that are likely to include more exclusive words (Roberts et al., 2014). However, at a certain point, the increase may cause redundancy by making some topics hardly distinguishable from each other for humans (Chang et al., 2009). On the other hand, selecting too few topics for the LDA estimation may lead to unnecessary generalisations. Prior research recommends that the needed trade-off should be guided by a principle of parsimony (Banks et al., 2018).

[16]All symbols included in the Unicode class S.

As there is no statistical method generally accepted as superior to select the best number of topics, we use several statistical metrics to identify the number of topics that leads to the best score (minimum or maximum) for most of them. Specifically, we use the R package *ldatuning* (Nikita & Chaney, 2020) to apply four methods. Namely, the *Arun2010* method, based on Arun et al. (2010), considers LDA as a matrix factorization of a given corpus whose quality depends on the right number of topics chosen. Arun et al. (2010) show that the minimum value of the symmetric KL-Divergence of salient distributions, derived from these matrix factors, identifies the optimal number of topics. The *CaoJuan2009* method, based on Cao et al. (2009), finds the optimal number of topics based on the topic density. It assumes that the LDA model performs best when the average cosine distance between topics is minimized. The *Deveaud2014* method, based on Deveaud et al. (2014), considers as the optimal number of topics that which maximizes the information divergence (Jensen-Shannon divergence) between all pairs of topics in a given LDA model. Finally, the *Griffiths2004* method, based on Griffiths and Steyvers (2004), selects the best number of topics that leads to the maximum log-likelihood approximation of the LDA model. Figure 1 shows the graphs of these four metrics for different numbers of topics ranging from 3 to 20.

(Insert Figure 1 here)

Regarding the metrics *CaoJuan2009* and *Arun2010* to be minimized, they tend to decrease with the increase of the number of topics. However, their improvement, especially that of *CaoJuan2009* metric, is marginally decreasing beyond nine topics as their curves start flattening. Similarly, the metrics *Deveaud2014* and *Griffiths2004*, to be maximized, tend to increase with the number of topics. Nevertheless, at nine topics *Deveaud2014* reaches the maximum and beyond nine topics the improvement rate of *Griffiths2004* diminishes significantly. Overall, the four metrics suggest that nine topics might be the best given that the relatively low model performance gains beyond nine topics may not outweigh the negative effect of additional topics on the human ability to differentiate between them (Chang et al., 2009).

Another metric widely used to select the best number of topics is the perplexity score (Blei et al., 2003). The perplexity score is a goodness of fit measure on the ability of the probabilistic LDA model to predict the sample. A lower perplexity indicates a better prediction. Using a subsample of 70% of our Facebook posts, we train several LDA models[17] with a number of

[17]We use the R package *topicmodels* (Grün & Hornik, 2011) to estimate the LDA models.

topics ranging from 3 to 20. Subsequently, we compute and plot the perplexity score of each LDA model over the held-out subsample of 30% of our Facebook posts. Figure 2 shows the graphs of the perplexity score for each number of topics using both training data (dotted line) and held-out data (continuous line).

(Insert Figure 2 here)

It is noteworthy that the perplexity decreases as the number of topics increases, indicating a better prediction of the held-out data. The slope of the curves and, therefore, the improvement rate decreases with the number of topics. Similar to the metrics of Figure 1, the improvement rate starts becoming relatively low beyond nine topics. Therefore, the perplexity score analysis provides further evidence that nine topics might be the best choice for our LDA estimation.

We use our human judgement to confirm that any LDA estimation with more than nine topics does not produce any topic clearly distinguishable from those resulting from the estimation with nine topics. More specifically, any LDA estimation with more than nine topics[18] produces a minimum of two topics containing at least five identical or semantically similar words in the top ten words (Jaworska & Nanda, 2018). In addition, previous studies find that in normal conditions the content posted by Western European local governments on their Facebook pages could be represented by a number of topics even lower than nine (Bonsón et al., 2015, 2019; Gesuele et al., 2016; Hofmann et al., 2013)**.**

As in previous studies (Geva et al., 2019; Griffiths & Steyvers, 2004), we estimate the LDA model with nine topics by using Gibbs sampling with hyperparameters $\alpha = 50/T$, where T is the number of selected topics, $\beta = 0.1$, and number of iterations = 1,000. Following the estimation, we label each topic based on the 20 most likely words automatically assigned to each topic. Each of the four co-authors of this study independently proposes the labels after reading the five most representative posts per topic to confirm the semantic validity of their proposals (Roberts et al., 2019). Finally, we agree on the final labels by majority rule. Table 1 shows the top 20 most likely Italian words for each topic, in descending order of probability, with their English translation and the label assigned to each topic.

(Insert Table 1 here)

[18]We test LDA estimations with 10, 11, 12, and 13 topics.

Interestingly, we identify two topics related to COVID-19. Namely, the topic 1 that we label as 'COVID-19 restrictive measures' due to the highly probable words 'coronavirus' and 'COVID-19' accompanied by the word 'measures' and semantically similar words such as 'ordinance', 'decree', 'provisions', and references to restrictions like 'closure', 'containment', among others. In addition, we label the topic 3 as 'COVID-19 support measures' due to the highly probable words 'coronavirus' and 'COVID-19', other words referring to public support initiatives such as 'shopping_vouchers'[19], 'public health care', 'solidarity', among others, and words like 'data', 'update', 'situation'. The remaining topics are labelled as follows: topic 2 as 'public order measures', topic 4 as 'commemorative events', topic 5 as 'social and environmental projects', topic 6 as 'cultural events', topic 7 as 'educational services', topic 8 as 'public works', and topic 9 as 'civil protection from calamities'. Except for the two contingent topics related to COVID-19, the other identified topics are mostly consistent with prior findings of studies examining the thematical content of SoMe publications of Western European local governments (Bonsón et al., 2015, 2019; Hofmann et al., 2013).

4.2 Descriptive Statistics and Univariate Analysis

Table 2 shows some descriptive statistics of the regression variables used to test our hypotheses.

(Insert Table 2 here)

Notably, the mean of sentiment polarity (*TONE*) is 0.216, the median is 0.224, and more than 75% of the observations (P25 = 0.020) have a sentiment polarity greater than zero. This provides evidence of the tendency of municipalities to adopt a positive communication strategy through their Facebook pages. As suggested by previous studies, this strategy may aim at enhancing citizen engagement and political consensus and attracting voters (Nave et al., 2018; Stieglitz & Dang-Xuan, 2013).

The average number of weekly posts (*N_POSTS*) of 14.59 and the median of 12 suggest an active usage of Facebook by Italian municipalities. This is consistent with studies finding that Facebook has become the favourite SoMe platform of local governments to inform and interact with their citizens (Bonsón et al., 2017; Enli & Skogerbø, 2013; Guillamón et al., 2016; Larsson & Skogerbø, 2018; Silva et al., 2019).

