Fears of Disinformation and COVID-19 Vaccine Hesitancy among 15 Countries

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Abstract

The COVID-19 pandemic has shown the vitality of reliable communication channels that allow the flow of novel information to the masses. The internet, particularly social media, was utilized by various institutions in order to connect to people, inform them about the disease, and encourage behaviour that would help decrease transmissions. This paper hypothesizes that perceptions of such institutions are critical for the adoption of the behaviour they propose. Notably, different levels of trust in those institutions and the information they share on social media would correspond to varying levels of adoption of an encouraged behaviour, such as vaccination. Moreover, trust in different types of institutions might have different relationships with vaccine acceptance. By employing multiple linear regression, this paper explores the significance of distrust in various national and foreign institutions in predicting COVID-19 vaccine hesitancy in a country. The results conclude that the most significant predictor for vaccine hesitancy in a country is trust in foreign governments and the information they share on social media. The relationship reveals that in countries where people believe foreign governments and their agents use social media for disseminating false information more frequently, there are higher percentages of vaccine hesitant populations. The paper discusses how this result can be interpreted by highlighting the hegemonic nature of knowledge production during the pandemic. Finally, it calls for action aimed to restore trust, a factor that proved to be of vital functionality during certain periods.

1 Introduction

With the rise of social media and the consequent rise in communication, individuals started to be exposed to an increasing amount of information. The so-called democratic nature of social media allowed every user to contribute somewhat equally to the environment; these new opportunities have been successful in addressing multiple issues such as representation. However, the lack of a filter or a check mechanism permits all types of information to be released, whether true or false. Some groups and governments have utilized this nature of the information environment to spread propaganda and incorrect information intended to help their political agendas. This phenomenon is usually referred to as disinformation campaigns or information operations. The uncertainty of the truthiness of online information increases scepticism and decreases trust in the information received online. Coupled with distrust in institutions, individuals might start disregarding important information by officials they encounter on social media. This effect has increasing importance in times when information shared is lethal, and the information campaigns rely predominantly on digital systems like social media. For instance, whether the information shared about vaccination in the time of a pandemic reaches the audience successfully might be a matter of life and death for individuals and crisis for governments. Consequently, any patterns in the reasons of refusal should be studied carefully.

Vaccine hesitancy predates COVID-19 and has existed since the first uses of vaccines. Just before the start of the COVID-19 pandemic, the World Health Organization listed vaccine hesitancy among the top ten threats to global health because it prevents the ability to tackle vaccine-preventable diseases (WHO, 2019). The organization (2019) defined vaccine hesitancy as "the reluctance or refusal to vaccinate despite the availability of vaccines." Research has been trying to identify the reasons behind such reluctance. Although the reasons are complex, some underlying factors have been identified. These are socio-economic inequalities and convenience, complacency, confidence in institutions (MacDonald, 2015; Razai, 2021). Lack of confidence or high levels of distrust in national or international institutions is likely to be highly correlated with hesitancy in believing the information provided by them. Any doubts about the honesty of institutions might result in a snowballing effect where the search for alternative information can be biased by an inclination for self-validation and exposure to such alternative information can feed back and increase the level of distrust.

With the emergence of COVID-19, a pandemic affecting billions of people worldwide, the importance and urgency of vaccination only increased. Vaccinating significantly decreases the impact of the disease and deaths while also helping

to control the transmission nation or worldwide by providing immunity. Therefore, although getting vaccinated may seem like an individual health matter, it also concerns international organizations and governments because of the collective significance of the outcomes of those individual acts. Hence, many launched vaccination campaigns and vaccine information campaigns to inform citizens and promote vaccination. Most of these information campaigns rely predominantly on social media to reach people. Therefore, people's trust in institutions and the information they share on social media is important for these campaigns to successfully spread information on COVID-19 and vaccination. In a world where more than "70% of Americans and 80% of Europeans use the internet as a source for health information" (Massey, 2015), it is of great importance to provide people with trusted online sources. This can be considered a responsibility for governments towards their citizens. The distrust in governmental institutions might influence people to seek information elsewhere, which is especially risky considering the high amount of misinformation available online about COVID-19. The fears of being misinformed by the information those institutions provide, especially during the pandemic, strongly relate with the reluctancy to accept vaccination and information on vaccines, which is widely accepted as "scientific" or "official". These two phenomena can both be influenced or caused by a common factor such as tendency to believe conspiracy theories, but the analysis in this paper will only examine correlation and will not seek causation, thus will forward the search of an intermediately factor to future work. The analysis presented in this paper will rather try to examine the relationship between distrust in various institutions and vaccine hesitancy, and explore the significance of each.

