THE EFFECT OF POLITICAL BELIEF ON COVID-19 VIRUS TRANSMISSION, VACCINE RESISTANCE, AND RESPONSE TO NATIONAL CLOSURE: EVIDENCE FROM ISRAEL

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ABSTRACT

We employ comprehensive Israeli data to study how political belief affects COVID-19 virus risk, vaccine uptake, and response to closure policy. We identify households that hold divergent political beliefs based on votes in Israel's 2020 national election. Results indicate substantial variation in outcomes across belief clusters. Clusters update beliefs heterogeneously. Among some clusters, belief effects are mediated by emergent health risk. Elsewhere, beliefs are durable so as to limit vaccination uptake. Economic closure is more effective among clusters holding durable beliefs. Findings suggest that a common public signal about virus health risk is differentially acted upon depending on worldview, underscoring the importance of belief-targeted interventions.

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1. Introduction

Substantial anecdotal evidence suggests the salience of household worldview and political belief to COVID-19 virus transmission, vaccine resistance, and efficacy of crisis policy interventions. Reports suggest striking disparities among belief groups in disease incidence as well as substantial challenges to government policymakers seeking to lift vaccine uptake and mitigate virus spread. Yet there exists little systematic real-world evidence as to the role of divergent population worldview and belief in COVID-19 virus outcomes and in response to pandemic crisis policy. Specifically, little is known about the quantitative significance of political and ideological worldview and belief to virus proliferation. Further, few researchers have investigated the extent to which the estimated belief effects are durable when confronted with immediate virus risks or implications thereof for vaccine resistance. Finally, there has been only limited systematic investigation of the extent to which worldview and belief affect the efficacy of pandemic mitigation strategies. That information appears critical to the design of effective policy for disease control and in light of ongoing substantial vaccine resistance despite the prevalence of new highly virulent COVID-19 strains.

In the academic literature, research across diverse fields highlights the importance of political, ideological or religious worldview and belief to household response to economic or policy signals. In financial markets, numerous studies find that trading and returns differ among investors who hold different worldviews [e.g., Kandel and Pearson (1995); Kaustia and Torstila (2011); Meeuwis *et al*. (2018); and Carlin, Longstaff, and Mantoba (2014)]. Other analyses, including Stulz and Williamson (2002), Kumar *et al*. (2011), and Shu *et al*. (2012) show that religious belief affects investment and financial market outcomes. Studies by Bartels (2002), Gaines et al. (2007), and Curtin (2016) show that partisan political bias as proxied by party identification shapes individual reaction to political events. Similarly, Mian *et al*. (2015) find that economic expectations vary with partisan affiliation.

Moreover, recent survey findings and other reports suggest that divergent worldview and belief affect COVID-19 virus propagation and efficacy of policy response. A 2021 NPR/PBS/Marist survey reveals that a full one-half of Republican men in the U.S. do not plan to get vaccinated, compared to only 6 percent of Democratic counterparts.[1] A 2021 Pew Research Center survey similarly reports that 45 percent of the 41 million white Christian evangelicals in the U.S. are reticent to get vaccinated.[2] Similarly, Hornsey *et al*. (2020) show that political conservatism is associated with concerns about vaccination.[3] Barrios and Hochberg (2020) and Gollwitzer et al. (2020) provide evidence that share of county voters supporting Trump in 2016 is associated with reduced virus social distancing. Among other studies, Reiter *et al*. (2020) find a greater willingness to get vaccinated among households holding a liberal and moderate political stance; also, Callaghan *et al*. (2020) provide early evidence of vaccine hesitancy among African-Americans, women, and conservatives.[4] Research undertaken pre-pandemic similarly indicates an

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[1] See Los Angeles Times, "Half of Republican Men say they don't want the vaccine" Doyle MaManus, March 21, 2021.

[2] See New York Times, "White Evangelical Resistance Is Obstacle in Vaccination Effort," April 5, 2021.

[3] Further, the authors show that Donald Trump's (pre-COVID-19) anti-vaccine tweets exacerbated concerns about vaccines among Trump supporters.

[4] Among other recent papers, Calvillo *et al*. (2020) suggest conservatives perceive the COVID-19 virus as less threatening; Pedersen and Favero (2020) find Democrats report greater social distancing under COVID-19; Rothberger *et al*. (2020) and Christensen *et al*. (2020) find compliance with social distancing is more common among liberals; and van Holm *et al*. (2020) find liberals and moderates are more likely to abide by COVID-19 government

association between political ideology and vaccine uptake.[5] However, and in contrast to our approach (below), prior studies of vaccination uptake rely on sample surveys of limited size.

In this paper, we show that political belief is salient to COVID-19 virus transmission, vaccine uptake, and efficacy of policy response. Using recent comprehensive voting data from Israel, we identify households that ex ante likely hold divergent beliefs. We match this information with the universe of data on vaccination and infection cases in Israel to estimate the effects of political belief on virus incidence and pandemic intervention outcomes. We further establish that different worldview clusters update beliefs heterogeneously when confronted by immediate and localized virus risk. Among some clusters, the estimated belief effects are mediated by emergent health risk. Elsewhere, belief effects are durable in the face of virus exigency, so as to limit the reach of public vaccination efforts. Results also show that stringent pandemic policy controls such as economic closure are more effective among those clusters holding durable beliefs.

Israel provides an ideal laboratory to undertake analyses of political belief in COVID-19 health risk, policy treatment, and response. The country is comprised of diverse populations holding significantly divergent worldviews and political beliefs, including left- and right-wing ideologues, Arab ethnic and religious minorities, and orthodox Jewish groups. Moreover, unlike the U.S., the policy response to COVID-19 virus risk in Israel was not framed in partisan political

recommendations. Similarly, households express a range of views about COVID-19 vaccination [see, for example, Dror *et al*. (2020); Wang *et al*. (2021); Reiter *et al*. (2020); Earnshaw *et al*. (2020); and Lazarus *et al*. (2020)].

[5] Mesch and Schwirian (2015) find Democrats are more willing to be vaccinated against influenza. Similarly, Baumgaetner et al. (2018) show conservatives are less likely to vaccinate against pertussis, measles, and influenza. Rabinowitz et al (2016) show liberals are more likely to support pro-vaccination statements, whereas Featherstone et al. (2019) find conservative political orientation is more susceptible to vaccine conspiracy beliefs.

terms and was supported by leaders across the political spectrum.[6] The country witnessed three severe spikes in virus incidence during 2020–2021 and was an early adaptor of comprehensive testing and vaccination.[7] Further, Israel COVID-19 policy response over the period of analysis was national in scope and uniform across geography. Finally, provision of universal health care and related availability of comprehensive electronic medical records in Israel allowed full, accurate, and timely tracking of virus incidence and vaccine uptake.

We identify households that likely hold divergent political beliefs based on small statistical area (akin to census tract) voting outcomes from general (parliamentary) elections held in Israel in March 2020 (on the eve of the COVID-19 outbreak).[8,9] We merge that data with statistical area population characteristics and the universe of all COVID-19 infections in Israel for the March 15

[6] In the U.S., the debate surrounding COVID-19 risk and related policy interventions became politically-charged and highly partisan. Further, while decisions regarding U.S. COVID-19 virus policy largely devolved to state and local government, Israel pandemic response was formulated and implemented by the national government, such that all areas were treated identically over sample period.

