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**FOLLOW THE LEADER?
PUBLIC HEALTH
MESSAGING AND
CONTAINMENT OF
MOBILITY DURING A
PANDEMIC**

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FOLLOW THE LEADER? PUBLIC HEALTH MESSAGING AND CONTAINMENT OF MOBILITY DURING A PANDEMIC¹

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Abstract

The effectiveness of widespread policy measures during the COVID-19 pandemic hinges upon compliance with ordinances. This study explores how leaders' discourse relates to compliance with stay-at-home orders to mitigate the spread of COVID-19 in Mexico. It uses municipality-level mobility data from geolocation events of smartphone users and daily briefings from the President and the coronavirus czar. Quantile regressions, sentiment analysis and topic modelling are used to shed light on the dynamics between political discourse and containment of mobility. Discrepancies were found between the content and tone of the President and those of the coronavirus czar. These contrasts translate into differences in the association between the content of the speeches and mobility patterns. The discourse's association to mobility is mediated by awareness of COVID-19-related topics and by individuals' political affiliation.

Keywords: COVID-19, pandemic, public health messaging, non-pharmaceutical prevention measures, compliance, Mexico

JEL codes: D83, D91, H11, H12, I12, I18, O54.

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¿SIGUIENDO AL LÍDER? MENSAJES DE SALUD PÚBLICA Y CONTENCIÓN DE LA MOVILIDAD DURANTE UNA PANDEMIA¹

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Resumen

La eficacia de las medidas de salud pública durante la pandemia de COVID-19 depende de su cumplimiento. Este estudio explora cómo el discurso de los líderes se relaciona con el cumplimiento de los mandatos de quedarse en casa para mitigar la propagación de COVID-19 en México. Este estudio utiliza datos de movilidad a nivel municipal de eventos de geolocalización de usuarios de teléfonos inteligentes y sesiones informativas diarias del presidente y el zar del coronavirus. Se utilizan regresiones cuantílicas, análisis de sentimientos y modelos de temas para explorar la dinámica entre el discurso político y la contención de la movilidad. Se encontraron discrepancias entre el contenido y el tono del Presidente y los del zar del coronavirus. Estos contrastes se traducen en diferencias en la asociación entre el contenido de los discursos y los patrones de movilidad. La asociación del discurso con la movilidad está mediada por la concientización de los temas relacionados con COVID-19 y la afiliación política de las personas.

Palabras clave: COVID-19, pandemia, mensajes de salud pública, medidas preventivas no farmacéuticas, cumplimiento, México.

Clasificación JEL: D83, D91, H11, H12, I12, I18, O54.

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1. Introduction

Leadership and prevention efforts are at the core of public health policies. Many of these efforts entail messaging for the population to take preventive measures. Effective messaging that encourages the public to protect themselves is particularly important for at-risk populations. Air quality warnings, sexual education campaigns and obesity prevention campaigns are notable examples included in the essential toolbox of health policymakers.¹ The coronavirus disease (COVID-19) global pandemic is no exception: even on the eve of massive vaccination campaigns to inoculate the population, flattening the curve by enforcing or recommending social or physical distancing remains a crucial strategy of nearly every public health agency in the world.² The effectiveness of prevention messaging depends on consistency, reinforcement and health authorities' leadership throughout the pandemic (Fraser, 2020; Guest et al., 2020).

People who need to assess the risks of engaging in activities outside the home tend to rely on public authorities for guidance, as research has shown that regular people are not good at evaluating risks in their everyday lives (Tversky & Kahneman, 1974). Furthermore, when the population receives mixed messages regarding a potential health risk, they may update their prior beliefs in a suboptimal way. In the face of the COVID-19 pandemic, leadership is crucial in handling a global health crisis. One of its key components is success in managing populations' behaviour and expectations (Michie et al., 2020). Several countries have struggled to generate confidence in leadership; health ministers have resigned in an array of countries from Czechia to New Zealand, and others have openly contradicted their Presidents, including in Brazil and the United States. In Mexico, the information flow regarding the health measures to be taken has been criticized for lacking credibility and containing inconsistencies and contradictory messages.³

This paper seeks to explore whether leaders' stance on the pandemic and their discourse on public health efforts are effectively mitigating mobility outside of people's homes and social interactions. Effectiveness is measured by looking at changes in people's behaviour (proxied by mobility) and the number of COVID-19 cases and related deaths. To measure leaders' messaging, transcriptions were compiled of daily press conferences by the Mexican President Andrés Manuel López Obrador and his COVID-19 czar, Dr. Hugo López-Gatell. Topic modelling was used to explore whether changes in their pandemic discourse were related to the mobility of the Mexican population during the COVID-19 pandemic, focusing on the period between March and September 2020. Changes in tone and content in messaging regarding the spread and prevalence of COVID-19 have had significant effects on population mobility, which is crucial for containment and the prevention of COVID-19-related deaths.

In addition, this paper explores the association between discourse and public awareness (proxied by exposure to the conferences using Google searches). When more people watch

¹ On the impact of air pollution warnings, see for instance Aguilar-Gomez (2020) and Neidell (2010). Kirby et al. (2007) provides an excellent review of the literature on the impact of sexual education on adolescents and youth. Finally, Kite et al. (2018) reviews the literature on the effect of obesity campaigns.

² As of January 2021, vaccination campaigns had begun in most of the developed world. In Mexico, a slow roll-out began in February 2021.

³ Julio Frenk, the former Health Minister, criticized the communications strategy in June 2020. Even the authorities of the World Health Organization have called for a coherent and consistent message.

the President's daily conferences, the word 'pandemic' has a higher number of searches. In comparison, the same is true of the word 'epidemic' when more people watch Dr. López-Gatell's conferences. Searches for terms like 'vaccine', 'test', 'safe distance', 'stay home' and COVID-related words have a positive and significant association with views of Dr. López-Gatell's conferences. Lastly, tests were conducted to determine whether Google searches also respond to new daily global COVID-19 cases and political affiliation. Since global cases and political affiliation are orthogonal to mobility, these variables may work well as instrumental variables. The test revealed that lagged mobility changes do not impact the discourse of either President López Obrador or Dr. López-Gatell, and it is concluded that Google searches are exogenous.

This work explores how political discourse is associated with the population's compliance with health policy recommendations in Mexico. The first strand of literature to which this study contributes is the work on public health messaging. Previous research has found that news about COVID-19 has an impact on the public's interest, but that this response can be very short-lived, which raises doubts about the potential effectiveness of government messaging (Bento et al., 2020). However, it has been documented that public health communication can raise awareness of infectious diseases and promote the adoption of recommended treatment regimens (Guttman & Salmon, 2004). Research in psychology and political science has highlighted the importance of delivering consistent messages to the public (Guttman & Salmon, 2004). Information is an important mechanism to change individuals' health behaviour (Bursztyn et al., 2020), and citizens are highly susceptible to framing effects in their health choices (Gallagher & Updegraff, 2012). Deslatte (2020) shows that the type of messenger, i.e. the President or other high-ranking officials, can shape the effectiveness of public messaging during emergency conditions, but the message alone matters. This study finds that the two main actors within the Government have diverging messages, impacting the effectiveness of mobility reduction.

This paper will also contribute to the literature on how partisanship can shape the public's compliance with public health policies. Around the world, public messaging during the COVID-19 pandemic has diverged sharply along partisan lines. For instance, in the United States, Republican governors have downplayed the severity of the crisis, while Democratic governors have emphasized the immediate and long-term consequences of the pandemic (Allcott et al., 2020). Fancourt et al. (2020) documented that the violation of lockdown rules by Dominic Cummings, senior aide to Boris Johnson, in the United Kingdom led to a drop in public confidence in the Government's ability to handle the pandemic. Matters can go beyond the public's trust. Political partisanship shapes health policy directly (Green et al., 2020). In the United States, there is evidence that partisanship has a large effect on governors' policy responses during the pandemic (Adolph et al., 2020; Hatem & Young, n.d.). Apart from shaping policy, partisanship and discourses also have an incidence on the public's compliance with health policy recommendations.⁴ In that connection, the study that most relates to these findings is Allcott et al. (2020), who show that partisanship is a strong driver of social distancing in the United States. It should be noted that this paper, as well as most research on partisanship and COVID-19, is based on a developed country.

⁴ In the case of Italy, see Barbieri and Bonini (2020). For the United States, see Allcott et al. (2020), Barrios and Hochberg (2020), Grossman et al. (2020) and MacMillen (2020).

Lastly, this paper also contributes to the COVID-19-specific literature on public policy responses. All countries face the same threat, but government responses vary. Many Governments worldwide have implemented mandatory stay-at-home orders, punishing non-compliance with sanctions that range from a 374-euro fine in France to revoking work passes and stripping people of their permanent resident status in Singapore and Hong Kong. Other Governments have mostly relied on public health recommendations that are not enforceable by law. In the case of Mexico, no punitive measures have been established for individuals, and compliance and oversight have focused on firms, which are subject to fines and closures if they do not comply with the restrictions imposed by the color-coded 'COVID-19 traffic lights' system. Mexico is not alone in this strategy; other countries in the Latin American and Caribbean region are also avoiding imposing sanctions on individuals. In the face of a pandemic—and the accompanying preventive measures—which seems bound to last in the medium term, permanent sanctions appear to be an increasingly unlikely solution. The Mexican experience emphasizing public health messaging over mandatory restrictions can therefore shed light on whether this could be an alternative for more countries in the medium term, especially as global mobility and habitat degradation could result in more frequent pandemic emergencies.

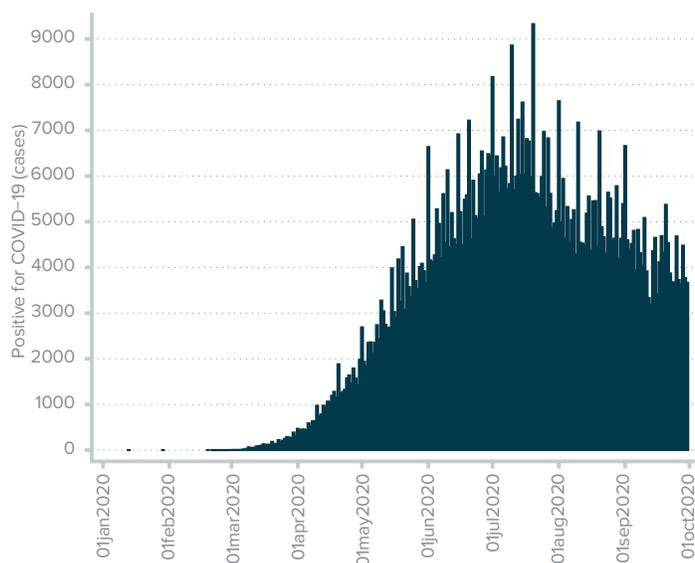
Mexico's political and social landscape differs from that of other regions recently explored in the literature. Nevertheless, it is extremely relevant for other developing countries that have similar conditions but worse data quality. In Mexico, there is a large informal employment sector, workers lack safety nets, and prevalent housing overcrowding challenges compliance with stay-at-home orders. On the other hand, the Government has not provided economic stimuli to individuals and has merely launched a credit programme for a few firms. Hence, lessons for Mexico can be helpful for places where stay-at-home checks are economically or politically infeasible. This study sheds light on the importance of unified public health messaging around non-mandatory health measures. When high-level officials repeatedly contradict each other, non-enforceable recommendations are less effective in reducing mobility and therefore do not halt the spread of a pandemic.

The rest of the paper is organized as follows. Section 1 sets the paper in the Mexican context. Section 2 presents the different data sources and processing methods. Section 3 explains the empirical models. Section 4 shows the results, whereas Section 5 explores plausible mechanisms for these findings and a test for reverse causality. Section 6 concludes.

2. Background: The pandemic in Mexico, policy response, discourse and context

The COVID-19 pandemic, caused by the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first identified in Mexico on 28 February 2020. Figure 1 shows the evolution of lab-confirmed COVID-19 cases using data from the General Directorate of Epidemiology [Dirección Nacional de Epidemiología] from January to September 2020. Within that period, Mexico reached the peak number of cases in late July; however, data up to February 2021 indicates that a new peak was reached in late January.

