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 explusion
- **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

$$\begin{aligned} \beta_j &\sim Normal(0, 100) \\ \alpha_i &\sim Normal(0, 1000) \end{aligned} \quad (1)$$

Negative Binomial and Generalized Pareto Distribution Double Hurdles Models

$\mathbf{p}$ **= P(zero-count)**

$$\text{logit}(\mathbf{p}) = \mathbf{X}\gamma + \mathbf{V}\alpha$$

μ **= mean of typical-count distribution.**

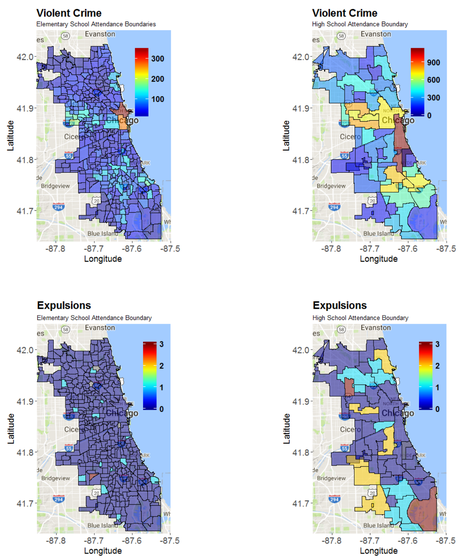
$$\log(\mu) = \mathbf{log}(School.Pop) + \mathbf{X}\beta + \mathbf{V}\alpha$$

$\mathbf{q}$ **= P(large-count | nonzero-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
  - $\mathbf{x}_1 - \mathbf{x}_3$ = 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

Crime Regression Coefficients for Elementary School Models

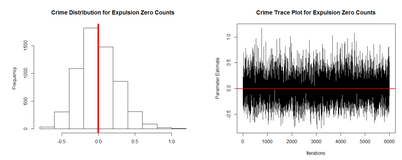


Figure: Expulsion Models for Elementary Schools

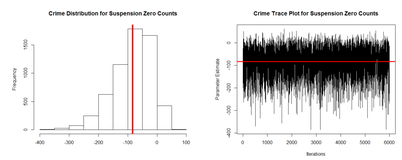


Figure: Suspension Models for Elementary Schools

Crime Regression Coefficients for High School Models

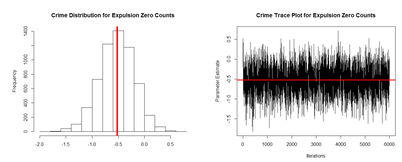


Figure: Expulsion Models for High Schools

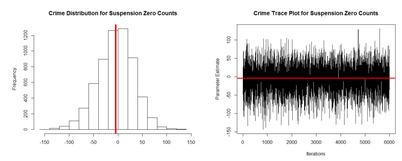


Figure: Suspension Models for High Schools

- **Interpretation Example:** A parameter estimate of -0.52 has a .594 multiplicative effect on the probability of a zero count for high school suspensions

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: Elemetary 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 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 occurance 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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