[19]Shopping vouchers (*buoni spesa*) are financial subsidies disbursed by Italian municipalities for people and families in financial difficulty due to COVID-19 to purchase food, drugs, and basic necessities. Shopping vouchers were established by the decree-law of 25 May 2021, n. 73.

Interestingly, about 53% of the municipalities are governed by left-wing mayors (*LEFT_MYR*), the average and median age of the mayors is 54 (*AGE_MYR*), and only 9.7% of the mayors are women (*FEM_MYR*). This low percentage of female mayors further confirms the unsolved issue of the women's under-representation in the Italian political institutions (Braga & Scervini, 2017).

Regarding the prevalence of the nine topics, the differences between means and medians of all topics appear relatively small considering that each topic prevalence must be between 0 and 1 and the total for all topics should be equal to 1 for each document. Indeed, the means range from a minimum of 0.104 (*COVID-19 support measures*) to a maximum of 0.115 (*Educational services*). Conversely, the medians range from a minimum of 0.095 (*COVID-19 support measures*) to a maximum of 0.108 (*Educational services).* The results show that, during our study period, each contingent COVID-19 related topic has a similar prevalence to the other topics that previous studies find to be typical of the local governments' communication through Facebook (Bonsón et al., 2015, 2019; Hofmann et al., 2013). In this regard, Table 3 shows the pairwise Wilcoxon signed-ranks tests between all topics.

(Insert Table 3 here)

It should be noted that the median of the topic on *COVID-19 restrictive measures* (0.102) is not significantly different at conventional levels[20] from the median of topics on *public order measures* (0.103), *social and environmental projects* (0.105)*,* and *cultural events* (0.104). In contrast, the median of the topic on *COVID-19 support measures* (0.095) is significantly lower than the median of the other topics. However, the median of the topic sum of the two COVID-19 topics (0.205) is about double the median of each of the other topics and significantly higher (p-value < 0.001) based on the two-tailed Wilcoxon signed-ranks test. Overall, our results show that Italian municipalities largely used their official Facebook pages to communicate about COVID-19 during the examined 13 months of the pandemic. These results are consistent with other studies finding that, in Italy, governmental agencies and government representatives extensively resorted to SoMe to inform on COVID-19 and related government decisions (Ruiu, 2020).

Table 4 displays descriptive statistics of COVID-19 topics by month over our study period.

(Insert Table 4 here)

[20]In this study, we consider to be significant any two-tailed p-value lower than 0.05.

The non-parametric Friedman test and the one-way repeated-measures ANOVA test indicate that distributions and means of COVID-19 topics, respectively, significantly change over the 13 months. To better assess the trends of average COVID-19 topics by year-month, we present their charts in Figure 3.

(Insert Figure 3 here)

The charts show that in March 2020 topic 1 on COVID-19 restrictive measures scores the highest prevalence over the examined time series. Indeed, in March 2020 the Italian government adopted the most restrictive measures of the pandemic by placing the Italian population in lockdown, closing non-essential business and industries, suspending public events, and restricting movements and gatherings of people (Ruiu, 2020)[21]. The prevalence of topic 1 decreases in April 2020, during the lockdown period, and it rises again in May 2020 when the Italian government released most of the restrictions. In the following months, the prevalence of topic 1 keeps declining until October 2020 when it peaks again due to further restrictions on movement and social activities introduced by the Italian government to tackle the second wave of COVID-19 affecting the country. The following decrease in the prevalence of topic 1 stops in March 2021, the last month of our series, when the smaller peak may be due to further restrictive measures adopted by the Italian government.

Regarding topic 3 on COVID-19 support measures, it scores the highest prevalence over the examined time series during the lockdown in April 2020 and following the severe government restrictions of March 2020. In the following months, the prevalence of topic 3 declines and starts rising again significantly in September 2020 until it reaches another peak in November 2020 following the government restrictions of October 2020. Finally, the prevalence of topic 3 slightly decreases until March 2021. Overall, this monthly trend analysis of COVID-19 topics suggests that, during the analysed period, Italian municipalities adjusted their communication regarding COVID-19 to the different phases of the pandemic (Mori et al., 2020).

Figure 4 shows the Pearson pairwise correlations among the dependent variables and other covariates included in our regression models.

(Insert Figure 4 here)

[21]A complete description of the measures taken by the Italian government to combat the COVID-19 pandemic in Italy is available on https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Italy.

Notably, the variable *TONE* (sentiment polarity score) is significantly and negatively correlated with the topic 1 on COVID-19 restrictive measures. Furthermore, the variable *TONE* is significantly and positively correlated with the topic 3 on COVID-19 support measures. These results provide univariate support for the hypothesis H1.

Consistent with the hypothesis H2, the topic 1 on COVID-19 restrictive measures is significantly and negatively correlated with the number of positive cases in the municipal area (*CASES_COVID*). On the other hand, the significant and negative correlation between topic 2 on COVID-19 support measures and the variable *CASES_COVID* contrasts with the positive association between the two variables predicted by the hypothesis H3. However, to test our hypotheses, we mostly rely on the multivariate regression analysis, including municipality and year-week fixed effects, whose results are presented in the next section.

Both COVID-19 topics are significantly and negatively correlated with all other topics confirming the particularity of COVID-19 topics and the absence of any related topic strategically associated with them. Finally, the highest negative coefficient (-0.28) and the highest positive coefficient (0.25) are relatively low thus suggesting that collinearity is unlikely to bias our regression estimations. In addition, the average variance inflation factor (VIF) of all covariates is 1.20 and the maximum individual variable VIF is 1.40. This maximum VIF value is far below the maximum cut-off of 10 that prior studies generally consider to exclude multicollinearity concerns in regression estimations (Cameron & Trivedi, 2010).

4.3 Baseline Regression Results

Table 5 presents the estimations of Eq. (1) Tobit regression on the sentiment polarity variable *TONE* to test the hypothesis H1.

(Insert Table 5 here)

We show four specifications. Specifically, in the specification 1, we only include the topic on COVID-19 restrictive measures out of the nine identified topics. In the specification 2, we only include the topic on COVID-19 support measures. In the specification 3, we include both COVID-19 topics. Finally, in the specification 4, we include both COVID-19 topics and the other topics except topic 9. Topic 9 is omitted in the estimation to avoid perfect collinearity among the topics[22].

[22]In LDA topic modelling, topic prevalences add up to 1 for each document of the corpus.

Interestingly, the coefficient on *COVID-19 restrictive measures* is negative and significant ($p < 0.01$) in all related specifications, indicating that a higher prevalence of this topic is associated with a more negative tone of the municipalities' communication. These results suggest that the communication on COVID-19 restrictive measures may tend to be purely prescriptive and not included in a broader persuasion strategy aimed at positively engage citizens in the fight against the pandemic (Mori et al., 2020). On the other hand, the coefficient on *COVID-19 support measures* is positive and significant ($p < 0.01$) in all related specifications, indicating that a higher prevalence of this topic is associated with a more positive tone of the municipalities' communication. Overall, these results provide support for our hypothesis H1.

