

Linkage between COVID-19 Mask Wearing and 2020 Presidential Election Votes

Term Paper

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A GitHub repository where all code is hosted for this project is located at the following link:

https://github.com/marknathin/SURVMETH727_Project

The Shiny Application for this project is hosted on ShinyApps.io at the following link:

<https://marknathin.shinyapps.io/SURVMETH727/>

Abstract

In this project, we examined the linkage between the COVID-19 mask wearing willingness and 2020 US Presidential election votes. By applying county-level data from the American Community Survey (ACS), New York Times mask-wearing survey, 2020 presidential election votes, and Google Trends data, we found that mask-wearing tendencies are more closely related to political party election votes than traditional demographic variables such as race, level of education, and median household income. In fact, these traditional demographic variables had surprisingly small correlations with mask wearing willingness. We examined the linkage between these variables via correlational analyses and linear regression modeling. Finally, we provided corresponding visualizations showing the relations among these variables via a Shiny Application. Future research could try to introduce the google trends data or other kinds of social media data into the prediction model to systematically determine whether this information is related to mask wearing or voting behavior.

Introduction

Since the end of 2019 till today, the world has been in a seemingly never ending battle with the infectious disease COVID-19. The outbreak of COVID pandemic has not only changed our lifestyle, but it has also immersed us everywhere in our life including political life. Because we are now in the middle of the epidemic right now, data related to the disease are reliable and accessible nowadays. The World Health Organization (WHO) declared COVID-19 as being a worldwide pandemic in March 2020. Moreover, the CDC reported that, in the USA, total cases have surpassed 50 million with deaths totaling over 797 thousand as of December 15, 2021. Facing the severe spreading of COVID-19, health officials encouraged all people to wear facemasks in public and within six feet of another person to reduce the spread of the virus. Over time, the virus

became politicized with former US President Donald Trump and many of his supporters ignoring the CDC's recommendation of wearing facemasks in public.

It has been already recognized that the COVID pandemic is highly politicized in the US. However, to what extent is the case truly true? Considering the behaviors of the president can lay a great influence on the people who support him, this project is interested in the linkage between county-level mask-wearing behaviors and the 2020 presidential election votes outcomes. We are curious about how strong the relationship between reported mask usage frequently and 2020 Presidential election votes is. In addition, we introduce additional demographic variables from the American Community Survey (ACS) to provide additional context regarding the strength of this relationship. We had two primary research questions: i. How well can mask-wearing tendencies in counties predict 2020 Presidential election party support? ii. How much can other variables from the Census API improve these prediction models?

The remainder of this paper is organized as follows. The next section provides the empirical model employed and a description of the data used to test it. Section three contains the data analysis results. Section four follows with the discussion of the study, including some concluding thoughts and limitations of this study.

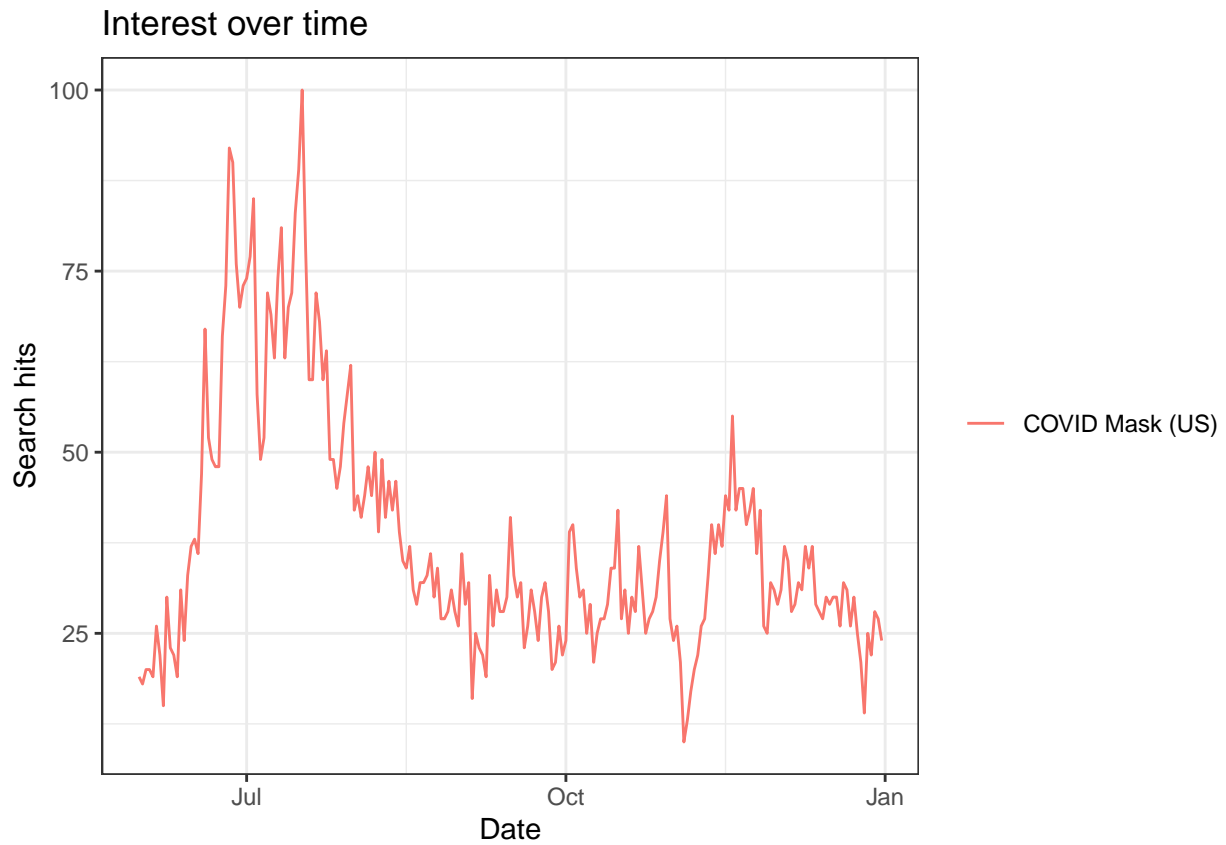


Figure 1: Wearing a mask to protect against COVID-19 has been highly politicized in the US due in part due to the conflicting messages between Joe Biden and Donald Trump"