[7] As of February 2021, Israel was the world leading country in population vaccination rates (see https://ourworldindata.org/covid-vaccinations; last opened on February 25, 2021). A limited spike in infections was associated with the transmission of the COVID-19 Delta variant in Israel in July 2021. However, data on that event is not yet available and beyond the scope of this analysis.

[8] ICBS divides Israel into geographical units known as statistical areas, which are roughly equivalent to U.S. census tracts. Each statistical area includes 3,000–5,000 residents (see ICBS, 2013). Our sample includes 1,350 of the 1,624 statistical areas in Israel.

[9] See also Bartels (2002), Gaines et al (2007), Curtin (2016) and Meeuvis et al (2018) for discussion of belief divergence among voters for different political parties.

– December 20 2020 period.[10] We also study the universe of first-dose vaccinations from date of vaccination commencement on December 20, 2020 through April 25, 2021.

Panels A–C in Figure 1 show salient differences in virus infection and vaccination rates over the sample period and among belief clusters. Over successive pandemic virus waves through December 2020, about 4 percent of the Israeli population had been infected. By end of the vaccination sample timeframe, a full 78 percent of eligible population (age 16 and over) had received at least one dose of vaccine. Summary information indicates elevated infection rates and low vaccination uptake among orthodox Jewish and to a lesser degree Arab areas whereas left-leaning clusters exhibited the highest (lowest) uncontrolled rate of vaccinations (infections).

We then comprise weekly COVID-19 vaccination and infection panels and estimate belief effects controlling for a large number of statistical area disease incidence, population socio-economic, demographic, housing, geographic access, civic engagement, and weekly fixed effects. All things equal, areas supporting left-leaning, centrist, and Arab parties are associated with lower odds of infection, whereas areas supporting orthodox Jewish parties consistently exhibit the highest infection likelihood. However, contrary to prevailing survey-based and anecdotal evidence, results indicate that the *average* likelihood of vaccine take-up, *ceteris paribus*, is insignificantly different across belief clusters.

We then examine whether estimated belief effects are mediated in the presence of localized and immediate infection risk. Here we find heterogeneous updating in belief response, as

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[10] We end the sample on December 20, 2020 due to detection at that time of virus variants (British and South African) in Israel as well as commencement of the vaccination campaign on that day. Also, for purposes of assessing robustness of infection incidence to virus testing regime, we conducted all statistical tests using COVID-19 hospitalization outcomes. Results were generally robust to hospitalizations. We include those findings in the online appendix.

interactions of belief cluster and 1-week lagged local virus incidence are associated with elevated odds of vaccination response and lower odds of infection propagation particularly among left, center, and Arab clusters, whereas orthodox Jewish and to a lesser extent right-leaning areas show durability of beliefs even when confronted by immediate virus risk.[11] Results underscore the importance to pandemic disease control of distinct COVID-19 vaccination campaigns tailored to the specific needs of divergent belief groups.

Finally, we examine differential response among belief clusters to COVID-19 policy treatment. Here treatment is comprised of national economic closure.[12] As in many nations, nationwide closure was imposed by the Israeli government in response to virus surge. Findings show robustness of estimated belief effects across closure and non-closure periods. That said, event study results reveal significant differences among belief clusters in response to closure policy measures. Indeed, national closure was most effective in mitigating infection odds over the four-week period following the initiation of closure among orthodox Jewish areas; in contrast, little closure effect was evidenced among the Arab cluster. A similar divergence in infection odds, albeit to a lesser extent, was recorded between right and left clusters. Accordingly, imposition of more stringent and binding public health measures appears critical to mitigation of disease spread among those populations more resistive to vaccination and holding more durable beliefs.

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[11] For example, the estimated elasticities of the odds of weekly vaccine uptake (infection) to weekly lagged cases of infection are 0.52 (0.01) for the left clusters, as compared to 0.17 (0.18), and 0.12 (0.40) among right and orthodox Jewish areas, respectively.

[12] Hsiang et al. (2020) find that anti-contagion intervention policies were generally effective in decreasing COVID-19 infection cases.

Overall, upon adjusting for a full range of controls, findings show salient differences among belief clusters in disease spread and in response to vaccination campaigns and economic closure. Results suggest that a common public signal about virus health risk or related policy measures is differentially interpreted and acted upon depending on cluster worldview. The estimated variance in belief response to health risk and heterogeneous updating thereof may derive from political ideological or religious imperative or from bias in information processing, as discussed by Stulz and Williamson (2003), Kumar et al. (2011), and Shu et al. (2012). Our results also are consistent with literature showing the importance of political belief to interpretation of news and in response to political and economic events and policy [see, e.g., Bartels (2002), Gaines et al. (2007), and Meeuwis *et al*. (2018)]. Further, results underscore the relevance of targeted messaging and treatment among belief groups so as to enhance policy efficacy and related disease control.

2. DATA

Table 1 provides summary information on statistical area controls from the Israel Central Bureau of Statistics (2013). As shown, average persons per statistical area (Pop) is 4,589. Statistical areas in Israel are densely populated with an average density ($Density$) of 13,177 persons per square kilometer. The population is relatively young and characterized by high birth rates: the average share of Israeli population over the age of 60 ($Age60$) is 0.20 whereas the average share of population under the age of 15 ($Age15$) is 0.24. We use the ICBS socioeconomic index score (SES) to control for statistical area variation in household income and education. The socioeconomic index is computed based on 16 indicators clustered into 4 groups, the latter comprised of standard of living, employment and welfare, schooling and education, and demography (see ICBS, 2013).[13] As shown, the average socioeconomic index score is about 0.22 with standard deviation of 1.01. We also control for geographical proximity of the statistical area to Tel Aviv, the "superstar" city and central business district of Israel (see, e.g., Ben-Shahar et al., 2020). The table also provides summary information on the share of non-voters among the eligible local voting population ($NonVoter$). The latter serves to proxy for reduced civic engagement and social capital (e.g, Putnam, 1993; Putnam, 1995; Uslaner and Brown, 2005; Atkinson and Fowler, 2014), as may adversely affect vaccine uptake and response to policy treatment.

Table 1 also presents summary statistics for statistical areas clustered by distinct ideological worldview and political belief. We proxy for statistical area belief using the distribution of votes among political parties in Israel's March 2020 national parliament elections. We compute votes by party in each of the statistical areas and then use the k-means clustering method (see Forgy, 1965 and Lloyd, 1982) to classify each of the 1,350 statistical areas into one of five political belief clusters.[14] Panel D of Figure 1 presents the average political party vote share by belief cluster including $Right$, dominated by votes for "Likud" and "Yamina" (38 percent of statistical areas in

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[13] The 16 indicators include: average years of education for population age 25–54; share of population with academic degree age 25–54; share of workers in academic or management positions; share of income earners age 15 and above; share of women age 25–54 not in the workforce; share of workers on the job at least two day per week; share of income earners below minimum wage; share of population with income support ; average per capita income; average number of cars per household; average number of rooms per household; average number of bathrooms per household; share of households with computer and internet connection; median age, dependency ratio, and average number of persons per household. The socioeconomic index is generated by factor analysis that reduces the 16 indicators to 3 main factors that explain 80% of the variation among the statistical areas (see Agmon, 2016).