Figure 1. Daily confirmed COVID-19 cases



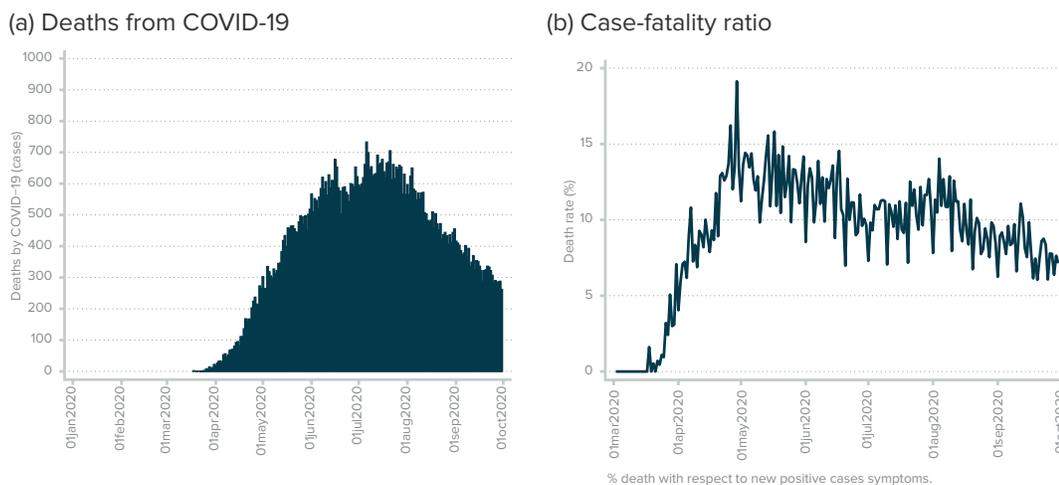
Note: Authors' estimates using data from the General Directorate of Epidemiology from January through September 2020. The figure shows daily confirmed COVID-19 cases. A case is considered confirmed when it has tested positive in a lab test.

There are several indicators that reveal the severity of the pandemic in Mexico. First, an indicator that has been crucial throughout the pandemic is the positivity rate of COVID-19 tests. Since April 2020, Mexico has consistently ranked at the bottom in terms of testing per 100,000 people and among the highest globally in terms of the positivity rate.⁵ At the first peak of the pandemic, positivity rates surpassed 50 percent (see figure A.1 in the appendix). Second, the COVID-19 outbreak has been particularly deadly in Mexico. Figure 2 displays the death counts from confirmed COVID-19 cases. During the July 2020 peak, Mexico reached over 700 daily deaths (see panel (a) in figure 2). Moreover, according to the mortality analysis of Johns Hopkins University, Mexico's observed case fatality averages 9.8 percent, making it the deadliest country using this indicator. If measured against population size, Mexico's deaths per 100,000 population stands at 75.3, the fifth highest in the world.⁶

⁵ On testing, see "Tests per thousand since the 100th confirmed case of COVID-19" in Our World in Data (<https://ourworldindata.org/grapher/total-tests-per-thousand-since-100th-case?time=2020-02-21..latest>). On the positivity rate, refer to "The share of COVID-19 tests that are positive" in Our World in Data (<https://ourworldindata.org/grapher/positive-rate-daily-smoothed?time=2020-04-03>).

⁶ Information retrieved on 10 November 2020 from <https://coronavirus.jhu.edu/data/mortality>.

Figure 2. Deaths due to COVID-19



Notes: Authors' estimates using data from the General Directorate of Epidemiology from January through September 2020. Panel (a) shows reported daily death counts from confirmed COVID-19 cases. Panel (b) shows the percentage of deaths with respect to confirmed COVID-19 cases.

Despite knowing in advance that the pandemic was imminent, the Mexican authorities did not respond quickly or forcefully. Almost a month after confirming the first case, the Mexican Ministry of Health implemented the National Social Distancing Program [Jornada Nacional de Sana Distancia] (JNSD), which lasted from 23 March to 30 May 2020 and consisted of emphasizing stay-at-home recommendations, social distancing and a series of non-pharmaceutical measures aimed at containing the coronavirus pandemic.⁷ Given that the stay-at-home periods were merely a recommendation, leadership messaging became crucial in persuading the population to practice social distancing and stay at home, despite the high economic costs of doing so.

While the COVID-19 czar, Dr. López-Gatell, was constantly messaging the public about JNSD, President López Obrador was still holding massive events in which he continued to have physical contact with the population. Daverio Occhini et al. (2020) have documented that the President's public meetings around the country are associated with increased population mobility. Hence, there is a contradiction between the measures recommended by health authorities and the President's actions and verbal messages. The President usually avoided mask wearing. The first time he wore a mask in public was during his official visit to the United States on 7 July 2020, and he stopped using it afterwards. It is worth noting that President López Obrador was elected with very high public support. He therefore had the potential to use his political capital to steer the public's behaviour towards preventive measures. Similar concerns have been raised by research done in other countries: Ajzenman et al. (2020) find that after Brazil's President publicly and emphatically dismissed the risks associated with the COVID-19 pandemic and advised against isolation, the social distancing measures taken by citizens in pro-government localities weakened compared to places in which political support for the president is less strong.

⁷ JNSD also entailed the closure of all non-essential activities and the cancellation of massive events. The non-pharmaceutical measures included frequent and thorough handwashing or use of hand sanitizers; sneezing and coughing etiquette and hand washing afterwards; avoidance of handshakes, kisses and hugs when greeting others; avoidance of face touching (eyes, nose and mouth, in particular); and self-isolation in cases of cough or fever.

On 1 June, Mexico began using a color-coded system called the ‘COVID-19 traffic lights’ to signal the local risk during the pandemic.⁸ The implementation of the ‘COVID-19 traffic lights’ system shifted the policy discourse around the pandemic from JNSD and strong stay-at-home recommendations to a ‘new normal’ coupled with a phased reboot of economic and social activities. The patterns in Google’s mobility data, which show that cross-country mobility began increasing between May and June 2020 (Google, 2020), suggest that the change in policy discourse altered the risk beliefs among the population, even in geographic areas where the red lights remained active. Perceived optimism in daily messaging may have been interpreted as substantial reductions in health risks and the end of the highest risk scenario. This paper is the first to show that when the COVID-19 czar’s discourse is positive, potentially reflecting optimism, mobility tends to decrease as compared to the baseline.

Mexico’s context further complicated compliance with stay-at-home recommendations. First, slightly over half the population works in the informal sector, and almost half of the population earns incomes below the poverty line. People in the informal sector are less likely to have employment contracts, job stability or safety nets and are more likely to have lower wages and no savings. Second, a sizable share of the population is unable to work from home. Monroy-Gómez-Franco (2020) documented that only 20 to 23 percent of workers can work from home, and they tend to be at the higher end of the income distribution. Lastly, the Government did not implement policies that would enable people or businesses to stop working. Only the Ministry of the Economy modified a previously existing microcredits programme to protect small businesses during the pandemic. By early October 2020, the ministry had awarded 1.2 million single payment credits of roughly US\$1,200 per business. In this context, this research provides a glance at population behaviour when a large proportion does not have the basic infrastructure, social protection or income to comply with non-mandatory stay-at-home orders. This demonstrates that, in the trade-off between mobility and economic activity, some people must be more mobile when they lack a safety net.

3. Data

This research design uses several sources of data, including UNDP-Grandata mobility data, daily press conferences and the number of COVID-19 cases and fatalities. This section describes the data and current relevant descriptive statistics.

3.1. Geographical mobility

UNDP-Grandata data were used, obtained through the call for research proposals issued in August 2020.⁹ Grandata collected geolocation events of smartphone owners using a Mobile Advertising ID (MADID) “hash” from March 1, 2020 through September 20, 2020. These

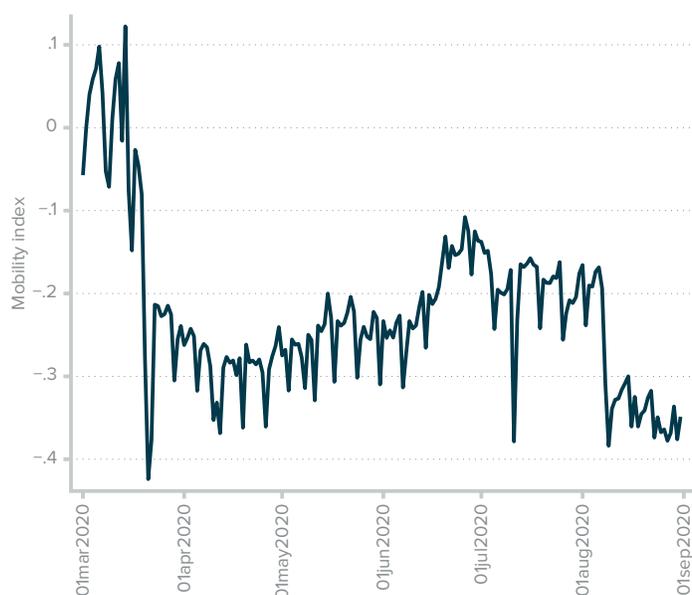
⁸ See <https://datos.covid-19.conacyt.mx/>. In this system, a red light implies that only essential activities can remain open, whereas the green light means “we are back to normal”. Orange and yellow lights have guidelines on the types of activities that can reopen and at what capacity (for instance, under the orange phase, non-essential activities can reopen but only at 30 percent capacity).

⁹ See <https://www.latinamerica.undp.org/content/rblac/en/home/presscenter/pressreleases/2020/exploring-impact-and-response-to-the-covid-19-pandemic-in-latin-.html>

events track smartphone users' mobility patterns for a sizable sample of the population of twelve Latin American and Caribbean countries.

Mobility indicators were constructed by Grandata by dropping all home events and summing the number of 'out-of-home' events for a particular region. Municipality-level mobility data were used to estimate the relation between COVID-19-related health messaging and mobility containment. The data were weighted by municipal population size to obtain representative mobility indicators at the municipal level. Figure 3 presents the evolution of the mobility index changes with respect to 1 March 2020. Mobility began to decrease in mid-March and reached a minimum around the beginning of JNSD. Since then, mobility has varied, though it has not recovered to its pre-March level. There is also evidence of the positive association between mobility and the implementation of the 'COVID-19 traffic lights' in June.

Figure 3. Percentage change in the mobility index relative to 1 March 2020



Note: Authors' estimations using Grandata mobility data for Mexico. The figure shows the percentage change in the mobility index with respect to 1 March 2020 at the national level (estimated using population weights).

3.2. Discourse

Web scraping was used on publicly available stenographic versions of press conferences held by President López Obrador and Dr. López-Gatell from March 2020 through September 2020, taken from the website for the Office of the President of Mexico. Each series of conferences was then processed and classified through natural language processing algorithms. Figures 4 and 5 highlight the differences in content between these conferences.¹⁰ As expected, the COVID-19 press conferences revolve around health topics, prevention

¹⁰ The original analysis was conducted in Spanish, and the Spanish versions of the word clouds are presented in figures A.2 and A.3 in the appendix.

day-municipality level.¹¹ Figures 1 and 2 (previously shown) present the trends of positive cases, fatalities and the case-fatality ratio.

3.4. Control variables and potential sources of heterogeneity

To control for several potential confounding factors and sources of heterogeneity on the mobility responses to the public health discourse, the study included measures of poverty, political affiliation and experience with the influenza A (H1N1) pandemic.

Economic factors have played an essential role in determining compliance during the COVID-19 pandemic in several regions (Wright et al., 2020). Poverty was measured using several indicators with variation at the municipality level obtained from the 2015 inter-census data. The first is housing overcrowding, measured as the ratio of people per room within a household, where 2.5 or above indicates that the household is overcrowded.¹² In addition, the study used several sanitation measures at the household level, such as sewage, trash collection and access to running water. Lastly, the analysis includes a measure for access to broadband Internet.

Political affiliation was proxied using the 2018 federal electoral results at the municipality level, publicly available at the National Electoral Institute [Instituto Nacional Electoral] website. The results of these electoral races were used to identify the winner, the percentage of votes the winner received and the difference in the percentage of votes between the winner and the candidate who finished second. Figure A.4 presents the winner of the races for President, Senate and Chamber of Deputies by municipality. The darkest colors correspond to either the President or the President's party, the National Regeneration Movement (MORENA) [Movimiento Regeneración Nacional]. Although there was an intensive campaign to vote for a single party in all elections, the maps show that voters split their votes in the different races. As a result, there is more variation in political preferences in the Senate and Chamber of Deputies races.

Finally, data for the H1N1 pandemic local experience was measured by the excess deaths from influenza and pneumonia during 2009 and 2010 at the municipality level. The mortality data come from death certificates from the National Health Information System [Sistema de Información en Salud], which record the cause of death using the International Classification of Diseases, as well as the municipality of residence. Since H1N1 is not explicitly identified as the cause of death in these data, estimates were made using the accumulated death counts at the municipal level from influenza and pneumonia (ICD codes J09-J18) and pneumonia of unspecified origin (J18) from 1998 to 2010. Using the pre-H1N1 period, a prediction model was estimated for the number of influenza and pneumonia cases,¹³ which was then applied to 2009 and 2010. Lastly, this prediction and the observed number of potential H1N1-cases were used to estimate the excess deaths during the H1N1 pandemic. Figure A.5 presents the evolution of deaths from influenza and pneumonia (panel (a)) and the distribution of these deaths across the territory (panel (b)).