Table 6 reports the estimations of Eq. (2) Beta regression on the two COVID-19 topics to test hypotheses H2 and H3.

(Insert Table 6 here)

We present two specifications for each COVID-19 topic regression. The specifications 1 do not include control variables for the other non-COVID-19 topics, whereas the specifications 2 include these control variables. Notably, the coefficient on *CASES_COVID* is not significant at conventional levels in the specification 1 of the *COVID-19 restrictive measures* regression. In contrast, in the specification 2 of the *COVID-19 restrictive measures* regression, the coefficient on *CASES_COVID* is negative and significant ($p < 0.01$) suggesting that, controlling on the other non-COVID-19 topics, an increase in COVID-19 positive cases is associated with a lower prevalence of the topic on COVID-19 restrictive measures relative to the topic on COVID-19 support measures.

Therefore, despite the increase in the number of positive cases, municipal incumbents may not post more on COVID-19 restrictive measures to avoid arousing negative emotions in their voters. Indeed, these negative emotions may boost the voters' perception of incumbents' inability to effectively tackle the pandemic and, therefore, erode the political consensus. Overall, these results provide support for the hypothesis H2.

In the specification 1 of the *COVID-19 support measures* regression, the coefficient on *CASES_COVID* is positive and significant ($p < 0.01$), suggesting that municipalities tend to post more on COVID-19 support measures when the number of COVID-19 positive cases grows. The coefficient on *CASES_COVID* remains positive and significant ($p < 0.05$) in the specification 2 after controlling on non-COVID-19 topics. These results provide support for the

hypothesis H3. Hence, they may reveal a communication strategy of municipal incumbents aimed at enhancing voters' perception about their effective response to the pandemic through the promotion of related support measures (Gallego, 2018; Masiero & Santarossa, 2021).

Table 7 reports the estimations of Eq. (3) Beta regression on the two COVID-19 topics to test hypotheses H4, H5, H6, and H7. We estimate the same two regression specifications as those of the Eq. (2) estimations and we report the effect of each moderating variable in a different table panel.

(Insert Table 7 here)

Notably, in Panel A, the coefficient on the interaction variable *CASES_COVID×LEFT_MR* is not significant at conventional levels in any specification of the *COVID-19 restrictive measures* regression and in the specification 2 of the *COVID-19 support measures* regression. In contrast, this coefficient is negative and significant ($p < 0.01$) in the specification 1 of the *COVID-19 support measures* regression. These results lead to reject the null hypothesis H4 and fail to reject the null hypothesis H5. More specifically, when the number of positive cases grows, municipalities led by right-wing mayors tend to promote COVID-19 support measures more on their Facebook pages than municipalities led by left-wing mayors do. Conversely, the mayor's ideology does not moderate the relation between *COVID-19 restrictive measures* and number of positive cases. These results may be explained by the fact that constituency and supporters of Italian right-wing parties, including small and medium-sized entrepreneurs and self-employed workers, have been significantly affected by the pandemic. Therefore, promoting public support measures could be a strategy of these parties to increase the political consensus among their voters (Klomp, 2019).

In Panel B, the coefficient on the interaction variable *CASES_COVID×AGE_MR* is not significant at conventional levels in the specification 1 of the *COVID-19 restrictive measures* regression, whereas it is negative and significant ($p < 0.01$) in the specification 2. Furthermore, the coefficient on the interaction variable *CASES_COVID×AGE_MR* is positive and significant ($p < 0.01$) in both specifications of the *COVID-19 support measures* regression. Consistent with the hypothesis H6, these results provide evidence that when the number of positive cases grows, municipalities led by older mayors tend to post less on COVID-19 restrictive measures and more on COVID-19 support measures than municipalities led by younger mayors.

Finally, in Panel C, the coefficient on the interaction variable *CASES_COVID×FEM_MR* is not significant at conventional levels in any specification of the estimated regressions. These

results fail to support the hypothesis H7. In this regard, the low percentage of municipalities governed by female mayors (9.7%) in our sample may partially explain why the gender of the mayor does not moderate the association between COVID-19 topics and number of positive cases.

4.4 Robustness Checks and Extensions

4.4.1 Proportion of COVID-19-Related Posts as Dependent Variable

As a robustness check, we estimate the Eq. (2) regression model by replacing the dependent variables based on the prevalence of COVID-19 topics with the proportion of COVID-19-related posts for every year-week of our study period. We adopt a conservative approach by assuming a post to be mostly related to COVID-19 restrictive measures or COVID-19 support measures when, within the post, the COVID-19 topic scores the highest prevalence among all topics and this prevalence is a least 15%[23]. Table 8 shows the estimations of the Eq. (2) regression using a fractional logit model (Papke & Wooldridge, 2008). The fractional logit model is appropriate in our context as that the dependent variable (proportion of COVID-19-related posts) takes values between 0 and 1 and may also be equal to 0 or 1.

(Insert Table 8 here)

Interestingly, the coefficient on *CASES_COVID* is not significant at conventional levels in any specification of the regression on *proportion of posts on COVID-19 restrictive measures*. Conversely, the coefficient on *CASES_COVID* is positive and significant ($p < 0.01$) in both specification of the regression on *proportion of posts on COVID-19 support measures*. Overall, these results strengthen the findings from the estimations of the Eq. (2) regression model with prevalence of COVID-19 topics as dependent variables and provide further support for the assumptions underlying the hypotheses H2 and H3.

4.4.2 The Role of Political Incentives

To further test the role of political incentives in the COVID-19 communication on municipal Facebook pages, we estimate the Eq. (3) regression model with two additional moderating variables related to mayor's political incentives. Specifically, previous research finds that higher political competition in local elections induces local governments to promote more their

[23]We repeat our analysis by considering minimum thresholds of 10%, 20%, 25%, 30%, 35% and 40% for COVID-19-related topics and the results, available on request, are qualitatively analogous to those presented in this paper.

activities on their official SoMe and websites to strengthen their political consensus among citizens (Silva et al., 2019; Tavares & da Cruz, 2017). Hence, we test the effect of the moderating variable margin of victory (*MAR_VICT*) on the association between COVID-19 topics and number of positive cases. As in previous studies (Ahn, 2011; Araujo & Tejedo-Romero, 2016; Silva et al., 2019), we define the margin of victory as the difference, in percentage points, between the percentage of votes obtained by the elected mayor and the second most voted candidate in the first round of the latest local elections[24].

