

Gun Series

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Base Panel Construction - ZCTA-Week Level

Hospital Data - ZCTA-Week level

```
hosp_zcta <- read_csv("minnepop_1620_agg_zipfull_updated.csv") %>%  
  arrange(zipcode, year, weekofyr) %>%  
  select(-c(`_chk`, zippop_tag)) %>%  
  filter(!(year==2016 & weekofyr==53))
```

ZCTAs and ACS 5-Year Estimates

```
#adding in 5-year ACS data  
census_api_key("ecda17575f4d914b502c70f2bae7a5f3d253792d")  
  
year <- lst(2016, 2017, 2018, 2019)  
  
acs <- map_dfr(  
  year,  
  ~ get_acs(geography = "zcta",  
            variables = c("B01001_001E", "B03003_003E",  
                          "B02001_003E", "B02001_002E",  
                          "B02001_004E", "B02001_008E",  
                          "B02001_005E", "B02001_006E",  
                          "B02001_007E", "B11001_003E",  
                          "B17001_002E", "B01002_001E",  
                          "B09010_002E", "B06009_005E",  
                          "B01001_002E", "B99233_005E"),  
            output = "wide",  
            survey = "acs5",  
            year = .x), .id = "year") %>%  
  rename(total_pop = B01001_001E,  
         white_pop = B02001_002E,  
         black_pop = B02001_003E,  
         na_pop = B02001_004E,  
         asian_pop = B02001_005E,  
         hpi_pop = B02001_006E,  
         other_pop = B02001_007E,
```

```

    biracial_pop = B02001_008E,
    hisp_pop = B03003_003E,
    ssi_snap = B09010_002E, #snap, ssi, public cash transfers
    med_age = B01002_001E,
    mar_fam = B11001_003E,
    povlevel = B17001_002E,
    bach_degree = B06009_005E,
    male = B01001_002E,
    nowork_12 = B99233_005E) %>%
select(-ends_with("M", ignore.case = F), -GEOID) %>%
mutate(zcta = str_sub(NAME, 6)) %>%
select(-NAME) %>%
select(zcta, everything()) %>%
mutate(year = as.numeric(year)) %>%
mutate_at(vars(-zcta, -year, -total_pop, -med_age), list(~(./total_pop)*100))

#linear imputation of 2020 until 2020 ACS release (12/9/2021)
acs_2020 <- acs %>%
  complete(zcta, year = 2016:2020) %>%
  group_by(zcta) %>%
  mutate_at(vars(-zcta, -year),
    funs(if(sum(!is.na(.))<2) {.} else{na_interpolation(., option = "linear")}))) %>%
  filter(year==2020)

acs_imp <- acs %>%
  rbind(acs_2020) %>%
  mutate(zcta = as.numeric(zcta))

#joining to hospital data
hosp_panel <- hosp_zcta %>%
  left_join(acs_imp, by = c("zipcode"="zcta", "year"))

#SF geometries - get all ZCTAs
zcta <- get_acs(geography = "zcta",
  variables = "B01001_001",
  output = "wide",
  year = 2019,
  geometry = T,
  survey = "acs5") %>%
  rename(zcta = GEOID,
    pop_2019 = B01001_001E) %>%
  select(-c(NAME, B01001_001M, pop_2019)) %>%
  mutate(zcta = as.numeric(zcta))

```

```
## |
```

```
|
```

```

#minneapolis shapefile (source: openminneapolis.gov)
mpls <- st_read("mpls_city-shp/16cdbbfa-ad10-493c-afaf-52b61f2e76e42020329-1-180h9ap.whbo.shp") %>%
  st_set_crs(st_crs(zcta))

```

```

## Reading layer '16cdbbfa-ad10-493c-afaf-52b61f2e76e42020329-1-180h9ap.whbo' from data source 'C:\User
## Simple feature collection with 1 feature and 4 fields
## Geometry type: POLYGON

```

```
## Dimension:      XY
## Bounding box:  xmin: -93.32911 ymin: 44.89059 xmax: -93.19433 ymax: 45.05125
## Geodetic CRS:  WGS 84
```

```
#zctas that intersect MPLS
zcta_intersect <- zcta %>%
  filter(ifelse(lengths(st_intersects(., mpls)) > 0, 1, 0)==1) %>%
  select(zcta)
```

```
#which zctas are not in hosp data but still intersect MPLS
setdiff(unique(zcta_intersect$zcta), unique(hosp_zcta$zipcode))
```

```
## [1] 55114 55105 55104 55113 55116 55111 55108
```

```
#joining to panel, filter to those ZCTAs intersecting MPLS
panel <- zcta %>%
  left_join(hosp_panel, by = c("zcta"="zipcode")) %>%
  filter(ifelse(lengths(st_intersects(., mpls)) > 0, 1, 0)==1 &
    zcta >= 55401) #queen contiguity

#creating date bookends
panel <- panel %>%
  group_by(zcta, year) %>%
  mutate(begin_date = ISOweek2date(paste(year, paste0("W", sprintf("%02d", weekofyr)), 1, sep = "-")),
    end_date = begin_date+weeks(1)-days(1))

#number of unique MPLS ZCTAs
n_zcta <- length(unique(panel$zcta))

#vector of intersecting ZCTAs for filtering downstream
zcta_universe <- unique(panel$zcta)
```

ZCTA-Week Level Police Data

```
#Minneapolis Police Department - Use of Force Dashboard
uof_spatial <- read_csv("Police_Use_Of_Force.csv") %>%
  mutate(date=ymd_hms(ResponseDate),
    year=isoyear(date),
    week=isoweek(date)) %>%
  select(OBJECTID, year, week, X, Y, Race) %>%
  st_as_sf(coords = c("X", "Y"), crs = "NAD83", remove=F) %>%
  mutate(intersection = as.integer(st_intersects(geometry, zcta)),
    zcta = ifelse(is.na(intersection), NA, zcta$zcta[intersection])) %>%
  st_drop_geometry() %>%
  filter(!is.na(zcta) & year >= 2016 & year <= 2020 & zcta %in% zcta_universe) %>%
  group_by(year, week, zcta, Race, .drop=F) %>%
  tally(name = "use_of_force") %>%
  filter(!is.na(Race) & Race!="not recorded") %>%
  ungroup() %>%
  complete(year, week, zcta=zcta_universe, Race, fill = list(use_of_force = 0)) %>%
  arrange(year, week, zcta, Race) %>%
```

```

mutate(race = str_to_lower(Race)) %>%
select(-Race) %>%
pivot_wider(names_from = race,
             values_from = use_of_force,
             values_fill = 0,
             names_glue = "{race}_{.value}") %>%
mutate(total_use_of_force = asian_use_of_force+black_use_of_force+`native american_use_of_force`+
`other / mixed race_use_of_force`+`pacific islander_use_of_force`+unknown_use_of_force+
white_use_of_force)

#MPD Stop Dashboard
stop_spatial <- read_csv("Police_Stop_Data.csv") %>%
  mutate(date=ymd_hms(responseDate),
         year=isoyear(date),
         week=isoweek(date)) %>%
  select(OBJECTID, year, week, lat, long, race) %>%
  st_as_sf(coords = c("long", "lat"), crs = "NAD83", remove=F) %>%
  mutate(intersection = as.integer(st_intersects(geometry, zcta)),
         zcta = ifelse(is.na(intersection), NA, zcta$zcta[intersection])) %>%
  st_drop_geometry() %>%
  filter(!is.na(zcta) & year >= 2016 & year <= 2020 & zcta %in% zcta_universe) %>%
  group_by(year, week, zcta, race, .drop=F) %>%
  tally(name = "police_stops") %>%
  filter(!is.na(race) & race!="not recorded") %>%
  ungroup() %>%
  complete(year, week, zcta=zcta_universe, race, fill = list(police_stops = 0)) %>%
  mutate(race = str_to_lower(race)) %>%
  arrange(year, week, zcta, race) %>%
  pivot_wider(names_from = race,
             values_from = police_stops,
             values_fill = 0,
             names_glue = "{race}_{.value}") %>%
  mutate(total_police_stops = asian_police_stops+black_police_stops+
`east african_police_stops`+latino_police_stops+`native american_police_stops`+
other_police_stops+unknown_police_stops+white_police_stops)

#Officer Involved Shootings - MPD
ois_spatial <- read_csv("Police_Officer_Involved_Shootings.csv") %>%
  mutate(date=ymd_hms(IncidentDate),
         year=isoyear(date),
         week=isoweek(date)) %>%
  select(OBJECTID, year, week, CenterLatitude, CenterLongitude, SubjectOfForceRace) %>%
  rename(race = SubjectOfForceRace,
         lat = CenterLatitude,
         long = CenterLongitude) %>%
  st_as_sf(coords = c("long", "lat"), crs = "NAD83", remove=F) %>%
  mutate(intersection = as.integer(st_intersects(geometry, zcta)),
         zcta = ifelse(is.na(intersection), NA, zcta$zcta[intersection])) %>%
  st_drop_geometry() %>%
  filter(!is.na(zcta) & year >= 2016 & year <= 2020 & zcta %in% zcta_universe) %>%
  group_by(year, week, zcta, race, .drop=F) %>%
  tally(name = "police_shootings") %>%
  filter(!is.na(race) & race!="not recorded") %>%