¹¹ The COVID-19 data set also collected information on patients' age, sex, ethnic origin and comorbidities, as well as variables that convey the severity of the case: whether the patient presented pneumonia, used a respirator or was admitted to an intensive care unit.

¹² This threshold is set by the National Council for the Evaluation of Social Development Policy [Consejo Nacional de Evaluación de la Política de Desarrollo Social].

¹³ The prediction model consisted of a linear regression with controls for municipality fixed effects, municipality-specific time trends and state-specific month fixed effects.

4. Empirical strategy

Automated text analysis was used to classify the content of 504 speeches by the President and the COVID-19 czar, the transcriptions of which have been web scraped from the Office of the President press site. Topic modelling and sentiment analysis were used to quantify the prevalence and nature of COVID-19-related topics in these daily press conferences, as well as the emotions that the discourse conveyed.

The strategy consisted of using topic modelling to identify the changes in the priorities of press conference messages. The approach to topic selection is data-driven, using latent Dirichlet allocation (LDA) as proposed by Blei et al. (2002): a three-level hierarchical Bayesian model. Each document is modeled as a combination of a finite set of topics.¹⁴ In a hierarchical Bayesian model, the distribution of certain parameters depends on other parameters within the model, so it is estimated at different levels hierarchically (Taboga, 2017). LDA assumes the existence of k latent topics over which any document is generated. Each topic is represented as a multinomial distribution over the total number of words in any given vocabulary $|V|$ (in this case Spanish). In this way, a document that has been generated with a subset of words from a given vocabulary has a mixture of latent topics. First, a document with N words is generated in such a way that θ is taken from a Dirichlet distribution of the k possible topics $(\alpha_1, \dots, \alpha_k)$ ($\theta \sim \text{Mult}(\alpha)$).¹⁵ Subsequently, for each of the N words (w_n), a topic z_n sampled from a multinomial distribution is chosen such that $p(z_n = i|\theta) = \theta_i$ ($z_n \sim \text{Mult}(\theta)$).¹⁶ Lastly, each word w_n is sampled conditioned on the distribution of the topic by $p(w_n|z_n; \beta)$ where β is a $k * |V|$ matrix and $\beta_{ij} = p(w_j = I|z_i = I)$ (Blei et al., 2002, 2003).¹⁷ There are two important things to notice in this specific case. First, there are two different vocabularies: one for President López Obrador's discourse and one for Dr. López-Gatell's. This can cause the same word to be associated with different topics in each of the discourses. Second, the algorithm does not assign names to the topics. These were chosen by the authors, taking the top 10 words and sentence examples into account.

The second step consisted of quantifying the content of the speeches. Sentiment analysis was used to examine the shift in the emotions conveyed during the press conferences throughout the different stages of the pandemic. Sentiment analysis classifies a lexicon into the emotions it evokes and its valence (positive or negative).¹⁸ Emotions were classified into anger, anticipation, disgust, fear, joy, sadness, surprise and trust, following Mohammad and Turney (2013).¹⁹ Then, all the times an emotion was evoked by a word in the document were added up and divided by the total of 'effective words' in the document.²⁰ The same procedure was done with the valence of the words to obtain a relative measure of percentages associated with each emotion and valence in each document.

¹⁴ This assumption allows for topic probabilities to provide a full representation of the text.

¹⁵ Where θ lies in the $k-1$ dimension.

¹⁶ From the multinomial distribution, it can be determined that $\theta_i > 0$ and $\theta_i \in [0, 1] \rightarrow \sum_{i=1}^k \theta_i = 1$

¹⁷ The probability of a document can then be expressed as:

$$p(W) = \int_{\theta} \left(\prod_{n=1}^N \sum_{z_n=1}^k p(w_n|z_n; \beta) p(z_n|\theta) \right) p(\theta; \alpha) d\theta$$

¹⁸ A lexicon is a list of words; any given document can be divided into a list of words that are used to form the document.

¹⁹ The lexicon used is provided by Jockers (2020), which is available through the 'syuzhet' R package.

²⁰ Note that a word can be associated with various emotions. The effective words are defined as the total number of words that evoke emotions.

The third step aimed to identify the words, topics and emotions that best predict mobility changes in Mexico. Merging the speech content and the UNDP-Grandata mobility data, lasso model selection was used to examine: (a) which topics mentioned in the conferences are most associated with mobility patterns during the pandemic and (b) whether the emotions and their valence correlate with mobility and, therefore, compliance with stay-at-home recommendations.

The central assumption is that, when controlling for simultaneous cases at the municipality level, which rule the availability bias (Tversky & Kahneman, 1974), it is possible to isolate the correlation between public health messaging on concurrent mobility and cases two weeks later. Since the political discourse may not affect every person in the same way, depending on factors such as the possibility of working from home or the ability to afford a period of inactivity, a quantile regression approach was used (Koenker & Bassett, 1978; Koenker & Hallock, 2001). Due to the high number of independent variables, a data-driven approach was implemented to find the most relevant components of public discourse. Thus, the regression was penalized using the L1 norm (lasso regression), as proposed by Yi and Huang (2017). Mobility changes are a function of the following linear model:

$$Y_{mt} = \alpha + D_{t-1}\beta + S_{t-1}\gamma + W_{t-1}\delta + C_m\theta + \epsilon_{mt} \quad (1)$$

where Y_{mt} represents mobility changes in municipality m and day t ; D_{t-1} is a vector of press conference topics from the previous day; S_{t-1} is a vector of conference sentiments; W_{t-1} is a vector of key words in the public health discourse; C_m are control variables, which include municipality level sociodemographic variables, political preferences and H1N1 pandemic experience; and ϵ_{mt} is the error term.

For simplicity, the vector of parameters to be estimated is redefined as:

$$\pi = [\alpha', \beta', \gamma', \delta', \theta'] \quad (2)$$

and the matrix of explanatory variables as:

$$X_{mt} = [I, D_{t-1}, S_{t-1}, W_{t-1}, C_m] \quad (3)$$

Then, the lasso penalized quantile regression problem is given by:

$$\min_{\pi} \frac{1}{n} \sum_{mt} \rho_{\tau}(y_{mt} - X_{mt}^T \pi) + \lambda \sum_j |\pi_j| \quad (4)$$

where n is the number of observations (municipality-day) and $j \in (1, J)$ are the parameters to be estimated, contained in vector π . The quantile loss function $\rho_{\tau}(l)$ for quantile τ is computed as:

$$\rho_{\tau}(l) = l(\tau - I(l < 0)) \quad (5)$$

In the model, l is replaced by residuals. A λ of 0.001106 was obtained using 10-fold cross validation, which is considered small.²¹ Normally, when estimating machine learning models such as the lasso regression, one random part of the observations is left as a test or validation group. When dealing with time series specifically, the last n percent of observations tends to be left out. Since this study used panel data with a time series component, this procedure

²¹When lambda is small, the result is essentially the least squares estimate. As lambda increases, shrinkage occurs so that variables that are at zero can be thrown away. As a result, a major advantage of lasso is that it is a combination of both shrinkage and selection of variables. In cases with a very large number of features, lasso allows for efficiently finding the sparse model that involves a small subset of the features.

must be followed. However, as will be seen in section 4, some topics became irrelevant as the pandemic evolved. This could result in underestimating the parameters. To mitigate this, the model was estimated 100 times with a subset of the data to obtain robust estimations using bootstrapping. This allows for estimating confidence intervals for the parameters to obtain robust estimations. The aim of this strategy is to identify which topics, sentiments and words have a stronger association to mobility.

Heterogeneity in the response to the messages was also tested. Those in the low-income population may be less able to protect themselves by following stay-at-home recommendations. Poverty was proxied using housing overcrowding at the municipality level and the average availability of basic public services such as running water, sewage and trash collection in the municipalities' households (Brown et al., 2020). In addition, this study assessed whether the press conferences of President López Obrador or Dr. López-Gatell have a differential association by political affiliation, as has been documented in other countries (see Allcott et al., 2020; Baekkeskov (2016); Barbieri & Bonini, 2020; Barrios & Hochberg, 2020; and MacMillen, 2020). Lastly, it estimated whether the relationship between mobility patterns and messaging is different in municipalities with higher death tolls from H1N1 in 2009. It is hypothesized that municipalities with high pandemic-related mortality rates from H1N1 have more information on the burden of disease, will be more responsive to safety measures during the COVID-19 pandemic and will be less inclined to guide themselves by political ideology. Evidence on the effectiveness of policy messaging in generating population-level behaviour change can shed light on the efficacy of stay-at-home orders, when they can safely be relaxed and, perhaps, the geographical locations where enforcement efforts should be emphasized.

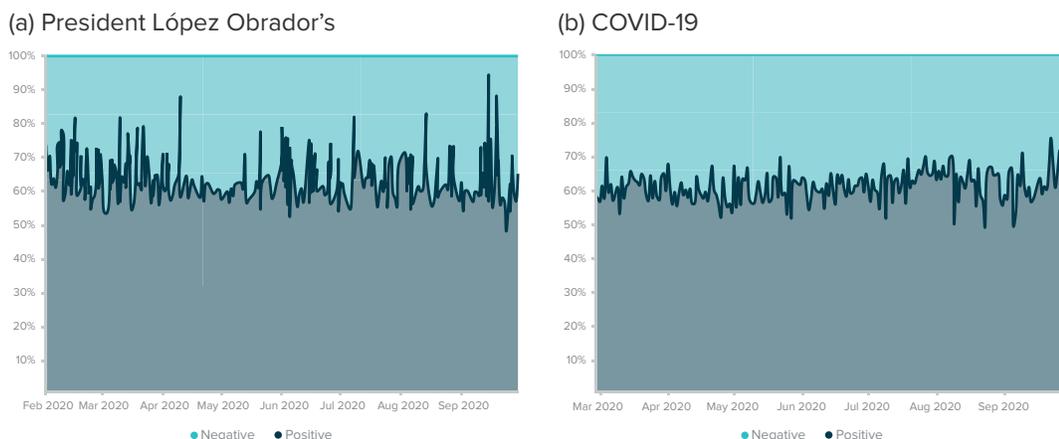
5. Results

Results are presented in the following order. First, there is a discussion of the analyses of the evolution of the discourses of President López Obrador and Dr. López-Gatell. Next, there is a discussion of the results from the quantile regressions. This section concludes with a reflection on potential mechanisms and a test for reverse causality.

5.1. Evolution of discourse

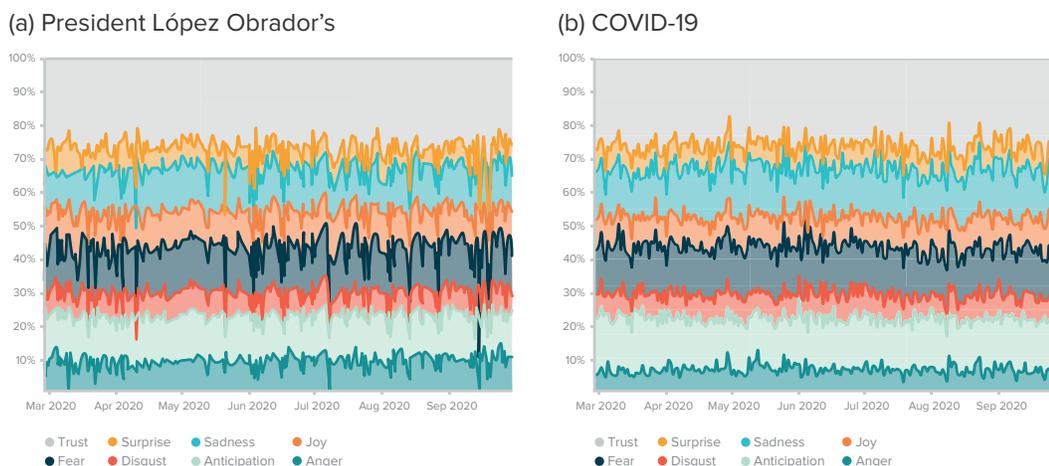
The first step of the text analysis was to conduct a sentiment analysis to identify whether there was variation in the emotions conveyed by the press conferences. Figure 6 presents the findings. Both groups of conferences have a predominantly positive tone. However, President López Obrador's conferences exhibit more variation than Dr. López-Gatell's conferences. Figure 7 presents the emotional composition of both groups of conferences. The main sentiment conveyed in both is trust. However, there are some differences between President López Obrador and Dr. López-Gatell. Again, President López Obrador displays much more variation than Dr. López-Gatell in his emotions; anger, fear and surprise are the emotions that present the most variation. In addition to trust, the predominant emotions in both sets of speeches are anticipation, fear and sadness.