The second moderating variable that we test is an indicator variable for mayors being in their first term of office (*TERM1*)[25]. Indeed, according to the Italian law[26], a mayor in office for two consecutive terms cannot be re-elected. Therefore, to increase her/his chances of re-election, a mayor in the first term of office may have stronger incentives to use SoMe for self-promotion and political marketing (Agostino & Arnaboldi, 2016; Bonsón et al., 2017; Silva et al., 2019). Table 9 presents the results of these additional estimations. We estimate the same two regression specifications as those of the Eq. (2) estimations and we report the effect of each moderating variable in a different table panel.

(Insert Table 9 here)

In Panel A, the coefficient on the interaction variable *CASES_COVID×MAR_VICT* is positive and significant ($p < 0.01$) in the specification 2 of the *COVID-19 restrictive measures* regression, whereas it is negative and significant ($p < 0.01$) in both specifications of the *COVID-19 support measures* regression. This means that, when the number of positive cases grows, mayors with a higher margin of victory and, therefore, a stronger political position due to lower political competition may have fewer incentives to foster their political legitimacy by downplaying negative information on COVID-19 restrictive measures and promoting positive information on COVID-19 support measures on municipal Facebook pages.

In Panel B, the coefficient on the interaction variable *CASES_COVID×TERM1* is negative and significant ($p < 0.05$) in the specification 2 of the *COVID-19 restrictive measures* regression, whereas it is negative and significant ($p < 0.01$) in both specifications of the *COVID-19 support measures* regression. Therefore, relative to mayors in the second term of office,

[24]Based on Legislative Decree n. 267/2000, in Italian municipalities above 15,000 inhabitants, a candidate is elected mayor in the first round of municipal elections if he/she obtains the absolute majority of valid votes. If none of the running candidates receives more than 50% of valid votes during the first round, the two most voted candidates run in a second-round ballot after two weeks.

[25]In our sample, about 70% of mayors are in their first term of office.

[26]Article 52 of Legislative Decree n. 267/2000.

when the number of positive cases grows, mayors in the first term of office aspiring to re-election may have more incentives to foster their political consensus by downplaying negative information on COVID-19 restrictive measures and promoting positive information on COVID-19 support measures on municipal Facebook pages.

4.4.3 Analysis of non-COVID-19 Topics

The severity of the pandemic in terms of number of COVID-19 positive cases may also affect the prevalence of other non-COVID-19 topics on municipal Facebook pages. Indeed, on the one hand, the organization of social activities and events and the related communication by municipalities may be constrained by the number of positive cases. On the other hand, when the number of positive cases grows, municipalities may try to distract citizens and relieve their stress by posting more on positive and socially relevant topics. That said, we perform an exploratory analysis and estimate the Eq. (2) regression model on each of the non-COVID-19 topics. We report two specifications for each regression. The specifications 1 do not include control variables for COVID-19 topics, whereas the specifications 2 include these control variables. Table 10 present the results of these estimations only for topic regressions whose variable of interest *CASES_COVID* is significant at conventional levels[27].

(Insert Table 10 here)

Notably, the coefficient on *CASES_COVID* is negative and significant at least in one specification of the regressions on topics related to commemorative events and social and environmental projects. These results suggest that when the number of positive cases grows, municipalities may decrease their communication on social activities and events that may cause more infections. On the other hand, the coefficient on *CASES_COVID* is positive and significant at least in one specification of the regressions on topics related to educational services and civil protection from calamities. Therefore, when the number of positive cases grows, municipalities may inform more on services related to education that have high social relevance and arouse positive emotions among citizens. In addition, municipalities may post more on civil protection from calamities to discourage movements and travels that can boost COVID-19 infections especially when the number of positive cases rises.

[27]Results of untabulated estimations for the other topics are available on request.

5 Conclusions and Discussion

We examine how Italian municipalities manage the COVID-19 communication on their official Facebook pages. For this purpose, to extract latent topics from Facebook posts, we apply the LDA topic modelling procedure on a sample of 76,139 posts published on the official Facebook pages of 103 Italian provincial capital municipalities over the COVID-19 pandemic period from 1 March 2020 to 26 March 2021. We identify two topics related to COVID-19 consisting of COVID-19 restrictive measures and COVID-19 support measures. Subsequently, using regression models including both municipality and year-week fixed effects, we find that the prevalence of the topic on COVID-19 restrictive measures negatively affects the tone of communication. Conversely, the prevalence of the topic on COVID-19 support measures positively affects the tone of communication. More importantly, we show that the number of COVID-19 positive cases in the municipal area is negatively associated with the prevalence of the emotionally negative topic on COVID-19 restrictive measures and positively associated with the emotionally positive topic on COVID-19 support measures.

These associations may provide evidence of a strategically positive communication of municipalities aimed at inducing positive perceptions in their citizens about the ability of municipal incumbents to effectively respond to the pandemic through suitable support measures. Furthermore, we find that these associations are strengthened for municipalities led by right-wing mayors and older mayors. Finally, the role of political incentives is confirmed by an additional analysis revealing that mayors with a stronger political position, granted by a higher margin of victory, tend to strategically manage less their COVID-19 communication to foster their political consensus. In contrast, the strategic management of COVID-10 communication is stronger for mayors in their first term of office that, unlike mayors in their second term, are allowed to run in the following elections.

Our findings may have some policy implications for possible public regulators of local governments' disclosures on SoMe. Specifically, during emergency situations arising from natural disasters or health crises the public interest in properly informing and engaging citizens should prevail over political incentives that may bias the information and create conflicts with information coming from other public bodies or central government. Biased information disseminated by local governments may undermine the credibility of recommendations provided by central government or other governmental agencies (Ruiu, 2020). A regulation of SoMe like that of official websites is hardly achievable in the short term. However, some alternative solutions may involve defining common internal municipal policies regarding the

SoMe communication of municipalities that may ensure greater consistency and objectivity of the SoMe communication. In addition, the definition of qualified roles for managing the SoMe communication that should be independent from elected political bodies may contribute to a more reliable, consistent, and politically independent communication.

However, our findings have some limitations. First, the LDA topic modelling procedure requires some subjective interpretation of the latent topics based on the most probable related terms as well as a prior definition of the best number of topics. Second, our sample only consists of the provincial capital municipalities and the results may be different for smaller municipalities. Finally, we address endogeneity concerns by including both municipality and year-week fixed effect in our regression models. However, we cannot exclude the presence of correlated omitted variables that may bias our estimations.