[14] Essentially, the k-means procedure partitions *N* observations into *k* sets, minimizing the within-set variance. The *k* number of sets is determined based on the elbow method (see, e.g., Thorndike, 1953 and Goutte et al., 1999).

the sample); $Left$, reflecting high share of votes for "Kahol-Lavan" and "HaAvoda-Meretz" (19 percent); $Center$, characterized by roughly equivalent votes for "Likud" and "Kahol-Lavan" (28 percent); non-Jewish $Arab$ minority, as defined by share of votes for the united Arab list "Hareshima Hameshutefet" (5 percent); and highly observant Jewish religious $Orthodox$, dominated by votes for "Yahadut Hatora" and "Shas" (10 percent).[15] As shown in Table 1, $Left$ areas on average exhibit the highest socioeconomic index score, the lowest housing density, and are closest to Tel Aviv. In contrast, $Orthodox$ statistical areas on average exhibit the highest housing density and household size, the youngest population, and the lowest average socioeconomic index score.

3. EFFECT OF BELIEF ON VACCINATIONS AND INFECTIONS

As discussed above, summary information (Panels B and C in Figure 1) indicates salient differences in COVID-19 disease incidence and vaccine uptake among statistical areas clustered by political belief.[16] To identify the effects of belief systems on COVID-19 vaccinations and infections, we comprise a weekly panel among the 1,350 statistical areas and estimate the following model:

$$Y_{it} = \beta_0 + \vec{\beta}_1 I_i + \beta_2 Infections_{i,t-1} + \vec{\beta}_3 I_i \times Infections_{i,t-1} + \vec{\beta}_4 X_i + \vec{\beta}_5 \tau_t + \varepsilon_{1it}. \quad (1)$$

[15] Following Figure 1, we label the clusters by $Right$, $Center$, $Left$, $Arab$, and $Orthodox$ based on their respective vote share.

[16] As vaccinations commenced in the second half of December 2020, weekly data in Figure 1 is available only from December 20, 2020.

where the outcome term Y_{it} is the log odds (i.e., ln $[p_{it}/(1-p_{it})]$) of either first-dose vaccination uptake or infection in location (statistical area) i at time (week) t and where p_{it} is the probability of vaccination uptake (infection), computed as the ratio of vaccinations (infections) to eligible (at risk) population for all i and t.[17] The vector I represents a series of belief fixed-effects based on the k-means classification procedure (described above), including $Right$ (base category); $Left$; $Center$; $Arab$; and $Orthodox$ areas. Other controls include statistical area virus incidence as measured by the log of the number of COVID-19 infection cases in the prior week, $Infections_{t-1}$; interactions of the vector I with $Infections_{t-1}$, which enables estimation of the response by belief cluster to immediate health risk as proxied by the lagged number of statistical area weekly infections (where $Right \times Infections_{t-1}$ is the base category);[18] and X, a vector of statistical area characteristics including Pop, the population size of the statistical area; $Density$, the ratio between the number of people in statistical area and the geographic size in square-meters; $Age60$, the share of population over the age of 60; $Age15$, the share of population under the age of 15; $PersonHH$, the average number of persons per household; $RoomsHH$, the average number of rooms per standard person; $ProximityTA$, the standardized proximity of the statistical area from Tel Aviv; the share of non-voters among the population eligible for voting in the statistical area,

[17] Eligible population for vaccination changes over time in accordance to public health protocol that allowed vaccination of increasingly younger age groups. Also, those already vaccinated are subtracted from the eligible vaccination population. The population under risk of infection declines over time as we assume that those already infected or got vaccinated are not subject to infection risk.

[18] Anecdotal evidence suggests that persons holding particular religious beliefs may prioritize adherence to belief norms relative to infection risk. In the U.S., for example, Catholic and Evangelical groups expressed reticence to receive the Johnson & Johnson vaccine, which was developed with abortion-derived fetal cell lines. See *New York Times*, April 1 2021.

$NonVoter$; and SES, the socioeconomic index score of the statistical area. Finally, the estimating equations include a vector τ of time (week) fixed-effects, β_0 and β_2 are estimated parameters, $\vec{\beta}_1$ and $\vec{\beta}_3 - \vec{\beta}_5$ are vectors of estimated parameters, and ε_1 is a random disturbance term.

We report results separately for COVID-19 infection and vaccination outcome terms. Also, we assess robustness of belief findings to continuous versions of those controls and to replacement of the lagged infection control term with lagged hospitalizations and two-week lagged infection control. As described below, empirical findings on belief disagreement are largely robust to those model specifications. Hence those results are relegated to the appendix.

Vaccinations

Table 2 presents results of panel estimation of equation (1) for log of the weekly number of vaccinations ($Vaccinations$) among the 1,350 statistical areas over the 19 weeks ending April 25, 2021. Column 1 presents benchmark outcomes controlling only for political cluster fixed effects (vector I).[19] As shown, statistical areas in the $Orthodox$ cluster exhibit the lowest likelihood of vaccination uptake, followed by $Arab$, $Right$, $Center$, and $Left$.

In column 2, we re-estimate the model including all controls (described above) exclusive of the lagged infection terms. Results here differ from both uncontrolled estimates (column 1 and Figure 1 Panel C) and findings of survey-based literature (discussed earlier). Results (column 2) indicate that the *average* likelihood of local area vaccine uptake among political belief clusters is sensitive to the inclusion of local area controls. Specifically, controlling for population socio-

[19] Full results from the estimation of (1) inclusive of control terms omitted from Table 2 for the sake of brevity appear in Appendix Table A1. We use weighted least squares procedure in all estimations, whereby the weight is determined by eligible population (respectively for vaccinations and infections) in *i* and *t*.

economic status, density, share of non-voters, and other factors, the average likelihood of vaccine uptake is insignificantly different among belief clusters. Also, the coefficient on $NonVoter$ (Table A1) implies that a 1 basis point increase in the share of non-voters among eligible population is associated with about 1.5 percent reduction in the odds of vaccination incidence. This result suggests that political disengagement or disaffection among local population may adversely affect vaccination results.

In column 3 of Table 1, we evaluate the extent to which vaccine uptake among belief clusters is mediated by local infection risk. We do so by including $Infections_{t-1}$ and the vector of interaction terms $I \times Infections_{t-1}$ on the right-hand side of equation (1). Summing the coefficients on $Infections_{t-1}$ and the interaction term $I \times Infections_{t-1}$, a 1 percent increase in weekly lagged number of infection cases is associated with a 0.52, 0.32, 0.28, 0.17, and 0.12 percent increase in the odds of vaccination take-up among statistical areas in $Left$, $Arab$, $Center$, $Right$, and $Orthodox$ clusters, respectively (all significant at the 1 percent level). Also, the interactive political belief effect coefficients (associated with the vector $I \times Infections_{t-1}$) are largely different from one another at the 1 or 5 percent level (with the exception of the coefficients for $Center$ and $Arab$).