Figure 6. Daily sentiment valence of the press conferences



Notes: Authors' estimates using data from the stenographic versions of the COVID-19/López-Gatell's press conferences and President López Obrador's daily press conferences. Each graph presents the valence composition of the conferences over the entire period of analysis: 1 March 2020 through 30 September 2020.

Figure 7. Daily sentiment valence of the press conferences



Notes: Authors' estimates using data from the stenographic versions of the COVID-19/López-Gatell's press conferences and President López Obrador's daily press conferences. Each graph presents the composition of emotions conveyed in the press conferences over the entire period of analysis: 1 March 2020 through 30 September 2020.

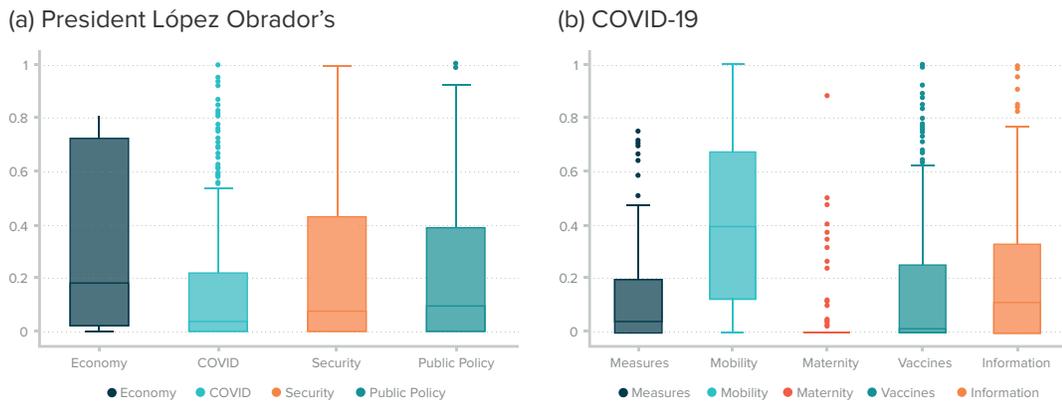
Using topic modelling, the conferences' discourse was classified into its central themes. In the case of President López Obrador's press conferences, the data-driven approach to topic identification distinguished four main topics with a coherence score of 0.38: the economy, COVID-19, security and public policy.²² In contrast, five main topics were identified in the

²² Topics are coherent if the topic's top N words are related. C_v is used as a measure of coherence as proposed by Syed and Spruit (2017). C_v is a four-step algorithm in which each of the top N words is segmented and paired with every other top N word. Subsequently, probabilities are calculated for those segments by counting the number of documents in which each word occurs, divided by the total number of documents. Once all the probabilities are established, a measure of confirmation is estimated through the similarity of the distribution of the top N words via normalized pointwise mutual information. The final coherence score is the arithmetic mean of all confirmation measures ϕ .

COVID-19 press conferences with a coherence score of 0.36: measures, mobility, maternity, vaccines and information on the pandemic status in Mexico. Appendix table B.1 presents the words most commonly associated with each of those topics for the press conferences, along with an example of a sentence classified in that topic.

Figure 8 presents the frequency per topic. In President López Obrador’s case (panel a), the economy is the prevailing topic in his morning conferences, followed by security, public policy and COVID-19, in that order. The COVID-19 press conferences placed a greater emphasis on mobility restrictions and the provision of information about the epidemic in Mexico; then vaccines and health measures; and lastly, maternity issues.²³

Figure 8. Overall topic composition of the press conferences

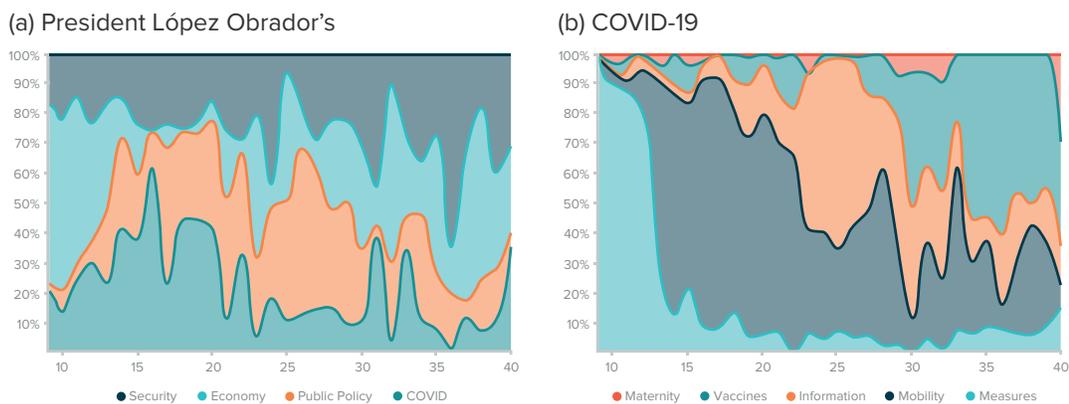


Notes: Authors’ estimates using data from the stenographic versions of the COVID-19/López-Gatell’s press conferences and President López Obrador’s daily press conferences. Each graph presents the overall topic composition of the conferences over the entire period of analysis: 1 March 2020 through 30 September 2020. The topics were identified via topic modelling (see appendix table B.1).

Over time, however, there is a wide variation on the topics that President López Obrador and Dr. López-Gatell emphasize in their corresponding press conferences. Figure 9 shows the topic composition of both groups of press conferences. Panel (a) shows that the economy dominated the President’s conferences at the beginning of the pandemic, but references to public policies and COVID-19 became more prevalent as the situation evolved. In Dr. López-Gatell’s conferences (panel (b)), health measures dominated at the beginning of the pandemic, but this pattern quickly shifted towards mobility messaging. Mobility messaging itself displays variation over the period of analysis with peaks and troughs over the final 15 weeks. As the pandemic progressed, by week 30 of the year, vaccines began to take greater importance in the discourse. Lastly, one of the COVID-19 press conference objectives is to inform the population about daily changes in positive, suspected and fatal cases. Between weeks 22 and 28, the discourse centred more on providing information, along with mobility messages.

²³ Dr. López-Gatell did not talk about maternity very often, but it is classified separately because its content is very different from the rest.

Figure 9. Weekly topic composition of the press conferences



Notes: Authors' estimates using data from the stenographic versions of the COVID-19/López-Gatell's press conferences and President López Obrador's daily press conferences. Each graph presents the topic composition of the conferences on a weekly basis from March through September 2020. Week 9 represents the first week of March 2020. The topics were identified via topic modelling (see appendix table B.1).

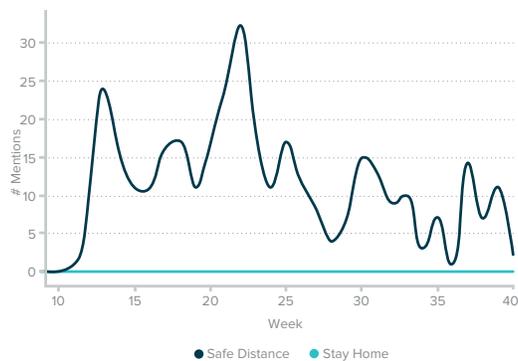
The analysis identified some frequently used keywords to which the population may potentially respond: 'epidemic', 'pandemic', 'safe distance' and 'stay at home'. Other frequently used and policy-relevant words were grouped into four categories: scientific messaging (e.g. communicating the scientific aspects of transmission), control measures, vaccines and testing. Figure 10 presents some interesting findings yielded by this analysis.²⁴ The first noteworthy result is that President López Obrador has never mentioned 'stay at home' (panel (a) in yellow) in his press conferences, even though this recommendation is one of the key COVID-19 prevention levers worldwide. For his part, Dr. López-Gatell starkly toned down this message throughout the pandemic, decreasing from over 30 mentions at the peak relevance of this topic to less than 5 at the end of the period of analysis (panel (b) in yellow). Social distancing is another key component of public health measures to prevent contagion. Both the President and his COVID-19 czar strongly convey this message, though they have both toned it down in the final 10 weeks of the period of analysis. Panel II presents the comparisons between the mentions of 'vaccines' and 'tests'. Vaccines took on greater importance in the COVID-19 press conferences during the final few weeks of the analysis period, reaching a striking number of weekly mentions that surpasses 140. In contrast, the word 'tests' has been constantly mentioned, though it has exhibited some variation in both the conferences of President López Obrador and Dr. López-Gatell.

²⁴ Figure A.6 in the appendix presents the other keywords.

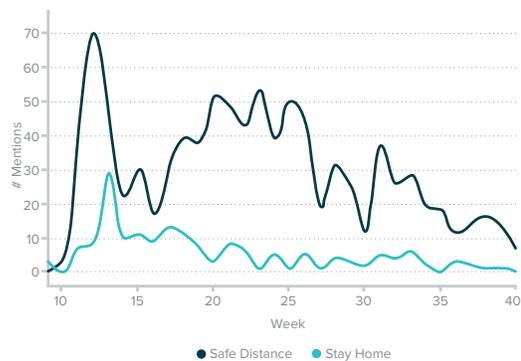
Figure 10. Evolution of keywords in the press conferences

Safe distance vs. stay at home

(a) President López Obrador's

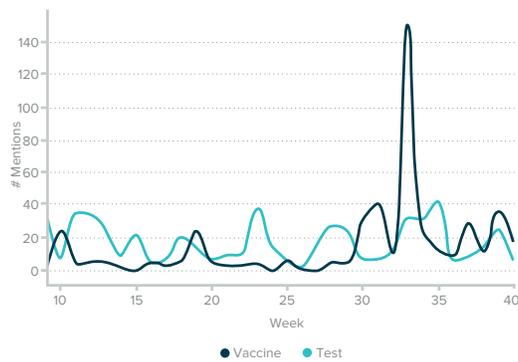


(b) COVID-19

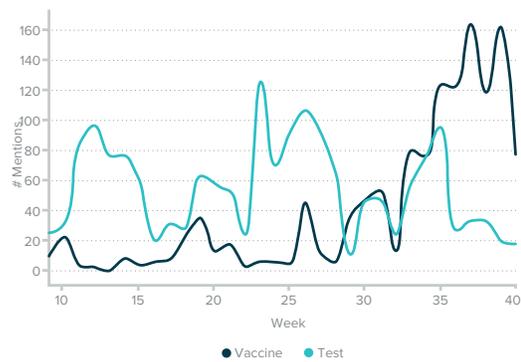


Vaccine vs. test

(c) President López Obrador's



(d) COVID-19



Notes: Authors' estimates using data from the stenographic versions of the COVID-19/López-Gatell's press conferences and President López Obrador's daily press conferences. Each graph presents the evolution of weekly mentions of two keywords over the period of analysis: 1 March 2020 through 30 September 2020. Panel I presents mentions of 'safe distance' (in blue) and 'stay at home' (in yellow). Panel II shows mentions of 'vaccines' (in blue) and 'tests' (in yellow).

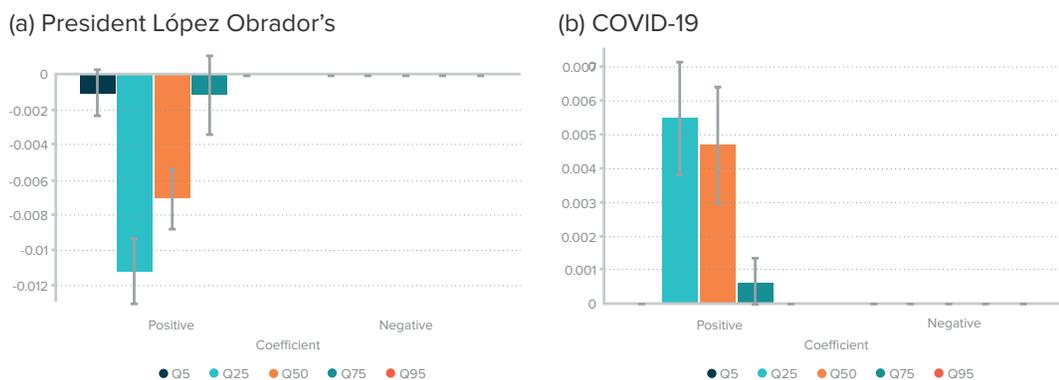
5.2. Quantile regression results

Figures 11 to 14 present the coefficient estimations of equation 4, the lasso penalized quantile regression. The coefficient estimates were split into different figures for ease of presentation; however, all the results come from the same regression. The first set of results shows the association between mobility changes and discourse valence.²⁵ As figure 11 shows, whenever President López Obrador's discourse is positive, mobility tends to decrease compared to 2 March 2020.

