The Drivers and Impacts of Pretrial Detention: A Bayesian Analysis

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I. Problem Description

Every year, over 300,000 individuals are arrested in Virginia. Most are released quickly on their own recognizance or with a bond to ensure return for their court date. However, some defendants face pretrial detention, remaining in jail while awaiting trial; such defendants are still considered innocent under the mantra of "innocent until proven guilty in a court of law," but the state has determined that the risk to public safety outweighs this individual's presumption of innocence.[1] The state typically weighs a variety of factors in determining conditions of release, such as prior convictions, presumptions against bail based on the offense, calculated risk score, and the magistrate's discretion. However, data around criminal sentencing suggests disparities in the treatment of defendants. Rates of release vary among defendants when sorted by geography, age, race, gender, and combinations thereof. While we will be exhaustively exploring data around drivers and impacts of pretrial detention for our Capstone project, in this abbreviated analysis we focus on only two factors, race and locality, using Bayesian regression to regularize our model and to quantify uncertainty in evaluating apparent trends in the data regarding rates of pretrial release for Black defendants in localities across Virginia.

Our data comes from the Virginia Pretrial Data Project.[2] The General Assembly of Virginia in 2018 authorized the Virginia State Crime Commission to collect and aggregate pretrial data for study, and the commission identified approximately 22,000 individuals arrested in October of 2017 who faced the possibility of pretrial detention. The data set contains demographic information as well as criminal history, locality, current charges, lawyer type (e.g. public defender or private attorney), and pretrial outcomes.

II. Probability Model

We have chosen to look at the *rate of pretrial release* for defendants in the 2017 cohort. This metric simply measures whether defendants were detained for their entire pretrial period rather than posting bond or being released on their own recognizance. For the whole cohort, defendants were granted

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[1] The United States Supreme Court ruled in 1987 in US vs. Salerno that pretrial detention is constitutional. At the federal level, "Where Congress has mandated detention on the basis of some other compelling interest -- here, the public safety -- the Eighth Amendment does not require release on bail." (United States v. Salerno et al., 481 U.S. 739 (1987). https://www.loc.gov/item/usrep481739/)

[2] http://www.vcsc.virginia.gov/pretrialdataproject.html

pretrial release 83% of the time.[3] That means that 17%, over 3,800 defendants, were detained the entire pretrial period before they had been convicted of the crime for which they had been arrested. When we break down this overall metric between defendants identified as Black and White in the data set, we find a statewide rate of release of 81% for Black defendants, but 85% for White defendants.[4] Moreover, when broken out across judicial districts, White defendants show a higher rate of pretrial release in 24 districts, while Black defendants have a higher release rate in only 7 districts. These broad-stroke findings indicate that there may be a signal worth investigating regarding the role of race and locality in determining pretrial release. Our analysis takes an even more granular approach, looking at 126 named localities rather than the 31 judicial districts.

Localities across Virginia differ dramatically in size and racial composition. In our data set, for instance, we have five arrests from Bath County, but over 1700 for Fairfax County. Complete pooling disguises trends that may obtain in local areas. On the other hand, creating separate, unpooled models for each locality leaves us with highly unbalanced samples. Our solution to investigate our problem of interest, therefore, is to incorporate the "best of both worlds" with partial pooling using a hierarchical model. The model itself is a simple Bayesian linear regression:[5]

$$Release_{i,\ell} = \alpha_\ell + \beta_\ell * Indicator\_Black_{i,\ell} + \epsilon_\ell$$

$$\alpha_\ell \sim \mathcal{N}(\mu_\alpha, \sigma_\alpha^2); \mu_\alpha \sim \mathcal{N}(0, 1e5), \sigma_\alpha \sim \mathcal{E}xp(0.5)$$
$$\beta_\ell \sim \mathcal{N}(\mu_\beta, \sigma_\beta^2); \mu_\beta \sim \mathcal{N}(0, 1e5), \sigma_\beta \sim \mathcal{H}alfCauchy(5)$$

$$\epsilon_\ell \sim \mathcal{U}nif[0, 100]$$

Partial pooling allows us to find estimates for every locality while incorporating the fact that all localities implement a set of shared state-wide policies. That is, we can model the localities as each having Gaussian distributions for their slope and intercept terms, but the parameters for those 126 distributions each draw their respective parameters from a shared prior distribution. The means, μ_α and μ_β, are each drawn from Gaussian distributions with mean 0 and large variance. The variances for

[3] NB: While most defendants who were granted pretrial release got out immediately (the overwhelming majority of those released were reported as spending zero days between contact event and release), over 600 defendants counted as "released pretrial" nevertheless spent more than a month in jail leading up to their pretrial release. Subsequent study will look at more nuanced measures of pretrial treatment than the binary "released or not."