Considering the importance and urgency of the topic, this paper hypothesizes that public trust in the information shared by various institutions on social media can explain a significant amount of variance in a country's COVID-19 vaccine hesitancy.

In particular, this paper addresses the following research questions and tests the respective hypotheses:

RQ_1: Is distrust in the truthfulness of the information shared by governments, other political parties and foreign governments on social media correlated?
H_1: They are all positively correlated with each other. The distrust in the information on social media is a more general phenomenon and is somewhat independent of the type of institution that posts.

RQ_2: Are the trust variables for various institutions' activity on social media significant in predicting a country's COVID-19 vaccine hesitant population percentage?

H_2: Yes, they can explain a significant amount of variance in COVID-19 vaccine hesitancy.

RQ_3: The distrust in which type of governments or actors has a stronger relationship with a country's vaccine hesitancy the most?
H_3: The significance of distrust in foreign institutions is more substantial.

2 Methods

2.1 Data

For measuring the trust in the information shared by various institutions, I use Digital Society Survey Data (Mechkova et al., 2021). The survey consists of 35 questions about the political nature of the internet and social media. The data was conducted with expert-coded surveys and represented answers from 179 countries from 2000 to 2020. For my analysis, I use the most recent data. I select the questions from the "Coordinated Information Operations" category, specifically the questions asking the participants how frequently they think each actor uses social media for propaganda and manipulation. The actors are national governments, major political parties, foreign governments. Responses with lower values correspond to believing in a higher frequency of propaganda, thus, less trust. Responses with higher values correspond to believing in a less frequency of propaganda by that actor; hence, more confidence. For more information about the survey questions and answers, see Appendix A.

The data scale is ordinal and converted to an interval by the V-Dem measurement model. This model aggregates the ratings and provides "a probability distribution over country-year scores on a standardized interval scale by accounting for the disagreement and measurement error" (Pemstein et al., 2021). A low score indicates low trust, and a high score indicates high trust in the honesty of information shared on social media by that actor.

Table 1: Summary Statistics of the Disinformation Data

	Trust in government	**Trust in major political parties**	**Trust in foreign governments**	**Trust in foreign governments' ads**
count	179	179	179	179
mean	-0.110257	-0.288162	-0.053799	-0.187844
std	1.483532	1.199373	1.245655	1.177588
min	-3.456000	-3.534000	-4.271000	-3.813000
max	2.873000	2.812000	2.543000	2.442000

Table 1 presents the main summary statistics for this dataset. It shows that the trust in foreign governments has the lowest mean, meaning it is believed that foreign governments disseminate false information more often across 179 countries. It also has the highest standard deviation, meaning that it also varies the most between countries.

For measuring COVID-19 vaccine hesitancy, I use data from Imperial College London's YouGov COVID19 Behaviour Tracker Data Hub. The survey is conducted monthly on unvaccinated people from 15 countries who are above 18 years of age. Participants are asked to score their agreement to the statement "If a COVID-19 vaccine were made available to me this week, I would definitely get it." The formulation of the statement allows controlling the vaccine availability differences across countries. The responses of 3 are considered uncertain, and responses above 3 are considered unwilling to get vaccinated. For further information, see Appendix B. This paper will consider uncertain to be hesitant, and thus, all answers equal or above 3 to be vaccine hesitant. The responses are then aggravated as percentages for each country. Some countries had more recent entries than others, so I use the most recent entries for all countries. See Appendix C for more information on the data used.

