Supplemental Materials for the Spatial-Temporal Poisson Regression Analysis

WEB APPENDIX

Model fit. For comparative purposes we also ran basic Poisson regression analyses without accounting for overdispersion with these two additional effects. We then compared basic and spatial-temporal Poisson regression to assess whether accounting for the extra Poisson variability associated with expected counts improved model fit relative to models ignoring the spatial-temporal correlation. We used the expected predicted deviance (EPD) to formally compare model fits, similar to results shown in Waller et al. (1). Models with smaller EPD estimates are preferred and suggest an improved overall fit of the data. In addition, we also fit zero-inflated Poisson models to each city/store type dataset for comparison purposes and found that our space-time models had drastically improved model fit in each case where the zero-inflated model converged.

Transformation of variables included in Poisson regression analysis. Different transformations of the covariates were included in the models since associations between store counts and covariates changed across cities and store types. For each city and store type combination, the selected transformation for the covariates was determined based on the model fit criteria. Different store types within the same city sometimes required different covariate transformations to accurately represent the association between the variable and the store counts outcome.
For poverty, we considered the continuous poverty variable, the empirical logit transformation of poverty, poverty tertiles, as well as a quadratic poverty term as potential covariates in each of the models. The empirical logit transformation (2, 3) of the continuous poverty measure resulted in

a more linear association with the log of supermarket counts and improved model fit in all four cities and with convenience store counts in Birmingham, Minneapolis and San Francisco (low, medium and high poverty categories were used for Chicago convenience store counts). For tract area, we considered area itself and the log of area in each of the models. For population, we considered population itself (divided by 1,000) and the log of population in each of the models.

REFERENCES

1. Waller L, Carlin B, Xia H, Gelfand A. Hierarchical spatio-temporal mapping of disease rates. *Journal of the American Statistical Association*. 1997;92:607-617.
2. Haldane JB. The estimation and significance of the logarithm of a ratio of frequencies. *Annals of Human Genetics*. 1956;20(4):309-311.
3. Cox DR. Analysis of binary data. Boca Raton, FL: Chapman & Hall/CRC Press; 1970.

Web Table 1. Overall Expected Predicted Deviance Score for Basic Poisson and Spatial-Temporal Poisson Regression Models in Order to Assess Model Fit[a]

Model and Metropolitan Statistical Area	Expected Predicted Deviance Score	
	Basic Poisson Model	Spatial-Temporal Poisson Model
Supermarkets		
Birmingham, AL	7,138.17	6,599.89
Chicago, IL	51,620.31	48,889.66
Minneapolis, MN	14,795.26	13,999.29
San Francisco, CA	31,249.16	27,157.13
Convenience stores		
Birmingham, AL	15,867.89	13,102.49
Chicago, IL	101,424.20	88,641.81
Minneapolis, MN	32,554.87	30,179.72
San Francisco, CA	51,225.71	37,087.30

[a] The geographic areas included in this study are census tracts falling within the Metropolitan Statistical Areas (MSAs) [using 2010 census tract boundaries] of Birmingham AL (264 tracts), Chicago IL (2,210 tracts), Minneapolis MN (772 tracts), and San Francisco CA (975 tracts), spanning 2006 to 2012.

Web Table 2. Associations Between Census Tract-level Poverty and Racial/Ethnic Composition, and Counts of Supermarkets from Basic Poisson Regression Model in the 4 US Metropolitan Statistical Areas[a]

Parameter	Birmingham, AL		Chicago, IL		Minneapolis, MN		San Francisco, CA	
	Estimate[b]	95% CI[b]	Estimate[b]	95% CI[b]	Estimate[b]	95% CI[b]	Estimate[b]	95% CI[b]
Intercept	-0.19	-0.35, -0.03	-7.24	-7.38, -7.12	-5.87	-6.14, -5.46	-0.33	-0.47, -0.18
Logit poverty	0.14	0.11, 0.18	0.09	0.07, 0.11	0.26	0.23, 0.28	0.22	0.18, 0.26
Racial/ethnic composition[c]								
Predominantly black vs. white	-0.24	-0.41, -0.09	0.08	0.01, 0.15	-	-	-	-
other vs. white	-0.08	-0.26, 0.08	0.17	0.10, 0.24	-0.11	-0.21, -0.01	-0.30	-0.44, -0.17
Poverty × racial composition								
Poverty × predominantly black vs. white	0.15	0.04, 0.25	0.14	0.10, 0.19	-	-	-	-
Poverty × other vs. white	0.07	-0.02, 0.15	0.12	0.09, 0.14	0.03	-0.02, 0.08	-0.00	-0.05, 0.04

