

The Association of Crime Occurrence on Rates of Suspensions and Expulsions in Chicago Public Schools Using Double Hurdle Models

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Motivation

- **Goal:**
 - ▷ To gain a better understanding of factors that may influence student expulsion
- **Steps:**
 - ▷ Investigate potential factors leading to student expulsion
 - ▷ Analyze the effects of the amount of violent crime in a school attendance boundary
 - ▷ Examine spatial effects of school attendance boundaries

Model

Priors for Beta and Alpha Parameters

$$\beta_j \sim \text{Normal}(0, 100)$$
$$\alpha_i \sim \text{Normal}(0, 1000) \quad (1)$$

Negative Binomial and Generalized Pareto Distribution Double Hurdles Models

p = P(zero-count)

$$\text{logit}(\mathbf{p}) = \text{log}(\text{School.Pop}) + \mathbf{X}\boldsymbol{\gamma} + \mathbf{V}\boldsymbol{\alpha}$$

μ = mean of typical-count distribution.

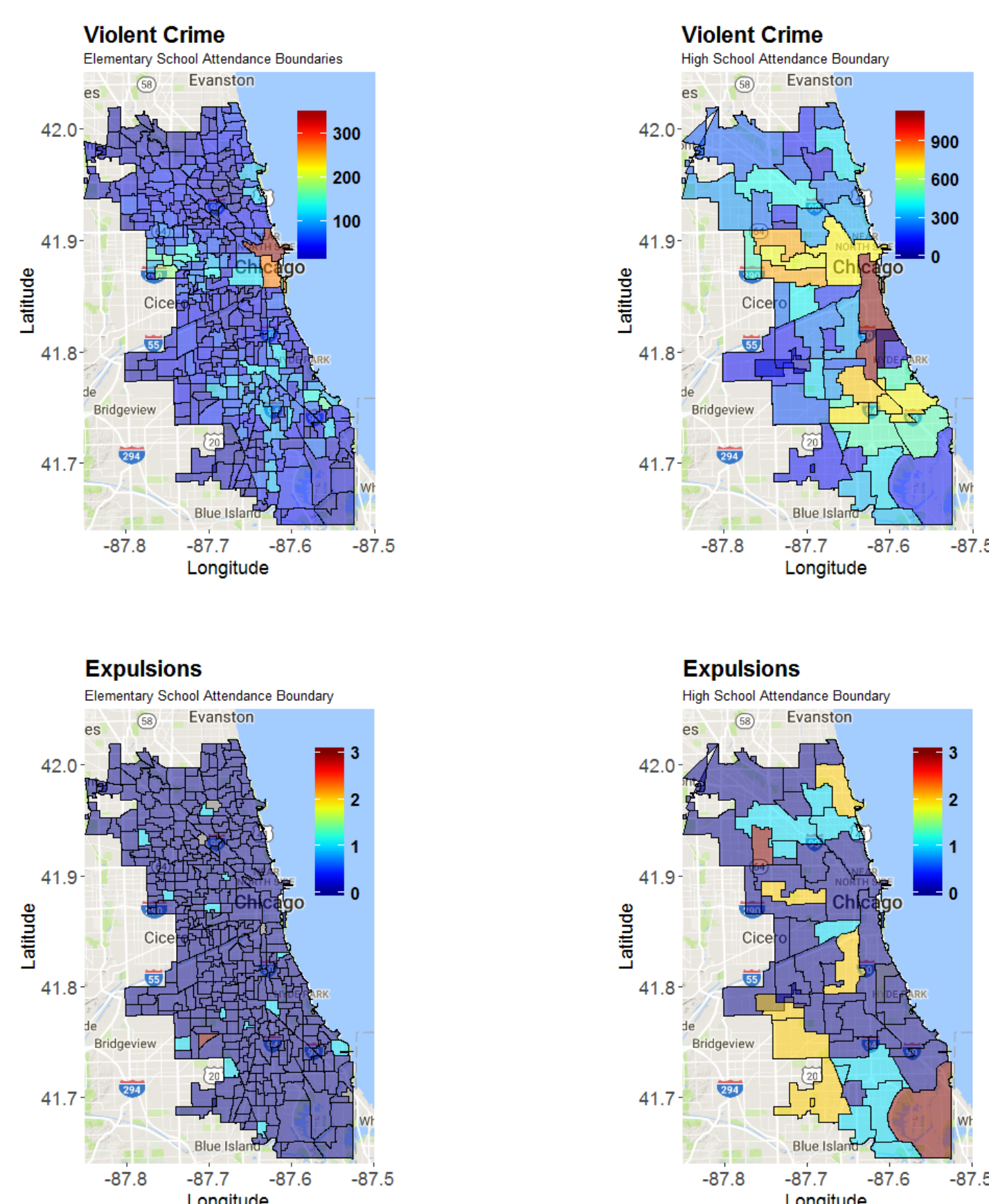
$$\text{log}(\boldsymbol{\mu}) = \text{log}(\text{School.Pop}) + \mathbf{X}\boldsymbol{\beta} + \mathbf{V}\boldsymbol{\alpha}$$

q = P(large-count | nonzero-count)

$$\text{logit}(\mathbf{q}) = \text{log}(\text{School.Pop}) + \mathbf{X}\boldsymbol{\delta}$$