```

```

ungroup() %>%
complete(year=2016:2021, week=1:53, zcta=zcta_universe, race, fill = list(police_shootings = 0)) %>%
mutate(race = str_to_lower(race)) %>%
arrange(year, week, zcta, race) %>%
pivot_wider(names_from = race,
             values_from = police_shootings,
             values_fill = 0,
             names_glue = "{race}_{.value}") %>%
mutate(total_police_shootings = asian_police_shootings+black_police_shootings+
       hispanic_police_shootings+other_police_shootings+
       unknown_police_shootings+white_police_shootings)

panel <- panel %>%
  left_join(uof_spatial, by = c("year", "weekofyr"="week", "zcta"="zcta")) %>%
  left_join(stop_spatial, by = c("year", "weekofyr"="week", "zcta"="zcta")) %>%
  left_join(ois_spatial, by = c("year", "weekofyr"="week", "zcta"="zcta"))

#creating period indicators for panel
panel <- panel %>%
  mutate(post_floyd = ifelse(begin_date >= as.Date("2020-05-25"), T, F),
         post_floyd_3 = ifelse(begin_date >= (as.Date("2020-05-25")+months(3)), T, F),
         stay_at_home = ifelse(begin_date >= as.Date("2020-03-28"), T, F),
         state_of_emerg = ifelse(begin_date >= as.Date("2020-03-13"), T, F),
         period = factor(case_when(
           post_floyd==F & post_floyd_3==F ~ "Pre-Treatment",
           post_floyd==T & post_floyd_3==F ~ "0-3 Months Post-Treatment",
           post_floyd==T & post_floyd_3==T ~ "3+ Months Post-Treatment"),
           levels = c("Pre-Treatment", "0-3 Months Post-Treatment", "3+ Months Post-Treatment"))) %>%
  group_by(zcta) %>%
  arrange(year, weekofyr) %>%
  mutate(t = row_number(),
         uof_lag = dplyr::lag(total_use_of_force, 1),
         stops_lag = dplyr::lag(total_police_stops, 1),
         shoot_lag = dplyr::lag(total_police_shootings, 1))

```

Time Series Construction - Week Level

Aggregate Hospital Panel to Week-Level

```

#panel to week-level, aggregating over ZCTAs
hosp_series <- panel %>%
  group_by(year, weekofyr) %>%
  summarize(assault_tot = sum(assault_tot, na.rm = T),
            unintent_tot = sum(unintent_tot, na.rm = T),
            suicide_tot = sum(suicide_tot, na.rm = T),
            undeter_tot = sum(undeter_tot, na.rm = T),
            legal_tot = sum(legal_tot, na.rm = T),
            combined_tot = sum(combined_tot, na.rm = T),
            total_pop = sum(total_pop, na.rm = T)) %>%
  mutate(assault_incid_c = (assault_tot/total_pop)*1000,

```

```

    unintent_incid_c = (unintent_tot/total_pop)*1000,
    suicide_incid_c = (suicide_tot/total_pop)*1000,
    undeter_incid_c = (undeter_tot/total_pop)*1000,
    legal_incid_c = (legal_tot/total_pop)*1000,
    combined_incid_c = (combined_tot/total_pop)*1000) %>%
ungroup() %>%
mutate(week_id = row_number()) %>%
st_drop_geometry()

```

Police Data Week-Level

```

#Minneapolis Police Department - Use of Force Dashboard
uof <- read_csv("Police_Use_Of_Force.csv") %>%
  mutate(date=ymd_hms(ResponseDate),
         year=isoyear(date),
         week=isoweek(date)) %>%
  group_by(year, week, .drop=F) %>%
  tally(name = "use_of_force") %>%
  arrange(year, week) %>%
  ungroup() %>%
  select(year, week, everything())

#merge onto series
series <- hosp_series %>%
  left_join(uof, by=c("year", "weekofyr"="week")) %>%
  mutate(use_of_force_rate = (use_of_force/total_pop)*1000)

#MPD Officer Involved Shootings
ois <- read_csv("Police_Officer_Involved_Shootings.csv") %>%
  mutate(date=ymd_hms(IncidentDate),
         year=isoyear(date),
         week=isoweek(date)) %>%
  group_by(year, week, .drop=F) %>%
  tally(name = "off_inv_shooting") %>%
  arrange(year, week) %>%
  ungroup() %>%
  select(year, week, everything())

#merge onto series
series <- series %>%
  left_join(ois, by=c("year", "weekofyr"="week")) %>%
  mutate(off_inv_shooting = ifelse(is.na(off_inv_shooting), 0, off_inv_shooting),
         off_inv_shooting_rate = (off_inv_shooting/total_pop)*1000)

#Minneapolis Police Department - Police Stops Dashboard
stop <- read_csv("Police_Stop_Data.csv") %>%
  mutate(date=ymd_hms(responseDate),
         year=isoyear(date),
         week=isoweek(date)) %>%
  group_by(year, week, .drop=F) %>%

```

```

tally(name = "police_stops")

#merge onto series
series <- series %>%
  left_join(stop, by = c("year", "weekofyr"="week")) %>%
  mutate(police_stops = ifelse(is.na(police_stops), 0, police_stops),
         police_stop_rate = (police_stops/total_pop)*1000)

#creating date variable
series <- series %>%
  mutate(begin_date = ISOweek2date(paste(year, paste0("W", sprintf("%02d", weekofyr)), 1, sep = "-")),
         end_date = begin_date+weeks(1)-days(1))

```

Weather Data

```

# Minnesota DNR Daily Date
# https://www.dnr.state.mn.us/climate/historical/daily-data.html?sid=mspthr&sname=Minneapolis/St%20Paul
# Station Name: Minneapolis/St Paul Threaded Record - Station ID: mspthr

weather <- read_csv("dnr_weather.csv") %>%
  mutate(year=isoyear(Date),
         week=isoweek(Date),
         precip_in = as.numeric(ifelse(`Precipitation (inches)`=="T", .001, `Precipitation (inches)`)),
         snow_in = as.numeric(ifelse(`Snow (inches)`=="T", .001, `Snow (inches)`)),
         tmax_f = `Maximum Temperature degrees (F)`)%>%
  filter(year >= 2016 & year <= 2020) %>%
  select(year, week, precip_in, snow_in, tmax_f) %>%
  group_by(year, week) %>%
  summarize(precip_in = mean(precip_in, na.rm = T),
         snow_in = mean(snow_in, na.rm = T),
         tmax_f = mean(tmax_f, na.rm = T))

#join to series
series <- series %>% left_join(weather, by = c("year","weekofyr"="week"))

```

Sunset Data

```

#setting lat-lon for MPLS
mpls_lonlat <- geocode("Minneapolis, MN", output = "latlon", source="google")

#scrape sunset times for each begin date
#mutate to UTC-6 CST
#calculate hours of darkness before midnight
sun_series <- getSunlightTimes(date = seq(min(series$begin_date),
                                         max(series$begin_date),
                                         "days"),
                             lat = 44.97775 ,

```

```

lon = -93.26501,
keep = "sunset",
tz = "UTC") %>%
mutate(sunset = sunset-hours(6),
midnight = as.POSIXlt(date+days(1), format = '%Y-%m-%d %H:%M:%S'),
dark = as.numeric(midnight-sunset),
year = year(date),
week = isoweek(date)) %>%
group_by(year, week) %>%
summarize(dark_before_12 = mean(dark, na.rm = T))

#joining to series
series <- series %>%
left_join(sun_series, by = c("year", "weekofyr"="week"))

```

School Data

```

#created manually from online MPLS Public School Calendars: https://mpls.k12.mn.us/calendars
school <- series %>%
select(year, weekofyr, begin_date, end_date) %>%
mutate(days_in_week = as.numeric((end_date-begin_date))+1,
days_in_school = NA_integer_)

school[1,6] <- 5
school[2,6] <- 4
school[3,6] <- 3
school[4,6] <- 5
school[5,6] <- 5
school[6,6] <- 4
school[7,6] <- 4
school[8,6] <- 5
school[9,6] <- 5
school[10,6] <- 4
school[11,6] <- 4
school[12,6] <- 5
school[13,6] <- 0
school[14,6] <- 5
school[15,6] <- 5
school[16,6] <- 5
school[17,6] <- 5
school[18,6] <- 5
school[19,6] <- 5
school[20,6] <- 5
school[21,6] <- 5
school[22,6] <- 4
school[23,6] <- 2
school[24,6] <- 0
school[25,6] <- 0
school[26,6] <- 0
school[27,6] <- 0