Table 2: Summary Statistics of Total Hesitancy(%)

	Total Hesitancy (%)
count	15
mean	20.435333
std	4.478742
min	14.350000
25%	17.360000
50%	20.290000
75%	22.800000
max	30.370000

Table 2 displays the summary statistics of the variable I will focus on, the percentage of the total hesitancy in the population. The country with the maximum hesitant population percentage (30.37%) is the United States, whereas the country with the minimum (14.35%) is Singapore.

I merge these two datasets to start exploring their connection.

2.2 Multiple linear regression

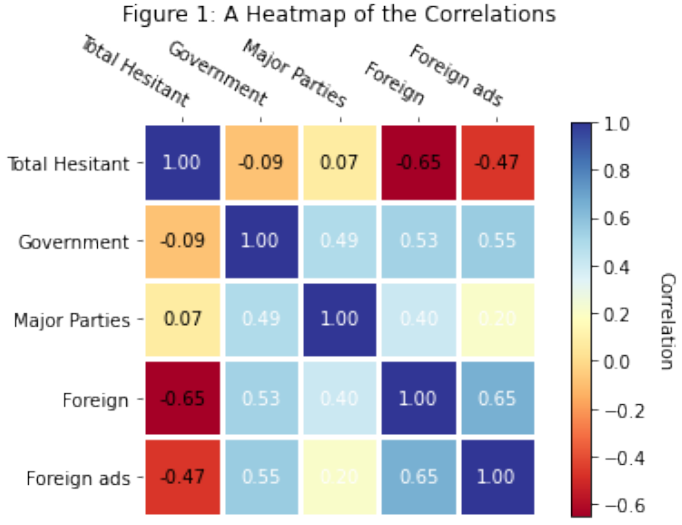
I use multiple linear regression to be able to address the different trust variables as independent variables. By doing so, I assume the following linear model for all of the 15 countries:

$$\begin{aligned} Vaccine\ Hesitancy_i = \alpha\ &+\ \beta_1 Trust\ in\ Government_i \\ &+\ \beta_2 Trust\ in\ Major\ Political\ Parties_i \\ &+\ \beta_3 Trust\ in\ Foreign\ Governments_i \\ &+\ \beta_4 Trust\ in\ Foreign\ Governments\ Ads_i\ +\ \epsilon_i \\ &\qquad for\ i = 1, ..., 15 \quad (1) \end{aligned}$$

I will conduct ordinary least squares (OLS) regression using the statsmodels package to test the assumption and find the coefficients. I will investigate the model to explore the significance of the independent variables. I will also plot the residuals against the fitted values to check for homoscedasticity.

3 Results

Figure 1: A Heatmap of the Correlations



The correlation heatmap in Figure 1 shows that none of the independent variables is significantly correlated with another. However, although minorly, they are all positively correlated with each other. Therefore, H_1 is found to be true.

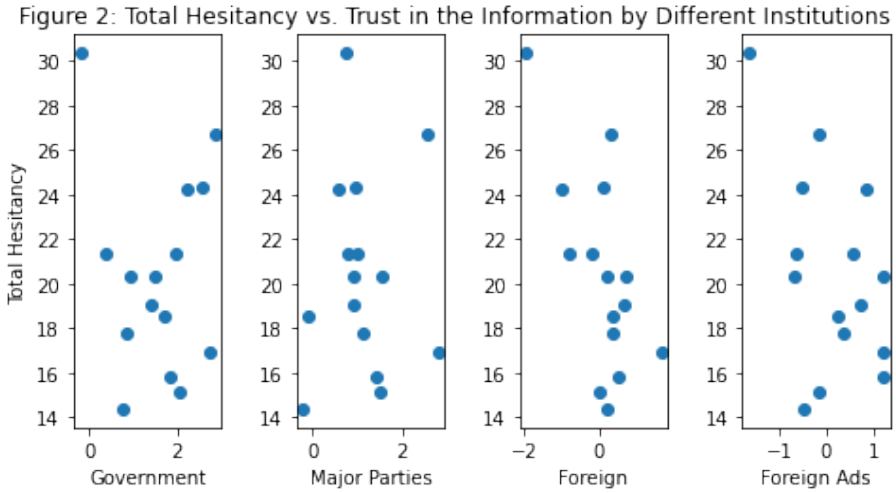


Figure 2 plots all the independent variables against the response variable separately. Except for trust in the information by foreign governments, none of them appears to have a linear relationship with the dependent variable. Looking at both the heat map and the scatter plot, one can see that the relationship between trust in foreign governments and hesitancy percentage is negative. The more the people in a country have trust in the information shared by foreign governments on social media, the less portion of the population is vaccine hesitant.