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Table 1. Top 20 most probable words by labelled topic

	Top 20 most probable words	
Topic label	**Original Italian words**	**English translation**
1) COVID-19 restrictive measures	attivita; ordinanza; misure; regione; salute; decreto; coronavirus; covid-19; presidente; disposizioni; nuove; chiusura; commerciali; dpcm; pubblico; contenimento; vigore; interno; sicurezza; spostamenti	activity; ordinance; measures; region; health; decree; coronavirus; covid-19; president; provisions; new; closure; commercial; prime minister's decree; public; containment; force; indoor; safety; travels
2) Public order measures	comunale; sindaco; assessore; amministrazione; polizia; amministrazione_comunale; giunta; president; ordine; locale; seduta; sport; stampa; polizia_locale; approvato; polizia_municipale; struttura; piano; manifestazione; controlli	municipal; mayor; council member; administration; police; municipal_administration; council; president; order; local; session; sport; press; local_police; approved; municipal_police; structure; plan; demonstration; checks
3) COVID-19 support measures	emergenza; coronavirus; covid-19; buoni_spesa; dati; sanitaria; cittadini; casa; consegna; domicilio; regione; aggiornamento; difficolta; casi_positivi; solidarietà; alimentari; situazione; asl; mascherine; base	emergency; coronavirus; covid-19; shopping_vouchers; data; health; citizens; home; delivery; residence; region; update; difficulty; positive_cases; solidarity; food; situation; public healthcare; masks; base
4) Commemorative events	giornata; palazzo; museo; occasione; arte; musei; mostra; piazza; nazionale; donne; buongiorno; storia; cerimonia; memoria; visita; vittime; associazione; internazionale; aperta; comunità	day; building; museum; occasion; art; museums; show; square; national; women; good morning; history; ceremony; memory; visit; victims; association; international; open; community
5) Social and environmental projects	progetto; sociale; raccolta; iniziativa; giovani; centro; collaborazione; rifiuti; incontro; progetti; lavoro; politiche; partecipazione; associazioni; partecipare; mobilita; cittadini; università; ambiente; operatori	project; social; collection; initiative; young people; centre; cooperation; waste; meeting; projects; employment; policies; participation; associations; participate; mobilise; citizens; university; environment; operators

Table 1. Top 20 most probable words by labelled topic

	Top 20 most probable words	
Topic label	**Original Italian words**	**English translation**
6) Cultural events	cultura; diretta; teatro; programma; appuntamento; biblioteca; streaming; festival; eventi; turismo; musica; evento; pagina; prenotazione; edizione; unica; bambini; canale; spettacolo; concerto	culture; live; theater; program; appointment; library; streaming; festival; events; tourism; music; event; page; reservation; edition; unique; children; channel; show; concert
7) Educational services	servizi; pubblico; sito; scuole; scuola; servizio; avviso; domande; comunali; ufficio; modalita; uffici; famiglie; contributo; scolastico; infanzia; bando; sostegno; pubblicato; richiesta	services; public; site; schools; school; service; notice; applications; municipal; office; mode; offices; families; contribution; educational; childhood; announcement; support; published; request
8) Public works	lavori; piazza; area; interventi; corso; viale; nuova; intervento; parco; sicurezza; centro_storico; sosta; tratto; strada; storico; realizzazione; quartiere; riqualificazione; verde; manutenzione	works; square; area; interventions; street; avenue; new; intervention; park; safety; old_town; stop; stretch; road; historic; realization; neighborhood; redevelopment; green; maintenance
9) Civil protection from calamities	servizio; protezione_civile; informazioni; numero; possibile; cittadini; allerta; meteo; centro; maggiori; regionale; avviso; cittadinanza; informa; territorio; attenzione; rischio; partire; condizioni; gialla	service; civil_protection; information; number; possible; citizens; alert; weather forecast; centre; further; regional; notice; citizenship; inform; territory; attention; risk; leave; conditions; yellow

Notes: The words for each topic are presenting in descending order of probability as they come out of the LDA model estimation.

Table 2. Descriptive statistics of regression variables

Variables	N	Mean	Std	P25	Median	P75	Min	Max
TONE	5207	0.216	0.345	0.020	0.224	0.423	-1.000	1.000
TOPICS:								
1) COVID-19 restrictive measures	5207	0.115	0.044	0.090	0.102	0.125	0.052	0.603
2) Public order measures	5207	0.112	0.032	0.091	0.103	0.124	0.044	0.340
3) COVID-19 support measures	5207	0.104	0.033	0.085	0.095	0.113	0.042	0.351
4) Commemorative events	5207	0.111	0.031	0.091	0.106	0.127	0.043	0.367
5) Social and environmental projects	5207	0.111	0.030	0.093	0.105	0.121	0.044	0.440
6) Cultural events	5207	0.112	0.039	0.088	0.104	0.127	0.044	0.520
7) Educational services	5207	0.115	0.034	0.094	0.108	0.127	0.050	0.472
8) Public works	5207	0.113	0.034	0.091	0.106	0.127	0.040	0.514
9) Civil protection from calamities	5207	0.107	0.037	0.088	0.098	0.112	0.043	0.628
Total COVID topics (1 + 3)	5207	0.219	0.055	0.182	0.205	0.243	0.097	0.657
CASES_COVID	5207	1,647.0	1,936.3	170.66	715.42	2,799.4	0.000	12,796.1
CASES_COVID (log)	5207	6.325	1.875	5.145	6.574	7.938	0.000	9.457
N_POSTS	5207	14.59	11.80	6.00	12.00	20.00	1.00	122.00
N_POSTS (log)	5207	2.34	0.90	1.79	2.48	3.00	0.00	4.80
LEFT_MR	5207	0.531	0.499	0	1	1	0	1
AGE_MR	5207	54.12	10.31	45.82	54.05	62.28	32.62	84.95
FEM_MR	5207	0.097	0.296	0	0	0	0	1

Notes: The sample period is from 1 March 2020 to 26 March 2021. N is the number of municipality-weeks in the sample. *TONE* is the sentiment polarity score of municipal Facebook posts; TOPICS includes the prevalence of each topic from LDA estimation; *CASES_COVID* is the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level; *N_POSTS* is the number of weekly posts on each municipal Facebook page; *LEFT_MR* is an indicator variable for left-wing mayors; *AGE_MR* is the mayor's age in years; *FEM_MR* is an indicator variable for female mayors.

Table 3. Pairwise Wilcoxon signed-ranks tests between topics

TOPICS	1	2	3	4	5	6	7	8	9	10
1) COVID-19 restrictive measures	NA									
2) Public order measures	NS	NA								
3) COVID-19 support measures	***	***	NA							
4) Commemorative events	*	**	***	NA						
5) Social and environmental projects	NS	NS	***	**	NA					
6) Cultural events	NS	NS	***	***	NS	NA				
7) Educational services	***	***	***	***	***	***	NA			
8) Public works	***	**	***	NS	***	**	***	NA		
9) Civil protection from calamities	***	***	***	***	***	***	***	***	NA	
10) Total COVID topics (1 + 3)	***	***	***	***	***	***	***	***	***	NA

Notes: *, ** and *** denote significance levels at 10% ,5% and 1%, respectively, based on a two-tailed Wilcoxon signed-ranks test for the differences in medians of topic prevalences. NS stands for 'not significant' and NA stands for 'not applicable'.