```



```
school[28,6] <- 0
school[29,6] <- 0
school[30,6] <- 0
school[31,6] <- 0
school[32,6] <- 0
school[33,6] <- 0
school[34,6] <- 0
school[35,6] <- 5
school[36,6] <- 4
school[37,6] <- 5
school[38,6] <- 5
school[39,6] <- 5
school[40,6] <- 5
school[41,6] <- 5
school[42,6] <- 2
school[43,6] <- 5
school[44,6] <- 3
school[45,6] <- 5
school[46,6] <- 5
school[47,6] <- 2
school[48,6] <- 5
school[49,6] <- 5
school[50,6] <- 5
school[51,6] <- 0
school[52,6] <- 0
school[53,6] <- 4
school[54,6] <- 5
school[55,6] <- 4
school[56,6] <- 4
school[57,6] <- 4
school[58,6] <- 5
school[59,6] <- 4
school[60,6] <- 4
school[61,6] <- 5
school[62,6] <- 5
school[63,6] <- 5
school[64,6] <- 5
school[65,6] <- 3
school[66,6] <- 0
school[67,6] <- 5
school[68,6] <- 5
school[69,6] <- 5
school[70,6] <- 5
school[71,6] <- 5
school[72,6] <- 5
school[73,6] <- 5
school[74,6] <- 4
school[75,6] <- 5
school[76,6] <- 3
school[77,6] <- 0
school[78,6] <- 0
school[79,6] <- 0
school[80,6] <- 0
```

```
school[81,6] <- 0
school[82,6] <- 0
school[83,6] <- 0
school[84,6] <- 0
school[85,6] <- 0
school[86,6] <- 0
school[87,6] <- 5
school[88,6] <- 4
school[89,6] <- 5
school[90,6] <- 5
school[91,6] <- 5
school[92,6] <- 5
school[93,6] <- 5
school[94,6] <- 2
school[95,6] <- 5
school[96,6] <- 3
school[97,6] <- 5
school[98,6] <- 5
school[99,6] <- 2
school[100,6] <- 5
school[101,6] <- 5
school[102,6] <- 5
school[103,6] <- 5
school[104,6] <- 0
school[105,6] <- 0
school[106,6] <- 0
school[107,6] <- 5
school[108,6] <- 4
school[109,6] <- 3
school[110,6] <- 5
school[111,6] <- 5
school[112,6] <- 4
school[113,6] <- 4
school[114,6] <- 5
school[115,6] <- 5
school[116,6] <- 5
school[117,6] <- 5
school[118,6] <- 4
school[119,6] <- 0
school[120,6] <- 5
school[121,6] <- 5
school[122,6] <- 5
school[123,6] <- 5
school[124,6] <- 5
school[125,6] <- 5
school[126,6] <- 5
school[127,6] <- 4
school[128,6] <- 5
school[129,6] <- 0
school[130,6] <- 0
school[131,6] <- 0
school[132,6] <- 0
school[133,6] <- 0
```

```
school[134,6] <- 0
school[135,6] <- 0
school[136,6] <- 0
school[137,6] <- 0
school[138,6] <- 0
school[139,6] <- 0
school[140,6] <- 5
school[141,6] <- 4
school[142,6] <- 5
school[143,6] <- 5
school[144,6] <- 5
school[145,6] <- 5
school[146,6] <- 5
school[147,6] <- 2
school[148,6] <- 5
school[149,6] <- 3
school[150,6] <- 5
school[151,6] <- 5
school[152,6] <- 2
school[153,6] <- 5
school[154,6] <- 5
school[155,6] <- 5
school[156,6] <- 5
school[157,6] <- 0
school[158,6] <- 0
school[159,6] <- 5
school[160,6] <- 5
school[161,6] <- 2
school[162,6] <- 5
school[163,6] <- 5
school[164,6] <- 4
school[165,6] <- 4
school[166,6] <- 5
school[167,6] <- 5
school[168,6] <- 5
school[169,6] <- 5
school[170,6] <- 4
school[171,6] <- 0
school[172,6] <- 5
school[173,6] <- 5
school[174,6] <- 5
school[175,6] <- 5
school[176,6] <- 5
school[177,6] <- 5
school[178,6] <- 5
school[179,6] <- 4
school[180,6] <- 5
school[181,6] <- 0
school[182,6] <- 0
school[183,6] <- 0
school[184,6] <- 0
school[185,6] <- 0
school[186,6] <- 0
```

```
school[187,6] <- 0
school[188,6] <- 0
school[189,6] <- 0
school[190,6] <- 0
school[191,6] <- 0
school[192,6] <- 0
school[193,6] <- 4
school[194,6] <- 5
school[195,6] <- 5
school[196,6] <- 5
school[197,6] <- 5
school[198,6] <- 5
school[199,6] <- 2
school[200,6] <- 5
school[201,6] <- 4
school[202,6] <- 5
school[203,6] <- 5
school[204,6] <- 5
school[205,6] <- 2
school[206,6] <- 5
school[207,6] <- 5
school[208,6] <- 5
school[209,6] <- 0
school[210,6] <- 0
school[211,6] <- 5
school[212,6] <- 4
school[213,6] <- 4
school[214,6] <- 5
school[215,6] <- 5
school[216,6] <- 5
school[217,6] <- 3
school[218,6] <- 5
school[219,6] <- 5
school[220,6] <- 5
school[221,6] <- 5
school[222,6] <- 4
school[223,6] <- 0
school[224,6] <- 5
school[225,6] <- 5
school[226,6] <- 5
school[227,6] <- 5
school[228,6] <- 5
school[229,6] <- 5
school[230,6] <- 5
school[231,6] <- 4
school[232,6] <- 5
school[233,6] <- 0
school[234,6] <- 0
school[235,6] <- 0
school[236,6] <- 0
school[237,6] <- 0
school[238,6] <- 0
school[239,6] <- 0
```

```

school[240,6] <- 0
school[241,6] <- 0
school[242,6] <- 0
school[243,6] <- 0
school[244,6] <- 0
school[245,6] <- 4
school[246,6] <- 5
school[247,6] <- 5
school[248,6] <- 5
school[249,6] <- 5
school[250,6] <- 5
school[251,6] <- 3
school[252,6] <- 4
school[253,6] <- 5
school[254,6] <- 4
school[255,6] <- 5
school[256,6] <- 5
school[257,6] <- 2
school[258,6] <- 5
school[259,6] <- 5
school[260,6] <- 5
school[261,6] <- 0
school[262,6] <- 0

school <- school %>%
  mutate(school = days_in_school/days_in_week) %>%
  select(year, weekofyr, school)

series <- series %>% left_join(school, by = c("year", "weekofyr"))

```

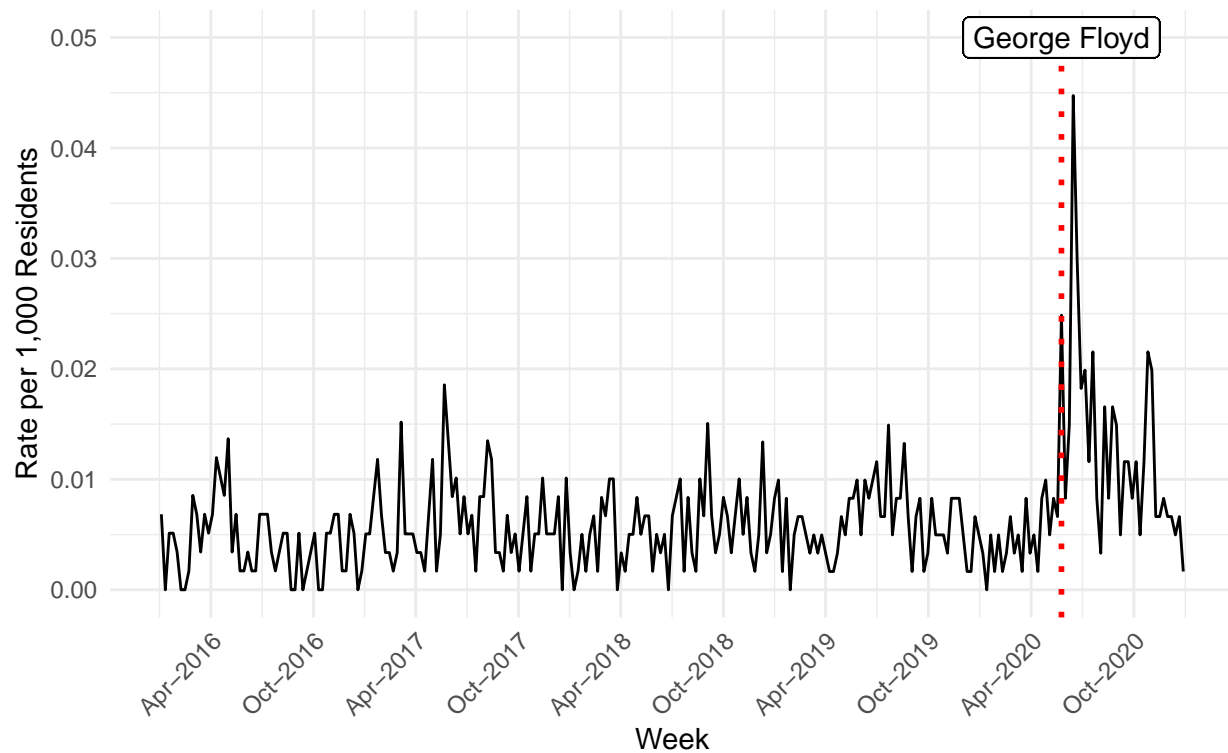
Time Series Vizualization

```

ggplot(series)+
  geom_line(aes(x=begin_date, y=assault_incid_c))+
  scale_x_date(date_labels = "%b-%Y", date_breaks = "6 months")+
  geom_vline(xintercept=series$begin_date[series$year==2020 & series$weekofyr==isoweek(date("2020-05-25"),
    linetype="dotted", color="red", size=1))+
  geom_label(aes(x=series$begin_date[series$year==2020 & series$weekofyr==isoweek(date("2020-05-25"))],
    y=0.050),
    label = "George Floyd", show.legend = FALSE)+
  labs(title = "Figure 1: Weekly Firearm Assaults, 2016-2020",
    subtitle = "MHA Hospital Data",
    x = "Week",
    y = "Rate per 1,000 Residents")+
  theme_minimal()+
  theme(axis.text.x=element_text(angle=45, hjust=1))

