Geography is Destiny:
Educational Attainment Case Study in a New Mexico Public School District

Geospatial & Population Studies
University of New Mexico, Albuquerque, New Mexico

Adelemar Alcantara, Nomalanga Nefertari,
Srini Vasan, Xiaomin Ruan
Introduction

- Social scientists link segregation by race to socioeconomic status, resident location, and language (Orfield and Lee, 2005).

- The U.S. educational system is unequal, offering very different learning opportunities based on a child’s social status (Hammond, 2011), skin color (Kozol, 1991) and neighborhood (de Souza Briggs, 2005).
Geographic opportunity

- The geography through which a student enters school reflects the opportunity and expectations she is encouraged to embrace.

- Geographic resource and mobility disparities are widening since the late 80’s and neighborhoods show resegregation trends (Orfield, 2001).

- According to Peske & Haycock (2006), poor and minority students are “shortchanged on teacher quality” throughout the nation, routinely assigned “teachers with less experience, less education, and less skill than those who teach other children.”
Good Schools

• Increase property values for homeowners and neighborhoods (Fac & Grenet, 2007)

• Have well-qualified, experienced teachers with adequate fiscal and social resources and are whiter and more affluent in student composition with smaller classroom sizes (Hammond, 1998).
Primary Research Question

- Is there a relationship between student geographic location (residence), income, ethnicity and educational achievement in Albuquerque elementary schools consistent with national metro-area trends?
New Mexico

- New Mexico is one of the poorest states in the nation with poverty rates between 25.4% and 40.39%. Over 80% of student qualify for a free lunch program. School populations range from 72% to 98% minority throughout the state (U.S. Department of Commerce).

- Albuquerque is the largest city in New Mexico, home to 32% of the state’s 2 million residents. Albuquerque Public Schools (APS) is the largest school district in the state (BBER, 2010).
APS Elementary Schools

- Caucasians are overrepresented in the highest income group, and significantly underrepresented among lower income students.
- Hispanic student enrollments = Reduced Meal student percentages in lowest half of income.
Methodology

Aggregate Data

- Individual student performance data is not available because of legal confidentiality requirements. Instead, we use publicly available aggregate data on student performance.

- Since this data is available over a geography (ES school district), the corresponding independent variables are also aggregated (over census tracts and/or ES districts, such as poverty level, median HH income, % foreign born students, median household value, no of bedrooms, % single unit dwelling, etc.).
Methodology

Student Performance

- Proficiency scores from elementary schools (grades 3-5) in the 2004-2006 time frame were obtained in Reading, Math and Science. The scores were spatially mapped (using ArcGIS and GeoDa) as a function of geographical variables, followed by running regression models of student performance.
Ethnic Diversity in Elementary Schools (Data Source: Albuquerque Public Schools)
2010 Income and Poverty Data: Albuquerque (Data Source: ACS Census 2005-09)
Median Household Income Across Census Tracts

Model Summary and Parameter Estimates

Dependent Variable: Poverty

<table>
<thead>
<tr>
<th>Equation</th>
<th>R Square</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
<th>Constant</th>
<th>b1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverse</td>
<td>.817</td>
<td>55035.908</td>
<td>1</td>
<td>12328</td>
<td>.000</td>
<td>-8.196</td>
<td>1009186.4</td>
</tr>
</tbody>
</table>

The independent variable is Income.

![Graph showing the relationship between Income and Poverty with a linear regression line.](image-url)
AYP2011-12 Math Proficiency vs. Proportion of ES students in Meal Program
AYP2011-12 Reading Proficiency vs. Proportion of ES students in Meal Program
Prior to running a regression, it is important to assess if the dependent (and independent) variables exhibit a neighborhood clustering effect, i.e., low (or high) performance scores in an area within a school boundary affect the performance scores to be low (or high) in the neighboring area(s).

