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

Nicholas Fox,   John Cote,   Dr. Earvin Balderama

Department of Mathematics & Statistics, Loyola University Chicago, Chicago, IL, USA

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

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

Negative Binomial and Generalized Pareto Distribution Double Hurdles Models

- $\mathbf{p} = \mathbf{P(zero\text{-}count)}$
  $$\text{logit}(\mathbf{p}) = \mathbf{X}\gamma + \mathbf{V}\alpha$$
- $\mu = $ **mean of typical-count distribution.**
  $$\log(\mu) = \log(School.Pop) + \mathbf{X}\beta + \mathbf{V}\alpha$$
- $\mathbf{q} = \mathbf{P(large\text{-}count \mid nonzero\text{-}count)}$
  $$\text{logit}(\mathbf{q}) = \mathbf{X}\delta$$

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
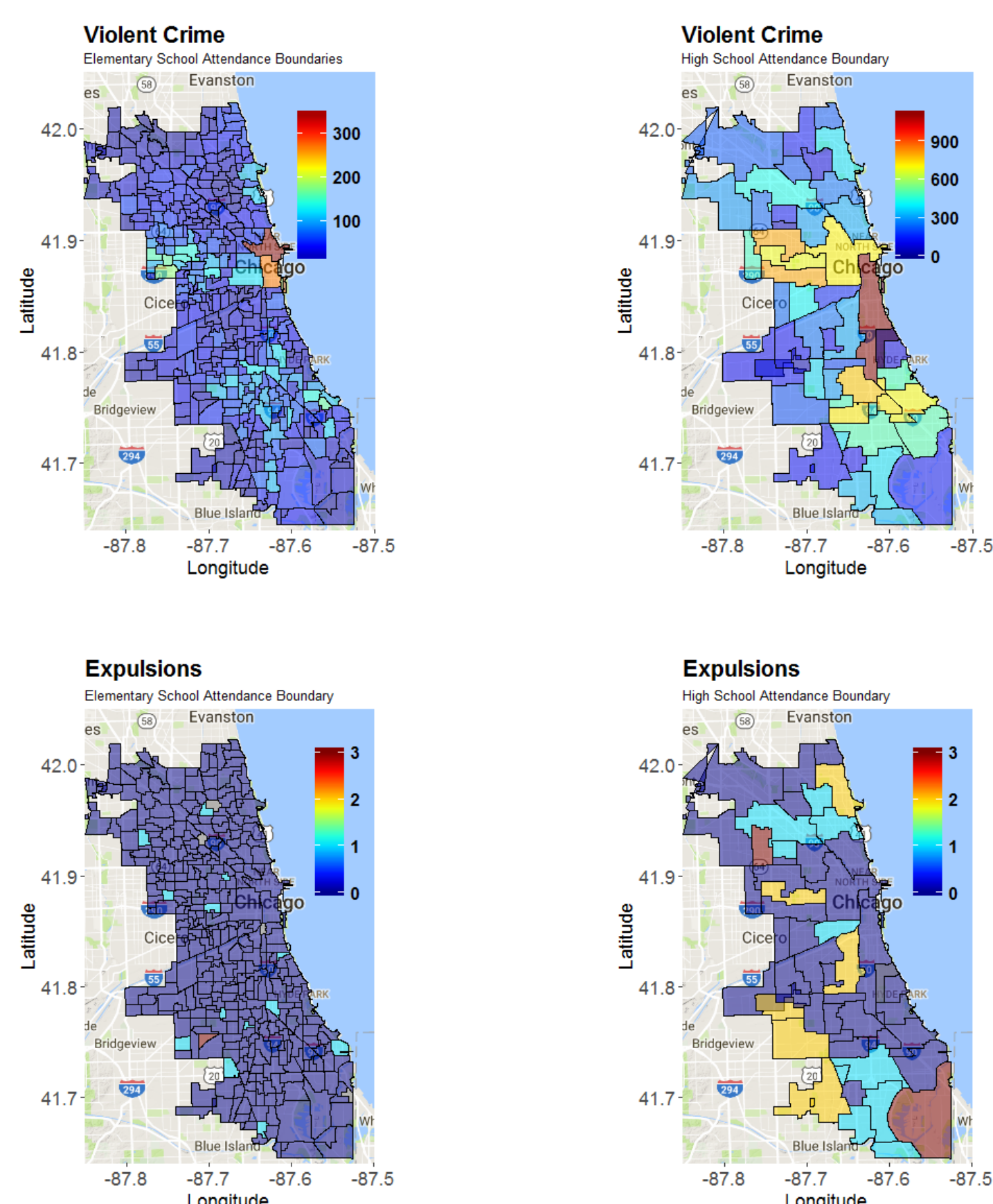
Model Variables and Results

Response data:
- Expulsions → Expulsions counts for each Chicago Public School
- Suspensions → Suspension counts for each Chicago Public School