```

Figure 1: Weekly Firearm Assaults, 2016–2020
MHA Hospital Data



Time Series Analysis

```
series <- series %>%
  mutate(t = 1:length(assault_incident_c),
         post_floyd = as.numeric(begin_date >= as.Date("2020-05-25")),
         post_floyd_3 = as.numeric(begin_date >= as.Date("2020-05-25")+months(3)),
         stay_at_home = as.numeric(begin_date >= as.Date("2020-03-28") &
                                   state_of_emerg = as.numeric(begin_date >= as.Date("2020-03-13")))

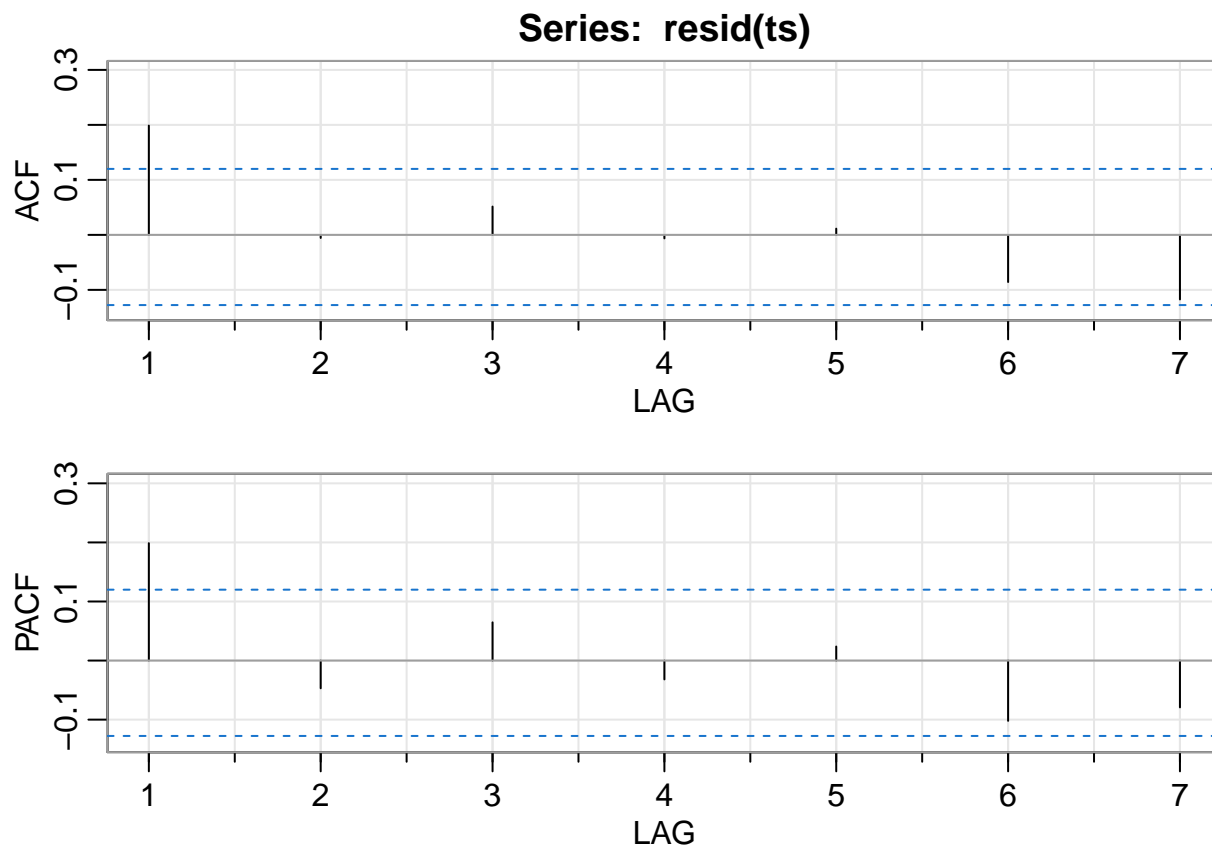
ts <- lm(assault_incident_c~t+state_of_emerg+stay_at_home+post_floyd+post_floyd_3+
        tmax_f+snow_in+precip_in+dark_before_12+school,
        data = series)

summary(ts)
```

```
##
## Call:
## lm(formula = assault_incident_c ~ t + state_of_emerg + stay_at_home +
##     post_floyd + post_floyd_3 + tmax_f + snow_in + precip_in +
##     dark_before_12 + school, data = series)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.0139072 -0.0025135 -0.0002368  0.0018088  0.0273037
```

```
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   6.637e-03  3.557e-03   1.866   0.0633 .
## t             6.573e-06  4.524e-06   1.453   0.1475
## state_of_emerg -3.394e-03  2.573e-03  -1.319   0.1883
## stay_at_home   3.078e-03  2.646e-03   1.163   0.2459
## post_floyd     1.360e-02  2.631e-03   5.167 4.86e-07 ***
## post_floyd_3   -6.644e-03  1.633e-03  -4.068 6.36e-05 ***
## tmax_f         1.333e-05  2.415e-05   0.552   0.5814
## snow_in        -5.169e-04  7.725e-04  -0.669   0.5041
## precip_in      -2.400e-04  2.524e-03  -0.095   0.9243
## dark_before_12 -5.074e-04  4.136e-04  -1.227   0.2211
## school         7.116e-04  9.511e-04   0.748   0.4551
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.004188 on 250 degrees of freedom
## Multiple R-squared:  0.3509, Adjusted R-squared:  0.325
## F-statistic: 13.52 on 10 and 250 DF,  p-value: < 2.2e-16
```

```
acf2(resid(ts), max.lag = 7)
```

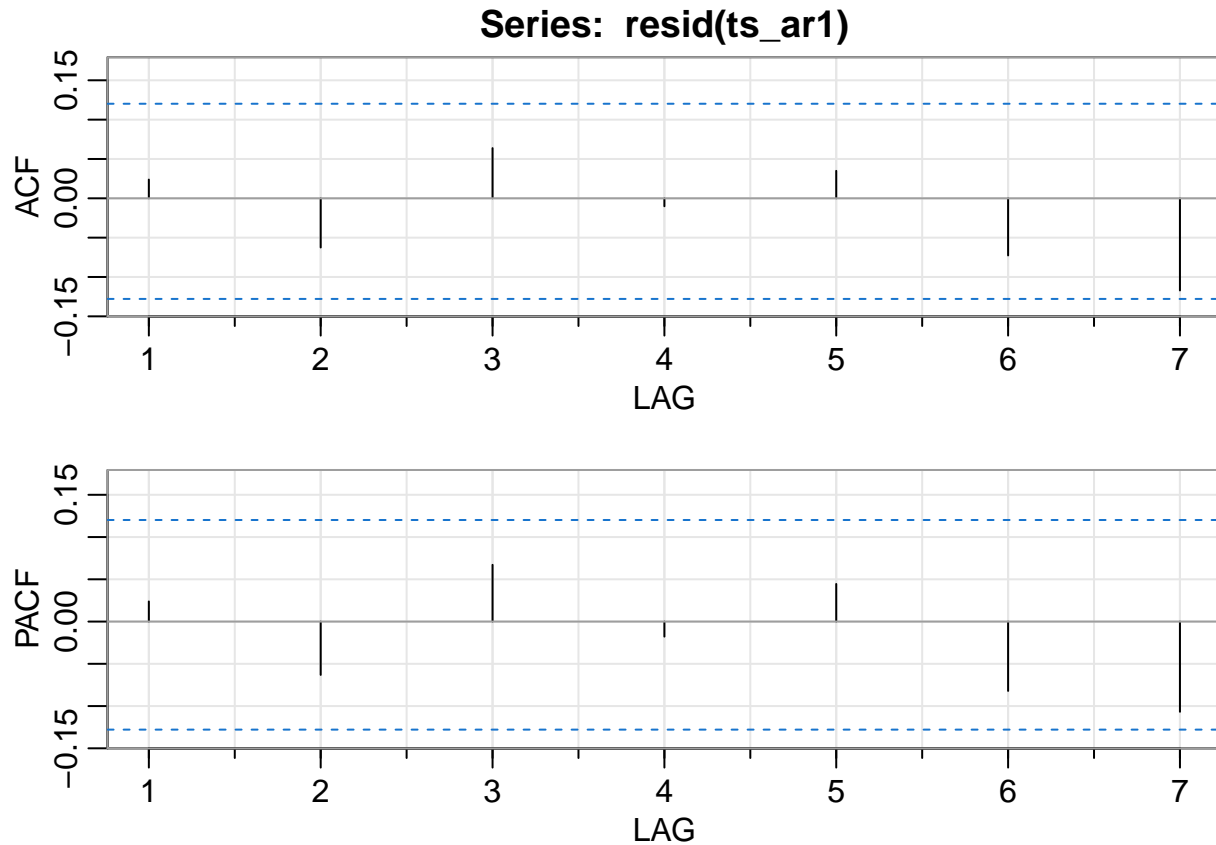


```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7]
## ACF   0.2 -0.01 0.05 -0.01 0.01 -0.09 -0.12
## PACF   0.2 -0.05 0.06 -0.03 0.02 -0.10 -0.08
```

```
ts_ar1<- lm(assault_incid_c~t+state_of_emerg+stay_at_home+post_floyd+post_floyd_3+
            tmax_f+snow_in+precip_in+dark_before_12+school+
            dplyr::lag(assault_incid_c, 1), data = series)
summary(ts_ar1)
```

```
##
## Call:
## lm(formula = assault_incid_c ~ t + state_of_emerg + stay_at_home +
##     post_floyd + post_floyd_3 + tmax_f + snow_in + precip_in +
##     dark_before_12 + school + dplyr::lag(assault_incid_c, 1),
##     data = series)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.0122313 -0.0026183 -0.0002489  0.0020128  0.0277111
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    5.373e-03  3.528e-03   1.523  0.12902
## t              5.744e-06  4.512e-06   1.273  0.20425
## state_of_emerg -3.649e-03  2.535e-03  -1.439  0.15128
## stay_at_home    3.529e-03  2.611e-03   1.352  0.17769
## post_floyd      1.202e-02  2.642e-03   4.548 8.49e-06 ***
## post_floyd_3    -5.645e-03  1.641e-03  -3.441  0.00068 ***
## tmax_f          1.031e-05  2.383e-05   0.433  0.66551
## snow_in        -4.415e-04  7.613e-04  -0.580  0.56252
## precip_in       1.817e-04  2.490e-03   0.073  0.94190
## dark_before_12  -4.423e-04  4.083e-04  -1.083  0.27983
## school          8.569e-04  9.383e-04   0.913  0.36199
## dplyr::lag(assault_incid_c, 1) 1.863e-01  6.179e-02   3.015  0.00284 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.004125 on 248 degrees of freedom
## (1 observation deleted due to missingness)
## Multiple R-squared:  0.3753, Adjusted R-squared:  0.3476
## F-statistic: 13.54 on 11 and 248 DF,  p-value: < 2.2e-16
```

```
acf2(resid(ts_ar1), max.lag = 7)
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7]
## ACF  0.02 -0.06 0.06 -0.01 0.03 -0.07 -0.12
## PACF 0.02 -0.06 0.07 -0.02 0.04 -0.08 -0.11
```

```
stargazer(ts_ar1,
  title = "Interrupted Time Series Model of Firearm Assaults",
  covariate.labels = c("T", "COVID - State of Emergency", "COVID - Stay at Home",
    "Post-Treatment", "Post-Treatment 3 Months", "AR(1)"),
  dep.var.caption = "Firearm Assaults",
  dep.var.labels = "Rate per 1,000",
  model.numbers = FALSE,
  single.row = TRUE,
  align = T,
  omit = c("tmax_f", "snow_in", "precip_in",
    "dark_before_12", "school"),
  omit.stat = "adj.rsq",
  star.cutoffs = c(.05, .01, .001), star.char = c(" ", "*", "**", "***"),
  notes.label = "Model includes controls for seasonality.")
```