Data

- Chicago Data Portal
 - ▷ Chicago Crime Records for the year 2015
 - ▷ Shapefiles for CPS attendance boundaries
- Chicago Public School Data from the CPS Website
 - ▷ Attendance records
 - ▷ Education quality scores
 - ▷ Standardized test scores
 - ▷ Suspension, expulsion, and misconduct information



Model Variables and Results

Response data:

Expulsions → Expulsions counts for each Chicago Public School

Model Covariates covariates:

- Common Covariates
 - $\mathbf{x}_1 - \mathbf{x}_3$ = Ethnicity counts for schools; White, African American, Hispanic respectively
 - \mathbf{x}_4 = Number of misconducts per school
- Unique Elementary School Covariates
 - \mathbf{x}_5 = School quality score
 - \mathbf{x}_6 = PARCC average math score
 - \mathbf{x}_7 = PARCC English Language Arts average score
 - \mathbf{x}_8 = Crime counts based on school attendance boundary
- Unique High School Covariates
 - \mathbf{x}_5 = Average ACT composite score per school
 - \mathbf{x}_6 = Crime counts based on school attendance boundary
 - \mathbf{x}_7 = School quality score
- Spatial Random Effects are included for each model

Elementary School Crime Frequency Coefficients

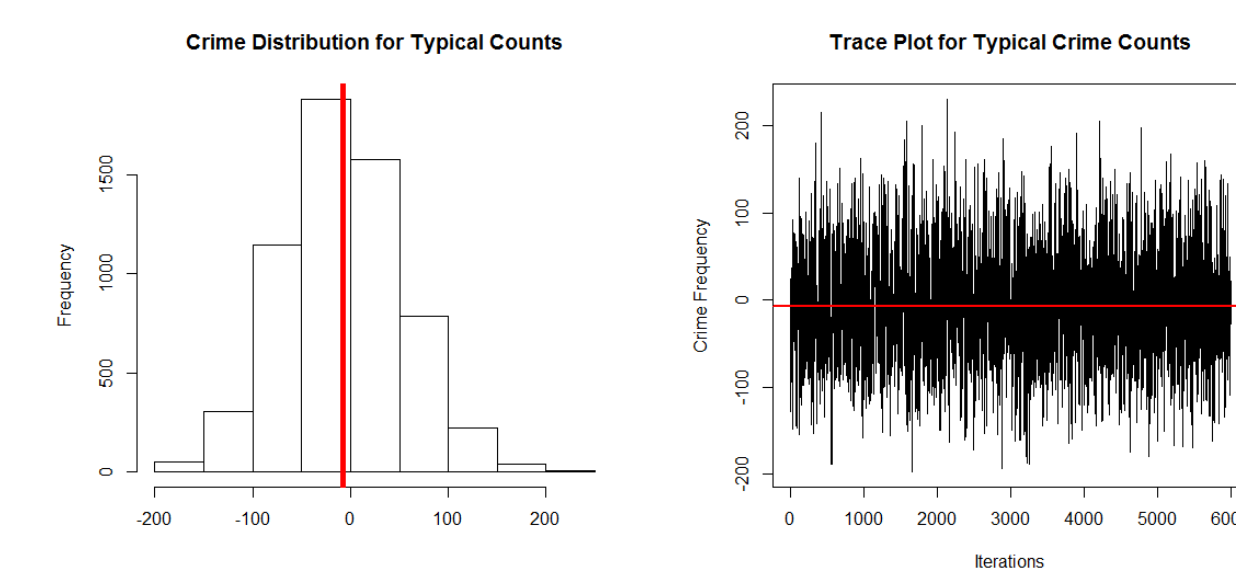


Figure: Expulsion Models for Elementary Schools