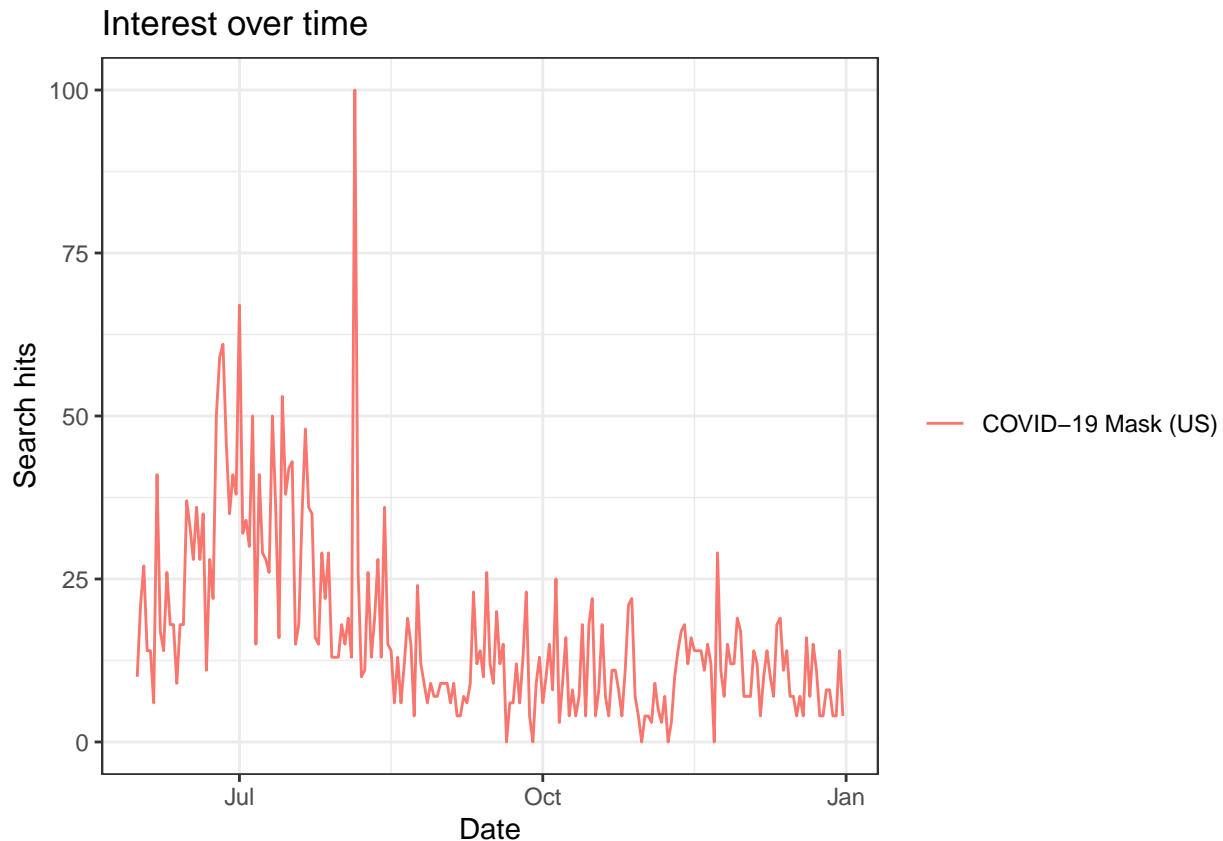
Google Trends

To determine whether different regions of the US had different attitudes about wearing a mask to protect against COVID-19, we used Google Trends and the Google Trends API. Google trends can analyze the popularity of search queries and report state level interest in given search terms. The following two plots show search interest over time for the keywords "COVID mask" and "COVID-19 Mask" respectively between May of 2020 and December 2020.

```
library(gtrendsR)
covid <- gtrends(c("COVID Mask"), geo = "US",
                 time = "2020-05-31 2020-12-31", low_search_volume = T)
plot(covid)
```



```
library(gtrendsR)
covid2 <- gtrends(c("COVID-19 Mask"), geo = "US",
                  time = "2020-05-31 2020-12-31", low_search_volume = T)
plot(covid2)
```



We can see that search interest in both of these terms was very high in July of 2020 which happened to be when the mask wearing survey data from the NY Times was collected.

The google trends website provides a breakdown of various search terms by subregion which includes states in the US. Figure 2 displays these results for the “COVID Mask” search term as an example.

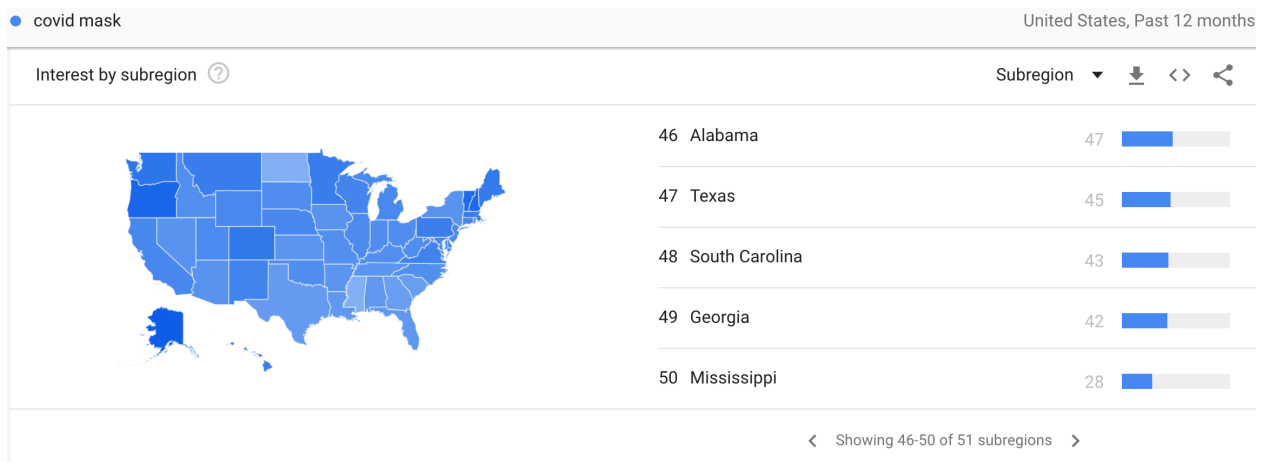


Figure 2: Google Trends Results for “covid mask”

Although the shades of blue are slightly hard to distinguish from one another, we can see that the northeast and west coast parts of the country have stronger search interest in this term compared to much of the south and midwest. This is often how the US political landscape looks with the northeast and western parts of the country showing strong support for left-leaning Democratic politicians and much of the south and midwest showing stronger support for right-leaning Republican candidates. We can see on the right that many states

near the bottom of the search interest for “covid mask” such as Alabama, South Carolina, and Mississippi all showed very strong support for former President Donald Trump.

These results are very interesting and helped motivate us to go deeper into figuring out the linkage between the mask wearing behavior and election votes.