% Table created by stargazer v.5.2.2 by Marek Hlavac, Harvard University. E-mail: hlavac at fas.harvard.edu
 % Date and time: Fri, Jul 30, 2021 - 1:51:48 AM % Requires LaTeX packages: dcolumn

```
#aggregate to zip-level over years
zip_level <- panel %>%
  group_by(zcta, period) %>%
```

Table 1: Interrupted Time Series Model of Firearm Assaults

	Firearm Assaults
	Rate per 1,000
T	0.00001 (0.00000)
COVID - State of Emergency	-0.004 (0.003)
COVID - Stay at Home	0.004 (0.003)
Post-Treatment	0.012*** (0.003)
Post-Treatment 3 Months	-0.006*** (0.002)
AR(1)	0.186** (0.062)
Constant	0.005 (0.004)
Observations	260
R ²	0.375
Residual Std. Error	0.004 (df = 248)
F Statistic	13.545*** (df = 11; 248)
Model includes controls for seasonality. *p<0.05; **p<0.01; ***p<0.001	

```

summarize(assault_tot = sum(assault_tot, na.rm = T),
          unintent_tot = sum(unintent_tot, na.rm = T),
          suicide_tot = sum(suicide_tot, na.rm = T),
          undeter_tot = sum(undeter_tot, na.rm = T),
          legal_tot = sum(legal_tot, na.rm = T),
          combined_tot = sum(combined_tot, na.rm = T),
          total_pop = sum(total_pop, na.rm = T)) %>%
mutate(assault_incid_c = (assault_tot/total_pop)*1000,
       unintent_incid_c = (unintent_tot/total_pop)*1000,
       suicide_incid_c = (suicide_tot/total_pop)*1000,
       undeter_incid_c = (undeter_tot/total_pop)*1000,
       legal_incid_c = (legal_tot/total_pop)*1000,
       combined_incid_c = (combined_tot/total_pop)*1000) %>%
ungroup() %>%
st_drop_geometry() %>%
left_join(zcta, by = "zcta")

#george floyd square
gfs <- geocode("George Floyd Square, Minneapolis", output = "latlon") %>%
  st_as_sf(coords = c("lon", "lat"), crs = "NAD83", remove=F) %>%
  mutate(name = "George Floyd Square")

ggplot() +
  geom_sf(data = zip_level, aes(geometry = geometry, fill = assault_incid_c)) +
  geom_sf(data = mpls, aes(geometry = geometry), color = "black", alpha = 0)+
  geom_sf(data = gfs, aes(geometry = geometry), color = "black")+
  geom_text_repel(data = gfs, aes(x=lon, y=lat, label = name),
                 size = 2,
                 fontface = "bold",
                 nudge_x = 1, nudge_y = -1)+
  facet_wrap(~period)+
  scale_fill_distiller(palette = "Spectral")+
  labs(title = "Figure 2: Firearm Assault Rates by ZCTA and Period",

```

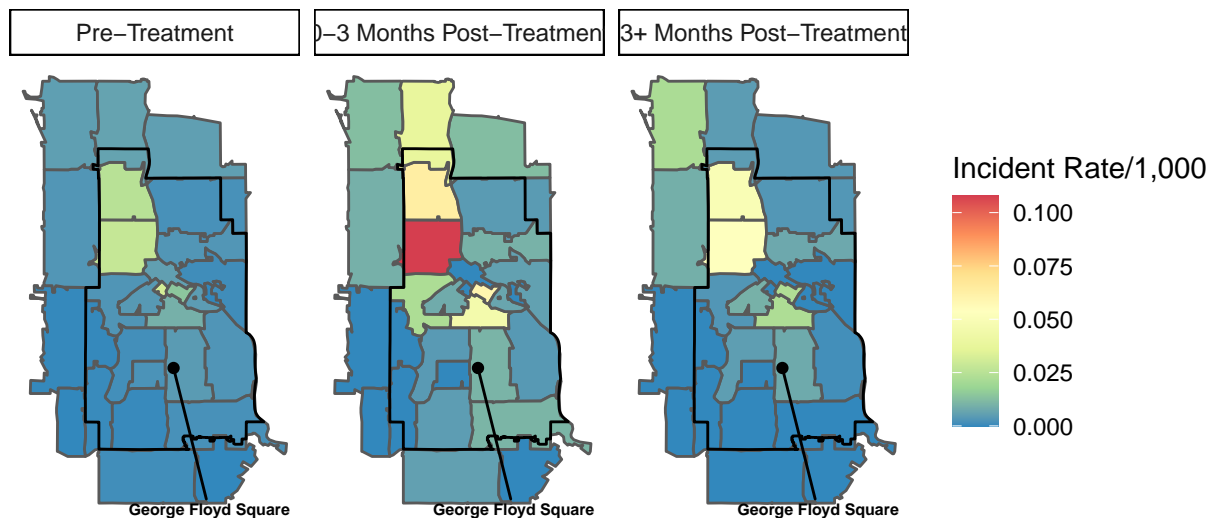
```

    subtitle = "MHA Hospital Discharge Data",
    fill = "Incident Rate/1,000")+
theme(axis.text = element_blank(),
axis.line = element_blank(),
axis.ticks = element_blank(),
panel.border = element_blank(),
panel.grid = element_blank(),
axis.title = element_blank(),
panel.background = element_blank(),
panel.grid.major = element_line(colour="transparent"),
plot.subtitle = element_text(face="italic"),
strip.background = element_rect(fill = "white",
                                colour = "black"))

```

Figure 2: Firearm Assault Rates by ZCTA and Period

MHA Hospital Discharge Data



Panel Analysis

```

##
## Call:
## lm(formula = assault_incid_c ~ t + state_of_emerg + stay_at_home +
##      post_floyd + post_floyd_3 + as.factor(zcta), data = panel)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.330  -0.570  -0.258  -0.012  264.312