²⁵ Russell (1980, 2003) argues that the three primary independent dimensions of emotions are valence or pleasure (positiveness–negativeness/pleasure–displeasure), arousal (active–passive) and dominance (dominant–submissive). He argues that individual emotions such as joy, anger and fear are points in a three-dimensional space of valence, arousal and dominance. This paper focuses on valence because it is the most relevant dimension in analyzing press conferences.

In contrast, when Dr. López-Gatell is positive in his COVID-19 conferences, mobility increases relative to 2 March 2020.²⁶ Moreover, across the distribution of mobility changes, those in the inter-quantile range are more responsive to the discourse. The largest response, observed for the second quintile in panel (a) of figure 11, is predicted to be a 1.2 percentage point decrease in mobility. This effect is roughly 5.4 percent of the average mobility change observed during the pandemic. Hence, while the effect of discourse is not very large, it is not negligible in a context in which any reduction in mobility helps prevent disease spread and potentially save lives, and health messaging is virtually costless as it is incorporated into daily press conferences. This heterogeneity in behaviour across quantiles is observed across the results presented below.²⁷

Figure 11. Main results: Association between mobility and discourse valence



Note: Authors' estimates. Each bar represents a coefficient from the lasso penalized quantile regression in equation 4, where the dependent variable is the change in mobility (Grandata) and the main variables of interest are defined by the discourses of President López Obrador and Dr. López-Gatell in their respective press conferences (stenographic versions of the press conferences from website for the Office of the President of Mexico). The discourse variables are presented in the x-axis. The estimations include controls for sociodemographic characteristics at the municipality level (2015 inter-census data), political preferences (2018 federal elections, based on data from the National Electoral Institute) and previous experience with the H1N1 pandemic (death certificate data from the National Health Information System). Ninety-five percent confidence intervals are shown.

When looking at the association between mobility and emotions (see figure 12), the public responds differently to emotions conveyed in President López Obrador's discourse and that of the COVID-19 press conferences. Whenever President López Obrador expresses joy or surprise, mobility tends to increase, whereas mobility tends to decrease if he expresses anticipation or disgust. In contrast, if Dr. López-Gatell conveys anticipation or disgust in his discourse, mobility increases though only at the lower tail of the mobility distribution. Mobility is negatively associated with sadness and trust in Dr. López-Gatell's speech. A key finding of this exercise is that mobility is associated with a broader range of emotions in Dr. López-Gatell's discourse; a positive correlation was found between mobility and fear, joy and surprise, with the most considerable effects exhibited when Dr. López-Gatell conveys fear.

²⁶ Given that the mobility measure (the dependent variable) is calculated as a percentage change with respect to 2 March 2020, all the coefficient estimates are interpreted as a change with respect to this date. This clarification will be omitted henceforth.

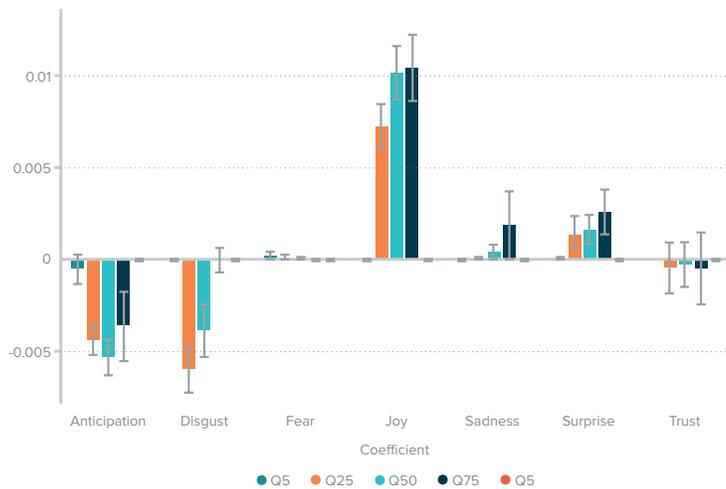
²⁷ In fact, the presence of this heterogeneity justifies the use of quantile regressions. When equation 1 was estimated with ordinary least squares (results not shown, but available upon request), the estimates at the mean masked the differences in the associations across the mobility distribution. In fact, these differences cancelled out at the mean.

Figure 13 presents the association between mobility and the thematic categories generated through topic modelling in the press conference discourses. The topics identified for President López Obrador are economy, security, public policy and COVID-19. Those for Dr. López-Gatell are information, mobility, measures, vaccines and maternity. For estimations regarding President López Obrador (the first three topics in the figure), the base category used to estimate the effects of other issues was ‘economy’. Economy is the base category because it is the most common topic in President López Obrador’s conferences. The coefficients presented in Figure 13 are therefore interpreted as the effect of deviating from the base topic, which is the economy. Some words among the top ten in this topic are ‘pesos’, ‘companies’, ‘money’ and ‘agreement’.²⁸

Similarly, for Dr. López-Gatell’s conferences, the base category of ‘information’ encompasses the statistical information provided by the COVID-19 czar on the progression of the pandemic in the various states and counties of Mexico. Some words included in this category are ‘trend’, ‘deaths’, ‘decrease’, ‘increase’ and ‘percentage’. First, virtually no association was found between mobility and President López Obrador’s discourse. In contrast, Dr. López-Gatell’s topics have prediction power on mobility changes. For instance, the topic ‘mobility’ is associated with an approximate 5 percentage point decrease in mobility at the 75th percentile. On the other hand, ‘measures’ is the predominant topic in Dr. López-Gatell’s discourse and predicts between a 2 and 8 percentage point increase in mobility in the interquartile range of the mobility distribution, with the most considerable effect on the 25th percentile.

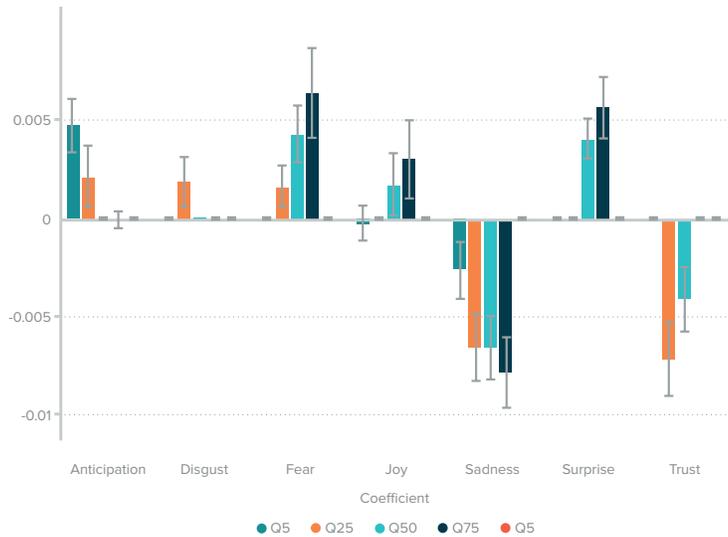
Figure 12. Main results: Association between mobility and discourse emotions

(a) President López Obrador’s



²⁸ For more information on topic composition, see appendix table B.1.

(b) COVID-19



Note: Authors' estimates. Each bar represents a coefficient from the lasso penalized quantile regression in equation 4, where the dependent variable is the change in mobility (Grandata) and the main variables of interest are defined by the discourses of President López Obrador and Dr. López-Gatell in their respective press conferences (stenographic versions of the press conferences from the website for the Office of the President of Mexico). The discourse variables are presented in the x-axis. The estimations include controls for sociodemographic characteristics at the municipality level (2015 inter-census data), political preferences (2018 federal elections, based on data from the National Electoral Institute) and previous experience with the H1N1 pandemic (death certificate data from the National Health Information System). Ninety-five percent confidence intervals are shown.

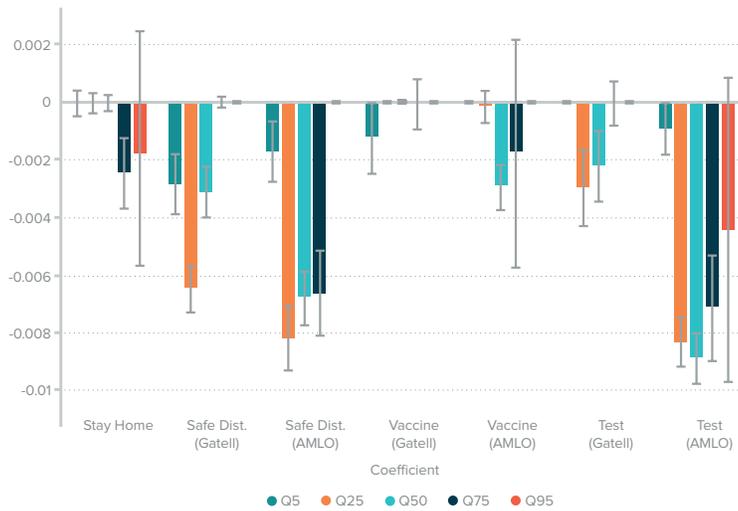
Figure 13. Main results: Association between mobility and discourse topics



Note: Authors' estimates. Each bar represents a coefficient from the lasso penalized quantile regression in equation 4, where the dependent variable is the change in mobility (Grandata) and the main variables of interest are defined by the discourses of President López Obrador and Dr. López-Gatell in their respective press conferences (stenographic versions of the press conferences from the website for the Office of the President of Mexico). The discourse variables are presented in the x-axis. The estimations include controls for sociodemographic characteristics at the municipality level (2015 inter-census data), political preferences (2018 federal elections, based on data from the National Electoral Institute) and previous experience with the H1N1 pandemic (death certificate data from the National Health Information System). Ninety-five percent confidence intervals are shown.

Figure 14 presents the association between the critical policy words and mobility. The mention of ‘stay at home’ during the COVID-19 press conferences predicts a slight decrease in mobility, only for the 75th percentile of the mobility distribution.²⁹ President López Obrador’s mentions of ‘safe distance’ predict a much larger mobility reduction than Dr. López-Gatell’s, albeit both coefficients are small in magnitude. Usage of the word ‘vaccines’ has very little prediction power on mobility: the effect is only statistically significant in President López Obrador’s case and only for the mobility distribution median. Lastly, mentions of ‘tests’ in President López Obrador’s and Dr. López-Gatell’s conferences predict reduced mobility, but with more considerable predictive power for President López Obrador. In summary, President López Obrador’s usage of key policy words predicts a reduction in mobility, which is higher in magnitude than that predicted by Dr. López-Gatell’s mentions. This finding is critical in terms of discourse as public policy. The prediction power of keywords is small in magnitude; however, after controlling for topics in general and other predictors, it has a consistent direction across messengers. Thus, both President López Obrador and Dr. López-Gatell can reinforce each other’s message.

Figure 14. Main results: Association between mobility and discourse keywords



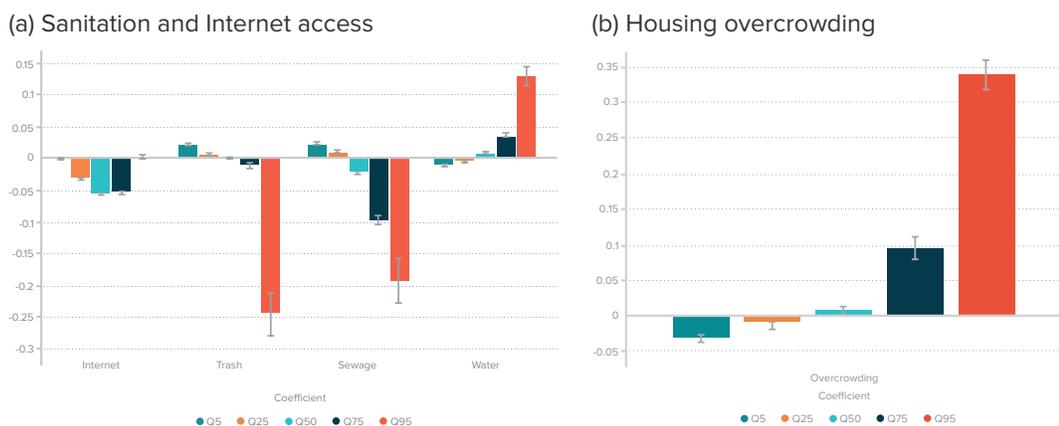
Note: Authors’ estimates. Each bar represents a coefficient from the lasso penalized quantile regression in equation 4, where the dependent variable is the change in mobility (Grandata) and the main variables of interest are defined by the discourses of President López Obrador and Dr. López-Gatell in their respective press conferences (stenographic versions of the press conferences from the website for the Office of the President of Mexico). The discourse variables are presented in the x-axis. The estimations include controls for sociodemographic characteristics at the municipality level (2015 inter-census data), political preferences (2018 federal elections, based on data from the National Electoral Institute) and previous experience with the H1N1 pandemic (death certificate data from the National Health Information System). Ninety-five percent confidence intervals are shown.