Model Covariates covariates:
- Common Covariates
  - $x_1 - x_3$ = Ethnicity counts for schools; White, African American, Hispanic respectively
  - x_4 = Number of misconducts per school
- Unique Elementary School Covariates
  - x_5 = School quality score
  - x_6 = PARCC average math score
  - x_7 = PARCC English Language Arts average score
  - x_8 = Crime counts based on school attendance boundary
- Unique High School Covariates
  - x_5 = Average ACT composite score per school
  - x_6 = Crime counts based on school attendance boundary
  - x_7 = School quality score
- Spatial Random Effects are included for each model

Crime Regression Coefficients for Elementary School Models
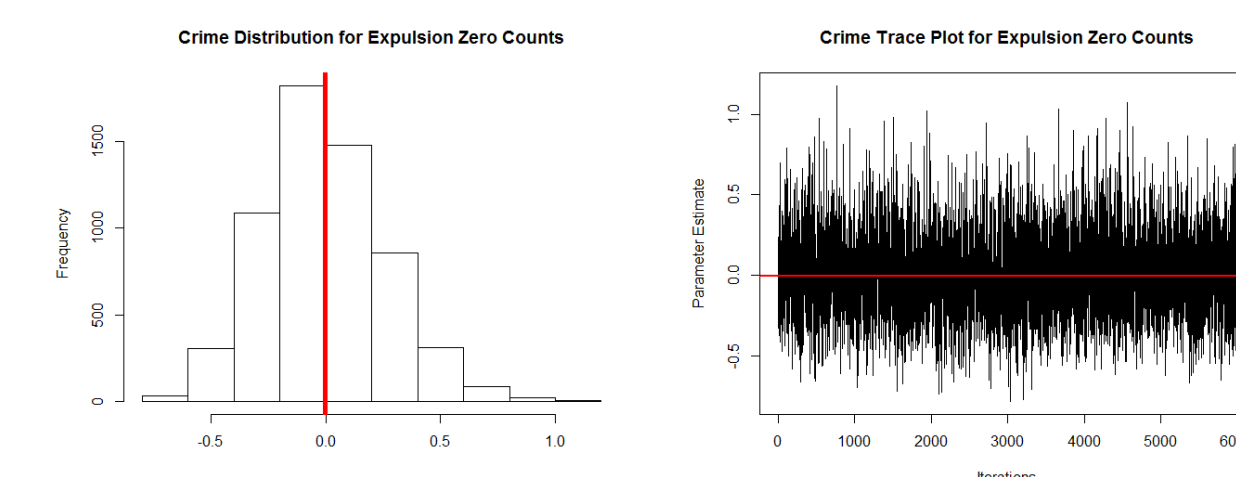

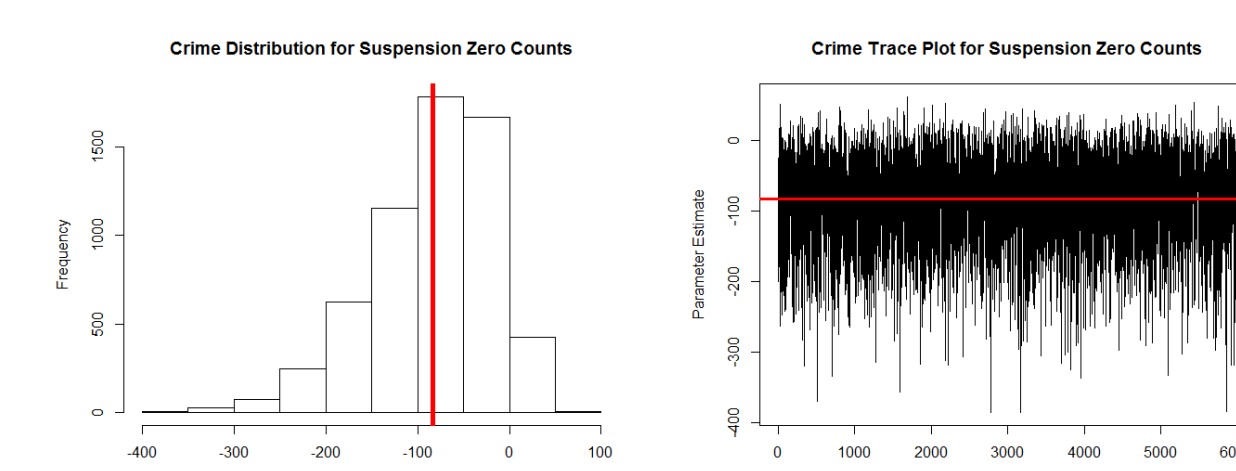Figure: Expulsion Models for Elementary Schools