```

```

##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.1907423   0.3218021   0.593  0.55338
## t              0.0018859   0.0009861   1.913  0.05584 .
## state_of_emergTRUE -0.4496492   0.6637870  -0.677  0.49817
## stay_at_homeTRUE  0.2395738   0.7287834   0.329  0.74237
## post_floydTRUE    0.9726379   0.4086992   2.380  0.01735 *
## post_floyd_3TRUE  -0.8144739   0.3288695  -2.477  0.01329 *
## as.factor(zcta)55402  2.0188457   0.4269945   4.728 2.31e-06 ***
## as.factor(zcta)55403  0.0171753   0.4269945   0.040  0.96792
## as.factor(zcta)55404  0.7732006   0.4269945   1.811  0.07021 .
## as.factor(zcta)55405 -0.0343970   0.4269945  -0.081  0.93580
## as.factor(zcta)55406 -0.1560144   0.4269945  -0.365  0.71484
## as.factor(zcta)55407  0.0582581   0.4269945   0.136  0.89148
## as.factor(zcta)55408 -0.2586522   0.4269945  -0.606  0.54470
## as.factor(zcta)55409 -0.2364360   0.4269945  -0.554  0.57979
## as.factor(zcta)55410 -0.4089703   0.4269945  -0.958  0.33820
## as.factor(zcta)55411  2.9258866   0.4269945   6.852 7.86e-12 ***
## as.factor(zcta)55412  2.4045153   0.4269945   5.631 1.86e-08 ***
## as.factor(zcta)55413 -0.0592224   0.4269945  -0.139  0.88969
## as.factor(zcta)55414 -0.3227576   0.4269945  -0.756  0.44974
## as.factor(zcta)55415  1.2416106   0.4269945   2.908  0.00365 **
## as.factor(zcta)55416 -0.4414446   0.4269945  -1.034  0.30124
## as.factor(zcta)55417 -0.2190085   0.4269945  -0.513  0.60803
## as.factor(zcta)55418 -0.2264396   0.4269945  -0.530  0.59591
## as.factor(zcta)55419 -0.3964493   0.4269945  -0.928  0.35320
## as.factor(zcta)55421  0.1187478   0.4269945   0.278  0.78094
## as.factor(zcta)55422 -0.0500345   0.4269945  -0.117  0.90672
## as.factor(zcta)55423 -0.3066886   0.4269945  -0.718  0.47263
## as.factor(zcta)55424 -0.4652388   0.4269945  -1.090  0.27594
## as.factor(zcta)55429  0.2386535   0.4269945   0.559  0.57624
## as.factor(zcta)55430  0.3444312   0.4269945   0.807  0.41990
## as.factor(zcta)55450 -0.4734850   0.4312374  -1.098  0.27225
## as.factor(zcta)55454  0.0086534   0.4269945   0.020  0.98383
## as.factor(zcta)55455 -0.4652388   0.4269945  -1.090  0.27594
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.878 on 7265 degrees of freedom
## (10 observations deleted due to missingness)
## Multiple R-squared:  0.03361,    Adjusted R-squared:  0.02935
## F-statistic: 7.896 on 32 and 7265 DF,  p-value: < 2.2e-16

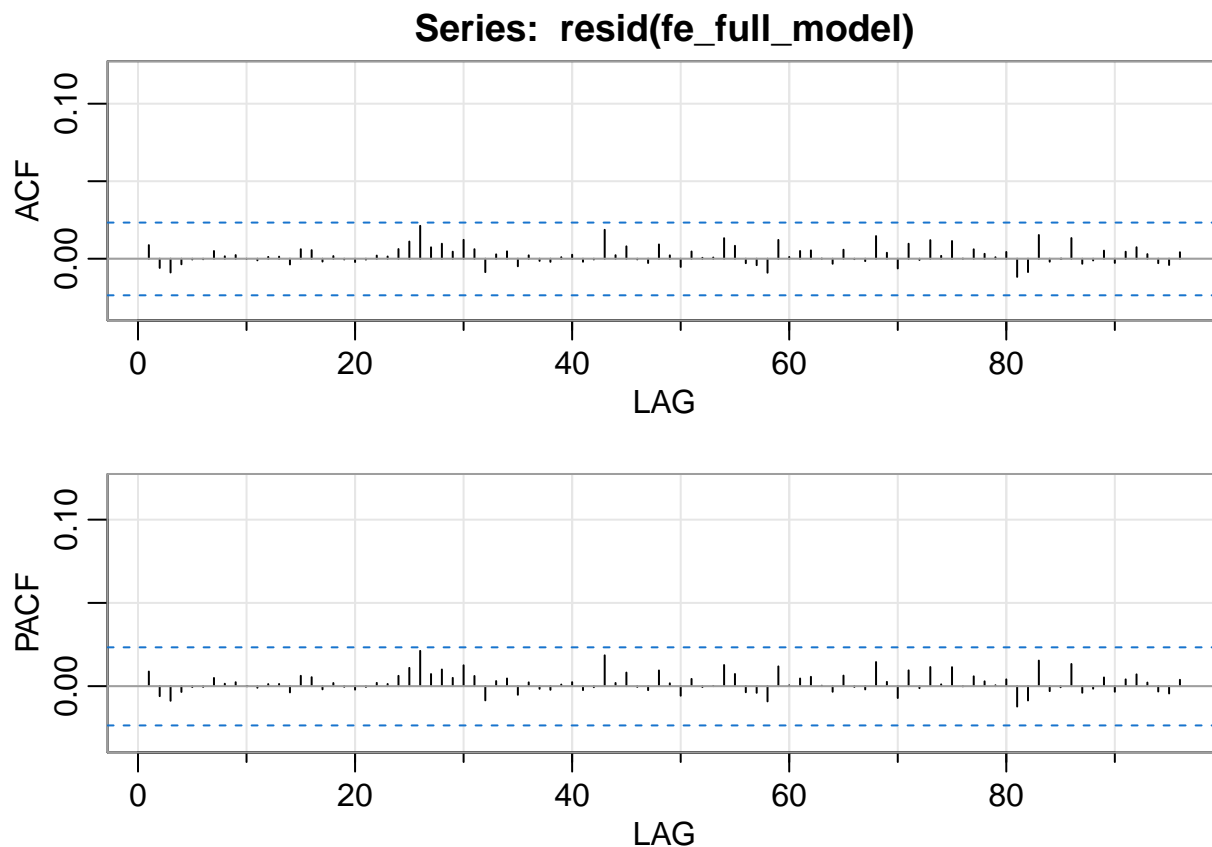
##
## Call:
## lm(formula = assault_incident_c ~ t + state_of_emerg + stay_at_home +
##     post_floyd + post_floyd_3 + uof_lag + stops_lag + shoot_lag +
##     as.factor(zcta), data = panel)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -4.563  -0.601  -0.257   0.005  264.088
##

```

```

## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.320738   0.335400   0.956  0.33896
## t              0.001667   0.001037   1.607  0.10808
## state_of_emergTRUE -0.422193   0.665379  -0.635  0.52576
## stay_at_homeTRUE  0.214605   0.730044   0.294  0.76880
## post_floydTRUE    0.998653   0.411349   2.428  0.01522 *
## post_floyd_3TRUE  -0.728391   0.331789  -2.195  0.02817 *
## uof_lag          -0.048015   0.023080  -2.080  0.03752 *
## stops_lag         0.002337   0.003198   0.731  0.46502
## shoot_lag        -0.307569   0.431806  -0.712  0.47631
## as.factor(zcta)55402 2.087844   0.429957   4.856 1.22e-06 ***
## as.factor(zcta)55403 0.031149   0.429527   0.073  0.94219
## as.factor(zcta)55404 0.700437   0.434029   1.614  0.10661
## as.factor(zcta)55405 -0.125671   0.430515  -0.292  0.77036
## as.factor(zcta)55406 -0.259344   0.431504  -0.601  0.54784
## as.factor(zcta)55407 -0.037101   0.433639  -0.086  0.93182
## as.factor(zcta)55408 -0.350205   0.447288  -0.783  0.43368
## as.factor(zcta)55409 -0.354429   0.436244  -0.812  0.41656
## as.factor(zcta)55410 -0.521349   0.438915  -1.188  0.23495
## as.factor(zcta)55411 2.896536   0.487635   5.940 2.98e-09 ***
## as.factor(zcta)55412 2.343070   0.432539   5.417 6.26e-08 ***
## as.factor(zcta)55413 -0.203472   0.433126  -0.470  0.63853
## as.factor(zcta)55414 -0.421798   0.430802  -0.979  0.32756
## as.factor(zcta)55415 1.169570   0.434967   2.689  0.00719 **
## as.factor(zcta)55416 -0.557549   0.440091  -1.267  0.20523
## as.factor(zcta)55417 -0.329319   0.436678  -0.754  0.45079
## as.factor(zcta)55418 -0.382944   0.435801  -0.879  0.37959
## as.factor(zcta)55419 -0.523939   0.433411  -1.209  0.22675
## as.factor(zcta)55421 0.009189   0.441496   0.021  0.98340
## as.factor(zcta)55422 -0.186029   0.441634  -0.421  0.67360
## as.factor(zcta)55423 -0.418147   0.441784  -0.946  0.34393
## as.factor(zcta)55424 -0.577370   0.441769  -1.307  0.19127
## as.factor(zcta)55429 0.129356   0.441799   0.293  0.76969
## as.factor(zcta)55430 0.244090   0.438015   0.557  0.57737
## as.factor(zcta)55450 -0.585136   0.446073  -1.312  0.18965
## as.factor(zcta)55454 -0.091995   0.436082  -0.211  0.83293
## as.factor(zcta)55455 -0.573697   0.441175  -1.300  0.19351
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.886 on 7234 degrees of freedom
## (38 observations deleted due to missingness)
## Multiple R-squared:  0.03426,    Adjusted R-squared:  0.02959
## F-statistic: 7.333 on 35 and 7234 DF,  p-value: < 2.2e-16