Table 3: Multiple Linear Regression

	Dependent variable: Hesitant Percentage		
	(1)	(2)	(3)
Intercept	20.683^{***}	18.324^{***}	16.853^{***}
	(0.915)	(1.494)	(2.157)
Foreign Governments	-3.493^{***}	-4.357^{***}	-4.432^{**}
	(1.132)	(1.128)	(1.540)
Major Political Parties		2.194^{*}	1.634
		(1.153)	(1.321)
Government			1.391
			(1.365)
Foreign Governments' Ads			−0.737
			(1.521)
Observations	15	15	15
R^2	0.423	0.55	0.599
Adjusted R^2	0.378	0.483	0.438
Residual Std. Error	3.531 (df=13)	3.221 (df=12)	3.357 (df=10)
F Statistic	9.521^{***} (df=1; 13)	7.532^{***} (df=2; 12)	3.730^{**} (df=4; 10)

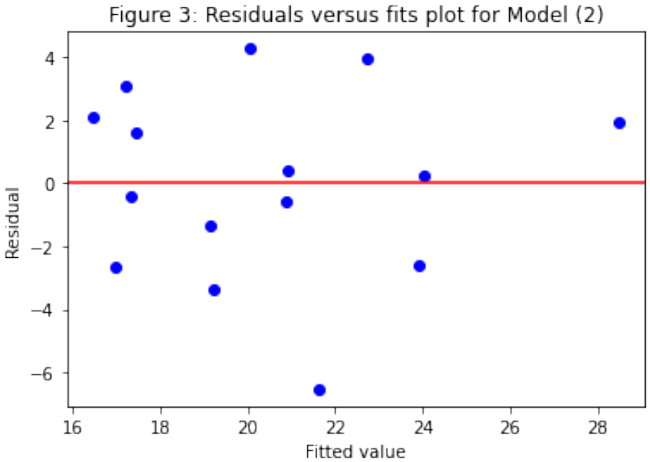
Note: Robust standard errors in parentheses, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 3 shows the regression results from multiple models using different variables. As we can see R^2 always increases as we include more variables, which indicate that it may be somewhat insensitive to overfitting. The increase in R^2 does confirm that there is a correlation with the additional variables Trust in Government and Trust in Foreign Governments' Ads, however significantly weak. Therefore, it is better to interpret adjusted R^2, which takes the number of predictors into account, to choose the best model. From model (2) to model (3), although R^2 increases, F statistic decreases, which means the additional predictors are only weakly correlated with the response and that they actually cause losing more error degrees of freedom than the total sums of squared errors. Considering these, model (2) can be chosen as the best predictive model as it has the highest adjusted R^2 and highest F statistic with the lowest Residual Standard Error. The model can explain approximately 55% of the variance in vaccine hesitancy. The model is statistically significant at the

0.01 significance level. Trust in foreign governments is a more statistically significant variable; therefore, it is the most important one in predicting vaccine hesitancy. However, as can be seen from the model (1), it cannot explain more than half of the variance in the predictor by itself alone. The coefficients further allow us to compare largely and in which direction they contribute to the predictor. Trust in foreign governments has a negative relationship with the predictor. The more people of a country trust in foreign governments' truthfulness in social media, the less there are hesitant towards vaccination for COVID-19. However, the correlation is positive for the variable Trust in Major political parties. The more people trust major political parties' truthfulness in their posts on social media, the more there is vaccine hesitancy in that country. The F-statistic shows the model has a low corresponding p-value (¡0.05), which is smaller than the common alpha level of 0.05. This allows us to reject the null hypothesis and conclude that there is, indeed, a statistically significant relationship between these two variables and vaccine hesitancy in a country. Specifically, having controlled for the trust in major political parties, I found a 4.357% decrease (±1.128) in the predicted value of hesitancy percentage in a given country for every 1% increase in the trust in foreign governments' and their agents' social media activities. Also, having controlled for the trust in foreign governments, I found a 2.194 % increase (± 1.153) in the hesitancy percentage in a given country for every 1% increase in the trust in those of major political parties. The selected model has the model of the form:

$$\begin{aligned} Vaccine\ Hesitancy_i = 18.324 + 2.194\ Trust\ in\ Major\ Political\ Parties_i \\ + -4.357\ Trust\ in\ Foreign\ Governments_i + \epsilon_i \\ for\ i = 1, ..., 15 \quad (2) \end{aligned}$$

Figure 3: Residuals versus fits plot for Model (2)



The residuals versus the fitted value plot for model (2) in Figure 3 allows us to verify our assumption about the residuals being randomly distributed and having a constant variance. As can be seen from the plot, the points are randomly distributed for both sides of the horizontal line of 0. Although one point has a questionable distance from 0, for this analysis, it will not be treated as an outlier, as its marginality is not significant enough. There is no recognizable pattern in the plot; this allows us to verify homoscedasticity.

4 Discussion

4.1 Findings

H_1 was confirmed as distrust in national governments, distrust in foreign governments and their ads, and distrust in major political parties were found to be, although minorly, positively correlated with each other. This proves that distrust in the information on social media by institutions is a rather more general phenomenon, where distrust in any type of institution's truthfulness on social media corresponds to high levels of distrust in other institutions' actions. In their report, Bradshaw and Howard (2019) confirmed that in 70 countries, "there is at least one political party or government agency using social media to shape public attitudes domestically." Additionally, seven countries (China, India, Iran, Pakistan, Russia, Saudi Arabia, and Venezuela) were found to use social media platforms for foreign influence operations. The evident use of social media as a computational propaganda tool has increased scepticism towards the truthfulness of information shared by almost every institution. The positive correlation between the variables might be indicative of awareness of such past occurrences.

The scepticism towards the honesty of institutions on social media has even higher importance during COVID-19, where information campaigns rely heavily on social media. Distrust in information related to COVID-19 might be lethal as people might have scepticism towards critical information regarding vaccines. As the reliance on social media as a source of information increases, the distrust in official information starts to have even more tangible effects as people turn to other sources to seek information where facts may not be checked before being shared. This can result in a loop where misinformation increases where there is a lack of trust in institutions and distrust increases as there is more and more competing information. To validate such a correlation, I explored linear regression models predicting vaccine hesitancy with trust in the truthfulness of posts on social media by the government, foreign governments, major political parties and foreign governments' ads. I found

that all these variables are somewhat correlated with vaccine hesitancy in a country, confirming H_2. The relationship found between trust and vaccine hesitancy supports previous findings on the subject (Jennings et al., 2021; Devine et al., 2020; Loomba et al., 2021; Featherstone et al., 2019) and contribute further by specifying the effects of distrust in different types of institutions. By investigating the results of the multiple linear regression, I found that the most influential variable predicting COVID-19 vaccine hesitancy is the trust in the truthfulness of foreign governments on social media, confirming H_3. This result might be reflecting how knowledge production on COVID-19, including the production of vaccines, is highly clustered among a few countries. The geo-politics of the pandemic is proved to be a critical factor in shaping attitudes towards vaccination. The categorization of national versus foreign information and the respective trust attributed to them gain special importance in a situation where the production of knowledge is highly monopolized by a few countries categorized as foreign by the rest. Therefore, in this case, the distrust in foreign governments and their agents might directly translate into seeking information elsewhere and adapting actions motivated by alternative viewpoints, such as vaccine hesitancy.