Panel A in Figure 2 depicts the projected odds of vaccination uptake associated with 1-week lagged infection risk by belief cluster (the exponent of the sum of $\hat{\beta}_0 + \vec{\hat{\beta}}_1 I + \hat{\beta}_2 Infections_{t-1} + \vec{\hat{\beta}}_3 I \times Infections_{t-1}$ for all I—holding all other control terms equal to zero), where $Infections_{t-1}$ ranges from 1st–99th percentile of its sample distribution. All things equal, while the $Left$ cluster exhibits a damped rate of vaccination uptake for low levels of health risk ($Infections_{t-1}$), they exhibit an elevated vaccination response as local health risk rises. In marked contrast, the $Orthodox$ cluster and to a somewhat lesser extent the $Right$ cluster appear impervious to localized and immediate COVID-19 infection risk. As such, the $Left$ and $Orthodox/Right$ clusters represent two ends of a response (to risk) distribution, whereby in the case of the former, initial low level of vaccine uptake is mediated and informed by increasingly elevated disease risk, whereas the opposite finding is evidenced in the case of the $Orthodox$ cluster. Indeed, $Orthodox$ statistical areas demonstrate high levels of belief durability even when confronted by ever-increasing local infection risk, suggesting challenges among that and like groups to vaccination campaigns in management and control of the pandemic. We see similar divergence, albeit to a lesser extent, among $Arab$ and $Center$ clusters. At low levels of disease incidence, vaccine uptake among $Arab$ areas is similar to that in $Center$ areas; however, the former exhibit higher levels of vaccination response in the face of rising health risks.

Note that the estimated vector of $I \times Infections_{t-1}$ political belief interaction terms is robust to the inclusion of a full set of interactions of $Infections_{t-1}$ with socio-economic, age, and density controls.[20] Further, results reported in sections 3 and 4 are largely robust to continuous specification of belief terms and to the replacement of $Infections_{t-1}$ with either $Hospitalizations_{t-1}$ or $Infections_{t-2}$. Results of estimation of those models are presented in Tables A2–A3 of the appendix.

[20] Specifically, we supplement the right-hand side of equation (1) with interactions of $Infections_{t-1}$ with SES, $Age60$, $Age15$, and $Density$. Results (not presented and available upon request) are robust to this model specification.

Infections

In columns 4–6 of Table 1 we repeat the panel estimation of equation (1) for the log odds of statistical area weekly COVID-19 virus infection cases ($Infections$).[21] Empirical findings provide evidence of salient effects of political belief on virus propagation. Specifically, in column 4, we include only belief fixed effects (i.e., vector I; $Right$ serves as the base group). As shown, statistical areas on the $Left$ cluster exhibit the lowest average infection likelihood, followed by the $Center$, $Right$, $Arab$, and $Orthodox$ clusters. In column 5, we include the full set of controls exclusive of the lagged local infection terms. While the pattern (coefficient sign) of disease incidence among belief groups is generally similar to that shown in column 4, estimated belief differences are damped. In both columns, coefficients on the cluster dummies are generally different from one another at the 1 percent level.

In column 6, we assess the extent to which disease propagation among political belief clusters is mediated by lagged local area infection risk. As above, we include $Infections_{t-1}$ and the vector of $I \times Infections_{t-1}$ interaction terms. As shown, the $Left$ cluster exhibits the lowest likelihood of disease transmission in response to lagged infection cases. Summing the coefficients on $Infections_{t-1}$ and the interaction term $I \times Infections_{t-1}$, a 1 percent increase in the number of weekly lagged infections is associated with a 0.01, 0.11, 0.17, 0.18, and 0.40 percent rise in the odds of infections among statistical areas in $Left$, $Center$, $Arab$, $Right$, and $Orthodox$ clusters, respectively (all significant at the 1 percent level). Also, the belief and infection incidence interactive coefficients (associated with the vector $I \times Infections_{t-1}$) are different from one

[21] The results on the controls in the vector X from the estimation of (1) for log odd of infection appear in Appendix Table A1

another at the 1 percent level (except for the insignificant difference between the $Arab$-$Right$ pair).

Panel B in Figure 2 depicts the projected odds of infection associated with 1-week lagged local infection risk by political belief cluster (sum of $\hat{\beta}_0 + \hat{\vec{\beta}}_1 I + \hat{\beta}_2 Infections_{t-1} + \hat{\vec{\beta}}_3 I \times Infections_{t-1}$ for all I—holding other control variables equal to zero), where $Infections_{t-1}$ ranges from the 1st–99th percentile of the sample distribution. As shown, *ceteris paribus*, statistical areas clustered by political belief exhibit similar rates of infection propagation at low levels of infection. The infection odds inevitably rise among all belief clusters over the course of the pandemic. That said, areas in the $Left$ cluster exhibit the lowest disease propagation response to increasing levels of infection, followed by areas in $Center$, $Arab$, $Right$, and $Orthodox$ clusters. Here the $Left$ and $Orthodox$ clusters represent two ends of an infection response (to local disease risk) distribution. While infection risk among the $Left$ is much informed by increasing levels of 1-week lagged disease, such is not the case among $Orthodox$ and to a lesser degree $Right$ and $Arab$ areas. Among those clusters, we find sharply elevated likelihood of disease transmission as infection rates rise, suggesting the durability of belief and related practice norms even when confronted by growing and immediate local health risks.

Finally, for robustness, we estimate the political belief cluster response to lagged infections only for the non-closure period (from May 10 – September 24 2020).[22] Outcomes (column 7) are generally robust across the full and sub-sample periods, as the sums of the coefficients on

[22] As described in the next section, two closures were imposed during our sample period—one toward the beginning of the sample period and the other toward the end. We therefore test for robustness between those closure periods.

$Infections_{t-1}$ and $I \times Infections_{t-1}$ for all I are insignificantly different from one another across the two samples.[23]

4. EVENT STUDY: BELIEF RESPONSE TO COVID-19 CLOSURE

The pandemic infections panel enables assessment of heterogeneity among political belief clusters in response to virus policy treatment. Here we examine treatment outcomes associated with a country-wide closure imposed by the Israeli Government in response to virus surge during September 25 – October 17, 2020.[24] During the lockdown period, widespread and stringent nationwide population restrictions were implemented including a stay-at-home order; shut down of schools, universities, and non-essential retail and workplaces; and only limited provision of public transportation.[25] Policy treatment was national and not specific to belief cluster. Consider the following estimated equation:

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[23] As noted earlier, results on the estimated vector of $I \times Infections_{t-1}$ belief interaction terms is robust to (*a*) the inclusion of a full set of interactions of $Infections_{t-1}$ with SES, $Age60$, $Age15$, and $Density$ controls (those results are not presented and available upon request) are robust to this model specification controls; (*b*) continuous specification of belief terms (see Table A2 in the appendix); and (*c*) the replacement of $Infections_{t-1}$ with either $Hospitalizations_{t-1}$ or $Infections_{t-2}$ (see Table A3 in the appendix).

[24] Israel imposed two other closures, from April 4 – May 4, 2020 and from January 8 – February 7, 2021. We omit assessment of behavioral response to those closures, as the former was associated with low morbidity rates in other than the Orthodox cluster, whereas response to the third closure reflects in part evolution in both the virus itself (increased prevalence of British and South African variants in Israel) and in vaccination take-up.