```



```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## ACF  0.01 -0.01 -0.01  0    0    0    0    0    0    0    0    0    0
## PACF  0.01 -0.01 -0.01  0    0    0    0    0    0    0    0    0    0
##      [,14] [,15] [,16] [,17] [,18] [,19] [,20] [,21] [,22] [,23] [,24] [,25]
## ACF      0  0.01  0.01    0    0    0    0    0    0    0  0.01  0.01
## PACF      0  0.01  0.01    0    0    0    0    0    0    0  0.01  0.01
##      [,26] [,27] [,28] [,29] [,30] [,31] [,32] [,33] [,34] [,35] [,36] [,37]
## ACF  0.02  0.01  0.01    0  0.01  0.01 -0.01    0    0  0.00    0    0
## PACF  0.02  0.01  0.01    0  0.01  0.01 -0.01    0    0 -0.01    0    0
##      [,38] [,39] [,40] [,41] [,42] [,43] [,44] [,45] [,46] [,47] [,48] [,49]
## ACF      0    0    0    0    0  0.02    0  0.01    0    0  0.01    0
## PACF      0    0    0    0    0  0.02    0  0.01    0    0  0.01    0
##      [,50] [,51] [,52] [,53] [,54] [,55] [,56] [,57] [,58] [,59] [,60] [,61]
## ACF -0.01    0    0    0  0.01  0.01    0    0 -0.01  0.01    0    0
## PACF -0.01    0    0    0  0.01  0.01    0    0 -0.01  0.01    0    0
##      [,62] [,63] [,64] [,65] [,66] [,67] [,68] [,69] [,70] [,71] [,72] [,73]
## ACF  0.01    0    0  0.01    0    0  0.01    0 -0.01  0.01    0  0.01
## PACF  0.01    0    0  0.01    0    0  0.01    0 -0.01  0.01    0  0.01
##      [,74] [,75] [,76] [,77] [,78] [,79] [,80] [,81] [,82] [,83] [,84] [,85]
## ACF      0  0.01    0  0.01    0    0    0 -0.01 -0.01  0.02    0    0
## PACF      0  0.01    0  0.01    0    0    0 -0.01 -0.01  0.02    0    0
##      [,86] [,87] [,88] [,89] [,90] [,91] [,92] [,93] [,94] [,95] [,96]
## ACF  0.01    0    0  0.01    0    0  0.01    0    0    0    0
## PACF  0.01    0    0  0.01    0    0  0.01    0    0    0    0
```

```
##
```

```
## Call:
## lm(formula = assault_incid_c ~ t + state_of_emerg + stay_at_home +
##      post_floyd + post_floyd_3 + as.factor(zcta) + post_floyd:as.factor(zcta) +
##      post_floyd_3:as.factor(zcta), data = panel)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10.771  -0.532  -0.261  -0.014  263.896
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    3.249e-01  3.398e-01   0.956  0.3391
## t              1.884e-03  9.846e-04   1.913  0.0558
## state_of_emergTRUE -4.495e-01  6.628e-01  -0.678  0.4976
## stay_at_homeTRUE   2.396e-01  7.277e-01   0.329  0.7420
## post_floydTRUE    -5.604e-01  1.378e+00  -0.407  0.6843
## post_floyd_3TRUE  -3.014e-02  1.736e+00  -0.017  0.9861
## as.factor(zcta)55402  2.301e+00  4.552e-01   5.055 4.40e-07
## as.factor(zcta)55403 -1.105e-01  4.552e-01  -0.243  0.8082
## as.factor(zcta)55404  4.278e-01  4.552e-01   0.940  0.3473
## as.factor(zcta)55405 -2.036e-01  4.552e-01  -0.447  0.6547
## as.factor(zcta)55406 -2.168e-01  4.552e-01  -0.476  0.6338
## as.factor(zcta)55407 -6.147e-02  4.552e-01  -0.135  0.8926
## as.factor(zcta)55408 -3.636e-01  4.552e-01  -0.799  0.4244
## as.factor(zcta)55409 -2.695e-01  4.552e-01  -0.592  0.5538
## as.factor(zcta)55410 -4.661e-01  4.552e-01  -1.024  0.3058
## as.factor(zcta)55411  2.256e+00  4.552e-01   4.958 7.30e-07
## as.factor(zcta)55412  1.964e+00  4.552e-01   4.316 1.61e-05
## as.factor(zcta)55413 -1.900e-01  4.552e-01  -0.417  0.6764
## as.factor(zcta)55414 -4.043e-01  4.552e-01  -0.888  0.3744
## as.factor(zcta)55415  8.710e-01  4.552e-01   1.914  0.0557
## as.factor(zcta)55416 -5.031e-01  4.552e-01  -1.105  0.2690
## as.factor(zcta)55417 -3.153e-01  4.552e-01  -0.693  0.4885
## as.factor(zcta)55418 -3.157e-01  4.552e-01  -0.694  0.4879
## as.factor(zcta)55419 -4.831e-01  4.552e-01  -1.061  0.2886
## as.factor(zcta)55421  2.839e-02  4.552e-01   0.062  0.9503
## as.factor(zcta)55422 -1.887e-01  4.552e-01  -0.415  0.6784
## as.factor(zcta)55423 -3.856e-01  4.552e-01  -0.847  0.3969
## as.factor(zcta)55424 -5.303e-01  4.552e-01  -1.165  0.2441
## as.factor(zcta)55429  2.157e-02  4.552e-01   0.047  0.9622
## as.factor(zcta)55430  1.214e-01  4.552e-01   0.267  0.7897
## as.factor(zcta)55450 -5.365e-01  4.603e-01  -1.166  0.2438
## as.factor(zcta)55454 -3.370e-02  4.552e-01  -0.074  0.9410
## as.factor(zcta)55455 -5.303e-01  4.552e-01  -1.165  0.2441
## post_floydTRUE:as.factor(zcta)55402 -2.301e+00  1.896e+00  -1.213  0.2250
## post_floydTRUE:as.factor(zcta)55403  9.617e-01  1.896e+00   0.507  0.6121
## post_floydTRUE:as.factor(zcta)55404  4.076e+00  1.896e+00   2.149  0.0316
## post_floydTRUE:as.factor(zcta)55405  2.444e+00  1.896e+00   1.289  0.1975
## post_floydTRUE:as.factor(zcta)55406  6.425e-01  1.896e+00   0.339  0.7348
## post_floydTRUE:as.factor(zcta)55407  1.107e+00  1.896e+00   0.584  0.5593
## post_floydTRUE:as.factor(zcta)55408  8.138e-01  1.896e+00   0.429  0.6678
## post_floydTRUE:as.factor(zcta)55409  2.695e-01  1.896e+00   0.142  0.8870
## post_floydTRUE:as.factor(zcta)55410  4.661e-01  1.896e+00   0.246  0.8058
## post_floydTRUE:as.factor(zcta)55411  8.509e+00  1.896e+00   4.487 7.32e-06
```

```

## post_floydTRUE:as.factor(zcta)55412 4.383e+00 1.896e+00 2.311 0.0208
## post_floydTRUE:as.factor(zcta)55413 1.192e+00 1.896e+00 0.628 0.5297
## post_floydTRUE:as.factor(zcta)55414 1.001e+00 1.896e+00 0.528 0.5977
## post_floydTRUE:as.factor(zcta)55415 5.063e+00 1.896e+00 2.670 0.0076
## post_floydTRUE:as.factor(zcta)55416 5.031e-01 1.896e+00 0.265 0.7908
## post_floydTRUE:as.factor(zcta)55417 1.390e+00 1.896e+00 0.733 0.4637
## post_floydTRUE:as.factor(zcta)55418 7.871e-01 1.896e+00 0.415 0.6781
## post_floydTRUE:as.factor(zcta)55419 9.939e-01 1.896e+00 0.524 0.6002
## post_floydTRUE:as.factor(zcta)55421 1.221e+00 1.896e+00 0.644 0.5196
## post_floydTRUE:as.factor(zcta)55422 1.146e+00 1.896e+00 0.605 0.5455
## post_floydTRUE:as.factor(zcta)55423 9.760e-01 1.896e+00 0.515 0.6068
## post_floydTRUE:as.factor(zcta)55424 5.303e-01 1.896e+00 0.280 0.7798
## post_floydTRUE:as.factor(zcta)55429 1.259e+00 1.896e+00 0.664 0.5069
## post_floydTRUE:as.factor(zcta)55430 3.680e+00 1.896e+00 1.941 0.0523
## post_floydTRUE:as.factor(zcta)55450 5.365e-01 1.898e+00 0.283 0.7774
## post_floydTRUE:as.factor(zcta)55454 7.463e-01 1.896e+00 0.394 0.6939
## post_floydTRUE:as.factor(zcta)55455 5.303e-01 1.896e+00 0.280 0.7798
## post_floyd_3TRUE:as.factor(zcta)55402 4.157e-15 2.454e+00 0.000 1.0000
## post_floyd_3TRUE:as.factor(zcta)55403 1.419e-01 2.454e+00 0.058 0.9539
## post_floyd_3TRUE:as.factor(zcta)55404 -2.237e+00 2.454e+00 -0.911 0.3621
## post_floyd_3TRUE:as.factor(zcta)55405 -1.892e+00 2.454e+00 -0.771 0.4409
## post_floyd_3TRUE:as.factor(zcta)55406 -2.601e-01 2.454e+00 -0.106 0.9156
## post_floyd_3TRUE:as.factor(zcta)55407 -2.324e-01 2.454e+00 -0.095 0.9246
## post_floyd_3TRUE:as.factor(zcta)55408 7.504e-02 2.454e+00 0.031 0.9756
## post_floyd_3TRUE:as.factor(zcta)55409 5.057e-15 2.454e+00 0.000 1.0000
## post_floyd_3TRUE:as.factor(zcta)55410 2.005e-14 2.454e+00 0.000 1.0000
## post_floyd_3TRUE:as.factor(zcta)55411 -5.421e+00 2.454e+00 -2.209 0.0272
## post_floyd_3TRUE:as.factor(zcta)55412 -1.411e+00 2.454e+00 -0.575 0.5655
## post_floyd_3TRUE:as.factor(zcta)55413 -2.226e-01 2.454e+00 -0.091 0.9277
## post_floyd_3TRUE:as.factor(zcta)55414 -5.965e-01 2.454e+00 -0.243 0.8080
## post_floyd_3TRUE:as.factor(zcta)55415 -3.626e+00 2.454e+00 -1.477 0.1396
## post_floyd_3TRUE:as.factor(zcta)55416 1.061e-14 2.454e+00 0.000 1.0000
## post_floyd_3TRUE:as.factor(zcta)55417 -1.074e+00 2.454e+00 -0.438 0.6616
## post_floyd_3TRUE:as.factor(zcta)55418 -1.048e-01 2.454e+00 -0.043 0.9660
## post_floyd_3TRUE:as.factor(zcta)55419 -5.108e-01 2.454e+00 -0.208 0.8351
## post_floyd_3TRUE:as.factor(zcta)55421 -8.608e-01 2.454e+00 -0.351 0.7258
## post_floyd_3TRUE:as.factor(zcta)55422 -2.660e-02 2.454e+00 -0.011 0.9914
## post_floyd_3TRUE:as.factor(zcta)55423 -5.903e-01 2.454e+00 -0.241 0.8099
## post_floyd_3TRUE:as.factor(zcta)55424 1.297e-14 2.454e+00 0.000 1.0000
## post_floyd_3TRUE:as.factor(zcta)55429 9.103e-01 2.454e+00 0.371 0.7107
## post_floyd_3TRUE:as.factor(zcta)55430 -3.309e+00 2.454e+00 -1.348 0.1777
## post_floyd_3TRUE:as.factor(zcta)55450 9.822e-15 2.454e+00 0.000 1.0000
## post_floyd_3TRUE:as.factor(zcta)55454 -7.126e-01 2.454e+00 -0.290 0.7716
## post_floyd_3TRUE:as.factor(zcta)55455 8.155e-15 2.454e+00 0.000 1.0000
##
## (Intercept)
## t
## state_of_emergTRUE
## stay_at_homeTRUE
## post_floydTRUE
## post_floyd_3TRUE
## as.factor(zcta)55402 ***
## as.factor(zcta)55403
## as.factor(zcta)55404

