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A Statistical Analysis of Body-Worn Cameras in Officer-Involved Shootings

Hope Johnson

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Personal motivation



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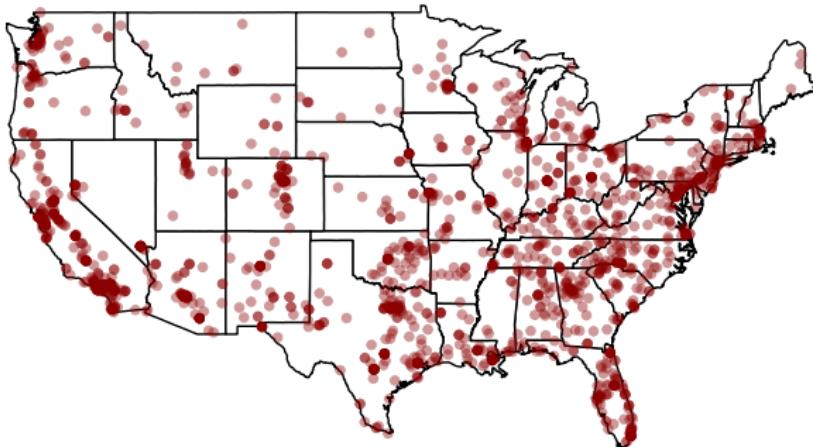
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Why look into officer-involved shootings?

- Number of fatal shootings between Jan. 2015 and Dec. 2016:
1,954



Source: Washington Post 2017

New data repositories

- Investigative journalism projects documenting officer-involved shootings:
 - The Washington Post (“Fatal Force Project”)
 - The Guardian (“The Counted Project”)
 - Stolen Lives Project
 - Killed by Police Database
 - US Police Shooting Database
 - Fatal Encounters Database

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Why look into the use of body cameras?



I research if there exists differential deployment of body-worn cameras with respect to:

Civilian race

Were Hispanics fatally shot by officers without activated body cameras at a disproportionately high rate compared to White and Black Americans?

Civilian armed status

Were unarmed civilians more likely than civilians armed with a gun to have been fatally shot by an officer wearing a body camera during the fatal encounter?

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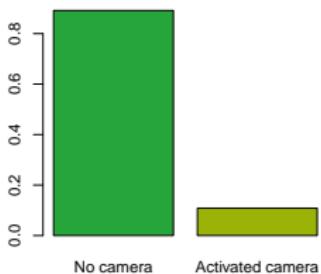
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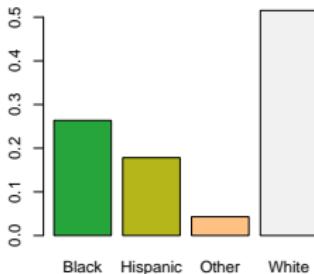
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Washington Post data

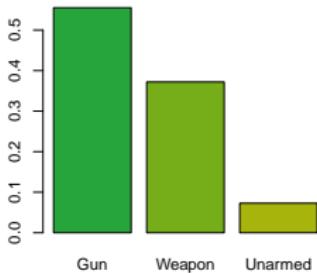
Body camera breakdown



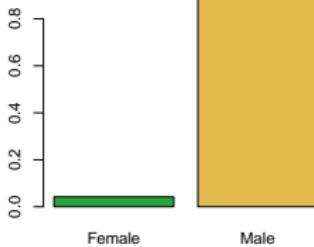
Race breakdown



Armed breakdown



Gender breakdown



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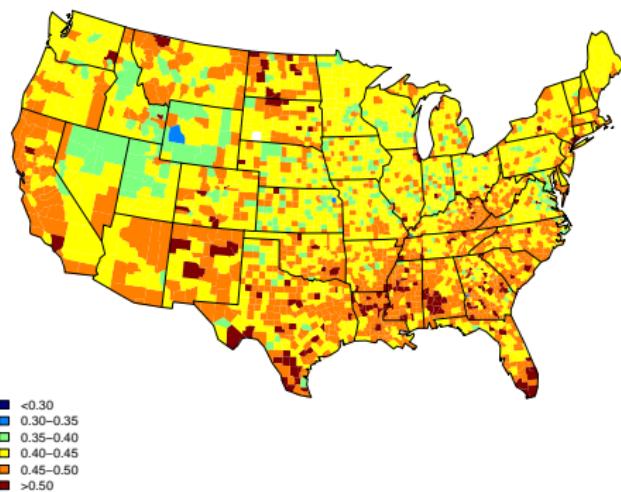
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Covariate data - Gini coefficient



A Gini coefficient of 0 reflects complete equality, and 1 reflects complete inequality.
Source: American Community Survey, U.S. Census, 2015