[4] The data set records 13172 White defendants and 9291 Black defendants. Using a Welch's two-sample t-test, a difference of .04 in the rates of release is statistically significant, with a p-value=1.4e-11.

[5] Graphical representation of the model is in Appendix (i).

the coefficient distributions must be non-negative; we have chosen to use a Half Cauchy distribution for our slope coefficient, but an Exponential distribution with λ=0.5 for our intercept coefficient. This distinction does not introduce a great deal or prior knowledge, but the variance for the intercept coefficients will be slightly more constrained than the variance for the slopes. We have sufficient data that these small choices do not have an outsized influence on the output of the model. Finally, the error term for the model is simply drawn from a uniform distribution.

III. Approach

Our approach is exploratory rather than explanatory at this stage. We have a strong suspicion that Black defendants receive different treatment in the criminal justice systems than White defendants. However, as we search for the signal of if and how racial disparity manifests in pretrial outcomes, we need to be aware of the uncertainty in our claims around a topic as sensitive as racial injustice. Posterior distributions for our parameters allow us to find not only point estimates but variance around those point estimates. We likewise acknowledge that subsequent work will have to take into account the many covariates that influence pretrial outcomes such as severity of the charge, prior criminal history, indigency status, age, and many others.

Our model and data were small enough that we were able to employ sampling, specifically No-U-Turn Sampling (NUTS), to estimate our posterior distributions in reasonable time. The reduced accuracy afforded by variational inference would likely have sufficed for this analysis, but the computation time was not prohibitive and so we were able to gain a bit more accuracy with sampling.

IV. Results

Our work is best summarized with the visualization found in Appendix (ii) where the rates of release for Black defendants are shown to be lower than that for White defendants in almost all localities. The difference is reflected in the slope of the lines for each locality. The overall trend is clearly negative, indicating higher pretrial release rates for White defendants versus Black defendants in Virginia. Among the 126 localities in our data set, only two had MAP estimates above zero for the slope coefficients, and those only very slightly positive. And here the uncertainty of our model becomes of paramount importance. While 124 of the 126 localities show negative MAP estimates for their slope coefficients, only 9 of those localities do not include 0 in their 94% credible intervals; furthermore, neither of the localities with positive MAP estimates for their slopes exclude 0. The 9 localities which credibly indicate disparate treatment of Black defendants in pretrial release are Arlington County, Greensville County, Loudoun County, Stafford County, Richmond City, Henrico County, Norfolk

City, Warren County, and Accomack County. Interestingly, these are not the nine counties with the steepest slopes, though six do overlap. Lunenburg County, Southampton County, and Bristol City all have steeper slopes than Stafford County, Henrico County, and Norfolk City, but the former group include 0 in their credible intervals while the latter group do not. As such, we have reason to investigate this latter group of localities further to determine what factors may be contributing to the observed disparity.[6]

Code for this project is accessible at: https://github.com/archytades/BML_Pretrial

V. Conclusions

Our objective, as stated above, was to explore the data on pretrial outcomes looking for signals about disparate treatment of defendants based on race and geography. We did detect disparate treatment of Black defendants in the pretrial detention data for October 2017. We also were able to show that this effect appears to be credible in 9 localities by using the uncertainty of our model to avoid overly broad conclusions about the 115 other localities which indicate negative slopes but which could credibly have slopes of 0.

We will continue work on this problem, expanding our data to include the recently released pretrial detention data for 2018. The new data set contains over 300,000 observations and over 500 variables. Our model only looks at the crude binary statistic of whether a defendant received pretrial release. There are many more outcomes of interest that we will be exploring, such as days between arrest and release,[7] bond type and amount, type of attorney, and rates of conviction and reoffending. Our model also does not yet control for the many covariates involved in pretrial detention, and next steps will include incorporating important factors like risk scores, prior criminal histories, and severity of offense into our analysis as we probe the drivers and impacts of pretrial detention in Virginia.