```



```

## as.factor(zcta)55405
## as.factor(zcta)55406
## as.factor(zcta)55407
## as.factor(zcta)55408
## as.factor(zcta)55409
## as.factor(zcta)55410
## as.factor(zcta)55411      ***
## as.factor(zcta)55412      ***
## as.factor(zcta)55413
## as.factor(zcta)55414
## as.factor(zcta)55415      .
## as.factor(zcta)55416
## as.factor(zcta)55417
## as.factor(zcta)55418
## as.factor(zcta)55419
## as.factor(zcta)55421
## as.factor(zcta)55422
## as.factor(zcta)55423
## as.factor(zcta)55424
## as.factor(zcta)55429
## as.factor(zcta)55430
## as.factor(zcta)55450
## as.factor(zcta)55454
## as.factor(zcta)55455
## post_floydTRUE:as.factor(zcta)55402
## post_floydTRUE:as.factor(zcta)55403
## post_floydTRUE:as.factor(zcta)55404      *
## post_floydTRUE:as.factor(zcta)55405
## post_floydTRUE:as.factor(zcta)55406
## post_floydTRUE:as.factor(zcta)55407
## post_floydTRUE:as.factor(zcta)55408
## post_floydTRUE:as.factor(zcta)55409
## post_floydTRUE:as.factor(zcta)55410
## post_floydTRUE:as.factor(zcta)55411      ***
## post_floydTRUE:as.factor(zcta)55412      *
## post_floydTRUE:as.factor(zcta)55413
## post_floydTRUE:as.factor(zcta)55414
## post_floydTRUE:as.factor(zcta)55415      **
## post_floydTRUE:as.factor(zcta)55416
## post_floydTRUE:as.factor(zcta)55417
## post_floydTRUE:as.factor(zcta)55418
## post_floydTRUE:as.factor(zcta)55419
## post_floydTRUE:as.factor(zcta)55421
## post_floydTRUE:as.factor(zcta)55422
## post_floydTRUE:as.factor(zcta)55423
## post_floydTRUE:as.factor(zcta)55424
## post_floydTRUE:as.factor(zcta)55429
## post_floydTRUE:as.factor(zcta)55430      .
## post_floydTRUE:as.factor(zcta)55450
## post_floydTRUE:as.factor(zcta)55454
## post_floydTRUE:as.factor(zcta)55455
## post_floyd_3TRUE:as.factor(zcta)55402
## post_floyd_3TRUE:as.factor(zcta)55403
## post_floyd_3TRUE:as.factor(zcta)55404

```

```
## post_floyd_3TRUE:as.factor(zcta)55405
## post_floyd_3TRUE:as.factor(zcta)55406
## post_floyd_3TRUE:as.factor(zcta)55407
## post_floyd_3TRUE:as.factor(zcta)55408
## post_floyd_3TRUE:as.factor(zcta)55409
## post_floyd_3TRUE:as.factor(zcta)55410
## post_floyd_3TRUE:as.factor(zcta)55411 *
## post_floyd_3TRUE:as.factor(zcta)55412
## post_floyd_3TRUE:as.factor(zcta)55413
## post_floyd_3TRUE:as.factor(zcta)55414
## post_floyd_3TRUE:as.factor(zcta)55415
## post_floyd_3TRUE:as.factor(zcta)55416
## post_floyd_3TRUE:as.factor(zcta)55417
## post_floyd_3TRUE:as.factor(zcta)55418
## post_floyd_3TRUE:as.factor(zcta)55419
## post_floyd_3TRUE:as.factor(zcta)55421
## post_floyd_3TRUE:as.factor(zcta)55422
## post_floyd_3TRUE:as.factor(zcta)55423
## post_floyd_3TRUE:as.factor(zcta)55424
## post_floyd_3TRUE:as.factor(zcta)55429
## post_floyd_3TRUE:as.factor(zcta)55430
## post_floyd_3TRUE:as.factor(zcta)55450
## post_floyd_3TRUE:as.factor(zcta)55454
## post_floyd_3TRUE:as.factor(zcta)55455
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.87 on 7211 degrees of freedom
## (10 observations deleted due to missingness)
## Multiple R-squared:  0.04372,    Adjusted R-squared:  0.03231
## F-statistic: 3.833 on 86 and 7211 DF,  p-value: < 2.2e-16
```

```
stargazer(fe_full_model,
  title = "Fixed Effects Interrupted Time Series Model of Firearm Assaults",
  covariate.labels = c("T","COVID - State of Emergency", "COVID - Stay at Home",
    "Post-Treatment", "Post-Treatment 3 Months",
    "MPD Use of Force t-1", "MPD Stops t-1","MPD Officer Involved Shootings"),
  dep.var.caption = "Firearm Assaults",
  dep.var.labels = "Rate per 1,000",
  model.numbers = FALSE,
  single.row = TRUE,
  align = T,
  omit = "zcta",
  omit.stat = "adj.rsq",
  star.cutoffs = c(.05, .01, .001), star.char = c("","**","***"),
  add.lines = list(c("ZCTA FE", "Yes")))
```

% Table created by stargazer v.5.2.2 by Marek Hlavac, Harvard University. E-mail: hlavac at fas.harvard.edu
 % Date and time: Fri, Jul 30, 2021 - 1:51:51 AM % Requires LaTeX packages: dcolumn

```
#maps of post_floyd and post_floyd_3 coefficients by zip - colored divergently
coef <- broom::tidy(fe_int_model$coefficients) %>%
  filter(str_detect(names, "post_floyd")) %>%
  mutate(period = ifelse(str_detect(names, "post_floyd_3"), "3+ Months Post-Treatment", "0-3 Months Post-Treatment"))
```

Table 2: Fixed Effects Interrupted Time Series Model of Firearm Assaults

	Firearm Assaults
	Rate per 1,000
T	0.002 (0.001)
COVID - State of Emergency	-0.422 (0.665)
COVID - Stay at Home	0.215 (0.730)
Post-Treatment	0.999* (0.411)
Post-Treatment 3 Months	-0.728* (0.332)
MPD Use of Force t-1	-0.048* (0.023)
MPD Stops t-1	0.002 (0.003)
MPD Officer Involved Shootings t-1	-0.308 (0.432)
Constant	0.321 (0.335)
ZCTA FE	<i>Yes</i>
Observations	7,270
R ²	0.034
Residual Std. Error	4.886 (df = 7234)
F Statistic	7.333*** (df = 35; 7234)
<i>Note:</i>	
*p<0.05; **p<0.01; ***p<0.001	

```

main_effect = ifelse(period=="3+ Months Post-Treatment", round(-0.0301406,2), round(-0.5604477
zcta = as.numeric(str_sub(names, -5)),
zcta = as.numeric(ifelse(is.na(zcta), "55401", zcta)),
interaction_effect = ifelse(zcta=="55401", 0, round(x,2)),
coef = main_effect+interaction_effect) %>%
select(zcta, period, coef, main_effect, interaction_effect) %>%
arrange(zcta, period)

```

```

## Warning: 'tidy.numeric' is deprecated.
## See help("Deprecated")

```

```

## Warning: 'data_frame()' was deprecated in tibble 1.1.0.
## Please use 'tibble()' instead.

```

```

## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion

```

```

#creating period rows in other spatial layers
coef_zip_level <- zip_level %>%
  filter(period!="Pre-Treatment") %>%
  left_join(coef, by = c("zcta", "period"))
coef_gfs <- gfs
coef_gfs[2,] <- gfs[1,]
coef_gfs$period <- c("3+ Months Post-Treatment", "0-3 Months Post-Treatment")
coef_mpls <- mpls
coef_mpls[2,] <- mpls[1,]
coef_mpls$period <- c("3+ Months Post-Treatment", "0-3 Months Post-Treatment")

ggplot() +

```

```

geom_sf(data = coef_zip_level, aes(geometry = geometry, fill = coef)) +
geom_sf(data = mpls, aes(geometry = geometry), color = "black", alpha = 0)+
geom_sf(data = coef_gfs, aes(geometry = geometry), color = "black")+
geom_text_repel(data = gfs, aes(x=lon, y=lat, label = name),
                size = 2,
                fontface = "bold",
                nudge_x = 1, nudge_y = -1)+
scale_fill_gradient2(trans="reverse")+
facet_wrap(~period)+
labs(title = "Figure 3: Treatment Effects by ZCTA",
      fill = "Coef.")+
theme(axis.text = element_blank(),
      axis.line = element_blank(),
      axis.ticks = element_blank(),
      panel.border = element_blank(),
      panel.grid = element_blank(),
      axis.title = element_blank(),
      panel.background = element_blank(),
      panel.grid.major = element_line(colour="transparent"),
      plot.subtitle = element_text(face="italic"),
      strip.background = element_rect(fill = "white",
                                      colour = "black"))+
guides(fill = guide_colorbar(reverse = TRUE))

```

Figure 3: Treatment Effects by ZCTA