4.2 Limitations

The findings are limited to the data they use, which, unfortunately, consists of a small sample of 15 countries. This study has tried to find a general relationship between distrust in institutions' social media activities and vaccine hesitancy; however, this relationship might differ for each country. Particularly, the 15 countries whose data were used are socio-economically powerful countries. It is important to investigate the effects of this feature on the relationship between the variables. It is also necessary to investigate the relationship separately for each country to account for possible differences. Incorporating country-level data will allow multilevel modelling and address such limitations. Country-level data might be illuminating as it has the potential to account for both demographic and political tendency differences within the population and how those correlate with trust in various institutions' social media activity and vaccine hesitancy. The investigation of such patterns on a country-level is a must for interpreting the results on the significance of trust in other major political parties in predicting vaccine hesitancy as it would provide context on the country's political environment.

As the findings of this study suggest, it is highly important to distinguish between different types of trust for a thorough analysis. Incorporating data on attitudes towards information found on social media in general and trust in institutions

separately will provide further details to results and sophisticate interpretations.

The findings on the importance of the variable concerning foreign governments and their agents in predicting vaccine hesitancy support the results of Wilson and Wiysonge's (2020) research; however, the same survey data on foreign disinformation campaigns are not considered as information on actual disinformation campaigns like they have, but as beliefs and trust towards the actors and the information they share. This divergence in the interpretation can be considered a limitation as the answers to the survey question "How routinely do foreign governments and their agents use paid advertisements on social media in order to disseminate misleading viewpoints or false information to influence domestic politics in this country?" can reflect both factual knowledge or subjective beliefs on the topic.

The results rely on the accuracy of the data used. However, both the responses on attitudes towards vaccination and towards disinformation campaigns have a strong potential to be biased considering participants' possible cognitive biases and social desirability factors. These factors might affect the objectivity of the data even more so in cases where there are pervasive norms around topics in question, which is the case for both trust in institutions and vaccination.

The analysis presented in this paper concludes that there is indeed a significant correlation between trust in some institutions and vaccine hesitancy. However, it does not claim causality. Different beliefs about disinformation on social media and trust in the institutions might motivate different patterns of information-seeking or be indicative of certain attitudes with a tendency towards scepticism. Such variables with potentially strong relationships with both the trust towards institutions and hesitancy towards vaccination should be included in further analysis to investigate causality. It is also essential to acknowledge the dynamic nature of the variable of trust and how it is constantly changing by reacting to new events and through a feedback mechanism where, for instance, high levels of vaccine hesitancy might result in difficulty in the containment of the disease and decrease the general trust and confidence in such institutions. Future work would hopefully incorporate larger samples and additional variables to investigate the relationship thoroughly.

5 Conclusion

Studies have shown that the internet, particularly social media, is increasingly being used as a source for health information (Westerman et al., 2014). Consequently, the online presence of institutions became a must to begin fighting misinformation and balancing information asymmetries. Yet, trust in those institutions

is crucial for the audience to believe the shared information. Unfortunately, the prevalent distrust is motivated not only by subjective opinions but also by proven instances of dishonesty. Many national and foreign governments are known to use social media in efforts to manipulate users and feed them with false information that would benefit their own agendas. These so-called disinformation campaigns further erodes confidence in institutions and increases scepticism towards the information they share.

"Trust is the foundation for the legitimacy of public institutions and a functioning democratic system. It is crucial for maintaining political participation and social cohesion" (OECD, 2021). Although this statement refers to trust in national institutions, it is appropriate for various types of institutions during a pandemic where global collective action is a must for the containment of the disease. Since the beginning of the COVID-19 pandemic, both national and international institutions have relied heavily on social media to inform people and encourage vaccination. Therefore, this paper hypothesized that confidence in the honesty of those institutions and their motivations would be tightly connected to attitudes towards the information they share. This paper used statistical methods to explore this relationship between trust and vaccine hesitancy. The analysis presented has attempted to formulate a general global relationship; however, it is critical to acknowledge that a more comprehensive approach should aim to integrate individual-level data to be able to employ multi-level modelling for making conclusions on an individual level and accounting for the context of each country.