VI. References

United States v. Salerno et al., 481 U.S. 739 (1987). https://www.loc.gov/item/usrep481739/

"Virginia Pretrial Data Project," [Online]. http://www.vcsc.virginia.gov/pretrialdataproject.html. [Accessed: 11-Dec-2022].

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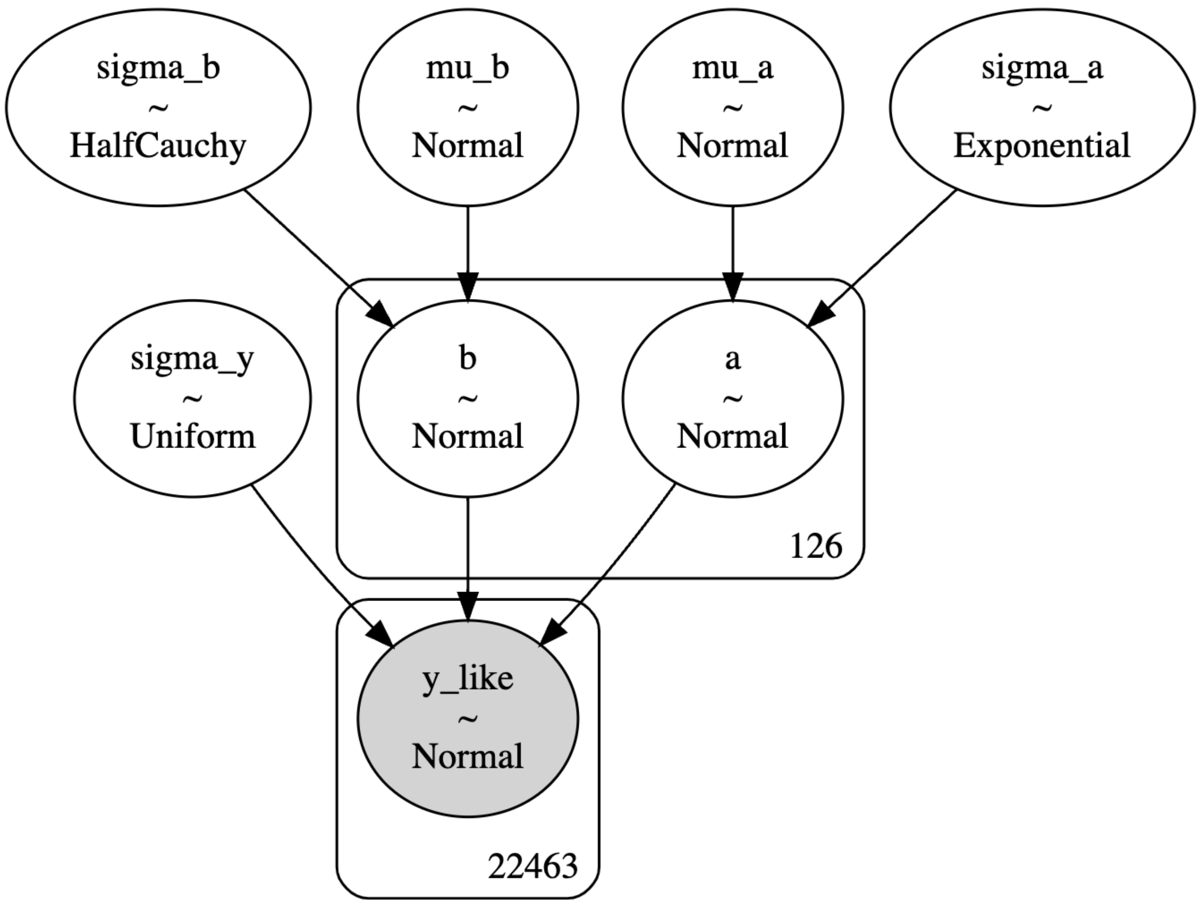
[6] The lists of counties with the steepest slopes as well as the counties with credibly non-zero slopes are seen in Appendix (iii).

[7] Cf. n.3 above.