Figure 15 presents the association between two sets of poverty-related measures and mobility. In panel (a), the evidence shows a small decrease in mobility across the 25th to 75th quantiles of mobility for individuals who live in counties with access to the Internet. There are substantial drops in mobility for individuals in the top percentile of the mobility distribution

²⁹ President López Obrador never mentioned ‘stay at home’ in his morning conferences, so this phrase is excluded from the analysis of his conferences.

who live in places with access to garbage collection and functioning sewage. For individuals in areas with access to running water, there is an increase in mobility among those in the highest mobility distribution percentile. In terms of marginalization by housing overcrowding, individuals that live in counties with a high share of overcrowded households are predicted to increase their mobility in the 75th and 95th percentiles of the mobility distribution, with the most significant effect observed at the top. All these results indicate that the individuals surrounded by the most disadvantaged environments are not in compliance with the stay-at-home ordinances.

Figure 15. Main results: Association between mobility and poverty (sanitation and marginalization by housing overcrowding)



Note: Authors' estimates. Each bar represents a coefficient from the lasso penalized quantile regression in equation 4, where the dependent variable is the change in mobility (Grandata) and the main variables of interest are defined by the discourses of President López Obrador and Dr. López-Gatell in their respective press conferences (stenographic versions of the press conferences from the website for the Office of the President of Mexico). The variables are presented in the x-axis. The estimations include controls for sociodemographic characteristics at the municipality level (2015 inter-census data), political preferences (2018 federal elections, based on data from the National Electoral Institute) and previous experience with the H1N1 pandemic (death certificate data from the National Health Information System). Ninety-five percent confidence intervals are shown.

6. Mechanisms

The current regression approach demonstrates that mobility changes are indeed associated with changes in the topic composition of press conferences and mentions of certain words and phrases. It is hypothesized that changes in mobility can be affected by government messaging through different mechanisms. First, people who see the daily morning reports or the COVID-19 reports may be more aware of the current situation, owing to the new information presented every day.³⁰ Second, people who are more affiliated with a politician or political party's ideology may take more action in response to the speech given by the President and his team.³¹

³⁰ Viewership was proxied by the views of each conference in the Government's official YouTube account.

³¹ Political affiliation was approximated through state-level 2018 electoral results for presidential and senatorial elections.

6.1. Direction of causality

It is hypothesized that people react to public officials' discourse and health messaging through awareness of specific topics (proxied by Google searches) and political affiliation (proxied by electoral results). However, to prove these hypotheses, it must be shown that discourse and awareness cause mobility and not the other way around. To that end, this section shows that mobility changes in $t-1$ to $t-2$ do not predict Dr. López-Gatell's discourse topics, using a seemingly unrelated regressions (SUR) system.³²

The SUR model consists of six equations: (1) COVID-19 positive cases, (2) COVID-19 fatalities, (3) mobility changes, (4) Dr. López-Gatell's mobility topic, (5) Dr. López-Gatell's measures topic and (6) President López Obrador's COVID-19 topic. Both COVID-19 cases and fatalities may respond to past mobility changes and public health messaging, if effective. At the same time, mobility may respond to information on COVID-19 cases and deaths and to the press conference discourse, if effective. Lastly, the discourse may adapt itself to the evolution of the pandemic (cases and deaths), as well as the public's geographical mobility in previous days. All this feedback renders it very difficult to give a causal interpretation to the results, especially if discourse is affected by past mobility.

Appendix table B.2 presents the estimates of the SUR model.³³ First, positive cases and fatalities have a limited association with mobility in the prior three weeks. The association is clearer in the case of fatalities, where an increase in mobility on a given day is related to an increase in deaths of people who presented symptoms five days later.³⁴ For its part, mobility in t has a high auto-correlation with mobility in the previous four days and a very small relation to positive cases and deaths. It is only associated with Dr. López-Gatell's measures topic.³⁵ More importantly, Dr. López-Gatell's discourse topics do not respond to mobility in the previous two days; the coefficients are not statistically significant at a 5-percent level. While President López Obrador's discourse seems to respond, mobility does not correlate to President López Obrador's messaging, as previously shown, thus potentially breaking the potential reverse causality.

Another interesting finding in the SUR model is the way in which the discourses of President López Obrador and Dr. López-Gatell react to each other.³⁶ President López Obrador's daily press conferences take place every workday morning, whereas Dr. López-Gatell's happen every day at 7 p.m. The model tested whether President López Obrador's COVID-19 topic is related to what Dr. López-Gatell said the previous evening. Similarly, tests were conducted to determine whether Dr. López-Gatell's conference topics relate to what President López Obrador said in the morning that same day and the previous day. Dr. López-Gatell's mobility

³² SUR is a generalization of a linear regression model that consists of several regression equations, each having its own dependent variable and potentially different sets of exogenous explanatory variables. Each equation is a valid linear regression on its own and can be estimated separately, but the error terms are assumed to be correlated across the equations.

³³ Appendix table B.3 presents the Breusch-Pagan test, which shows that the errors across the equations in the system are not independent.

³⁴ Recall that both positive cases and deaths are time-indexed to the date when the individuals first presented symptoms.

³⁵ These results may conflict with those presented in section 4.2 because the heterogeneity of the estimates across the mobility distribution cancels out at the mean, and those estimates examined only the previous day's messaging in the press conferences.

³⁶ The authors thank an anonymous referee for this suggestion.

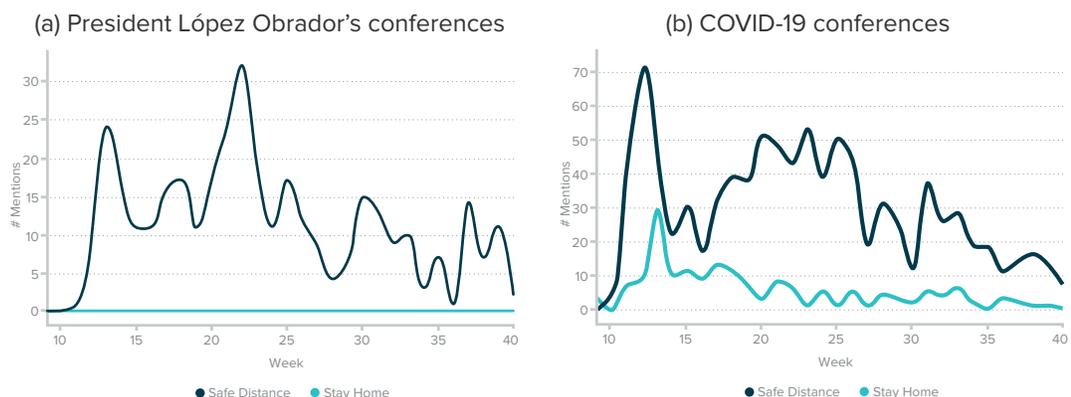
topic responds to what President López Obrador said about COVID-19 that same morning, whereas the measures topic is unrelated to President López Obrador’s COVID-19 talk. Furthermore, President López Obrador’s COVID-19 talk does not relate to Dr. López-Gatell’s mobility topic from the previous day, but it does correlate to the measures topic from the previous day. In summary, the messengers seem to respond to each other; however, given the current design, it is not possible to conclude whether they are reinforcing the message or counteracting it.

An instrument and an alternative endogeneity test were derived to test whether the press conferences were endogenous to mobility in the previous day. This alternative approach will be explained in subsection 5.4.

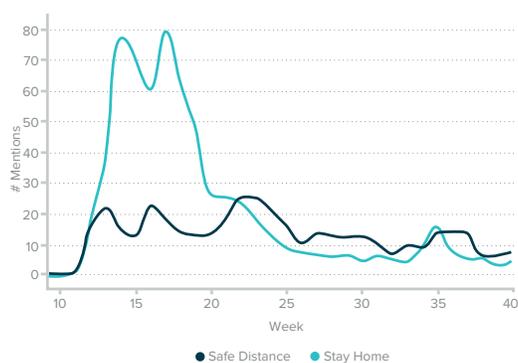
6.2. Awareness

COVID-19 is the first pandemic in the digital age, which has an unprecedented impact on the speed in which news travels and the effect that communications from the authorities can have if they harness the power of social media and digital communication. This section explores the association between discourse and public awareness. Awareness was measured using search indexes from Google trends, which were constructed by normalized raw search results to the time and location of a query. Each data point was divided by the total searches of the geography and time range it represents to compare relative popularity. The resulting numbers were then scaled on a range of 0 to 100 based on a topic’s proportion to all searches on all issues. Figure 16 shows a comparison between searches for ‘stay at home’ (in yellow) and ‘safe distance’ (in blue) and mentions of those two key containment policies by President López Obrador and Dr. López-Gatell. Google searches for ‘stay at home’ were high early in the pandemic and have substantially decreased following a pattern similar to that of Dr. López-Gatell’s mentions of these key policy words in his press conferences. Searches for ‘safe distance’ have remained relatively stable and do not seem to follow mentions by either President López Obrador or Dr. López-Gatell.

Figure 16. Interest in and/or awareness of the words ‘safe distance’ and ‘stay at home’



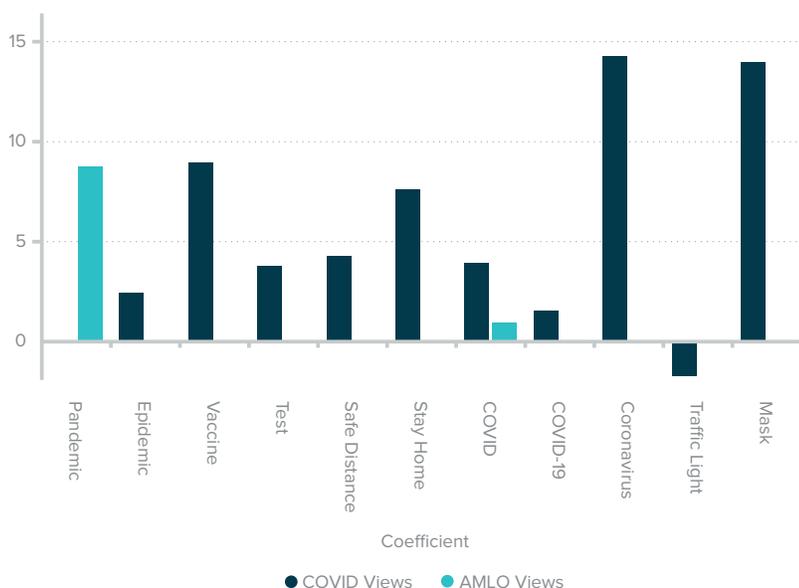
(c) Google searches



Note: Authors' estimates using data from the stenographic versions of the COVID-19/López-Gatell's press conferences and President López Obrador's daily press conferences and search indexes from Google Trends. Each graph presents the evolution of weekly mentions/searches of two keywords over the period of analysis: 1 March 2020 through 30 September 2020. Panels (a) and (b) present mentions of 'safe distance' (in blue) and 'stay at home' (in yellow) by President López Obrador and Dr. López-Gatell, respectively. Panel (c) presents the Google trends' index for 'safe distance' and 'stay at home' searches in Google.

Figure 17 shows that discourse is associated with awareness on key pandemic-related topics. Using Google searches at the national level as the dependent variable in a model in which awareness is a function of exposure to the conferences, the study finds that when more people see the President's daily conferences, the word 'pandemic' (predominantly used by the President, as shown in appendix figure A.6 (a)) has a higher number of searches. In comparison, the same thing happens when more people watch Dr. López-Gatell's conferences with the word 'epidemic' (predominantly used by Dr. López-Gatell, as shown in appendix figure A.6 (b)). Searches for terms like 'vaccine', 'test', 'safe distance', 'stay at home' and COVID-related words seemingly have a positive and significant association with views of Dr. López-Gatell's conferences. In contrast, almost none have a significant association with President López Obrador's speeches, which would be logical given the topic distribution of both groups of conferences. These results are shown in detail in table B.4 in the appendix.