[25] While the above date represents the official timeframe of the closure, entrance to and exit from closure was gradual; further, the population limitations imposed before, during, and after the closures were identical across places.

$$Y_{it} = \gamma_0 + \vec{\gamma}_1 I_i + \gamma_2 Infections_{i,t-1} + \vec{\gamma}_3 I_i \times Infections_{i,t-1} + \gamma_4 t + \vec{\gamma}_5 I_i \times t + \vec{\gamma}_6 X_i + \varepsilon_{2it}, \tag{2}$$

where the dependent variable, Y_{it}, is the log odds of infection in week t and statistical area i. The estimation of equation (2) differs from that of equation (1) in two ways. First, we estimate equation (2) only for the closure period and restrict the sample for t = (0, 1, 2, …4), where t = 0 is the week when the closure commences. Further, we omit τ (weekly fixed-effects) and supplement equation (2) with the vector $I_i \times t$, a series of interaction terms between the political belief fixed-effect and a time trend, so as to estimate divergent infection response paths to closure by belief system. Also, γ_0, γ_2, and γ_4 are estimated parameters, $\vec{\gamma}_1$, $\vec{\gamma}_3$, and $\vec{\gamma}_5 - \vec{\gamma}_6$ are vectors of estimated parameters, ε_2 is a random disturbance term, and all other variables are as discussed above.

Column 8 in Table 2 presents results of panel estimation of equation (2) for the closure treatment episode. Consistent with the outcomes in the previous section, response to lagged infections varies by political belief clusters, where once again the $Orthodox$ cluster exhibits the highest odds of disease transmission in response to lagged risk followed as before by the $Arab$, $Right$, $Center$, and $Left$ clusters. Also, the odds ratio between any pair of belief clusters is significantly different than 1 at the 1 percent level.[26]

Results further indicate that while pandemic economic lockdown was effective in decreasing the likelihood of infection cases among all belief clusters (as the sum of coefficients on t and the vector $I_i \times t$ are all negative and significant at the 1 percent level), the rate of decline in the likelihood of infections during the closure varied by belief cluster. The estimated response to government-imposed closure by belief cluster is plotted in Panel C of Figure 2. The plots compute

[26] The only exception is the pair $Arab$-$Right$ and $Arab$-$Center$ whose odds ratio in response to lagged infections is insignificantly different than 1.

the sum $\bar{Y}_{i0}I_i + \hat{\gamma}_2 t + \vec{\hat{\gamma}}_3 I_i \times t$ for all I and t = 0, 1,…, 4 as follow from the estimation results in column 7 of Table 2—translated to odds terms—where $\bar{Y}_{i0}I_i$ is the cluster average odds of infections (across statistical areas) at the beginning of the closure. As shown, the decline in infection odds during the closure mandate varied by ideological cluster and was most precipitous among $Orthodox$ statistical areas, followed by $Right$, $Center$, $Left$, and $Arab$ clusters. Further, the pair-wise difference between any pair of belief clusters in the decline in odds of infection during closure is significant at the 1 percent level. Findings of heterogeneity in closure effects among belief groups are generally robust to continuous specification of the belief effects;[27] substitution of hospitalizations for infections; and replacing $Infections_{t-1}$ with $Infections_{t-2}$. In sum, results suggest that imposition of rigorous state-mandated closure policy treatment was most effective among *Orthodox* and *Right* clusters less likely to be vaccinated in response to infection risk and adhering to more durable beliefs.

5. Conclusion

We show that political belief is salient to COVID-19 virus transmission, vaccine uptake, and response to national closure policy. Using comprehensive voting data from Israel, we identify households that ex ante likely hold divergent political beliefs and estimate the effects of worldview

[27] For robustness, we re-estimate equation (2) for the lockdown period, replacing the belief-fixed effects with continuous specification of belief terms. Results are presented in Table A2 in the appendix. As show, coefficients on the interaction term of the continuous belief variable with t are consistent with the fixed-effects specification and significant at the 1 percent level, suggesting robust differences in the likelihood of infection response to closure by ideology and belief. Also, as shown in Table A3 in the appendix, results are further robust the replacement of $Infections_{t-1}$ with either $Hospitalizations_{t-1}$ or $Infections_{t-2}$.

and belief on COVID-19 virus and disease related outcomes. We further establish that divergent worldview clusters update beliefs heterogeneously when confronted by immediate and localized virus risk. Among some clusters, estimated effects of political belief are mediated by emergent health risk. Elsewhere, belief effects are durable in the face of virus exigency, so as to limit the reach of public vaccination efforts. Results also show that stringent pandemic treatment controls such as economic closure are more effective among those clusters holding durable beliefs in the face of immediate virus risk.

Overall, results add to a growing body of literature suggesting that a common public signal about risk (in our case, virus infections) or related policy treatment is differentially interpreted and acted upon depending on worldview and political belief. The estimated belief effects may derive from political or ideological imperative or from bias in information processing. Also, our findings are consistent with literature showing the importance of political beliefs to interpretation of news and in response to political and economic events. Further, results underscore the importance of targeted messaging and treatment among belief groups so as to enhance the efficacy of policy measures for pandemic management and related disease control. Indeed, our results show that populations holding durable beliefs do better with more restrictive and binding pandemic crisis management. Future research should assess the external validity of results as belief effects may be of first order importance to ongoing COVID-19 variant transmission and to response formulation among decision-makers globally.

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Table 1: **Variables Description and Summary Statistics**

Variable	Description	Mean	Std	Min	Max	Right	Center	Left	Arab	Orthodox
Infections	Total number of weekly infections	4.6	12.2	0	544	3.9	3.0	2.0	5.1	16.2
Vaccinations	Total number of weekly vaccinations	195.4	169.9	0	2,334	185.9	215.7	226.0	200.6	114.6
Ln(OddsInfect)	Log odds of weekly infections	-6.17	1.89	-6.90	6.90	-6.12	-6.25	-6.42	-6.15	-5.73
Ln(OddsVac)	Log odds of weekly vaccinations	-4.79	3.72	-6.90	6.90	-4.94	-4.76	-4.55	-5.02	-4.74
Right	Dummy variable equals 1 for right-leaning cluster	0.38	0.48	0	1					
Center	Dummy variable equals 1 for center cluster	0.28	0.45	0	1					
Left	Dummy variable equals 1 for left-leaning cluster	0.18	0.38	0	1					
Orthodox	Dummy variable equals 1 for Orthodox Jewish cluster	0.10	0.30	0	1					
Arabs	Dummy variable equals 1 for Arab cluster	0.049	0.217	0	1					
RightCont	Share of votes for right-leaning parties	0.37	0.18	0	0.89	0.53	0.41	0.24	0.04	0.11
OrthodoxCont	Share of votes for Orthodox Jewish parties	0.17	0.24	0	0.98	0.16	0.07	0.02	0.01	0.85
ArabsCont	Share of votes for United Arab List									
NonVoter	Share of non-voters among those eligible to vote	0.34	0.09	0.10	0.86	0.37	0.35	0.3	0.38	0.27
Pop	Population size	4,589	2,465	1,974	27,768	4,279	4,454	4,393	5,796	5,917
Density	Population density (Pop divided by geographic area in square kilometers)	13,177	10,223	39.3	66,159	10,827	13,555	12,107	6,888	26,198
SES	Socioeconomic index score	0.22	1.01	-3.13	2.53	-0.11	0.63	1.52	-0.75	-1.59
ProximityTA	Distance to Tel Aviv (index)	0.68	0.93	-4.97	1.48	0.44	0.79	1.16	-0.06	0.77
Age60	Share of population over the age of 60	0.20	0.07	0	0.49	0.21	0.23	0.21	0.12	0.08
Age15	Share of population under the age of 15	0.24	0.08	0.05	0.65	0.24	0.22	0.21	0.27	0.43
PersonHH	Average number of persons in the household	3.18	0.83	1.50	7.10	3.13	2.94	2.74	3.82	4.66
RoomsHH	Average number of rooms per person	1.52	0.26	0.58	2.44	1.51	1.61	1.75	1.25	1.1

Notes: Table 1 presents summary statistics for the entire sample and sample stratified by ideological clusters.