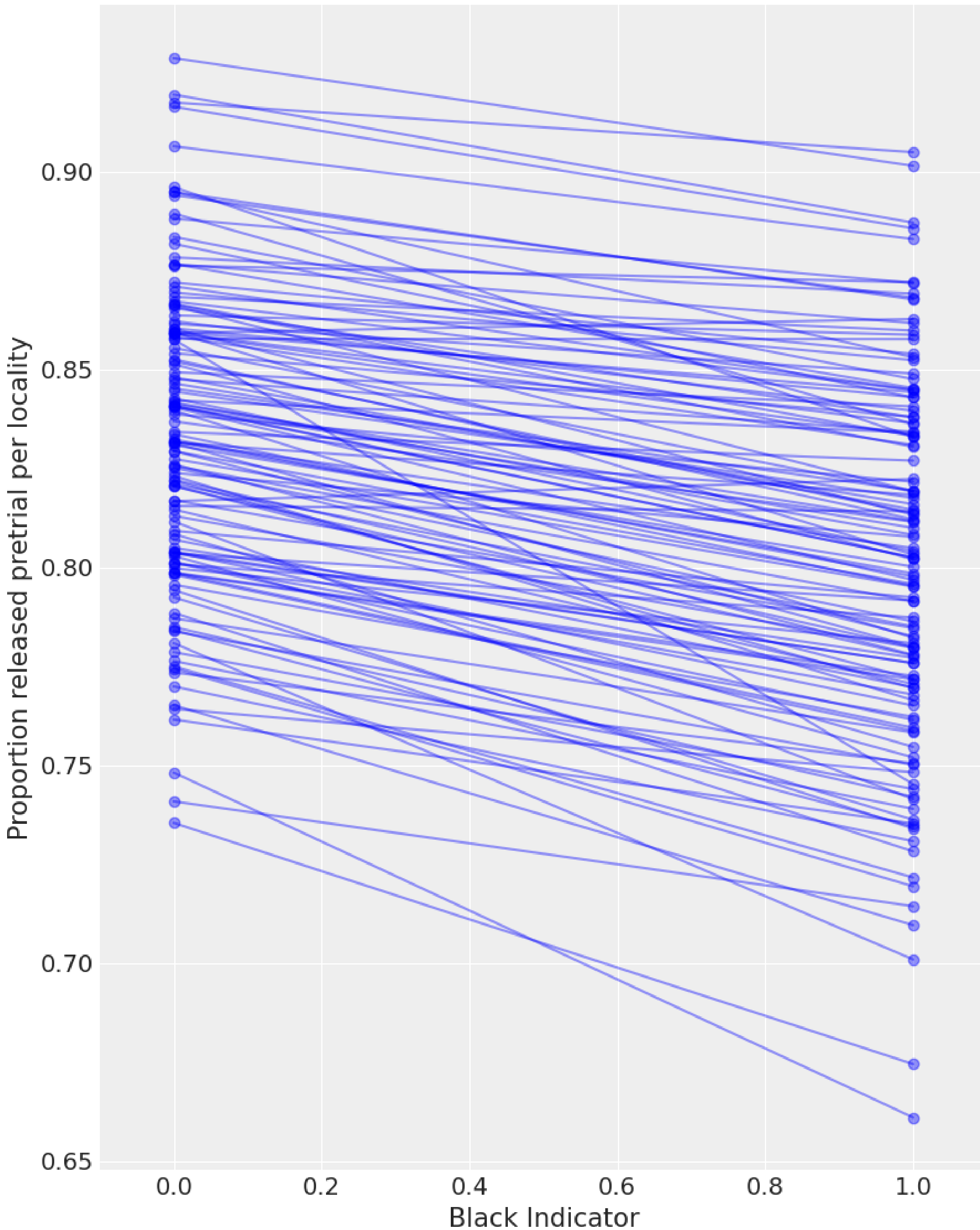
Wiecki, Thomas and Elbers, Danne "The best of both worlds: Hierarchical Linear Regression in PyMC3,"[Online.] https://twiecki.io/blog/2014/03/17/bayesian-glms-3/[Accessed: 11-Dec-2022].

Appendices

i. Graphical representation of our hierarchical model using partial pooling:



ii. Release rates by locality for White and Black defendants as estimated through partial pooling.



iii.

Localities with steepest slopes
Arlington County
Greensville County
Loudoun County
Richmond City
Lunenburg County
Warren County
Accomack County
Bristol City
Southampton County
Brunswick County

Localities with non-zero coefficients
Arlington County
Greensville County
Loudoun County
Stafford County
Richmond City
Henrico County
Norfolk City
Warren County
Accomack County