Data

Several data sources were used and combined together in order to complete this project. First, we extracted mask-wearing data from the NY Times public github repository. This was data from a survey conducted in July of 2020, around the end of the first major wave of the pandemic. The survey asked the following question: “How often do you wear a mask in public when you expect to be within six feet of another person?” The response options included Never, Rarely, Sometimes, Often, and Always. The data was compiled at the county level and includes estimated proportions of people responding to each option in each county. This data was downloaded from the NY Times Github and read in as a CSV file below.

```
mask_use <- read_csv("~/git/SURVMETH727/mask-use-by-county.csv")
```

Next, we will read in county level results from the most recent 2020 presidential election that took place in the United States. This data was also obtained from a GitHub repository. This data was from the general election and includes both counts and proportions of voters in each county who voted democrat (for Joe Biden) or republican/gop (for Donald Trump). We will also rename “COUNTYFP” to “county_fips” to make the data joining process easier later on. This variable describes county codes that are associated with each county in the United States.

```
Election <- read_csv("~/git/SURVMETH727/2020_US_County_Level_Presidential_Results.csv")
Election <- rename(Election, COUNTYFP = county_fips)
```

Our next data read-in consists of a CSV containing approximate latitude and longitude coordinates for all counties in the USA. We again renamed the county FIPS code variable to make it consistent with the rest of our data.

```
uscounties <- read_csv("~/git/SURVMETH727/uscounties.csv")
uscounties <- uscounties %>% rename(COUNTYFP = county_fips)
```

Our remaining variables in our dataset came from the U.S. Census Bureau and specifically the American Community Survey (ACS). The ACS is an ongoing survey that gathers a wide variety of information from households across the country. We specifically used variables from the ACS-5 which are collected every year and then averaged over a 5 year period. We used ACS-5 data collected between 2013 and 2017 which is the most recent currently available. Variables were accessed through the Census API and we used the ACS and TidyCensus packages in R to retrieve individual variables.

Before ingesting the actual data, we needed to look at the variables available. To do this, we used the `load_variables` function from the `tidycensus` package and specified the name of the survey (ACS-5) and year of the variables we wanted. [Alternatively, we looked through the ... to locate variables]

```
acs5 <- load_variables(year = 2017, dataset = "acs5", cache = TRUE)
```

Once we view the resulting table, we could then search for key words which makes it easier to identify tables with variables of interest. For the first set of variables we used related to racial breakdowns of each county, we use the `get_acs` command from the `tidycensus` package which allows us to access variables from the census API. The geography level is specified (county level), variables are renamed to match to their variable name in the census API, and the survey from which these variables are sourced are also specified. The source here is the American Community Survey 5-year data.

```
# Race data
race <- get_acs(geography = "county",
variables = c(RaceTotal = "B02001_001", White = "B02001_002",
```

```
Black = "B02001_003", AmericanIndianAlaskaNative = "B02001_004",
Asian = "B02001_005", NativeHawaiian = "B02001_006",
OtherRace = "B02001_007", TwoRaces = "B02001_008"),
survey = "acs5")
```

```
## Getting data from the 2015-2019 5-year ACS
```

Once we have the variables we need to remove the margins of error that are linked with each variable in the census API. We then use the spread function to convert the data from a narrow to a wide format. Changing the data into this format allows us to see the data in a more intuitive way, which, in this case, puts the variable names as column headers and lists names of counties in each respective row.

```
spRace <- race %>% select(-moe) %>% spread(variable, estimate)
```

Next, each variable in this set is converted into a proportion of the county population in order to standardize it. Standardization is necessary here because some counties have a much higher population than others. Therefore, we would expect higher counts of every race in LA County compared to, say, Ziebach County in South Dakota. Some of our variables came as proportions, rather than absolute counts, but the “race” variables did not so they are standardized in the “RaceCleaned” portion of the code.

```
# Standardizing variables by county population
RaceCleaned <- spRace %>% mutate(White = White/RaceTotal,
Black = Black/RaceTotal,
AmericanIndianAlaskaNative = AmericanIndianAlaskaNative/RaceTotal,
Asian = Asian/RaceTotal,
NativeHawaiian = NativeHawaiian/RaceTotal,
TwoRaces = TwoRaces/RaceTotal) %>%
select(GEOID, NAME, RaceTotal, White, Black, AmericanIndianAlaskaNative,
Asian, NativeHawaiian, TwoRaces)
```

These same basic processes were repeated several times to obtain other variables from the census API used in this project. These include variables related to employment, median household income, and level of education. Code chunks are hidden to avoid repeat code.

Joining Data and Data Cleaning

After obtaining all of our variables, our next task was to join the data together into a single dataset that we could more easily use for analysis. We did this using the functions `inner_join` and `left_join`.

For the Census API variables, We joined by the “NAME” column each time because all of the census tables contain a columns called NAME that lists all of the county names. We joined our other data by County FIPS code.

The first chunk below joins the mask usage, election data, and county location data.

```
Left <- left_join(Election, mask_use, by = "COUNTYFP")
Combined <- inner_join(Election, mask_use, by = "COUNTYFP")
Combined2 <- inner_join(Combined, uscounties, by = "COUNTYFP")
```

Next we do some data cleaning. This involves renaming variable names to make them more intuitive and consistent. We also create new variables including `Never_Rarely` and `Frequently_Always` which combines these two categories of the mask wearing survey into one. We did this because we thought these categories were quite similar to one another and this allows us to utilize a greater percentage of the data in our data modeling. Furthermore, we created a new variable called `Majority` which simply labels whether a higher percentage of voters in a county voted for Joe Biden or Donald Trump in the 2020 election. Finally, we round several of our variables off to two decimal places to make the numbers easier to look at in our Shiny Application.

```

CombinedClean <- Combined2 %>%
  select(state_name.x, COUNTYFP, county_name, per_gop, per_dem, per_point_diff, NEVER,
         RARELY, SOMETIMES, FREQUENTLY, ALWAYS, lat, lng, population) %>%
  rename(Percent_Democrat = "per_dem") %>%
  rename(Percent_Republican = "per_gop") %>%
  rename(Difference = "per_point_diff") %>%
  rename(State = "state_name.x") %>%
  rename(Never = "NEVER") %>%
  rename(Rarely = "RARELY") %>%
  rename(Sometimes = "SOMETIMES") %>%
  rename(Frequently = "FREQUENTLY") %>%
  rename(Always = "ALWAYS") %>%
  mutate(Never_Rarely = Never + Rarely) %>%
  mutate(Frequently_Always = Frequently + Always) %>%
  mutate(Majority = ifelse(Percent_Democrat > Percent_Republican, "Democrat", "Republican"))

CombinedClean$Percent_Democrat <- round(CombinedClean$Percent_Democrat, digits = 2)
CombinedClean$Percent_Republican <- round(CombinedClean$Percent_Republican, digits = 2)
CombinedClean$Difference <- round(CombinedClean$Difference, digits = 2)

```

The next chunk joins all of the census data together.

```

Join1 <- inner_join(RaceCleaned, EmploymentIncomeCleaned, by = "NAME")
Join2 <- inner_join(Join1, EducationCleaned, by = "NAME")
Join2 <- Join2 %>% select(-GEOID) %>% rename(COUNTYFP = "GEOID.x")

```

Finally, we combine our census data with all of our other data. We then rounded some additional variables to two decimal places (code hidden).

```

CombinedClean <- left_join(CombinedClean, Join2, by = "COUNTYFP")

```

Shiny App Data

For our Shiny Application, we selected a random sample of 1000 counties to display on our map. We selected only 1000 counties in order to avoid overcrowding the map with too many points. Furthermore, a randomly selected 1000 counties provides a fairly good representation of US counties as a whole. The plotting and data tabs on our Shiny App contains data from all counties in the USA.