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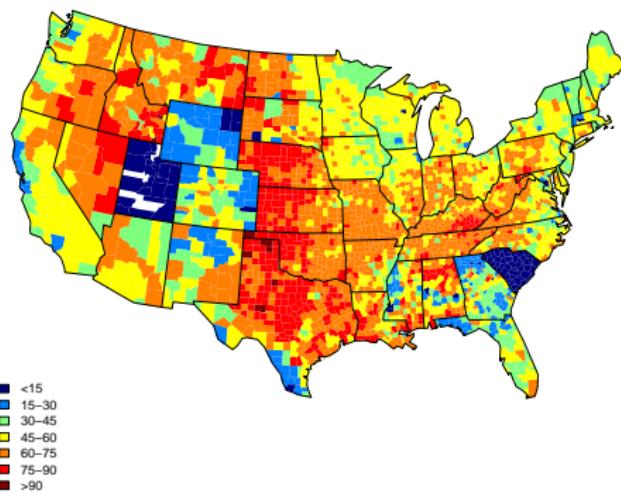
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Covariate data - Republican support (2012)



Source: The Guardian 2012

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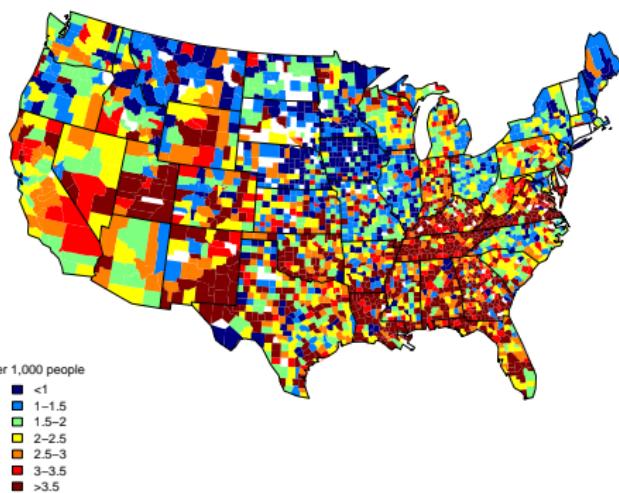
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Covariate data - local jail population



Source: Census of Jails, Bureau of Justice Statistics 2013

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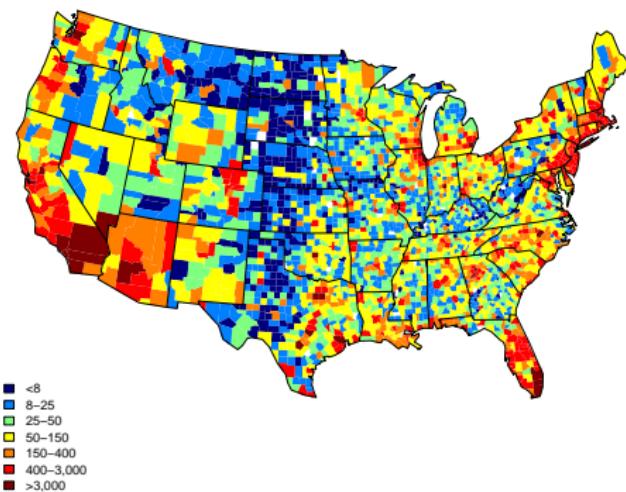
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Covariate data - size of police force



Source: Census Of State And Local Law Enforcement Agencies, Bureau of Justice Statistics 2008

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Time to model!

Dependent variable: Rate of police shootings in each county

Independent variables: Civilian race, camera status, their interaction, and covariates

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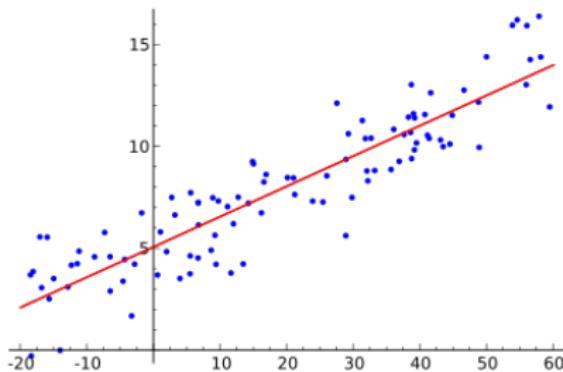
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Linear regression

$$Y = X\beta + \epsilon \rightarrow \epsilon \sim \text{Normal}(0, \sigma^2)$$



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Model Set-Up

$$X_i\beta = \beta_0 + \beta_1 X_{i1} + \dots + \beta_k X_{ik}$$

$$E(Y_i) = \exp(X_i\beta)$$

$$\log(E(Y_i)) = X_i\beta$$

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Include an offset

$$E(Y_i) = p_i * \exp(X_i\beta)$$

$$E\left(\frac{Y_i}{p_i}\right) = \exp(X_i\beta)$$

$$\log(E\left(\frac{Y_i}{p_i}\right)) = X_i\beta$$

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Negative Binomial Model

$$Y_i \sim \text{Negative Binomial} \left(r, \frac{e^{X_i \beta}}{e^{X_i \beta} + r} \right)$$