This paper's results highlight the significance of trust in foreign governments and agents about their honesty on social media in a country in predicting vaccine hesitancy. This finding underlines the gravity of geopolitics in forming attitudes towards information. During the COVID-19 pandemic, where knowledge (and vaccines) is produced by institutions that are foreign to most countries, the trust in such institutions and the information they share plays a key role in the adoption of an encouraged behaviour, such as vaccination. Considering the vital role vaccination has in controlling the disease, it is necessary for these institutions to start implementing policies that aim to restore trust. The pandemic has proven how the infodemic can become lethal. It revealed how institutions should protect their reliabilities not only for the ethical responsibility they have towards populations but also for those emergencies where compliance with their call for action is vital.

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Appendices

Appendix A

Table 4: Disinformation Survey

Variable	Question	Response
Government dissemination of false information domestic (v2smgovdom)	How often do the government and its agents use social media to disseminate misleading viewpoints or false information to influence its own population?	0: "Extremely often" 1: "Often" 2: "About half the time" 3: "Rarely" 4: "Never, or almost never"
Party dissemination of false information domestic (v2smpardom)	How often do major political parties and candidates for office use social media to disseminate misleading viewpoints or false information to influence their own population?	
Foreign governments dissemination of false information (v2smfordom)	How routinely do foreign governments and their agents use social media to disseminate misleading viewpoints or false information to influence domestic politics in this country?	
Foreign governments ads (v2smforads)	How routinely do foreign governments and their agents use paid advertisements on social media in order to disseminate misleading viewpoints or false information to influence domestic politics in this country?	

Appendix B

Table 5: Vaccination Survey

Question	Response	Interpretation
"If a COVID-19 vaccine were made available to me this week, I would definitely get it."	"Strongly agree" (1) ... "Strongly disagree" (5)	1-2: Agreement 3: Uncertain 4-5: Disagreement

Appendix C

Table 6: Vaccine Acceptance and Hesitancy by Country

Country	Day	People vaccinated (%)	Willing (%)	Uncertain (%)	Unwilling (%)	Total Hesitant (%)
Australia	2021-12-15	78.6	2.33	4.37	14.7	19.07
Canada	2021-12-15	82.21	2.68	2.69	12.42	15.11
Germany	2021-12-15	72.38	3.35	4.06	20.21	24.27
Denmark	2021-12-15	80.94	2.15	1.83	15.08	16.91
Spain	2021-11-15	81.66	2.52	2.98	12.84	15.82
France	2021-12-15	77.73	1.98	1.84	18.45	20.29
United Kingdom	2021-12-15	75.3	3.37	3.37	17.96	21.33
Italy	2021-12-15	79.09	2.34	1.93	16.64	18.57
Japan	2021-11-15	78.78	3.41	5.62	12.19	17.81
South Korea	2021-09-15	68.4	10.29	8.2	13.11	21.31
Netherlands	2021-12-15	77.4	2.31	2.85	17.44	20.29
Norway	2021-08-15	69.25	6.43	4.82	19.5	24.32
Singapore	2021-08-15	82.66	2.99	6.74	7.61	14.35
Sweden	2021-09-15	69.23	4.06	5.64	21.07	26.71
United States	2021-10-15	65.89	3.74	5.13	25.24	30.37