Figure: Suspension Models for Elementary Schools

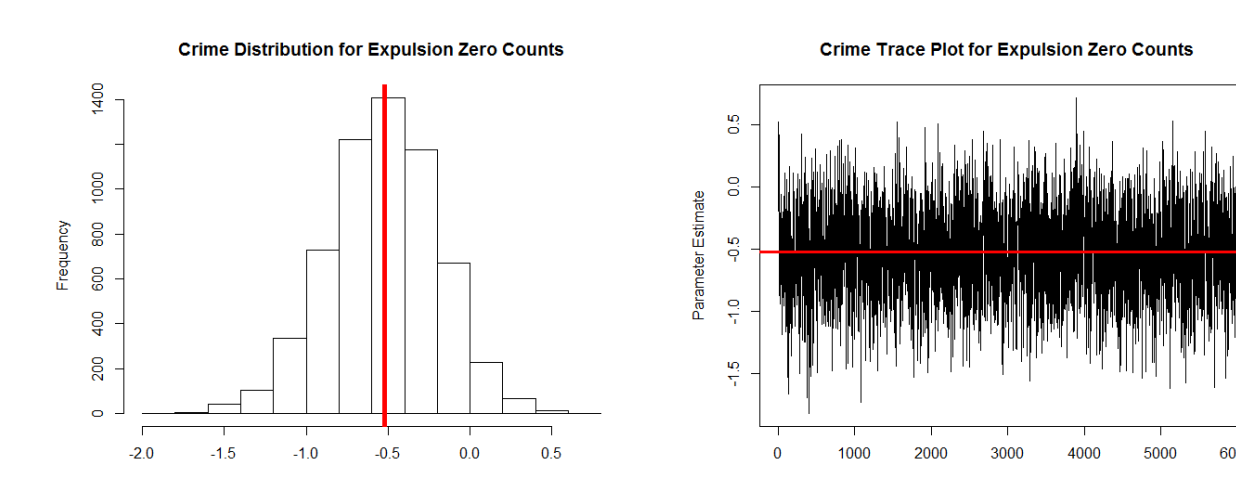**Crime Regression Coefficients for High School Models**
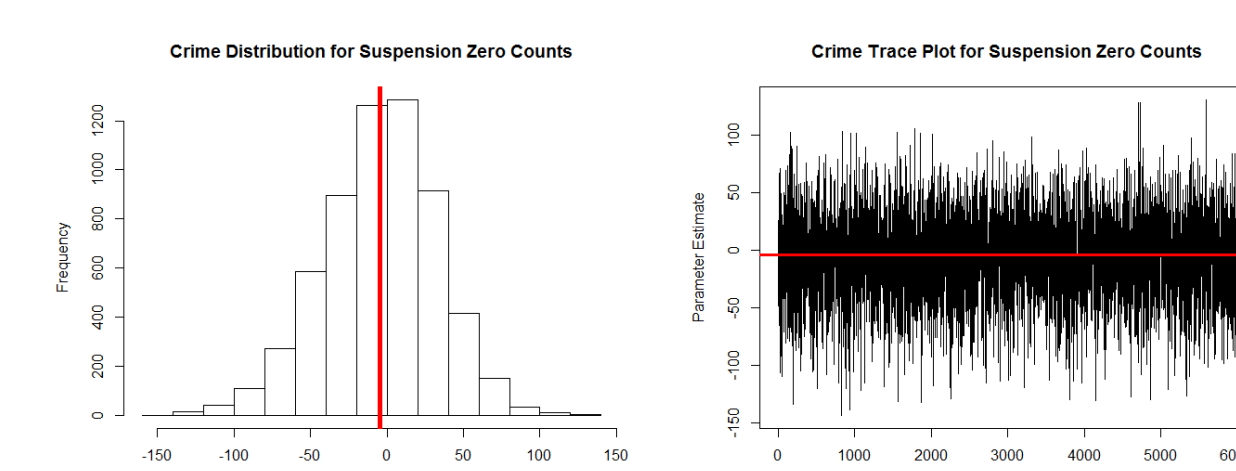

Figure: Expulsion Models for High Schools

Figure: Suspension Models for High Schools

- **Interpretation Example:** The odds of having zero expulsions decreases by 40.6% for every one standard deviation increase in the amount of crime

Model Diagnostics

Model	DIC	CPO	PPO		Model	DIC	CPO	PPO
GPD-Hurdle	189.0624	0.906428	0.910272		GPD-Hurdle	3891.406	0.009427	0.009448
Double-Hurdle	186.6292	0.906297	0.909889		Double-Hurdle	3901.314	0.008998	0.009682
NB-Hurdle	187.1526	0.90624	0.910572		NB-Hurdle	3891.117	0.009428	0.009446

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

Model	DIC	CPO	PPO		Model	DIC	CPO	PPO
GPD-Hurdle	399.6648	0.425075	0.445602		GPD-Hurdle	1140.971	0.010367	0.010546
Double-Hurdle	370.6124	0.422647	0.449454		Double Hurdle	1045.549	0.045831	0.060184
NB-Hurdle	371.3801	0.430773	0.455491		NB Hurdle	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 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 mostly insignificant for zero counts of suspensions and expulsions
  - Found to have a positive relationship between the amount violent crime and the mean number of suspension and expulsions for most cases
- Spatial Random Effects
  - This variable examined whether the occurrence of a suspension or expulsion at a school affects a neighboring school
  - 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

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