Table 4. Descriptive statistics of COVID-19 topics by month

		COVID-19 restrictive measures			COVID-19 support measures		
Year-month	**N. posts**	**Mean**	**Median**	**Std**	**Mean**	**Median**	**Std**
2020-03	7,294	0.156	0.110	0.108	0.124	0.105	0.067
2020-04	6,507	0.124	0.097	0.084	0.141	0.109	0.088
2020-05	5,889	0.134	0.099	0.094	0.107	0.090	0.064
2020-06	4,952	0.107	0.091	0.061	0.096	0.087	0.049
2020-07	5,517	0.098	0.090	0.048	0.092	0.084	0.050
2020-08	4,561	0.100	0.089	0.059	0.092	0.083	0.054
2020-09	5,312	0.098	0.088	0.049	0.093	0.084	0.053
2020-10	5,845	0.117	0.091	0.087	0.099	0.086	0.064
2020-11	5,943	0.111	0.090	0.078	0.113	0.090	0.083
2020-12	6,312	0.103	0.088	0.065	0.109	0.089	0.081
2021-01	5,731	0.102	0.087	0.066	0.107	0.085	0.085
2021-02	6,212	0.095	0.085	0.051	0.107	0.085	0.089
2021-03	5,874	0.102	0.087	0.066	0.103	0.086	0.075
Friedman test			***			***	
ANOVA test		***			***		

Notes: *, ** and *** denote significance levels at 10% ,5% and 1%, respectively, based on a two-tailed Friedman test for the differences in topic distributions and a one-way repeated measures ANOVA test for the differences in means of topics over the year-months.

Table 5. Tobit regressions on sentiment polarity of municipal Facebook posts

	TONE			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
TOPICS:				
1) COVID-19 restrictive measures	-0.7266***		-0.6845***	-0.7880***
	(0.245)		(0.244)	(0.251)
3) COVID-19 support measures		1.1843***	1.1306***	1.0357***
		(0.379)	(0.384)	(0.347)
Other topics	No	No	No	Yes
CASES_COVID	0.0213	0.0184	0.0189	0.0217
	(0.016)	(0.016)	(0.016)	(0.015)
N_POSTS	-0.0072	-0.0048	-0.0080	-0.0109
	(0.017)	(0.017)	(0.017)	(0.017)
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of observations	5,207	5,207	5,207	5,207
Pseudo R-squared	0.2191	0.2213	0.2289	0.2513

Notes: *, ** and *** denote significance levels at 10%, 5% and 1%, respectively, based on two-tailed tests. Standard errors clustered at the municipality level are presented in parentheses. *Other topics* are the other topic prevalences except topic 9; *CASES_COVID* is the natural logarithm of the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level; *N_POSTS* is the natural logarithm of the number of weekly posts on each municipal Facebook page; *Municipality FE* denotes municipality fixed effects; *Year-week FE* denotes year-week fixed effects.

Table 6. Beta regressions on COVID-19 topics

	COVID-19 restrictive measures		***COVID-19 support measures***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	0.0033	-0.0176***	0.0191***	0.0146**
	(0.011)	(0.006)	(0.007)	(0.007)
N_POSTS	-0.0184	0.0001	0.0169**	0.0375***
	(0.012)	(0.006)	(0.008)	(0.008)
Other topics	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207

Notes: *, ** and *** denote significance levels at 10%, 5% and 1%, respectively, based on two-tailed tests. Standard errors clustered at the municipality level are presented in parentheses. *CASES_COVID* is the natural logarithm of the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level; *N_POSTS* is the natural logarithm of the number of weekly posts on each municipal Facebook page; *Other topics* are the other non-COVID-19 topics; *Municipality FE* denotes municipality fixed effects; *Year-week FE* denotes year-week fixed effects.

Table 7. Beta regressions on COVID-19 topics with moderating variables

Panel A: The moderating effect of mayor's ideology

	COVID-19 restrictive measures		***COVID-19 support measures***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	0.0071	-0.0189***	0.0260***	0.0181**
	(0.012)	(0.006)	(0.008)	(0.007)
CASES_COVID×LEFT_MR	-0.0058	0.0025	-0.0120***	-0.0064
	(0.006)	(0.003)	(0.004)	(0.004)
N_POSTS	-0.0175	0.0000	0.0176**	0.0377***
	(0.012)	(0.006)	(0.008)	(0.008)
Other topics	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207

Panel B: The moderating effect of mayor's age

	COVID-19 restrictive measures		***COVID-19 support measures***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	0.0001	0.0281***	-0.0589***	-0.0344**
	(0.023)	(0.009)	(0.013)	(0.014)
CASES_COVID×AGE_MR	0.0001	-0.0008***	0.0014***	0.0009***
	(0.000)	(0.000)	(0.000)	(0.000)
N_POSTS	-0.0182	-0.0003	0.0166**	0.0370***
	(0.012)	(0.006)	(0.008)	(0.008)
Other topics	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207

Panel C: The moderating effect of mayor's gender

	COVID-19 restrictive measures		***COVID-19 support measures***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	0.0024	-0.0185***	0.0205***	0.0156**
	(0.011)	(0.006)	(0.007)	(0.007)
CASES_COVID×FEM_MR	0.0061	-0.0008	0.0118*	0.0069
	(0.013)	(0.005)	(0.007)	(0.008)
N_POSTS	-0.0180	0.0005	0.0161**	0.0367***
	(0.012)	(0.006)	(0.008)	(0.008)
Other topics	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207

Notes: *, ** and *** denote significance levels at 10%, 5% and 1%, respectively, based on two-tailed tests. Standard errors clustered at the municipality level are presented in parentheses. *CASES_COVID* is the natural logarithm of the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level; *LEFT_MR* is an indicator variable for left-wing mayors; *AGE_MR* is mayor's age in years; *FEM_MR* is an indicator variable for female mayors; *N_POSTS* is the natural logarithm of the number of weekly posts on each municipal Facebook page; *Other topics* are the other non-COVID-19 topics; *Municipality FE* denotes municipality fixed effects; *Year-week FE* denotes year-week fixed effects.

Table 8. Fractional logit regressions on proportion of COVID-19-related posts

	Proportion of posts on COVID-19 restrictive measures		***Proportion of posts on COVID-19 support measures***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	0.0162	-0.0579	0.2179***	0.1695***
	(0.047)	(0.038)	(0.057)	(0.057)
N_POSTS	-0.1890***	-0.0031	-0.0009	0.2173***
	(0.056)	(0.048)	(0.063)	(0.067)
Other topics	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207
Pseudo R-squared	0.1300	0.2056	0.1559	0.1984

Notes: *, ** and *** denote significance levels at 10%, 5% and 1%, respectively, based on two-tailed tests. Standard errors clustered at the municipality level are presented in parentheses. *CASES_COVID* is the natural logarithm of the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level; *N_POSTS* is the natural logarithm of the number of weekly posts on each municipal Facebook page; *Other topics* are the other non-COVID-19 topics; *Municipality FE* denotes municipality fixed effects; *Year-week FE* denotes year-week fixed effects.