Figure 17. Association between Google searches and YouTube views of President López Obrador's conferences and the COVID-19 conferences

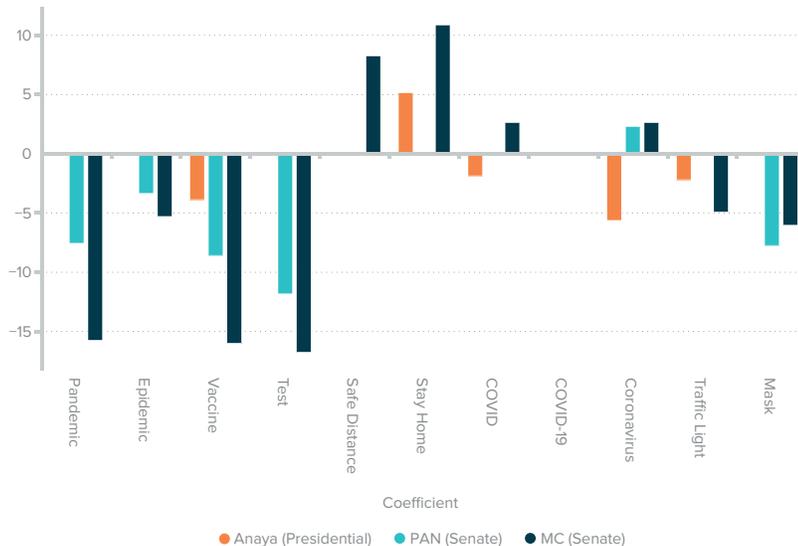


Note: Authors' estimates. Each bar represents a coefficient from the ordinary least squares regression for Google searches of COVID-19-related words and daily views of both President López Obrador's conferences (red) and the COVID-19 conferences (blue). Only statistically significant coefficients are shown.

6.3. Political affiliation

As reviewed in section 1, people who have a stronger affinity for a particular political party or candidate are expected to react positively to the messages conveyed by that public figure. In contrast, people who identify less with the governing party or candidate are less expected to follow the party members' or representatives' advice. To test these hypotheses, this study examines the association of state-level Google searches with electoral results. Figure 18 shows that, in states where the National Action Party [Partido de Acción Nacional] won the Senate race, fewer people search for 'pandemic', 'epidemic', 'vaccine', 'test' and 'mask' compared to states where the majority voted for the MORENA Party (the President's political party), while more people searched for the word 'coronavirus'. A similar trend is observed in states where Citizens' Movement [Movimiento Ciudadano] received the most Senate votes. In these states, the terms 'epidemic', 'vaccine', 'test', 'traffic light' and 'mask' were looked up less than in states where the MORENA Party won, while words like 'safe distance', 'stay at home' and COVID-19-related words had more searches. Overall, in states where the President's party lost, people look up fewer words associated with the pandemic, with the exception of terms that were never used by President López Obrador, such as 'stay at home'. These results are shown in detail in table B.4 in the appendix.

Figure 18. Association between Google searches and election results



Note: Authors' estimates. Each bar represents a coefficient from the ordinary least squares regression for Google searches of COVID-19-related words and electoral results at the state level. The index is built using principal component analysis of all Google searches. Only statistically significant coefficients are shown.

6.4. Awareness, political affiliation and mobility change

The next step is to show that mobility is affected by discourse-driven awareness about social distancing measures and other pandemic-related topics. On the one hand, Figure 17 shows that people are keener to look for COVID-19-related words when they watch the daily reports of that President and the czar. On the other hand, states where the President or his party do not have a majority tend to search less for COVID-19-related words, as shown in Figure 18.

Furthermore, using both awareness and political affiliation, an alternative endogeneity test

was devised. This strategy presupposes that Google searches are endogenous since they respond to press conferences, which may respond to mobility (the same argument as in subsection 5.1). Hence, the study tested whether Google searches also respond to new daily global COVID-19 cases and political affiliation. Since global cases and political affiliation are exogenous to the system in subsection 5.1, these variables may work well as instrumental variables. Column (1) in table 1 presents the relationship between each of these variables and their interaction with Google searches after controlling for daily COVID-19 cases and fatalities in Mexico as well as state, month and day of the week fixed effects. All variables are statistically significant at over 5 percent significance. The residuals from this regression were used to test whether the residuals are in turn related to mobility. The hypothesis is that if mobility is not related to Google searches, then Google searches are exogenous. The test revealed that mobility changes at the usual 5-percent level. It can therefore be concluded that Google searches are exogenous.

With this evidence and these arguments, table 2 shows that both political affiliation and awareness are associated with mobility changes. Specifically, the findings indicate that more Google searches reduce mobility, while political affiliation has mixed effects. These mixed effects of politics could be due to the mixed messaging of the President and the COVID-19 czar.

Table 1. Alternative endogeneity test

	Google searches index (1)	Residuals from (1) (2)
Daily global COVID-19 cases	-0.00005** (0.00000)	
Votes López Obrador percentage	0.02772* (0.01092)	
Votes MORENA percentage	0.05346** (0.01170)	
Global COVID-19 cases × votes López Obrador	-0.00000** (0.00000)	
Global COVID-19 cases × votes MORENA	-0.00000** (0.00000)	
Mobility change index		-0.00931 (0.00492)
Constant	-53.76764** (0.47446)	-0.00278 (0.39888)
Controls:		
COVID-19 positive cases	Yes	Yes
COVID-19 negative cases	Yes	Yes
COVID-19 death cases	Yes	Yes
State fixed effects	Yes	Yes
Month fixed effects	Yes	Yes
Day fixed effects	Yes	Yes
Observations	235,591	235,591
R^2	0.37288	0.00002
Adjusted R^2	0.373	-0.00018

Column (1) has robust standard errors in parentheses.

Column (2) has bootstrapped standard errors in parentheses with 1,000 repetitions.

** p < 0.01, * p < 0.05

Table 2. Effects of awareness and political affiliation on mobility

	Mobility change (1)
Google searches index	-.00187* (0.00084)
Votes López Obrador percentage	0.01333** (0.00286)
Votes MORENA percentage	-0.01920** (0.00327)
Constant	-4.19357** (0.77348)
Controls:	
COVID-19 positive cases	Yes
COVID-19 negative cases	Yes
COVID-19 death cases	Yes
State fixed effects	Yes
Month fixed effects	Yes
Day fixed effects	Yes
H1N1 fixed effects	Yes
Census fixed effects	Yes
Observations	235,591
R2	0.02908
Adjusted R2	0.02883

Robust standard errors in parentheses.

** p < 0.01, * p < 0.0

7. Conclusions

When faced with the need for risk assessment and crisis management, preparedness and effective communication from top government officials and health experts can steer the public's response and mitigate the adverse effects of an outbreak.

An analysis was conducted of the use of relevant prevention-related keywords mentioned during the press briefings of President López Obrador and Dr. López-Gatell, including 'epidemic', 'pandemic', 'safe distance', 'stay at home', 'vaccines' and 'test'. The findings indicated that both officials conveyed messages encouraging social distancing, but their prevalence showed a declining trend over time. The timing and word choice are strikingly different, suggesting that there is no concerted communication strategy between these two levels of Government.

The findings show that when President López Obrador's discourse is positive, mobility tends to decrease compared to the baseline. Conversely, when Dr. López-Gatell is positive in his COVID-19 conferences, mobility increases relative to the baseline. Across the distribution of mobility changes, those in the interquartile range are more responsive to the discourse.

However, the predicted effect of discourse on changes in mobility is small. The association between mobility and President López Obrador’s discourse is not significant.

Conversely, Dr. López-Gatell’s topics do influence mobility. Whenever the main issue of Dr. López-Gatell’s discourse is mobility, a decrease of 4 to 6 percentage points in mobility is observed. However, the measures topic in Dr. López-Gatell’s discourse predicts between a 2 and 8 percentage point increase in mobility in the interquartile range of the mobility distribution, with the most considerable effect on the 25th percentile. To address a potential concern of reverse causality, between past mobility patterns and discourse, a SUR model was used to test this hypothesis. Results from that model show compelling evidence that Dr. López-Gatell’s discourse in t does not react to mobility patterns in $t-1$, but mobility patterns in t do react to discourse in $t-1$. The mechanisms driving these results are also discussed. First, people who see the daily morning reports or the COVID-19 reports may be more aware of the current situation, owing to the latest information presented every day. Second, political affiliation with President López Obrador and the MORENA party is associated with more considerable reductions in mobility during the pandemic.

We acknowledge that our results are based on mobility data from a population with access to smart phones and an internet connection. According to the National Institute of Statistics and Geography (INEGI) in Mexico, there were 88.1 million cellphone users in Mexico in 2020, which amounts to 94% of the population 15 years and older. Nine out ten cellphone users in the country have a smartphone. There are 84.1 million internet users, which amounts to 90% of the population 15 years and older. While our results might not be representative of the population with the most limited resources for connectivity, smartphone mobility data is the only high-frequency and high-granularity data source to measure mobility with national coverage. Other data sources, such as public transport usage or car counts from speed monitors represent a much narrower segment of the population. Finally, it is worth noting, the population without internet access are much less likely to be exposed to the COVID and daily conferences. The three options to watch the conferences are: Youtube, Facebook and Twitter.

In summary, the results suggest that mobility can be affected through discourse, but this association is mediated through awareness of COVID-19-related topics and individuals’ political affiliation. It is possible that the effects are not significant because the messaging across the analysed top officials is mixed. It remains untested whether a concerted message would effectively increase compliance with social distancing. However, this paper argues that the small magnitude of the effects is not at odds with the relevant economic and/or epidemiological impact. Even slight changes in mobility can set in motion a series of events that can reduce the spread of COVID-19 and ease the burden on the health system, which becomes more relevant when considering that health messaging is virtually costless, as it is incorporated into daily press conferences.

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Figure A.3. Word cloud: Daily press conferences



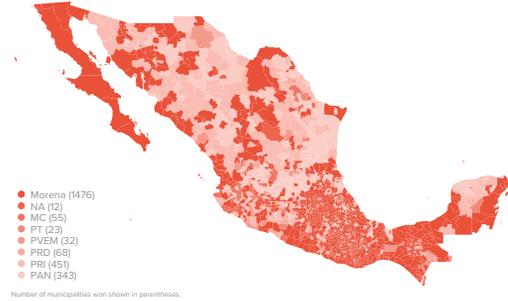
Note: Figure shows the original Spanish version of the word cloud generated using all the daily press conferences held by López Obrador, the President of Mexico.

Figure A.4. Winners in the 2018 federal elections

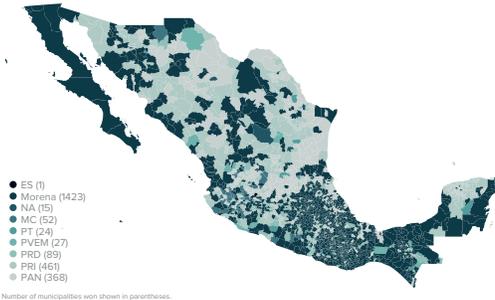
(a) Presidential election



(b) Senate elections



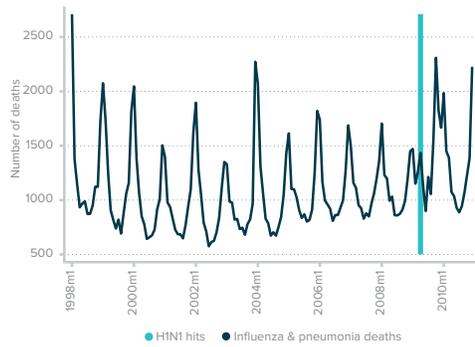
(c) Chamber of Deputies elections



Note: Authors' estimates using data from the National Electoral Institute from the 2018 federal elections. Panel (a) presents the presidential candidate who received the most votes, panel (b) presents the party of the Senator who received the most votes and panel (c) presents the party whose Deputy Candidates received the most votes.

Figure A.5. Influenza and pneumonia death cases

(a) Death cases and the H1N1 peak



(b) Accumulated excess death cases, March 2009 to December 2010

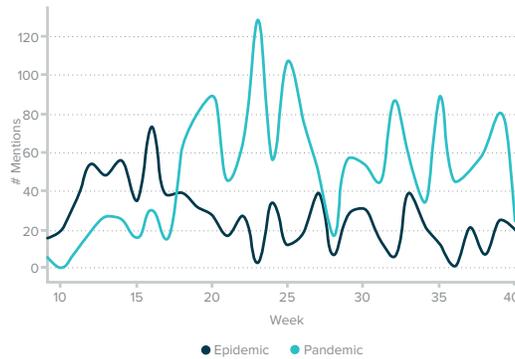


Note: Authors' estimates using data from the National Health Information System from 1998 to 2010. Panel (a) shows the time series of influenza and pneumonia monthly death cases. Panel (b) shows the distribution of influenza and pneumonia excess death cases between March 2009 and December 2010 in the territory. Excess death cases were estimated using a prediction model for the pre-H1N1 pandemic period. The prediction model controlled for municipality fixed effects, municipality-specific time trends and state-specific month fixed effects. This model was used to predict flu and pneumonia deaths in 2009 and 2010. Excess deaths are thus the difference between observed deaths and the predicted deaths.