Area[d]	-0.24	-0.29, -0.20	0.30	0.20, 0.37	-0.12	-0.14, -0.09	-0.21	-0.24, -0.19
Population[d]	0.10	0.07, 0.13	0.82	0.80, 0.84	0.68	0.63, 0.71	0.14	0.13, 0.15
Area × Population	0.03	0.02, 0.03	-0.04	-0.05, -0.03	0.01	0.01, 0.01	0.002	-0.003, 0.007
Time (linear)	0.001	-0.01, 0.02	0.001	-0.004, 0.007	0.01	-0.01, 0.02	0.01	0.002, 0.01
Time (quadratic)	-0.0002	-0.001, 0.0003	-0.00001	-0.0002, 0.0002	-0.0002	-0.0005, 0.0003	-0.0002	-0.0005, -0.000004

Abbreviation: CI, confidence interval.

[a] Note: The geographic areas included in this study are census tracts falling within the Metropolitan Statistical Areas (MSAs) [using 2010 census tract boundaries] of Birmingham AL (264 tracts), Chicago IL (2,210 tracts), Minneapolis MN (772 tracts), and San Francisco CA (975 tracts), spanning 2006 to 2012.

[b] The estimate and 95% CI values represent the posterior means and credible intervals from basic Poisson model.

[c] Reference cell coding is used with "white" as the reference race group. Racial/ethnic composition: Predominantly white or predominantly black tracts are defined as tracts with ≥70% of the tract population of a specific race/ethnicity. All other racial/ethnic categories such as predominantly Hispanic, predominantly Asian or racially mixed were combined as "other" given small sample size for analysis.

[d] Log-transformed area was used for Birmingham, Chicago and San Francisco Metropolitan Statistical Areas, whereas an untransformed area variable was used for Minneapolis site. Similarly, population/1000 transformation was used for Birmingham and San Francisco Metropolitan Statistical Areas, whereas a log-transformed population variable was used for Chicago and Minneapolis Metropolitan Statistical Areas.

Web Table 3. Associations Between Census Tract-level Poverty and Racial/Ethnic Composition, and Counts of Convenience Stores From Basic Poisson Regression Model in the 4 US Metropolitan Statistical Areas[a]

Parameter	Birmingham, AL		Chicago, IL		Minneapolis, MN		San Francisco, CA	
	Estimate[b]	95% CI[b]	Estimate[b]	95% CI[b]	Estimate[b]	95% CI[b]	Estimate[b]	95% CI[b]
Intercept	0.51	0.40, 0.60	-4.21	-4.30, -4.13	-4.51	-4.67, -4.37	0.52	0.44, 0.60
Logit poverty[b]	0.16	0.14, 0.18	-	-	0.23	0.22, 0.25	0.40	0.37, 0.42
Poverty level[b]								
High vs. low	-	-	0.50	0.44, 0.55	-	-	-	-
Medium vs. low	-	-	0.36	0.34, 0.38	-	-	-	-
Racial/ethnic composition[c]								
Predominantly black vs. white	0.43	0.34, 0.52	0.18	0.09, 0.27	-	-	-	-
Other vs. white	0.87	0.79, 0.96	0.15	0.13, 0.17	-0.39	-0.44, -0.32	-0.48	-0.57, -0.40
Poverty × racial/ethnic composition								
Poverty × predominantly black vs. white	0.12	0.07, 0.16	-	-	-	-	-	-
Poverty × other vs. white	0.31	0.27, 0.35	-	-	-0.22	-0.25, -0.19	-0.21	-0.24, -0.18