Below we select the most important variables from our dataset to include in our Shiny App and save the random sample of 1000 counties as a CSV called ShinyAppDS.csv. The full dataset of these variables is saved as a CSV called CombinedCleanApp.csv.

```

ShinyAppDS <- CombinedClean %>%
  select(State, county_name, lat, lng, Percent_Republican, Percent_Democrat, Difference,
         Never, Rarely, Sometimes, Frequently, Always, Never_Rarely, Frequently_Always,
         Majority, White, Black, UnemploymentRate, Med_Household_Income, LessHS, HSGrad,
         Bachelors, GradProfDegree)

numcounties <- 1000
ShinyAppDS <- ShinyAppDS[sample(1:nrow(ShinyAppDS), numcounties, replace = FALSE),]
# Select a random sample of 1000 counties
write_csv(ShinyAppDS, "ShinyAppDS.csv")

CombinedCleanApp <- subset(CombinedClean, select = -c(19, 22, 24, 25, 28, 29, 32))
write_csv(CombinedCleanApp, "CombinedCleanApp.csv")

```

Results

This section presents the main results.

Data exploration

Now that we have compiled and cleaned all of the data we can begin exploring it. One sub-question of interest to us was which counties in the United States were most and least likely to report wearing a mask in public during the height of the pandemic? Commands from the `dplyr` package allow us to easily answer this type of question.

```
CombinedClean %>% # Most likely to always wear mask
  select(State, county_name, Always) %>%
  group_by(State, county_name, Always) %>%
  arrange(desc(Always)) %>%
  head()
```

State	county_name	Always
California	Inyo County	0.889
New York	Yates County	0.884
California	Mono County	0.880
Texas	Hudspeth County	0.880
Texas	El Paso County	0.877
Nevada	Esmeralda County	0.872

We can see that Inyo County in California had an estimated 88.9% of people who would always wear a mask in public when within 6 feet of another person which is the highest in the US! Inyo County was followed closely by Yates County in New York at 88.4%. California and New York are known for being one of the most pro-democrat states in the country so this is not too surprising. However, Texas and Nevada are much more neutral on the political spectrum so it is slightly surprising to see counties in those states represented in the top 6.

```
CombinedClean %>% # Most likely to never wear mask
  select(State, county_name, Never) %>%
  group_by(State, county_name, Never) %>%
  arrange(desc(Never)) %>%
  head()
```

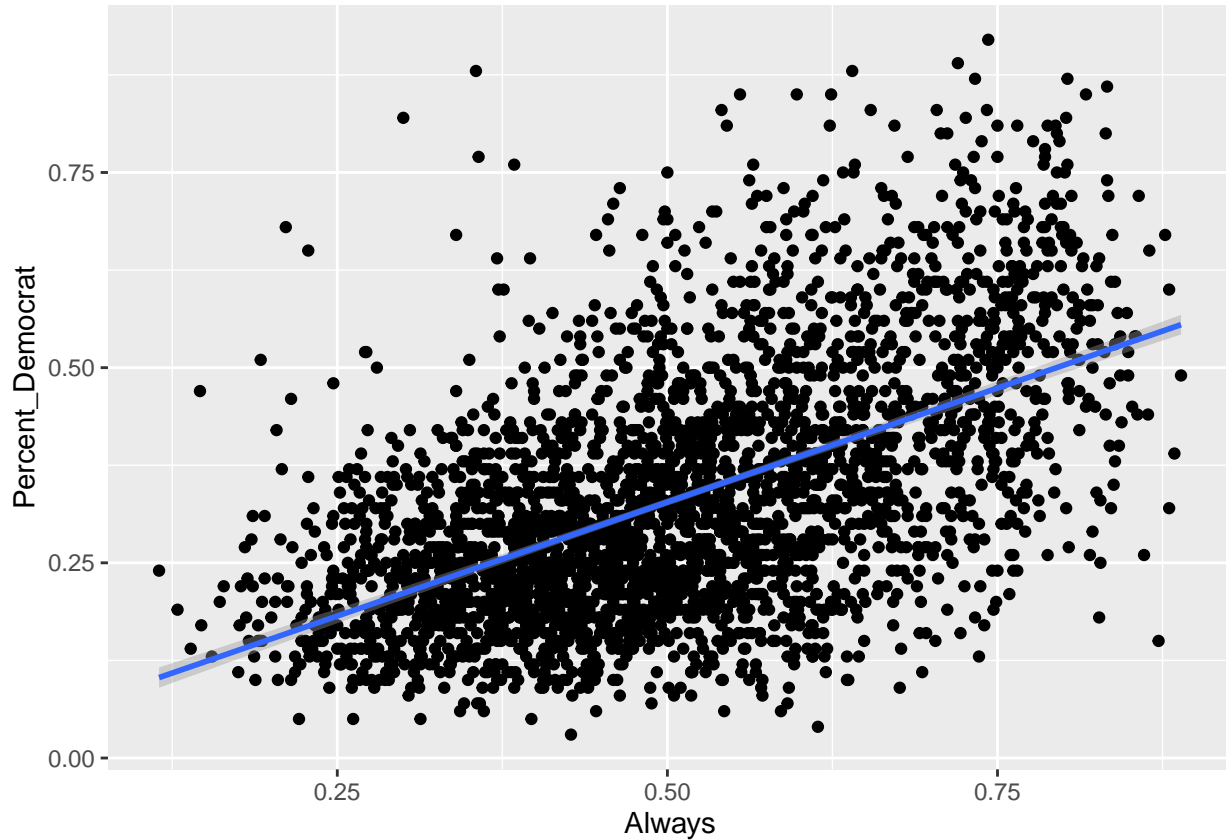
State	county_name	Never
Utah	Millard County	0.432
Missouri	Wright County	0.419
Iowa	Cass County	0.341
Utah	Juab County	0.335
Minnesota	Jackson County	0.325
Missouri	Laclede County	0.313

On the other end of the spectrum, we can see that Millard County in Utah, Wright County in Missouri, and Cass County in Iowa led among counties for the highest proportion of people saying they would never wear a mask in public at 43.2%, 41.9%, and 34.1% respectively. Utah, Missouri, and Iowa tend to be more Republican leaning states that voted for Donald Trump in the 2020 election so this is not a huge surprise. However, these percentages are much smaller than the above percentages for counties who led the way in **always** wearing a mask. We can already see that the mask-wearing data is more skewed towards people saying that they tend to wear a mask in public when they expect to be within 6 feet of another person.