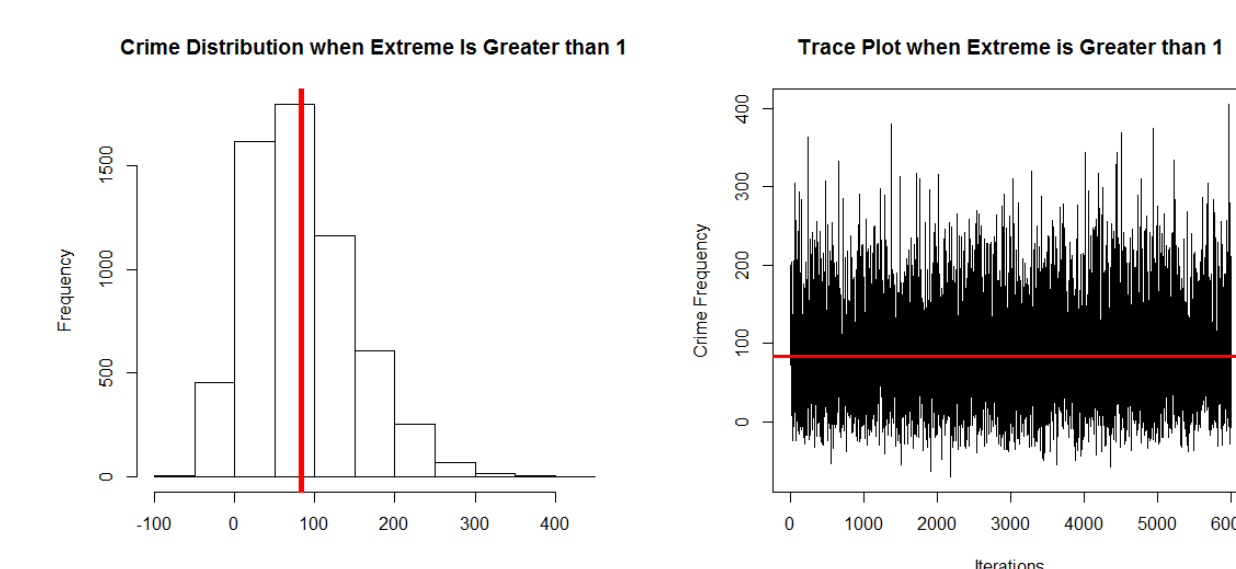


Figure: Suspension Models for Elementary Schools

High School Crime Frequency Coefficients

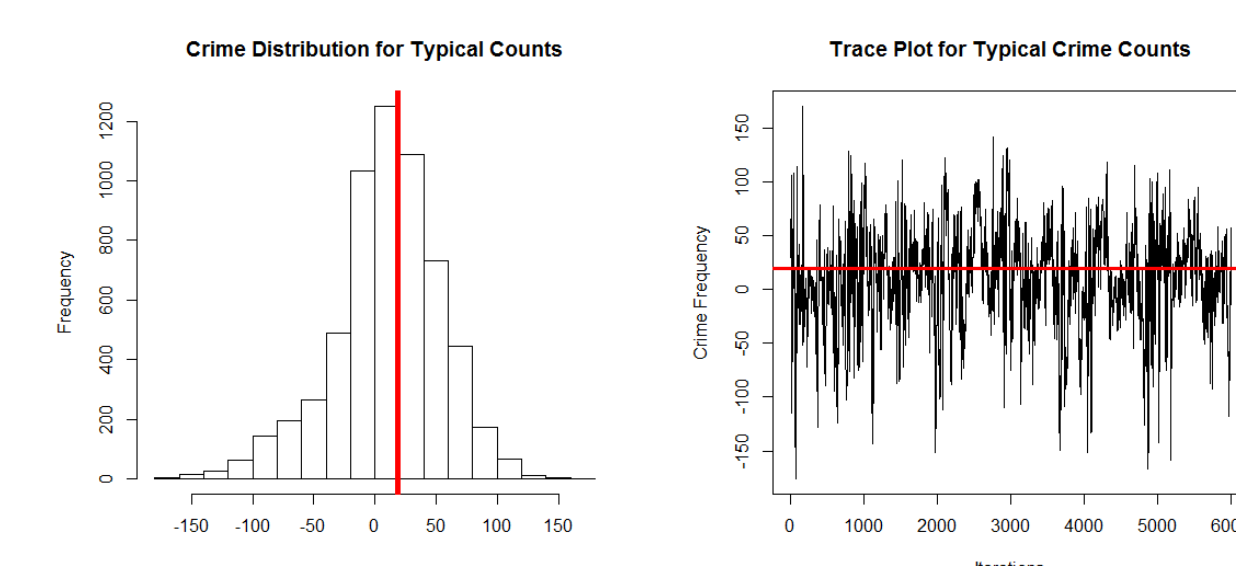


Figure: Expulsion Models for High Schools

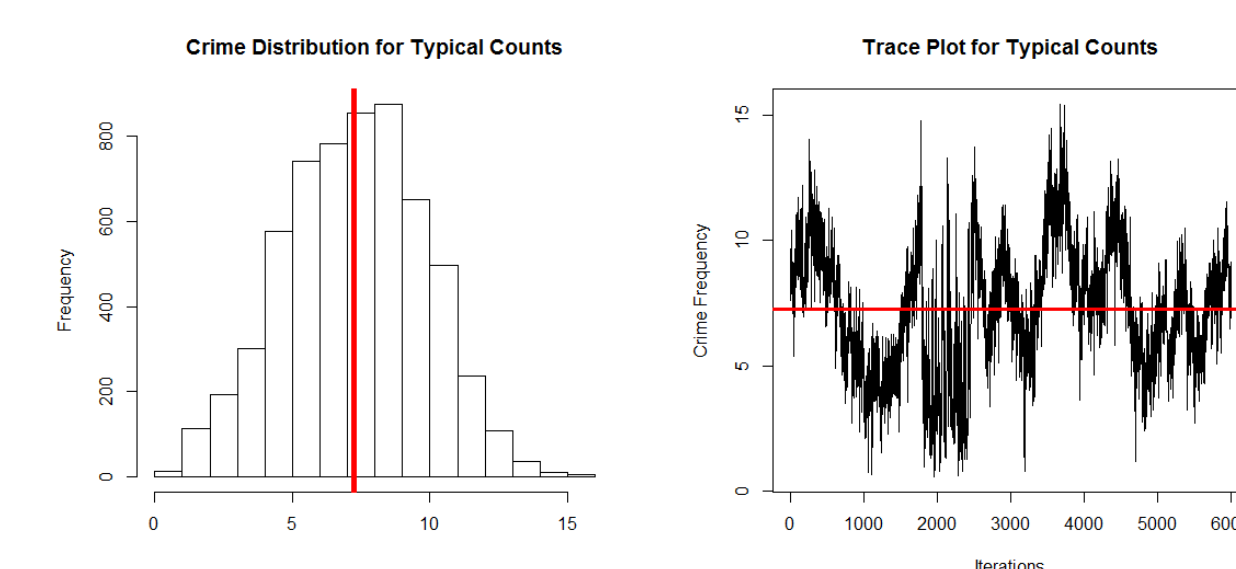


Figure: Suspension Models for High Schools

Model Diagnostics

Model	DIC	CPO	PPO
1	189.0624	0.906428	0.910272
95	186.6292	0.906297	0.909889
Extreme	187.1526	0.90624	0.910572

Model	DIC	CPO	PPO
1	3891.406	0.009427	0.009448
95	3901.314	0.008998	0.009682
Extreme	3891.117	0.009428	0.009446

Figure: Elementary School Expulsion Diagnostic (left) and Suspension Diagnostics (right)

Model	DIC	CPO	PPO
1	399.6648	0.425075	0.445602
95	370.6124	0.422647	0.449454
Extreme	371.3801	0.430773	0.455491

Model	DIC	CPO	PPO
1	1140.971	0.010367	0.010546
95	1045.549	0.045831	0.060184
Extreme	1135.263	0.015739	0.01652

Figure: High School Expulsion Diagnostic (left) and Suspension Diagnostics (right)

Discussion of Results

- Demographics
 - ▷ These factors were mostly insignificant
 - ▷ A couple were barely significant in a couple models, however overall not very important
- Test Scores
 - ▷ Test scores were used to look at student performance and were used as a proxy for student motivation
 - ▷ Most significant when modelling the mean number of non-zero expulsion counts
- Misconducts
 - ▷ The number of misconducts was significant in the majority of the models run. This is expected, as with the more misconducts we expect more suspensions and expulsions
- Quality Scores
 - ▷ A quality score provided by CPS for each school
 - ▷ Found to be insignificant in the majority of the models
- Violent Crime Frequency
 - ▷ Crime frequency was found to be significant for both suspensions and expulsions for most of the models
 - ▷ For most cases, it was found to be a positive relationship between the amount violent crime and the number of suspension and expulsions
- Spatial Random Effects
 - ▷ This variable examined whether the occurrence of a crime in one school boundary influenced crime in a neighboring school boundary
 - ▷ Found to be almost completely insignificant, implying there are not spatial influences between schools

Future Considerations

- Consider temporal factors as potentially affecting suspensions and expulsions
- Consider more types of crime than just violent crime
- Consider physical distances of crimes to a school

Acknowledgements

- Software Used: www.r-project.org
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