Predicting US Gun Deaths By County

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Introduction

Motivation

- Americans own nearly half the total number of civilian-owned guns worldwide
- Gun law reform has been a headline issue for 2020 presidential candidates

Research Question

- Which factors explain the differences in gun deaths across counties in the US?

Hypotheses

- Counties in states with tighter gun laws will have lower gun deaths per population
- Counties with higher rates of poverty and income inequality will have higher rates of gun violence

Data

Sources

- CDC, Census, Gifford's Law Center

Response Variable

- Gun deaths per 100,000 people (Crude Rate)

Categories of Predictor Variables

- Crime, Race, Socioeconomic, Political, Eduction, Geography, Other demographics

Overview

- 313 counties; 21 predictors

Best Interpretable Model

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Call:
lm(formula = I(Crude.Rate^(1/4)) ~ Median.Age + Unemployment.Rate +
    Violent.Crimes.Per.1000 + High.School.Or.Higher.Pct + Without.Health.Insurance.Pct +
    Female.Pct + Black.Pct + Foreign.Born.Pct + Gun.Law.Rank.2010 +
    Federal.Govt.Expenditure.Per.Person, data = final2)

Residuals:
     Min       1Q   Median       3Q      Max
-0.27446 -0.07309  0.00091  0.06700  0.39695

Coefficients:
                                     Estimate Std. Error t value Pr(>|t|)
(Intercept)                         3.6264396  0.5247698   6.911 2.87e-11 ***
Median.Age                          0.0105042  0.0019726   5.325 1.97e-07 ***
Unemployment.Rate                   0.0125719  0.0035357   3.556 0.000437 ***
Violent.Crimes.Per.1000             0.0156875  0.0029845   5.256 2.78e-07 ***
High.School.Or.Higher.Pct          -0.0061079  0.0017563  -3.478 0.000580 ***
Without.Health.Insurance.Pct        0.0106760  0.0015056   7.091 9.49e-12 ***
Female.Pct                         -0.0411993  0.0098548  -4.181 3.81e-05 ***
Black.Pct                           0.0036128  0.0006931   5.212 3.47e-07 ***
Foreign.Born.Pct                   -0.0131767  0.0010226 -12.886  < 2e-16 ***
Gun.Law.Rank.2010                   0.0039595  0.0006131   6.458 4.24e-10 ***
Federal.Govt.Expenditure.Per.Person 0.0052091  0.0010919   4.770 2.87e-06 ***
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1132 on 302 degrees of freedom
Multiple R-squared:  0.7117,    Adjusted R-squared:  0.7022
F-statistic: 74.56 on 10 and 302 DF,  p-value: < 2.2e-16
```

Interpretation

An increase in any of these predictors **increases** the Crude Rate (with all else equal):

- Median Age
- Unemployment Rate
- Violent Crimes per 1000 population
- Gun Law Rank (Note: an increase in gun law rank means a state's laws are *less* restrictive)
- Percent Without Health Insurance
- Percent of population that's black
- Federal Govt Expenditure Per Person

An increase in any of these predictors **decreases** the Crude Rate (with all else equal):

- Percent of population who have graduated high school
- Percent of population that's female
- Percent of population that's foreign born

Best Predictive Model