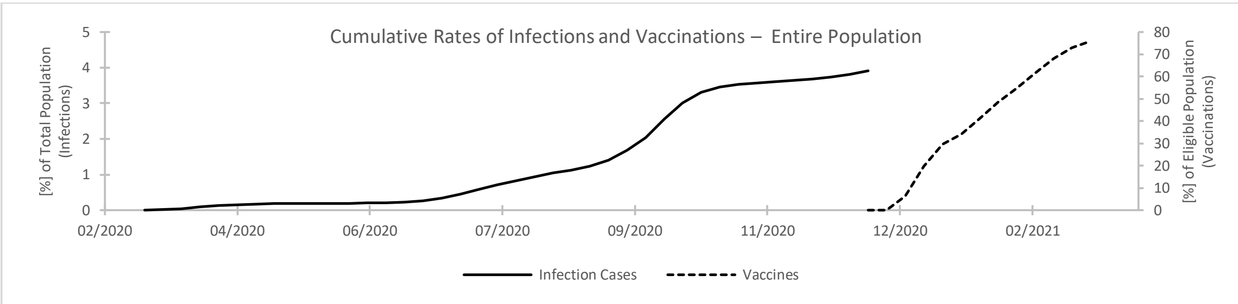
Table 2: **Results from the Estimation of Equations (1) and (2) – Log Odds of $Vaccination$ and $Infection$**

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome Term	**Vac**	**Vac**	**Vac**	**Infections**	**Infections**	**Infections**	**Infections**	**Infections**
Constant	-2.523	-2.482	-2.946	-6.671	-6.394	-6.638	-6.511	-5.950
	(0.024)	(0.333)	(0.325)	(0.005)	(0.097)	(0.071)	(0.089)	(0.179)
Left	0.520	-0.073	-0.517	-0.154	-0.065	0.089	0.50	-0.161
	(0.065)	(0.091)	(0.097)	(0.007)	(0.017)	(0.014)	(0.015)	(0.071)
Center	0.250	0.014	-0.159	-0.077	-0.031	0.050	0.040	-0.016
	(0.046)	(0.046)	(0.054)	(0.007)	(0.010)	(0.008)	(0.008)	(0.085)
Orthodox	-0.456	0.011	0.253	0.462	0.229	-0.259	-0.211	-0.318
	(0.075)	(0.122)	(0.128)	(0.020)	(0.028)	(0.023)	(0.025)	(0.137)
Arab	-0.152	0.119	-0.152	0.001	-0.056	-0.021	-0.050	-0.775
	(0.100)	(0.108)	(0.201)	(0.020)	(0.022)	(0.016)	(0.015)	(0.116)
$Infections_{t\text{-}1}$			0.177			0.179	0.165	0.272
			(0.018)			(0.008)	(0.009)	(0.016)
$Left\times Infections_{t\text{-}1}$			0.343			-0.168	-0.129	-0.167
			(0.044)			(0.014)	(0.014)	(0.027)
$Center\times Infections_{t\text{-}1}$			0.106			-0.071	-0.072	-0.065
			(0.018)			(0.010)	(0.010)	(0.030)
$Orthodox\times Infections_{t\text{-}1}$			-0.050			0.217	0.216	0.235
			(0.017)			(0.011)	(0.014)	(0.030)
$Arab\times Infections_{t\text{-}1}$			0.150			-0.010	0.011	-0.028
			(0.060)			(0.015)	(0.021)	(0.039)
t								-0.301
								(0.007)
$Left\times t$								0.149
								(0.011)
$Center\times t$								0.043
								(0.011)
$Orthodox\times t$								-0.121
								(0.015)
$Arab\times t$								0.227
								(0.024)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
N	25,650	25,650	25,650	51,300	51,300	51,300	27,000	6,750
# of weeks	19	19	19	39	38	38	20	5
Prob(F)	0	0	0	0	0	0	0	0
R2-overall	0.039	0.058	0.178	0.113	0.126	0.468	0.481	0.747

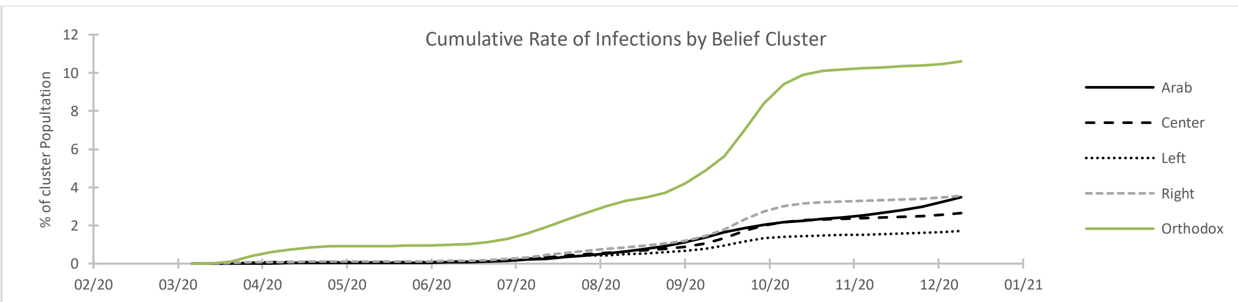
Notes: Table 2 presents results obtained from the estimation of Equations (1) and (2).

Figure 1: Cumulative Rates of COVID-19 Infections and Vaccinations (Total and by Belief Cluster) and Average Vote Rate for Political Parties by Cluster

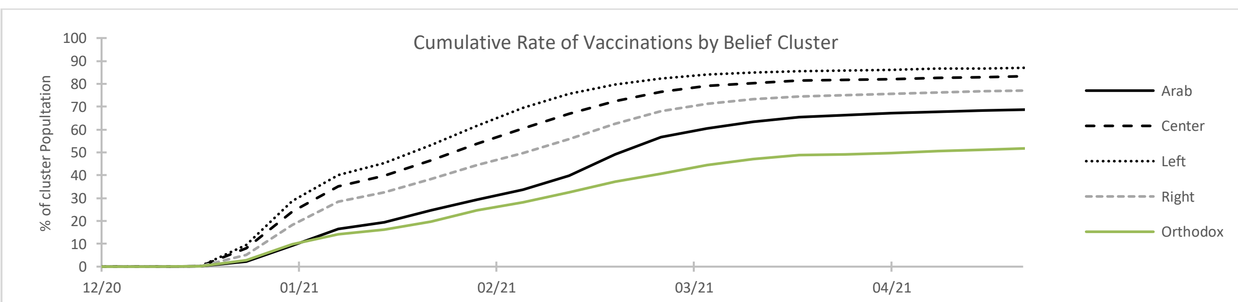
(A)