Appendix D: Code

```
# Setup
from pathlib import Path
import pandas as pd
import numpy as np
import statsmodels.formula.api as smf
import matplotlib.pyplot as plt
from stargazer.stargazer import Stargazer
from IPython.core.display import HTML
from zipfile import ZipFile
from io import BytesIO
import requests

heatmap_py_url = "https://raw.githubusercontent.com/aezarebski/aas-
    extended-examples/main/example-2.5/heatmap.py"
```

```
req = requests.get(heatmap_py_url)

with open("urlheatmap.py", "w") as f:
    f.write(req.text)

from urlheatmap import correlation_heatmap
```

```
# Wrangling
datadir = Path().cwd().parent/"Stats"

vaccine = pd.read_csv(datadir/ "covid-vaccine.csv")
vaccine = vaccine.groupby("Code").last()
vaccine.reset_index(inplace = True)
vaccine["Total_Hesitant"] = vaccine["
    uncertain_covid_vaccinate_this_week_pct_pop"] + vaccine["
    unwillingness_covid_vaccinate_this_week_pct_pop"]
vaccine_sum = vaccine[["Code","Entity","Total_Hesitant"]]

url = "http://digitalsocietyproject.org/wp-content/uploads/2021/04/
    DigitalSocietyProject-v3-CSV.zip"
filename = requests.get(url).content
zf = ZipFile( BytesIO(filename), "r" )
match = [s for s in zf.namelist() if "csv" in s][0]
information = pd.read_csv(zf.open(match), encoding = "latin-1")
information = information[information["year"] == 2020]
information = information[["country_name","country_text_id","
    v2smgovdom","v2smpardom","v2smfordom", "v2smforads"]]
for col in ["v2smfordom","v2smgovdom","v2smpardom", "v2smforads"]:
    information[col] = information[col].astype(np.float64)
```

```
# Table 1
information.describe()
```

```
# Table 2
vaccine["Total_Hesitant"].describe()
```

```
# Table 3
merged = pd.merge(vaccine[["Code","Entity","Total_Hesitant"]],
    information, how="left", left_on=["Code"],right_on=["
    country_text_id"])
merged.drop(["country_name","country_text_id"],axis=1,inplace=True)

form_1 = "Total_Hesitant ~ v2smfordom"
fit_1 = smf.ols(formula = form_1, data = merged).fit()

form_2 = "Total_Hesitant ~ v2smfordom + v2smpardom"
```

```
fit_2 = smf.ols(formula = form_2, data = merged).fit()

form_3 = "Total_Hesitant ~ v2smfordom + v2smgovdom + v2smpardom +
    v2smforads"
fit_3 = smf.ols(formula = form_3, data = merged).fit()

stargazer = Stargazer([fit_1,fit_2,fit_3])
HTML(stargazer.render_html())
```

```
# Table 6 (Appendix C)
table_6 = vaccine.drop(columns=["Code"]).rename(columns={"Entity":"
    Country","people_vaccinated_per_hundred":"People vaccinated (%)"
    ,"willingness_covid_vaccinate_this_week_pct_pop":"Willing (%)","
    uncertain_covid_vaccinate_this_week_pct_pop":"Uncertain (%)","
    unwillingness_covid_vaccinate_this_week_pct_pop":"Unwilling (%)"
    ,"Total_Hesitant":"Total Hesitant (%)"})
```

```
# Figure 1
col_names = merged.columns.to_list()
numeric_cols = col_names[2:]
correlation_heatmap(merged[numeric_cols])
plt.title("Figure 1: A Heatmap of the Correlations")
plt.show()
```

```
# Figure 2
plt.subplot(141)
plt.scatter(merged["v2smgovdom"],merged["Total_Hesitant"])
plt.xlabel("Government")
plt.ylabel("Total Hesitancy")

plt.subplot(142)
plt.scatter(merged["v2smpardom"],merged["Total_Hesitant"])
plt.xlabel("Major Parties")

plt.subplot(143)
plt.scatter(merged["v2smfordom"],merged["Total_Hesitant"])
plt.xlabel("Foreign")

plt.subplot(144)
plt.scatter(merged["v2smforads"],merged["Total_Hesitant"])
plt.xlabel("Foreign Ads")

plt.subplots_adjust(top=0.8, bottom=0.08, left=0.0, right=1.0,
    hspace=0.5, wspace=0.5)
plt.title("Figure 2: Total Hesitancy vs. Trust in the Information
    by Different Institutions",loc="right")
```

```
plt.show()
```

```
# Figure 3
def make_fittedvalues_resid_plot(fit):
    plt.figure()
    plt.scatter(fit.fittedvalues, fit.resid, color="b")
    plt.axhline(y=0, color="r")
    plt.xlabel("Fitted value")
    plt.ylabel("Residual")
    return

make_fittedvalues_resid_plot(fit_2)
plt.show()
```