```
Coefficients:
                                                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                                                      4.656e+00  1.282e+00    3.633 0.000334 ***
Foreign.Born.Pct                                                 1.755e-01  5.222e-02    3.361 0.000886 ***
Without.Health.Insurance.Pct                                     4.456e-02  3.339e-02    1.334 0.183194
Violent.Crimes.Per.1000                                         -1.004e-02  4.623e-03   -2.173 0.030658 *
Black.Pct                                                        7.714e-03  1.186e-03    6.505 3.61e-10 ***
Population.Density                                               1.242e-05  9.452e-06    1.314 0.189848
Gun.Law.Rank.2010                                                1.601e-03  1.060e-03    1.510 0.132067
Unemployment.Rate                                               -1.492e-01  4.113e-02   -3.629 0.000339 ***
High.School.Or.Higher.Pct                                       -5.054e-02  1.254e-02   -4.032 7.16e-05 ***
Federal.Govt.Expenditure.Per.Person                             2.771e-03  2.931e-03    0.946 0.345209
Median.Age                                                       8.124e-03  2.128e-03    3.818 0.000166 ***
Hispanic.Pct                                                     1.579e-03  3.313e-03    0.476 0.634124
Poverty.Rate                                                     9.618e-03  5.062e-03    1.900 0.058486 .
Voter.Group.2008Republican                                      1.310e+00  2.726e-01    4.805 2.54e-06 ***
Voter.Group.2008Swing                                            4.112e-01  1.741e-01    2.362 0.018865 *
Non.Violent.Crimes.Per.1000                                     3.012e-03  1.073e-03    2.807 0.005350 **
Female.Pct                                                       1.013e-02  1.395e-02    0.727 0.468020
Median.Household.Income                                         -5.570e-05  1.303e-05   -4.274 2.64e-05 ***
Mixed.Race.Pct                                                   1.419e-02  1.377e-02    1.030 0.303954
Foreign.Born.Pct:Violent.Crimes.Per.1000                        2.007e-03  3.318e-04    6.049 4.69e-09 ***
Foreign.Born.Pct:Population.Density                            -9.683e-07  2.792e-07   -3.469 0.000606 ***
Black.Pct:Gun.Law.Rank.2010                                    -1.760e-04  3.599e-05   -4.890 1.71e-06 ***
Unemployment.Rate:High.School.Or.Higher.Pct                     1.782e-03  4.796e-04    3.715 0.000246 ***
Without.Health.Insurance.Pct:Hispanic.Pct                      -3.518e-04  1.220e-04   -2.883 0.004248 **
Gun.Law.Rank.2010:Federal.Govt.Expenditure.Per.Person          3.491e-04  9.293e-05    3.756 0.000210 ***
Poverty.Rate:Voter.Group.2008Republican                       -4.073e-02  8.481e-03   -4.803 2.56e-06 ***
Poverty.Rate:Voter.Group.2008Swing                            -1.187e-02  5.310e-03   -2.236 0.026129 *
Without.Health.Insurance.Pct:Non.Violent.Crimes.Per.1000      -1.716e-04  5.591e-05   -3.068 0.002366 **
High.School.Or.Higher.Pct:Median.Household.Income              6.428e-07  1.387e-07    4.634 5.52e-06 ***
Foreign.Born.Pct:Female.Pct                                   -3.755e-03  1.029e-03   -3.651 0.000312 ***
Voter.Group.2008Republican:Median.Household.Income            -1.314e-05  3.227e-06   -4.073 6.07e-05 ***
Voter.Group.2008Swing:Median.Household.Income                 -4.091e-06  1.944e-06   -2.105 0.036197 *
Hispanic.Pct:Mixed.Race.Pct                                    1.186e-03  4.825e-04    2.458 0.014596 *
Federal.Govt.Expenditure.Per.Person:Mixed.Race.Pct           -1.694e-03  6.729e-04   -2.518 0.012372 *
Without.Health.Insurance.Pct:High.School.Or.Higher.Pct        -2.177e-04  3.632e-04   -0.599 0.549384
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Residual standard error: 0.09413 on 278 degrees of freedom
Multiple R-squared:  0.8165,    Adjusted R-squared:  0.794
F-statistic: 36.37 on 34 and 278 DF,  p-value: < 2.2e-16
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- Started with all squared and interaction terms
- Forward minimum BIC using JMP
- Used boxcox for *Crude Rate* transformation
- 33 total predictors

Cross Validation & Comparison

	Best Interpretable Model	Best Predictive Model
R^2	0.7028 (0.7117 from full model)	0.7776 (0.8165 from full model)
Train MSE	0.0120	0.0075
Test MSE	0.0141	0.0106

- Test MSE is lower for best predictive model
- Slightly larger gap between train MSE and test MSE for best predictive model (0.0031 vs. 0.0021)