Table 9. Beta regressions on COVID-19 topics with moderating variables

Panel A: The moderating effect of mayor's margin of victory

	COVID-19 restrictive measures		***COVID-19 support measures***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	-0.0026	-0.0243***	0.0264***	0.0216***
	(0.012)	(0.006)	(0.008)	(0.008)
CASES_COVID×MAR_VICT	0.0003*	0.0004***	-0.0004***	-0.0004***
	(0.000)	(0.000)	(0.000)	(0.000)
N_POSTS	-0.0182	-0.0002	0.0174**	0.0375***
	(0.012)	(0.006)	(0.008)	(0.008)
Other topics	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207

Panel B: The moderating effect of mayor's term of office

	COVID-19 restrictive measures		***COVID-19 support measures***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	0.0099	-0.0092	0.0075	0.0047
	(0.014)	(0.006)	(0.008)	(0.007)
CASES_COVID×TERM1	-0.0076	-0.0078**	0.0104**	0.0092**
	(0.008)	(0.003)	(0.005)	(0.004)
N_POSTS	-0.0186	-0.0002	0.0171**	0.0375***
	(0.012)	(0.006)	(0.008)	(0.006)
Other topics	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207

Notes: *, ** and *** denote significance levels at 10%, 5% and 1%, respectively, based on two-tailed tests. Standard errors clustered at the municipality level are presented in parentheses. *CASES_COVID* is the natural logarithm of the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level; *MAR_VICT* is the mayor's margin of victory in the last first round elections; *TERM1* is an indicator variable for mayors being in their first term of office; *N_POSTS* is the natural logarithm of the number of weekly posts on each municipal Facebook page; *Other topics* are the other non-COVID-19 topics; *Municipality FE* denotes municipality fixed effects; *Year-week FE* denotes year-week fixed effects.

Table 10. Beta regressions on non-COVID-19 topics

	Commemorative events		***Social and environmental projects***		***Educational services***		***Civil protection from calamities***	
Variables	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**	**(1)**	**(2)**
CASES_COVID	-0.0157**	-0.0112	-0.0456***	-0.0440***	0.0220**	0.0235***	0.0157*	0.0197**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
N_POSTS	0.0384***	0.0327***	0.0203**	0.0137	-0.0284***	-0.0320***	0.0276**	0.0210**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.011)	(0.011)
COVID-19 topics	No	Yes	No	Yes	No	Yes	No	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-week FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	5,207	5,207	5,207	5,207	5,207	5,207	5,207	5,207

Notes: *, ** and *** denote significance levels at 10%, 5% and 1%, respectively, based on two-tailed tests. Standard errors clustered at the municipality level are presented in parentheses. *CASES_COVID* is the natural logarithm of the number of COVID-19 positive cases per 100,000 inhabitants at the provincial level; *N_POSTS* is the natural logarithm of the number of weekly posts on each municipal Facebook page; *COVID-19 topics* are the COVID-19-related topics; *Municipality FE* denotes municipality fixed effects; *Year-week FE* denotes year-week fixed effects.