Poverty level × racial/ethnic composition								
High poverty × predominantly black	-	-	-0.39	-0.50, -0.28	-	-	-	-
Medium poverty × predominantly black	-	-	-0.35	-0.44, -0.25	-	-	-	-
High poverty × other	-	-	-0.43	-0.48, -0.36	-	-	-	-
Medium poverty × other	-	-	-0.14	-0.17, -0.11	-	-	-	-
Area[d]	0.14	0.12, 0.16	0.65	0.60, 0.70	-0.22	-0.29, -0.15	0.12	0.10, 0.14
Population[d]	0.14	0.12, 0.15	0.52	0.51, 0.53	0.65	0.64, 0.67	0.14	0.13, 0.15
Area × Population	-0.004	-0.008, -0.0002	-0.06	-0.06, -0.05	0.04	0.03, 0.04	-0.02	-0.02, -0.01
Time (linear)	0.005	-0.001, 0.01	0.02	0.02, 0.02	0.004	-0.0005, 0.009	0.03	0.03, 0.03
Time (quadratic)	-0.0002	-0.0003, -0.00007	-0.0006	-0.0007, -0.0005	-0.0002	-0.0003, -0.00001	-0.001	-0.001, -0.001

Abbreviation: CI, confidence interval.

[a] Note: The geographic areas included in this study are census tracts falling within the Metropolitan Statistical Areas (MSAs) [using 2010 census tract boundaries] of Birmingham AL (264 tracts), Chicago IL (2,210 tracts), Minneapolis MN (772 tracts), and San Francisco CA (975 tracts), spanning 2006 to 2012.

[b] The estimate and 95% CI values represent the posterior means and credible intervals from basic Poisson model.

[c] Continuous poverty variable for Birmingham, Minneapolis and San Francisco, categorical poverty for Chicago. Reference cell coding is used

with “white” as the reference race group. Racial/ethnic composition: Predominantly white or predominantly black tracts are defined as tracts with ≥70% of the tract population of a specific race/ethnicity. All other racial/ethnic categories such as predominantly Hispanic, predominantly Asian or racially mixed were combined as “other” given small sample size for analysis.

[d] Log-transformed area was used for Birmingham, Chicago, Minneapolis and San Francisco Metropolitan Statistical Areas. Population/1000 transformation was used for Birmingham and San Francisco Metropolitan Statistical Areas, whereas a log-transformed population variable was used for Chicago and Minneapolis Metropolitan Statistical Areas.

Web Table 4. Combined Interaction Effects (Race-Specific Slopes) Between Census Tract-level Poverty and Racial/Ethnic Composition, and Counts of Supermarkets From Spatial-Temporal Multivariable Poisson Regression Model Accounting for Region-wide Heterogeneity in the 4 US Metropolitan Statistical Areas[a]

City	Racial/Ethnic Group	Combined Effect Estimate[b]	95% CrI[b]
Birmingham, AL	White	0.13	0.09, 0.18
	Black	0.29	0.18, 0.40
	Other	0.22	0.14, 0.30
Chicago, IL	White	0.09	0.07, 0.11
	Black	0.22	0.18, 0.26
	Other	0.21	0.19, 0.23
Minneapolis, MN	White	0.27	0.25, 0.30
	Other	0.29	0.23, 0.35
San Francisco, CA	White	0.14	0.11, 0.22
	Other	0.21	0.18, 0.23

Abbreviation: CrI, credible interval.

[a] Note: The geographic areas included in this study are census tracts falling within the Metropolitan Statistical Areas (MSAs) [using 2010 census tract boundaries] of Birmingham AL (264 tracts), Chicago IL (2,210 tracts), Minneapolis MN (772 tracts), and San Francisco CA (975 tracts), spanning 2006 to 2012.

Web Table 5. Combined Interaction Effects (Race-Specific Slopes) Between Census Tract-level Poverty and Racial/Ethnic Composition, and Counts of Convenience Stores From Spatial-Temporal Multivariable Poisson Regression Model Accounting for Region-wide Heterogeneity in the 4 US Metropolitan Statistical Areas[a]

City	Racial/Ethnic Group	Combined Effect Estimate[b]	95% CrI[b]
Birmingham, AL	White	0.13	0.11, 0.16
	Black	0.28	0.22, 0.34
	Other	0.49	0.45, 0.54
Minneapolis, MN	White	0.23	0.22, 0.25
	Other	0.02	-0.02, 0.05
San Francisco, CA	White	0.42	0.34, 0.46
	Other	0.19	0.18, 0.21

Abbreviation: CrI, credible interval.

[a] Note: The geographic areas included in this study are census tracts falling within the Metropolitan Statistical Areas MSAs [using 2010 census tract boundaries] of Birmingham AL 264 tracts, Chicago IL 2,210 tracts, Minneapolis MN 772 tracts, and San Francisco CA 975 tracts, spanning 2006 to 2012.

[b] Chicago estimates are shown directly in Table 6 due to the use of the categorical poverty variable.