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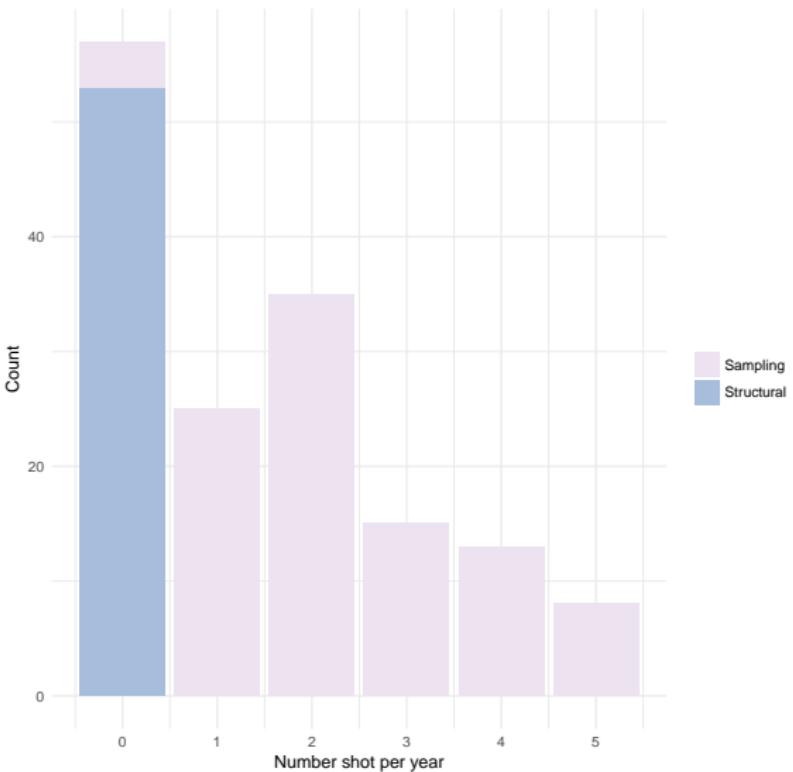
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Zero Inflated Model



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Zero-inflated Negative Binomial

$$Y_i = 0$$

$$p = \alpha_i$$

$$Y_i \sim \text{NB}(\text{mean} = e^{X_i\beta}, \text{overdisp.} = r) \quad p = (1 - \alpha_i).$$

$$Y_{crb} \sim \text{ZINB}(p_{rc} e^{\alpha_r + \beta_b + \eta_{r,b} + \epsilon_{crb}}, r_{crb})$$

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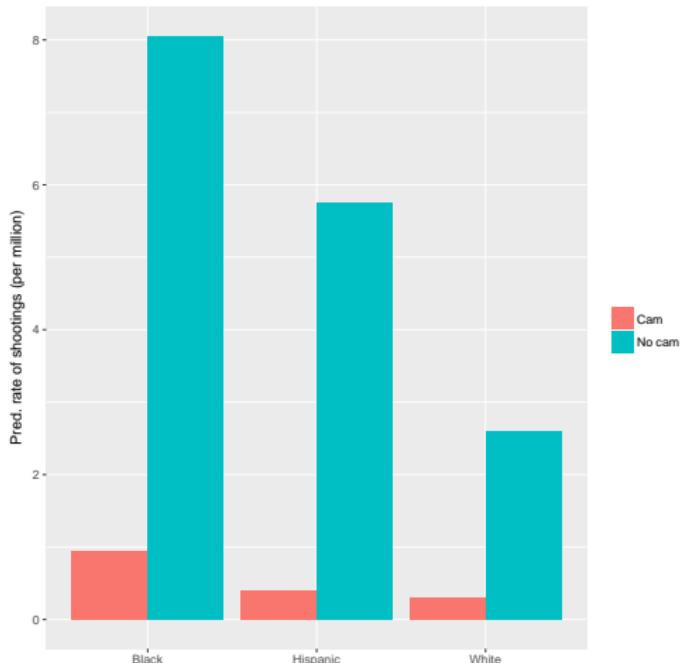
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Model predictions



Disproportionate differences

- Camera vs. no camera prediction differentials:
 - White civilians: **nine** times more likely to be shot by an officer without a camera than with one
 - Black civilians: **eight** times more likely to be shot by an officer without a camera
 - Hispanics civilians: **fifteen** times more likely to be shot by an officer without a camera than with a camera

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- What can be said about these results?