Figure 1. Metrics to select the best number of topics

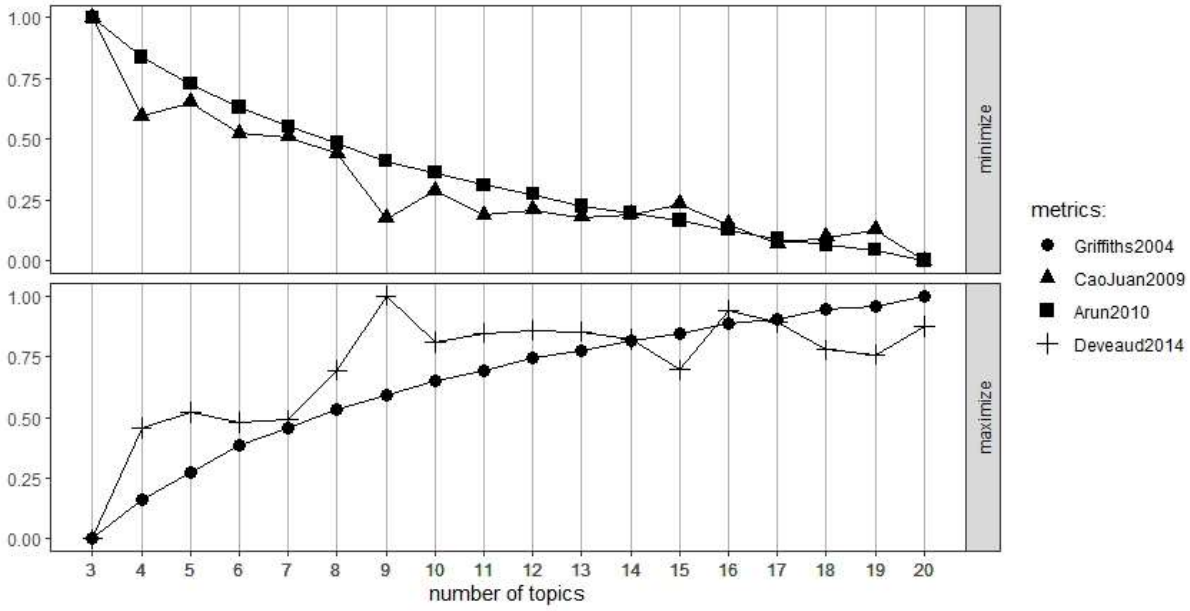


Figure 2. Perplexity score for different numbers of topics

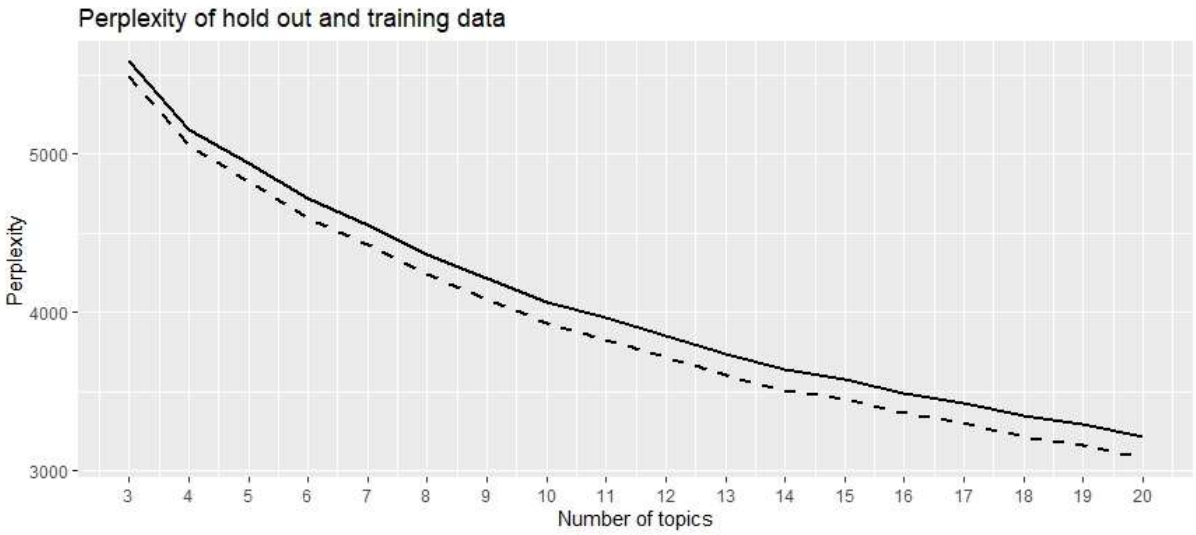


Figure 3. Trend of COVID-19 topics by year-month

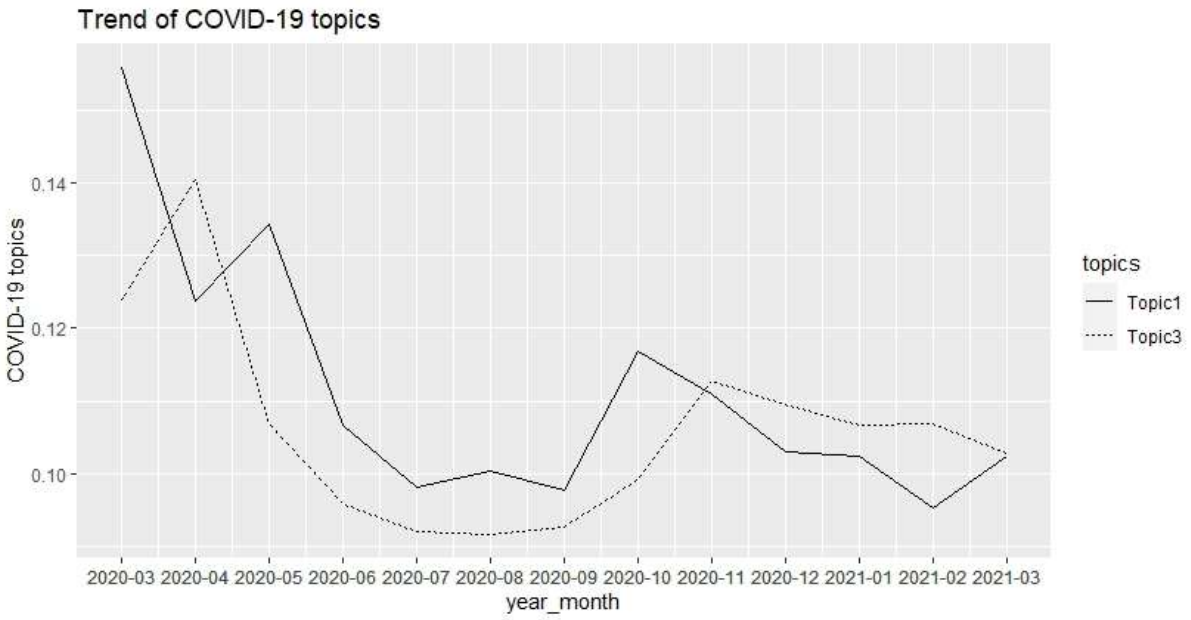
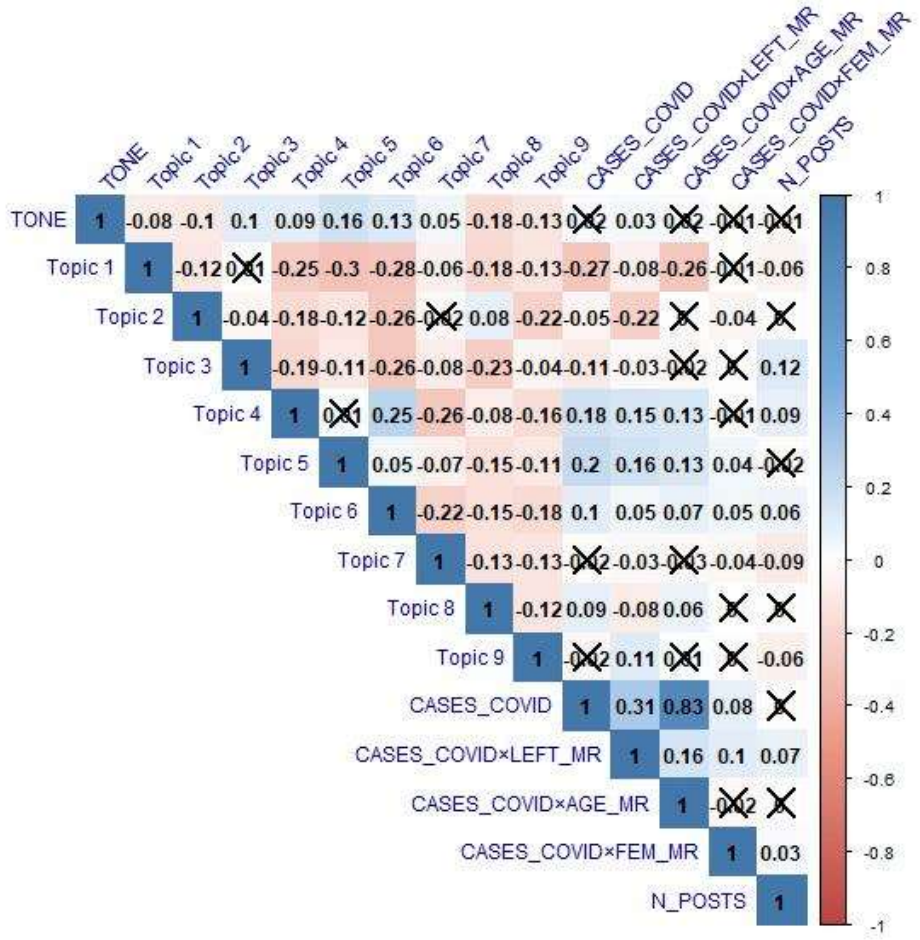


Figure 4. Pearson pairwise correlations among model variables



Notes: All coefficients are significant at least at the 5% level based on a two-tailed test, except crossed out coefficients that are not significant at conventional levels.