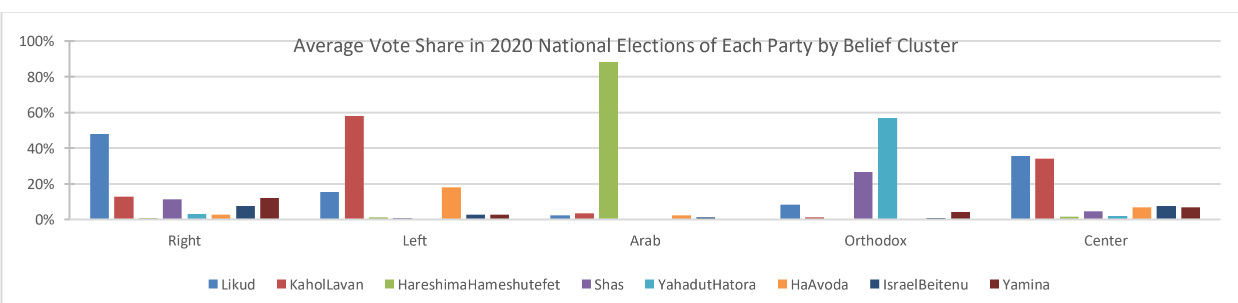
(B)



(C)



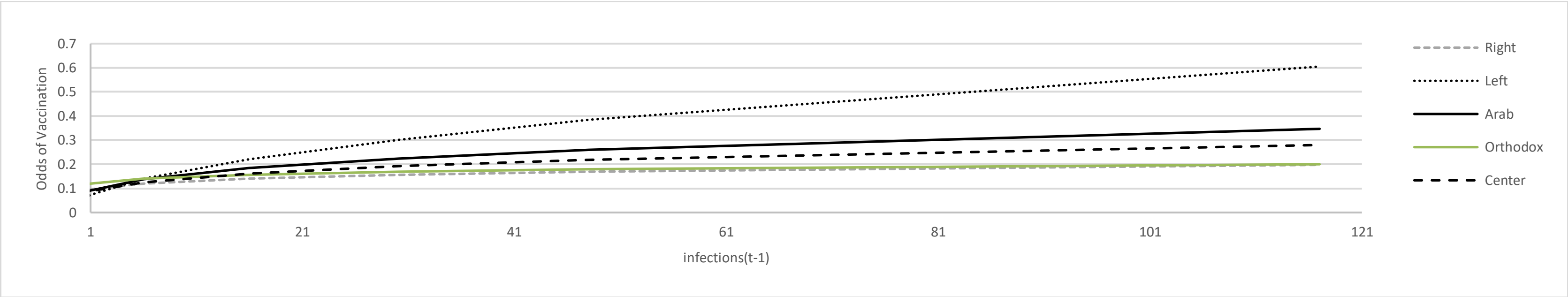
(D)



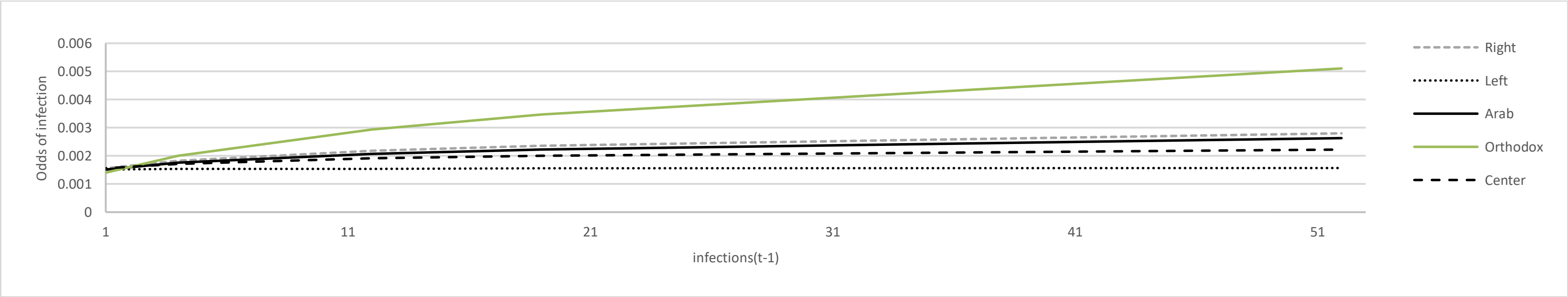
Notes: Figure A shows cumulative rates of COVID-19 infections and vaccinations; Figure B shows cumulative rates of infections by belief cluster; Figure C shows cumulative rates of vaccination by belief cluster; and Figure D shows the average vote share in the 2020 national elections of each party by cluster.

Figure 2: Estimated Belief Cluster Odds of Vaccination and Infection by Lagged Infections (Panels A and B, respectively) and Odds of Infection Response to Policy Closure (Panel C)

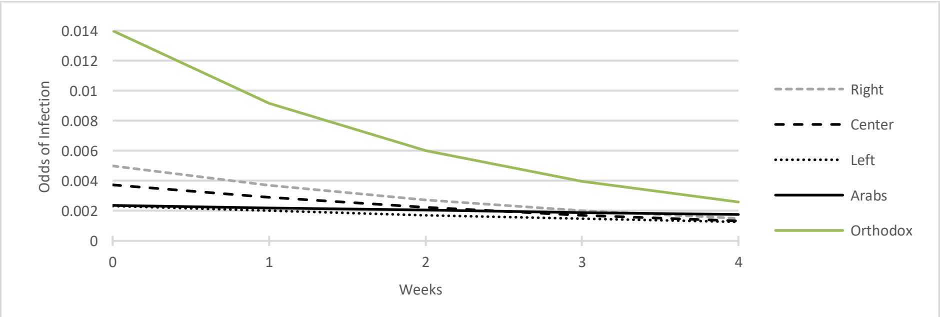
(A)



(B)



(C)



Notes: Figures A and B respectively present estimated belief cluster average vaccination and infection odds by $Infections_{t-1}$, where the latter ranges from 1st – 99th percentile of its sample distribution. Figure C presents the sum $\bar{Y}_{i0}I_i + \hat{\gamma}_2 t + \vec{\hat{\gamma}}_3 I_i \times t$ for all I and t=0,1,…,4 from estimates in column 7 of Table 2—in odds terms—where $\bar{Y}_{i0}I_i$ is the cluster average odds of infections at the beginning of the closure.

Appendix Tables

Table A1: **Results of Control Variables included in the Estimation of Equations (1) and (2)**

Column	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Outcome Term	**Vac**	**Vac**	**Vac**	**Infections**	**Infections**	**Infections**	**Infections**	**Infections**
Pop		-4e-06	-2.6e-05		-5e-06	-1.6e-05	-3e-05	-1.6e-05
		(8e-06)	(8e-06)		(2e-06)	(3e-06)	(6e-06)	(2e-06)
Density		-9e-06	8e-06		2e-06	0.0	1e-06	0.0
		(3e-06)	(3e-06)		(1e-06)	(0.0)	(1e-06)	(0.0)
SES		0.349	0.407		-0.090	-0.055	-0.172	-0.066
		(0.049)	(0.047)		(0.011)	(0.008)	(0.021)	(0.009)
ProximityTA		-0.015	-0.022		0.013	0.010	0.052	0.009
		(0.021)	(0.020)		(0.004)	(0.003)	(0.009)	(0.004)
*Age*60		0.702	0.813		-0.124	-0.183	0.048	-0.238
		(0.460)	(0.456)		(0.071)	(0.073)	(0.157)	(0.066)
*Age*15		0.928	0.981		-0.296	-0.196	-0.064	-0.299
		(0.526)	(0.497)		(0.121)	(0.104)	(0.253)	(0.116)
PersonHH		0.049	0.047		0.025	0.016	0.035	0.013
		(0.037)	(0.035)		(0.010)	(0.007)	(0.018)	(0.008)
RoomsHH		0.129	0.159		-0.007	0.014	0.062	0.021
		(0.150)	(0.146)		(0.035)	(0.029)	(0.051)	(0.028)
NonVoter		-1.542	-1.212		-0.705	-0.371	-0.867	-0.602
		(0.305)	(0.301)		(0.133)	(0.101)	(0.189)	(0.113)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
N	25,650	25,650	25,650	51,300	51,300	51,300	6,750	27,000
# of weeks	19	19	19	39	38	38	5	20
Prob(F)	0	0	0	0	0	0	0	0
R2-overall	0.039	0.058	0.178	0.113	0.126	0.468	0.747	0.481

Notes: Table A1 provides estimates of *X* vector control variables from equations (1) and (2) omitted from Table 2 for purposes of brevity.