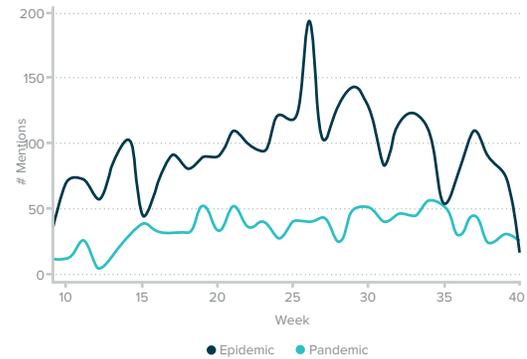
Figure A.6. Evolution of keywords in the press conferences

I. Epidemic vs. pandemic

(a) President López Obrador's

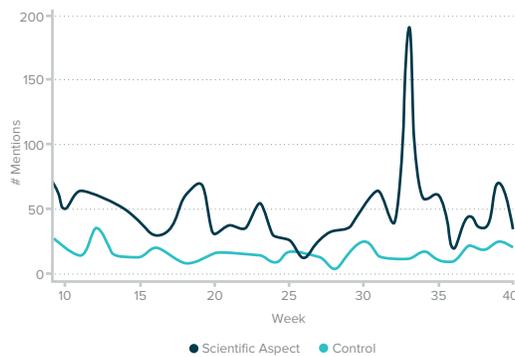


(b) COVID-19

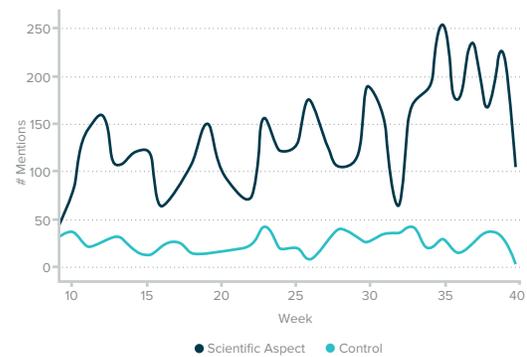


II. Scientific aspect vs. control

(c) President López Obrador's



(d) COVID-19



Note: Authors' estimates using data from the stenographic versions of the COVID-19/López-Gatell's press conferences and President López Obrador's daily press conferences. Each graph presents the evolution of weekly mentions of two keywords over the period of analysis: 1 March 2020 through 30 September 2020. Panel I presents mentions of 'epidemic' (in blue) and 'pandemic' (in yellow). Panel II shows mentions of 'scientific aspect' (in blue) and 'control' (in yellow).

B. Tables

Table B.1. Topic modelling: Definitions and keywords

Conference	Topic	Example phrases	Top 10 words
COVID-19	Measures	Let's all take care of ourselves, let's take care of ourselves in the community because in the community is where the epidemics stop with basic public health measures, hand washing, sneezing etiquette, not going out on the street if you are sick.	virus, stage, person, measurements, surveillance, coronavirus, test, phase, countries, contact
	Vaccines	The World Health Organization itself has said that it is too early to say whether or not it is the vaccine that the whole planet is waiting for due to the repercussions, for the time that the studies have to be done.	diseases, system, products, vaccines, virus, life, mortality, group, countries, strategy
	Maternity	I give the example of obstetric care, pregnant women from Social Security who have gone to private hospitals and there have been deliveries, cesarean sections, even other types of emergency care.	women, services, pregnancy, blood, theme, centre, adolescents, woman, violence, entities
	Information	We can also see in this graph the percentage of positivity, that is already 47 percent by week 31. We are starting below 50 percent, having reached this percentage, more or less up to 53 percent in previous weeks.	trend, entities, color, deaths, decrease, beds, increase, tests, percentage, availability
	Mobility	Because mitigation measures imply restricting the mobility of people and that leads to the massive suspension of social activities.	distance, virus, hospitals, patients, beds, measures, person, mobility, deaths, quantity
President López Obrador	Economy	It is considered that Calderon gave a subsidy to the consumption of gasoline of more than one billion pesos, which means one billion pesos, one million million pesos.	pesos, case, people, companies, issue, price, money, interlocutor, agreement, water
	COVID-19	A scientist of ours said something in a meeting that I transmit, that these epidemics are cured more at home.	health, cases, case, hospitals, doctor, measures, countries, disease, theme, epidemic
	Security	There has been a decrease in crime incidence in the five states where we hold security meetings.	security, case, people, support, secretary, elements, theme, workers, companies, credits
	Public policy	The wealth of this region with the skills of the local workforce in the 10 development towns that will be created in the area and that, with the participation of the private and social sectors, will allow us to generate the jobs they demand, the inhabitants of the Isthmus of Tehuantepec.	programme, town, governor, support, women, youth, development, life, towns, water

Table B.2. Seemingly unrelated regression: COVID-19, mobility and messaging

	Discourse topics:					
	Positive casest	Fatalitiest	Mobility Δ_t	López-Gatell: Mobility Δ_t	López-Gatell: Measures Δ_t	López Obrador: COVID Δ_t
	(1)	(2)	(3)	(4)	(5)	(6)
Mobility Δ_{t-1}	-3,236.83899*** [975.54526]	-151.36273 [120.33341]	0.40420*** [0.07184]	-1.03361 [0.77374]	0.59384 [0.30614]	2.10070*** [0.70637]
Mobility Δ_{t-2}	1,254.78823 [876.54213]	113.12663 [108.07798]	0.14040** [0.06595]	-0.43231 [0.81753]	0.11869 [0.32339]	-3.90475*** [0.69101]
Mobility Δ_{t-3}	467.51592 [687.42032]	-37.54078 [85.11094]	0.09913 [0.05968]			
Mobility Δ_{t-4}	338.26934 [631.12532]	-99.85027 [78.09750]	0.10932** [0.05435]			
Mobility Δ_{t-5}	749.63786 [628.35141]	180.16000** [77.76419]	-0.00932 [0.04905]			
Mobility Δ_{t-6}	-1,401.57389 [1,171.63559]	-201.77859 [144.99777]	0.01476 [0.08288]			
Mobility Δ_{t-7}	1,171.65592 [1,361.32206]	193.70878 [168.46552]	0.12038 [0.09501]			
Mobility Δ_{t-14}	38.67791 [736.19888]	88.04451 [91.11043]	0.07107 [0.05242]			
Mobility Δ_{t-21}	566.14391 [580.12428]	-47.44397 [71.81030]	0.05987 [0.04168]			
Mobility Δ_{t-28}	-843.27580 [529.97174]	-142.07190** [65.55003]	-0.05289 [0.03803]			
Positive cases $_{t-1}$	0.57589*** [0.09340]	-0.00278 [0.01151]	-0.00002*** [0.00001]	0.00004 [0.00008]	-0.00007** [0.00003]	-0.00012 [0.00008]
Positive cases $_{t-5}$	0.50601*** [0.11544]	0.04890*** [0.01423]	0.00000 [0.00001]	-0.00012 [0.00010]	0.00005 [0.00004]	0.00002 [0.00009]
Positive cases $_{t-6}$	-0.03527 [0.13201]	-0.02095 [0.01627]	0.00002** [0.00001]	0.00004 [0.00011]	0.00001 [0.00005]	0.00025** [0.00011]
Positive cases $_{t-12}$	-0.17688 [0.11287]	-0.01476 [0.01391]	-0.00001 [0.00001]	0.00006 [0.00010]	-0.00005 [0.00004]	-0.00016 [0.00009]
Positive cases $_{t-18}$	-0.10339 [0.09469]	-0.02468** [0.01167]	0.00000 [0.00001]	-0.00005 [0.00008]	0.00002 [0.00003]	0.00006 [0.00007]
Fatalities $_{t-1}$	0.49636 [0.95231]	0.37305*** [0.11738]	0.00018*** [0.00007]	-0.00088 [0.00079]	0.00049 [0.00031]	0.00063 [0.00076]
Fatalities $_{t-5}$	-0.37101 [1.02779]	0.14807 [0.12669]	0.00004 [0.00007]	0.00082 [0.00085]	-0.00037 [0.00034]	0.00052 [0.00082]
Fatalities $_{t-6}$	-1.45251 [0.98579]	0.13971 [0.12155]	-0.00013 [0.00007]	0.00033 [0.00081]	-0.00073** [0.00032]	-0.00159** [0.00076]
Fatalities $_{t-12}$	1.13037 [0.91728]	0.04868 [0.11304]	-0.00000 [0.00006]	-0.00025 [0.00080]	0.00031 [0.00032]	0.00103 [0.00077]
Fatalities $_{t-18}$	2.07565** [0.86557]	0.22429** [0.10668]	0.00001 [0.00006]	-0.00035 [0.00074]	0.00053 [0.00029]	-0.00108 [0.00071]
López-Gatell: Mobility Δ_{t-1}			0.00781 [0.00793]			0.07918 [0.09763]
López-Gatell: Mobility Δ_{t-2}			-0.00260 [0.00840]			
López-Gatell: Mobility Δ_{t-3}			-0.00487 [0.00859]			
López-Gatell: Mobility Δ_{t-4}			-0.00259 [0.00818]			
López-Gatell: Measures Δ_{t-1}			-0.01012 [0.01964]			0.48369** [0.23612]
Observations	109	109	109	109	109	109
R ²	0.99030	0.97479	0.88513	0.46322	0.29624	0.48688

Standard errors in brackets.

*** p<0.01, ** p<0.05

Table B.3. Correlation matrix of residuals

	Positive cases _t	Fatalities _t	Mobility Δ_t	López-Gatell: Mobility _t	López-Gatell: Measures _t	López Obrador: COVID _t
Positive cases _t	1					
Fatalities _t	0.4872	1				
Mobility Δ_t	0.2876	0.1273	1			
López-Gatell: Mobility _t	-0.048	0.032	0.0631	1		
López-Gatell: Measures _t	0.038	-0.0828	0.0191	-0.3951	1	
López Obrador: COVID _t	-0.1303	-0.0642	-0.0493	-0.0224	0.0213	1

Breusch-Pagan test of independence: $\chi^2(15) = 58.078$, p - value = 0.0000.

Table B.4. Mechanisms: Regression results

	Words										
	Pandemic	Epidemic	Vaccine	Test	Safe distance	Stay home	COVID	COVID-19	Coronavirus	Traffic lights	Mask
National level (YouTube views)											
COVID views	1.106	2.452**	8.963**	3.779**	4.295*	7.592**	3.903**	1.542**	14.298**	-1.710	13.985**
López Obrador views	8.745	-0.019	-3.178	-0.310	4.039	3.222	0.936*	-0.676	0.065	3.120	0.118
State Level (Election Results)											
Anaya (Presidential)	-1.010	1.060	-3.877**	-1.862	1.105	5.155**	-1.868**	0.009	-5.636**	-2.189	-0.808
National Action Party (Senate)	-7.561**	-3.353**	-8.596**	-11.835**	-0.680	-1.696	0.196	-0.172	2.283	-1.490	-7.750**
Citizens' Movement (Senate)	-15.757**	-5.340**	-15.999**	-16.745**	8.269**	10.876**	2.634**	-0.276	2.707*	-4.913**	-6.165**
Controls											
COVID positive (2)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
COVID negative (2)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
COVID death (2)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State* fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (national level)	89	89	89	89	89	89	89	89	89	89	89
Observations (state level)	5,307	5,307	5,307	5,307	5,307	5,307	5,307	5,307	5,307	5,307	5,307
R ² (national level)	0.410	0.741	0.481	0.879	0.514	0.903	0.929	0.371	0.858	0.865	0.862
Adjusted R ² (national level)	0.226	0.659	0.319	0.841	0.362	0.873	0.907	0.174	0.814	0.822	0.819
R2 (state level)	0.195	0.175	0.143	0.186	0.099	0.279	0.372	0.085	0.660	0.407	0.374
Adjusted R2 (state level)	0.188	0.169	0.137	0.179	0.092	0.273	0.367	0.078	0.657	0.403	0.369

Number of lags are shown in parenthesis. For the state-level regression, López Obrador (Presidential) and MORENA (Senate) are taken as base for comparison. The index is measured using the first principal component of all Google searches. This procedure is done once at the national level and once at the state level.

* Only for the state-level regression.

** p<0.01, * p<0.05