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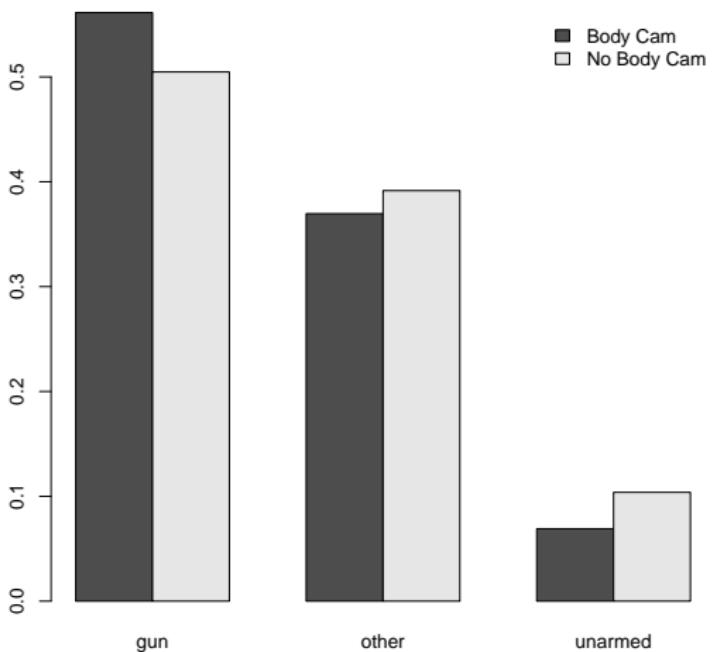
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Why investigate civilian armed status?

Armed status breakdown of camera use



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Logistic regression

Binary outcome 0/1

Cam_i

Probability (0, 1)

$$\Pr(Cam_i | AS_i, \beta_0, \beta_1)$$

Odds (0, ∞)

$$\pi_i = \frac{\Pr(Cam_i | AS_i, \beta_0, \beta_1)}{1 - \Pr(Cam_i | AS_i, \beta_0, \beta_1)}$$

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Logit transformation

Log odds $(-\infty, \infty)$

$$\log \left(\frac{\Pr(Cam_i | AS_i, \beta_0, \beta_1)}{1 - \Pr(Cam_i | AS_i, \beta_0, \beta_1)} \right)$$

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Model specification

$$\log \frac{\Pr(\text{Camera} = 1|x_1, x_2, \dots, x_7)}{\Pr(\text{Camera} = 0|x_1, x_2, \dots, x_7)} = \alpha + \beta_u x_1 + \beta_o x_2 + \\ \delta_m x_3 + \gamma_{\text{age}} x_4 + \gamma_{\text{Gini}} x_5 + \gamma_{\text{police}} x_6 + \gamma_{\text{jail}} x_7 + \epsilon$$

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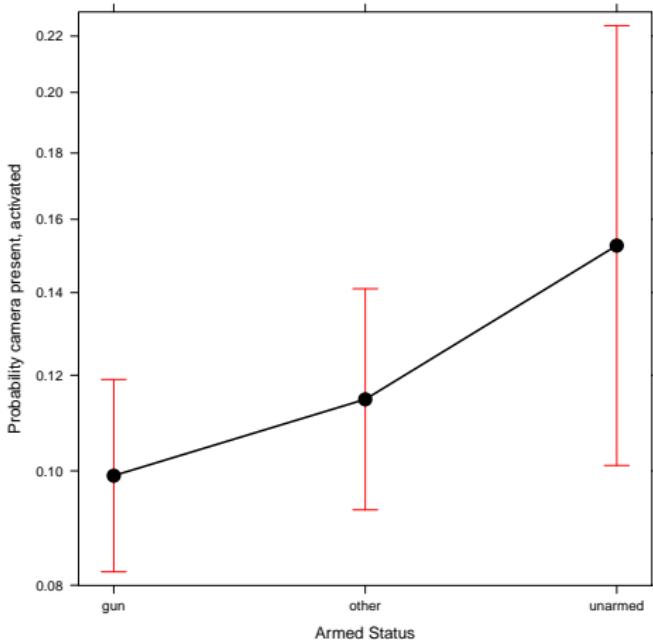
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Logistic regression results



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Next steps

- Continue analysis as database grows
- Smaller geographic scale
- Incorporate more detailed covariates

Acknowledgements

- Alicia Johnson
- Victor Addona
- Erik Larson
- Amy Damon
- My family: Alyria, Miles, & Cooper
- Friends: Nicola, Colleen, & Katie

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Thank you!