Table A2: **Results from the Estimation of Equations (1) and (2) – Replacing Belief Fixed-Effects with Continuous Belief Terms**

Column	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Outcome Term	**Vac**	**Vac**	**Vac**	**Infections**	**Infections**	**Infections**	**Infections**	**Infections**
Constant	-1.944	-2.320	-3.236	-6.876	-6.496	-6.517	-6.409	-6.216
	(0.073)	(0.375)	(0.370)	(0.007)	(0.113)	(0.082)	(0.100)	(0.202)
RightCont	-0.608	-0.148	0.249	0.154	0.133	-0.023	0.011	0.769
	(0.142)	(0.188)	(0.218)	(0.016)	(0.038)	(0.029)	(0.031)	(0.163)
OrthodoxCont	-1.145	-0.293	0.393	0.755	0.687	-0.232	-0.142	0.749
	0.103	(0.305)	(0.299)	(0.021)	(0.063)	(0.053)	(0.053)	(0.205)
ArabCont	-0.826	-0.090	0.068	0.227	0.205	-0.056	-0.056	-0.161
	(0.135)	(0.236)	(0.316)	(0.023)	(0.049)	(0.038)	(0.037)	(0.153)
$Infections_{t-1}$			0.515			-0.051	-0.021	0.077
			(0.041)			(0.018)	(0.018)	(0.028)
$RightCont \times Infections_{t-1}$			-0.422			0.250	0.177	0.204
			(0.068)			(0.029)	(0.033)	(0.051)
$OrthodoxCont \times Infections_{t-1}$			-0.403			0.480	0.434	0.431
			(0.042)			(0.020)	(0.021)	(0.045)
$ArabCont \times Infections_{t-1}$			-0.201			0.236	0.212	0.155
			(0.081)			(0.023)	(0.028)	(0.045)
t								-0.082
								(0.013)
$RightCont \times t$								-0.308
								(0.027)
$OrthodoxCont \times t$								-0.377
								(0.018)
$Arab \times t$								0.013
								(0.030)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
N	25,650	25,650	25,650	51,300	51,300	51,300	27,000	6,750
# of weeks	19	19	19	39	38	38	20	5
Prob(F)	0	0	0	0	0	0	0	0
R2-overall	0.043	0.058	0.181	0.125	0.132	0.465	0.482	0.756

Notes: Table A2 presents results from estimations of Equations (1) and (2), replacing the belief fixed-effects with continuous belief terms including: $RightCont$, $OrthodoxCont$, and $ArabCont$, where those terms represent the share of votes in each statistical area for right-leaning, orthodox, and united Arab parties, respectively.

Table A3: **Results of Estimation of Equations (1) and (2) – Replacing $Infections_{t-1}$ with either $Hospitalization_{t-1}$ or $Infections_{t-2}$**

Column	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Outcome Term	**Vac**	**Infections**	**Infections**	**Infections**	**Vac**	**Infections**	**Infections**	**Infections**
Constant	-2.506	-6.403	-6.347	-4.782	-3.047	-6.539	-6.415	-5.568
	(0.329)	(0.090)	(0.106)	(0.263)	(0.328)	(0.081)	(0.099)	(0.205)
Left	-0.156	-0.047	-0.044	-0.697	-0.309	0.064	0.014	-0.277
	(0.089)	(0.016)	(0.015)	(0.051)	(0.097)	(0.014)	(0.015)	(0.069)
Center	-0.014	-0.020	-0.025	-0.241	-0.060	0.037	0.019	-0.034
	(0.047)	(0.008)	(0.009)	(0.042)	(0.053)	(0.008)	(0.009)	(0.072)
Orthodox	0.019	0.145	0.154	0.677	0.382	-0.177	-0.164	-0.113
	(0.121)	(0.027)	(0.031)	(0.085)	(0.130)	(0.023)	(0.027)	(0.151)
Arab	0.001	-0.070	-0.110	-1.096	-0.172	-0.013	-0.060	-1.042
	(0.131)	(0.020)	(0.022)	(0.097)	(0.217)	(0.018)	(0.017)	(0.135)
Z	0.037	0.129	0.082	0.124	0.195	0.117	0.095	0.184
	(0.021)	(0.014)	(0.023)	(0.022)	(0.018)	(0.007)	(0.008)	(0.017)
Left×*Z*	0.599	-0.213	-0.167	-0.041	0.215	-0.151	-0.118	-0.161
	(0.139)	(0.031)	(0.050)	(0.045)	(0.047)	(0.013)	(0.014)	(0.028)
Center×*Z*	0.098	-0.076	-0.075	0.002	0.055	-0.063	-0.066	-0.070
	(0.040)	(0.029)	(0.033)	(0.051)	(0.019)	(0.009)	(0.010)	(0.029)
Orthodox×*Z*	0.011	0.308	0.293	0.029	-0.110	0.185	0.212	0.211
	(0.048)	(0.028)	(0.042)	(0.042)	(0.017)	(0.028)	(0.015)	(0.036)
Arab×*Z*	0.255	0.010	0.126	0.006	0.147	-0.023	0.009	0.009
	(0.106)	(0.036)	(0.062)	(0.073)	(0.065)	(0.016)	(0.021)	(0.044)
t				-0.375				-0.377
				(0.006)				(0.007)
Left×*t*				0.191				0.192
				(0.010)				(0.010)
Center×*t*				0.054				0.054
				(0.010)				(0.011)
Orthodox×*t*				-0.113				-0.167
				(0.016)				(0.015)
Arab×*t*				0.237				0.268
				(0.026)				(0.025)
Controls	No	Yes	No	Yes	Yes	Yes		Yes
N	25,650	25,650	51,300	25,650	51,300	51,300		6,750
# of weeks	19	19	39	19	38	38		5
Prob(F)	0	0	0	0	0	0		0
R2-overall	0.039	0.058	0.113	0.178	0.126	0.468		0.747

Notes: Table A3 presents results obtained from re-estimating equations (1) and (2), replacing $Infections_{t-1}$ with either $Hospitalization_{t-1}$ or $Infections_{t-2}$. The variable Z represents $Hospitalization_{t-1}$ and $Infections_{t-2}$ in columns 1–4 and 5–8, respectively. Column 1 and 2 (5 and 6) respectively present outcomes from the estimation of the vaccination and infection equations (1) for the full sample; column 3 (7) presents results from the estimation of the infection equation (1) for the period May 10 – September 20 2020, between the first and second rounds of closure; and column 4 (8) presents results from the estimation of equation (2) for the closure period sample. For the sake of brevity, results for the control vector X are omitted and available upon request.