We can also look at some basic scatterplots to evaluate the overall relationship between mask-wearing, voting behavior

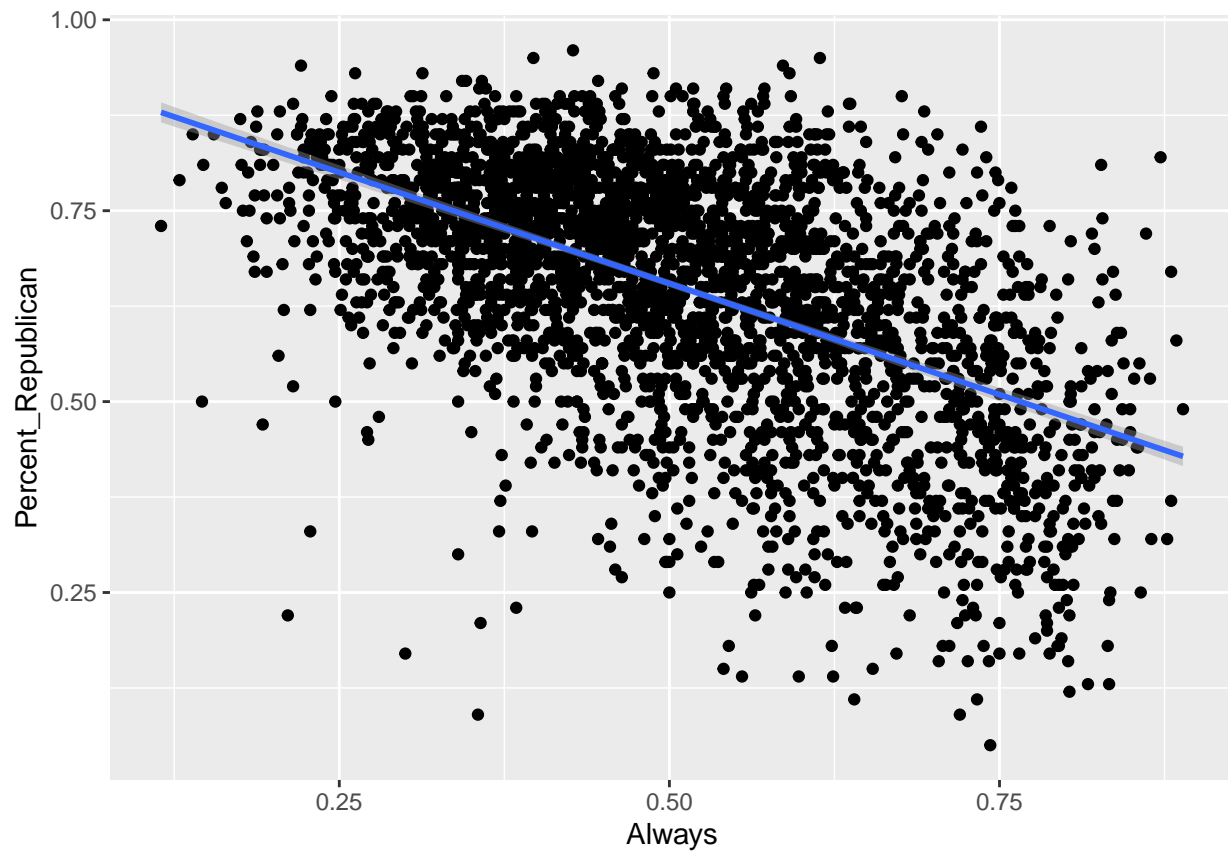
```
ggplot(data = CombinedClean) + aes(x = Always, y = Percent_Democrat) + geom_point() +  
  geom_smooth(method = "lm")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



```
ggplot(data = CombinedClean) + aes(x = Always, y = Percent_Republican) + geom_point() +  
  geom_smooth(method = "lm")
```

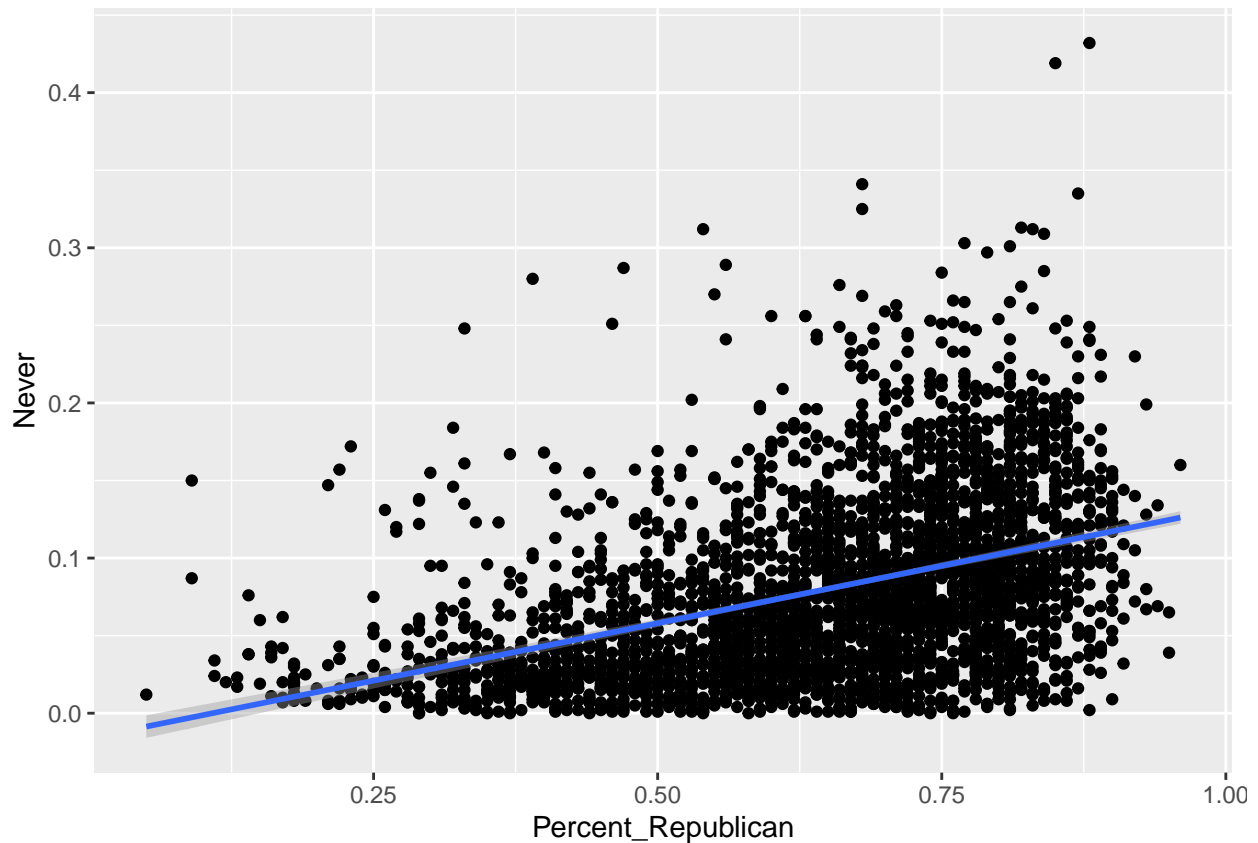
```
## `geom_smooth()` using formula 'y ~ x'
```



We can see that there is a very noticeable positive correlation between always wearing a mask in public and the percent of democrat votes. We see the reverse and a noticeable negative relationship between always wearing a mask in public and the percent of republican votes.