Summary & Conclusions

- Tighter gun laws matter, as do many other factors
- More races, voter-demographics in complex model
- Best predictive model explains 82% of the variation in *Crude Rate*
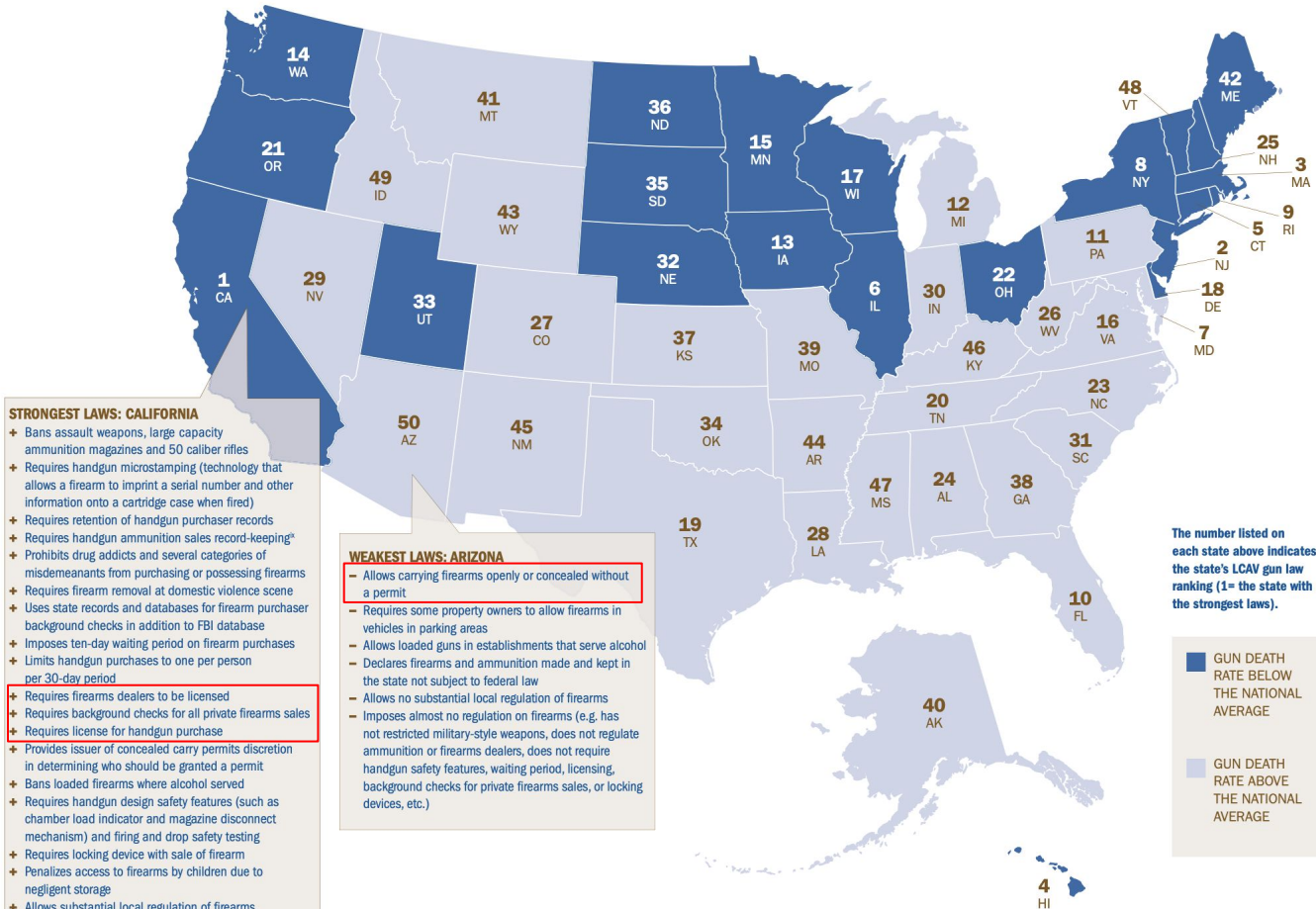
Limitations

- Cardinality of gun law variable
- Missing data in a few important counties

Future Work

- Splitting *Crude Rate* into its subcategories: suicide, homicide, accidents
- Non-fatal gun related injuries

Thank You

STATE-BY-STATE COMPARISON OF FIREARMS LAWS AND GUN DEATH RATES

14 WA
41 MT
36 ND
48 VT
42 ME
25 NH
3 MA
21 OR
15 MN
8 NY
49 ID
35 SD
17 WI
12 MI
5 RI
9 RI
1 CA
29 NV
43 WY
33 UT
32 NE
13 IA
6 IL
30 IN
22 OH
11 PA
2 NJ
18 DE
7 MD
16 VA
27 CO
37 KS
39 MO
46 KY
26 WV
23 NC
50 AZ
45 NM
34 OK
44 AR
20 TN
31 SC
47 MS
24 AL
38 GA
19 TX
28 LA
10 FL
40 AK
4 HI

STRONGEST LAWS: CALIFORNIA

+ Bans assault weapons, large capacity ammunition magazines and 50 caliber rifles
+ Requires handgun microstamping (technology that allows a firearm to imprint a serial number and other information onto a cartridge case when fired)
+ Requires retention of handgun purchaser records
+ Requires handgun ammunition sales record-keeping[ix]
+ Prohibits drug addicts and several categories of misdemeanants from purchasing or possessing firearms
+ Requires firearm removal at domestic violence scene
+ Uses state records and databases for firearm purchaser background checks in addition to FBI database
+ Imposes ten-day waiting period on firearm purchases
+ Limits handgun purchases to one per person per 30-day period
+ Requires firearms dealers to be licensed
+ Requires background checks for all private firearms sales
+ Requires license for handgun purchase
+ Provides issuer of concealed carry permits discretion in determining who should be granted a permit
+ Bans loaded firearms where alcohol served
+ Requires handgun design safety features (such as chamber load indicator and magazine disconnect mechanism) and firing and drop safety testing
+ Requires locking device with sale of firearm
+ Penalizes access to firearms by children due to negligent storage
+ Allows substantial local regulation of firearms

WEAKEST LAWS: ARIZONA

– Allows carrying firearms openly or concealed without a permit
– Requires some property owners to allow firearms in vehicles in parking areas
– Allows loaded guns in establishments that serve alcohol
– Declares firearms and ammunition made and kept in the state not subject to federal law
– Allows no substantial local regulation of firearms
– Imposes almost no regulation on firearms (e.g. has not restricted military-style weapons, does not regulate ammunition or firearms dealers, does not require handgun safety features, waiting period, licensing, background checks for private firearms sales, or locking devices, etc.)

The number listed on each state above indicates the state's LCAV gun law ranking (1= the state with the strongest laws).

GUN DEATH RATE BELOW THE NATIONAL AVERAGE

GUN DEATH RATE ABOVE THE NATIONAL AVERAGE

Histogram of Crude.Rate