```
ggplot(data = CombinedClean) + aes(y = Never, x = Percent_Republican) + geom_point() +  
  geom_smooth(method = "lm")
```

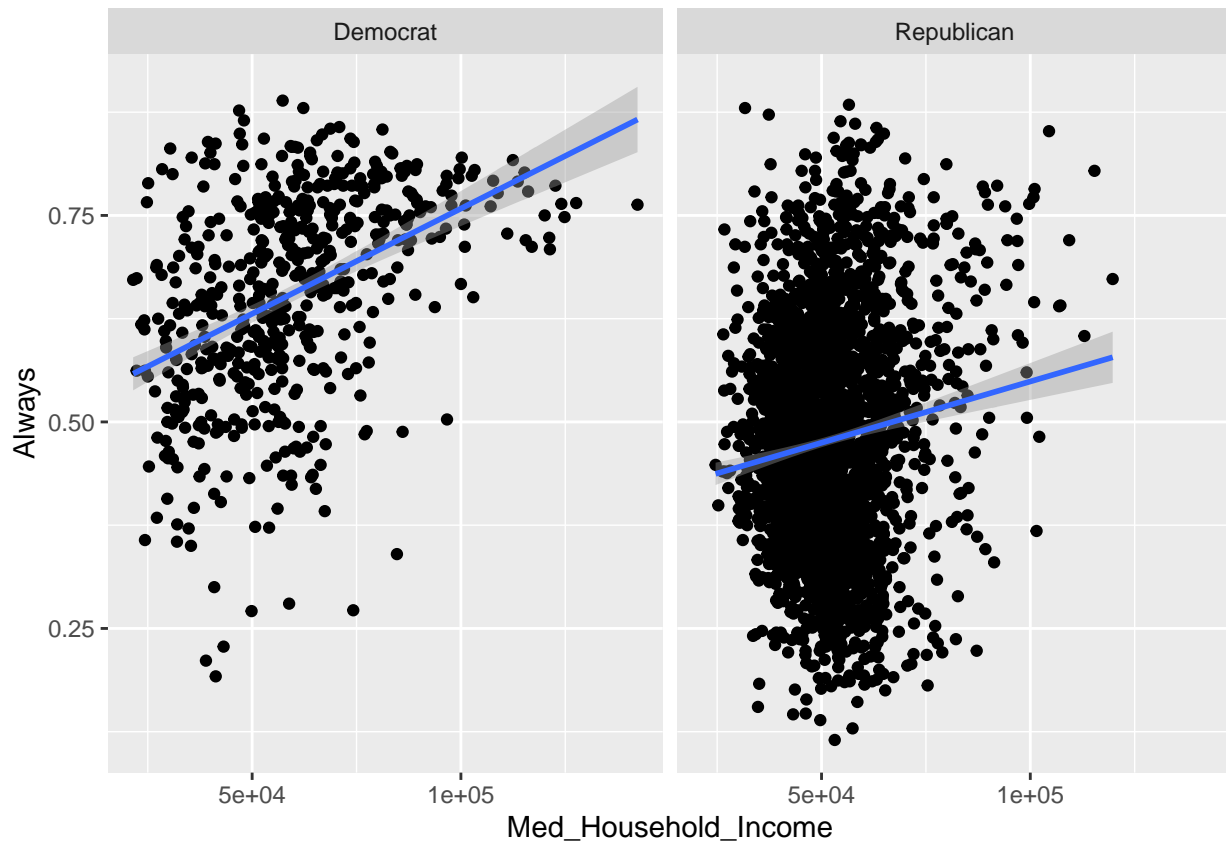
```
## `geom_smooth()` using formula 'y ~ x'
```



We see that there is indeed a positive relationship between Never wearing a mask in public and the percentage of Republican votes. Now we will briefly assess how some of the census variables fit into this relationship between mask-wearing and voting behavior.

```
ggplot(data = CombinedClean) + aes(y = Always, x = Med_Household_Income) + geom_point() +  
  geom_smooth(method = "lm") + facet_wrap(~ Majority)
```

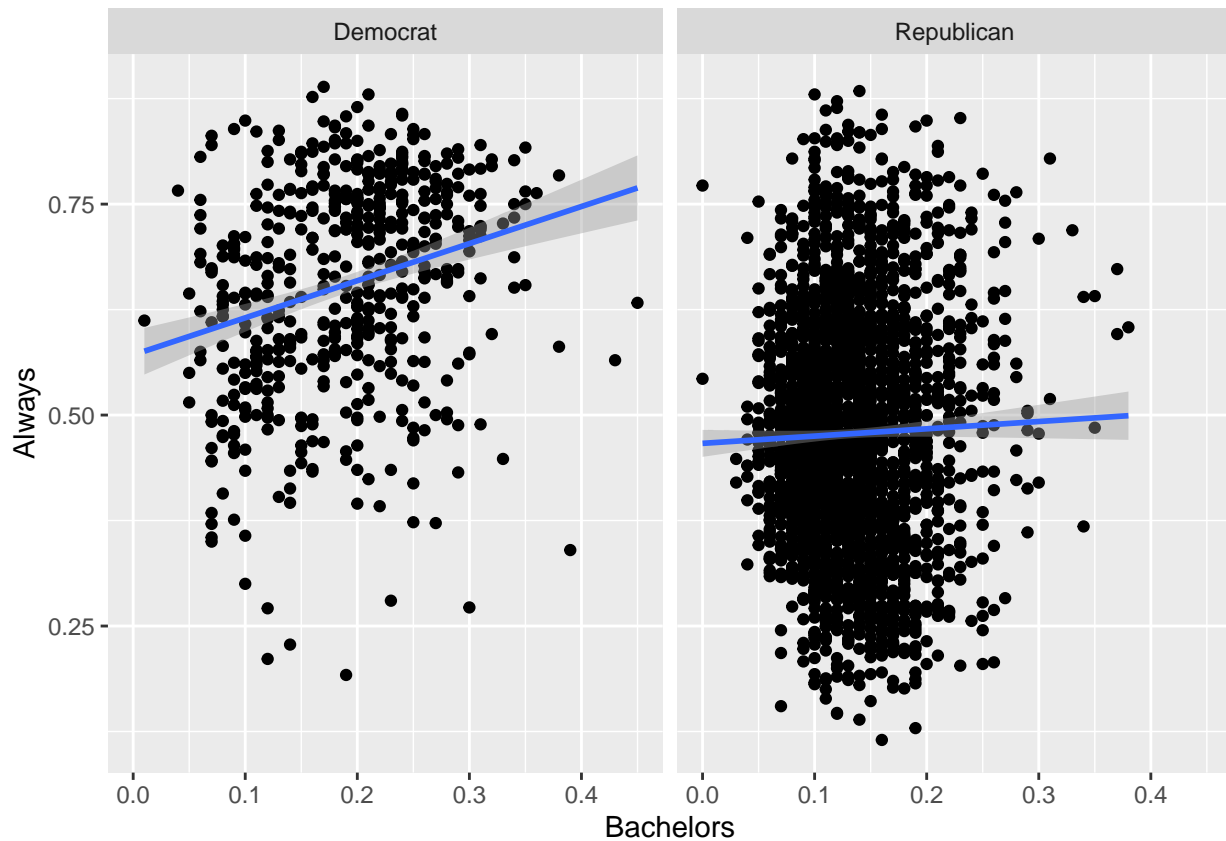
```
## `geom_smooth()` using formula 'y ~ x'
```



There looks to be a slight positive relationship between median household income and “Always” wearing a mask, irrespective of whether a county voted for Trump or Biden. In other words, higher median household income appears to indicate slightly more mask wearing.

```
ggplot(data = CombinedClean) + aes(y = Always, x = Bachelors) + geom_point() +  
  geom_smooth(method = "lm") + facet_wrap(~ Majority)
```

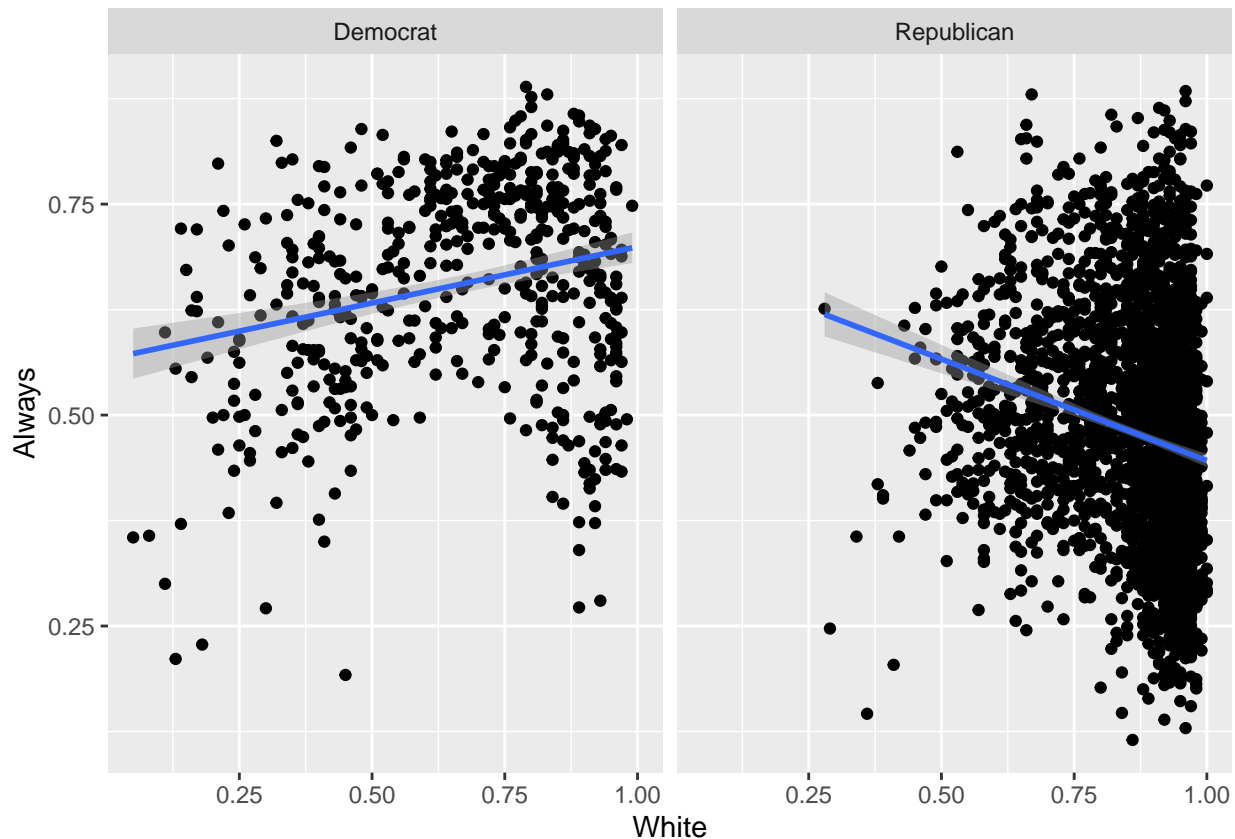
```
## `geom_smooth()` using formula 'y ~ x'
```



For Democratic voting counties, there is a positive relationship between the proportion of people having a bachelors degree and always wearing a mask. Interestingly, there looks to be almost no association between these variables for Republican voting counties.

```
ggplot(data = CombinedClean) + aes(y = Always, x = White) + geom_point() +  
  geom_smooth(method = "lm") + facet_wrap(~ Majority)
```

```
## `geom_smooth()` using formula 'y ~ x'
```



For Democratic voting counties, there is a slight positive relationship between the proportion of people who are white and always wearing a mask. However, this relationship looks reversed for Republican voting counties in that a higher proportion of white people is associated with less mask wearing. This finding suggests that a counties racial breakdown is not causing differences in mask wearing behavior. Clearly there are other factors at play here but it is interesting to see these differing relationships nonetheless.

For further analysis, our Shiny Application has an interactive plotting feature that allows users to explore the relationship between any two variables in our dataset.

Analysis

We divided our statistical analysis into two main parts including correlational analyses and some linear modeling to determine how well mask wearing tendencies can predict 2020 election candidate support.

Correlations

First, we look at some correlations.

```
cor(CombinedClean$Never_Rarely, CombinedClean$Percent_Republican)
```

```
## [1] 0.4883538
```

```
cor(CombinedClean$Frequently_Always, CombinedClean$Percent_Democrat)
```

```
## [1] 0.5286711
```

Building off our previous data exploration, we see that there are moderately positive correlations of around 0.5 between the percentage of Republican votes and never or rarely wearing a mask in public. Similarly, we see roughly equivalent positive correlations between the percentage of Democrat votes and frequently or always wearing a mask.

Now we will look at some correlations between our census variables and mask-wearing behavior.

```
cor(CombinedClean$Frequently_Always, CombinedClean$White)

## [1] -0.2496225
cor(CombinedClean$Frequently_Always, CombinedClean$Black)

## [1] 0.1900584
cor(CombinedClean$Frequently_Always, CombinedClean$PerCapitaIncome)

## [1] 0.2720843
cor(CombinedClean$Frequently_Always, CombinedClean$Bachelors)

## [1] 0.2691249
```

We can see that all of the above correlations are fairly low below 0.3. This suggests that education level, income, and race is not as strongly related to mask wearing as election votes.

Now we will look at correlations between some of these census variables and percentage voting democrat.

```
cor(CombinedClean$Percent_Democrat, CombinedClean$White)

## [1] -0.5673602
cor(CombinedClean$Percent_Democrat, CombinedClean$Asian)

## [1] 0.455086
cor(CombinedClean$Percent_Democrat, CombinedClean$PerCapitaIncome)

## [1] 0.316857
cor(CombinedClean$Percent_Democrat, CombinedClean$GradProfDegree)

## [1] 0.5746406
```

These correlations are all fairly high (above 0.3) which suggests race, income, and education are more strongly related to political affiliation than mask-wearing behavior. Based on these results we conclude that mask-wearing behavior is a somewhat unpredictable phenomenon that traditional demographic variables do not do a great job of explaining.

Linear Modeling

Based on the above correlations, we decided to construct some linear models to see how well mask wearing behavior can predict 2020 votes for Democrats or Republicans. We start with some simple linear regressions.

```
## Simple Linear Regression predicting Percent_Democrat
DemocratSupport <- lm(Percent_Democrat ~ Frequently_Always, data = CombinedClean)
summary(DemocratSupport)

##
## Call:
## lm(formula = Percent_Democrat ~ Frequently_Always, data = CombinedClean)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.40183 -0.09416 -0.01620  0.07939  0.59811
##
## Coefficients:
```

```
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.12770    0.01348  -9.474   <2e-16 ***
## Frequently_Always  0.64401    0.01854  34.733   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1357 on 3110 degrees of freedom
## Multiple R-squared:  0.2795, Adjusted R-squared:  0.2793
## F-statistic: 1206 on 1 and 3110 DF,  p-value: < 2.2e-16
```

As expected, frequently or always wearing a mask is a strong predictor of percentage of democrat votes. The R-squared is .2795 which means that 27.95% of the variation in percentage votes for Joe Biden can be explained by high mask wearing frequency.

```
# Simple Linear Regression predicting Percent_Republican
RepubSupport <- lm(Percent_Republican ~ Never_Rarely, data = CombinedClean)
summary(RepubSupport)
```

```
##
## Call:
## lm(formula = Percent_Republican ~ Never_Rarely, data = CombinedClean)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.61048 -0.08325  0.01788  0.09887  0.36132
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.516672   0.004956  104.26   <2e-16 ***
## Never_Rarely 0.815080   0.026117   31.21   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1408 on 3110 degrees of freedom
## Multiple R-squared:  0.2385, Adjusted R-squared:  0.2382
## F-statistic: 974 on 1 and 3110 DF,  p-value: < 2.2e-16
```

As expected, never wearing a mask is associated with voting Republican. 23.85% of the variation in percentage votes for Donald Trump can be explained by low mask wearing frequency. Interesting, this R-squared is slightly smaller than in the previous model. Our prediction for why we see this is that this is because, overall, a majority of the population was wearing masks frequently. Therefore, perhaps fewer Republicans reported wearing a mask than Democrats but the majority of Republicans still wore masks sometimes so the “Never_Rarely” variable is simply not as strong of a predictor as “Frequently_Always”.

Next, we will see how much this model can be improved by adding our census API variables. After trying many models with numerous combinations of predictors we decided that a simple 3 predictor model that includes Frequently_Always, White, and GradProfDegree (proportion of people in a county with a graduate/professional degree) does the best job overall in predicting Percent_Democrat.

```
Mult <- lm(Percent_Democrat ~ Frequently_Always + White + GradProfDegree, data = CombinedClean)
summary(Mult)
```

```
##
## Call:
## lm(formula = Percent_Democrat ~ Frequently_Always + White + GradProfDegree,
##      data = CombinedClean)
##
```



```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.38507 -0.06370 -0.00768  0.05857  0.43247
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.41513    0.01491   27.84  <2e-16 ***
## Frequently_Always 0.25819    0.01499   17.22  <2e-16 ***
## White          -0.46835    0.01076  -43.52  <2e-16 ***
## GradProfDegree   1.59174    0.04255   37.41  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.09562 on 3108 degrees of freedom
## Multiple R-squared:  0.6426, Adjusted R-squared:  0.6423
## F-statistic: 1863 on 3 and 3108 DF,  p-value: < 2.2e-16
```

We can see that all of three of these predictors are highly significant, although the coefficient is negative for `white`. The R-squared tells us that 64.26% of the variation in `Percent_Democrat` is accounted for by these three predictors which is very high. This is a major improvement from the 27.95% we saw in the simple linear regression model.

We can use the `vif` function from the `Faraway` package to calculate variance inflation factors which allow us to see whether any of these three predictors are correlated.

```
faraway::vif(Mult)
```

```
## Frequently_Always      White      GradProfDegree
##           1.317021         1.068484         1.241335
```

We can see that the VIF's for all 3 predictors are close to 1 which suggests multi-collinearity is not an issue with this model. This suggests all three of these variables are uniquely contributing to predicting `Percent_Democrat` which seems reasonable because each variable comes from a different domain (mask-wearing, race, education status).

We ended up arriving at a very similar model for predicting `Percent_Republican` but using `Never_Rarely` in place of `Frequently_Always`:

```
Mult2 <- lm(Percent_Republican ~ Never_Rarely + White + GradProfDegree, data = CombinedClean)
summary(Mult2)
```

```
##
## Call:
## lm(formula = Percent_Republican ~ Never_Rarely + White + GradProfDegree,
##     data = CombinedClean)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.42930 -0.05999  0.00745  0.06490  0.38745
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.34543    0.01005   34.38  <2e-16 ***
## Never_Rarely    0.30716    0.02034   15.10  <2e-16 ***
## White          0.46444    0.01102   42.13  <2e-16 ***
## GradProfDegree -1.71490    0.04249  -40.36  <2e-16 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.09799 on 3108 degrees of freedom
## Multiple R-squared:  0.6311, Adjusted R-squared:  0.6308
## F-statistic: 1773 on 3 and 3108 DF,  p-value: < 2.2e-16
```

We see that the R-squared is 63.11% which is only 1% less than the R-squared of the previous model predicting `Percent_Democrat`. This is all another huge improvement from the simple linear regression model that had an R-squared of 23.85%.

Discussion

This project supports the notion that the COVID-19 pandemic has become a strongly political issue in the US and it appears that whether or not to wear a mask has become a way of expressing political preference. To investigate the degree of this politicalization, we analyzed the linkage between facemask-wearing behaviors and 2020 presidential election votes by joining different kinds of data together including survey data, API data, election votes data and county location data.

We used the Google Trends API to search terms related to mask wearing and assessed search interest throughout the country to develop a basic understanding of how search interest for COVID-19 masks differs throughout the country. Unfortunately, Google trends can only provide state-level data and therefore we were not able to introduce it into our prediction model.

By evaluating the linkage between mask-wearing willingness and the election votes through data analysis, we found that census variables were much more useful for predicting 2020 election party support than predicting mask-wearing behaviors. It seems that mask-wearing behavior is a more unpredictable phenomenon compared to presidential election votes. Moreover, we also find that election party support has a stronger relationship with mask-wearing behavior than any of our other variables. We also provide visualizations showing these relationships via a Shiny Application that is hosted on ShinyApps.io.

There are several limitations of this project. For one, COVID-19 pandemic is changing fast and is an ongoing event. We only used data from a single point in time to fit in the prediction models and things may have changed since the data were collected. Secondly, there are still other variables such as mask mandates of different locations that likely strongly influence mask-wearing behaviors. In July 2020 some states had mask mandates in place which could have increased the number of people who reported that they frequently wear a mask compared to if a mandate was not in place. Lastly, we try to introduce the google trends data into the project to see how search interest may be tied in with mask-wearing tendencies. However, we were unable to include state-level google trends data into county-level prediction models.

Future research could extend this work in several ways. First, future studies may benefit from obtaining data from a long-term perspective, which fits the ongoing pandemic. Second, researchers can include more variables into the prediction models to make the prediction outcomes more accurate, such as accounting for mask mandates in different states. Third, as the internet is shaping our daily life and it can reflect people's ideas in some way, future research could incorporate more web data into the prediction model such as data from Facebook or Twitter and social media could also be a way to assess sentiment surrounding mask-wearing.

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