If the clustering is significant, then the model must take the spatial lag phenomenon into account.
Spatial Autocorrelation: Poverty
Spatial Autocorrelation: Proportion of Students on Reduced Price Meal Program
Spatial Autocorrelations in Elementary Schools % Proficiency

2004-2005

2005-2006

H=High
L=Low
Spatial Autocorrelations in % Proficiency
Grade 3 vs. 4

Grade 4 vs. 5

H=High
L=Low
Spatial Autocorrelations in % Proficiency
Reading vs. Math
Math vs. Science

H=High
L=Low
Modeling of Standardized Test Proficiency: Elementary Schools

- Proficiency data is available for 2004, 2005 and 2006 for Grades 3-5 and for Reading, Math and Science.
- Calculated for each elementary school Average Proficiency by Subject or by Grade
- Model Average Proficiency = f(Geographic characteristics)
- Geographic characteristics considered:
  - Proportion of students in reduced price meal program (proxy for poverty and median household income)
  - School enrollment size
  - Housing characteristics (home size, price, single unit/not, age of house)
  - Student characteristics (proportion foreign born)
  - Spatial autocorrelation (neighborhood cluster effects)
### Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
<th>Reading</th>
<th>Math</th>
<th>Science</th>
<th>% Students in lunch program</th>
<th>School Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>58.9</td>
<td>49.4</td>
<td>45.7</td>
<td>55.1</td>
<td>40.4</td>
<td>58.4</td>
<td>58.3</td>
<td>519</td>
</tr>
<tr>
<td><strong>Std Dev</strong></td>
<td>14.5</td>
<td>16.4</td>
<td>15.9</td>
<td>15.7</td>
<td>14.9</td>
<td>15.7</td>
<td>27.3</td>
<td>203</td>
</tr>
<tr>
<td><strong>Min</strong></td>
<td>27.6</td>
<td>14.4</td>
<td>14.1</td>
<td>22.1</td>
<td>10.9</td>
<td>23.8</td>
<td>0.0</td>
<td>220</td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>88.2</td>
<td>86.0</td>
<td>81.0</td>
<td>87.1</td>
<td>76.7</td>
<td>91.0</td>
<td>99.1</td>
<td>1347</td>
</tr>
</tbody>
</table>

Sample size = 83
Data from 2004-06

* free/reduced price
Results: Grade 3 proficiency

- **Spatial Weight**: ABQ_ES_AYP_Scores_04-06_sel.gal
- **Dependent Variable**: Grade_3
- **Number of Observations**: 83
- **Mean dependent variable**: 58.8575
- **S.D. dependent variable**: 14.3955
- **Lag coefficient (Rho)**: 0.132027
- **Number of Variables**: 4
- **Degrees of Freedom**: 79
- **R-squared**: 0.615457
- **Log likelihood**: -299.589
- **S.E of regression**: 8.92684

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>z-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Lag</td>
<td>0.1320266</td>
<td>0.09250636</td>
<td>1.427217</td>
<td>0.1535175</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>77.91945</td>
<td>7.583669</td>
<td>10.27464</td>
<td>0.0000000</td>
</tr>
<tr>
<td>Enrollment</td>
<td>-0.00977247</td>
<td>0.004744913</td>
<td>-2.059568</td>
<td>0.0394398</td>
</tr>
<tr>
<td>Reduced$_Meal</td>
<td>-0.3721078</td>
<td>0.04127908</td>
<td>-9.01444</td>
<td>0.0000000</td>
</tr>
</tbody>
</table>
## Results: Grade 4 Proficiency

- **Spatial Weight**: ABQ_ES_AYP_Scores_04-06_sel.gal
- **Dependent Variable**: Grade_4
- **Number of Observations**: 83
- **Mean dependent variable**: 49.3816
- **S.D. dependent variable**: 16.291
- **Degrees of Freedom**: 79
- **Lag coefficient (Rho)**: 0.141061
- **R-squared**: 0.771243
- **Log likelihood**: -288.319
- **S.E of regression**: 7.79173

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>z-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Lag</td>
<td>0.1410607</td>
<td>0.08116509</td>
<td>1.737948</td>
<td>0.0822200</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>75.46071</td>
<td>6.27453</td>
<td>12.02651</td>
<td>0.0000000</td>
</tr>
<tr>
<td>Enrollment</td>
<td>-0.01072057</td>
<td>0.00414033</td>
<td>-2.589303</td>
<td>0.0096171</td>
</tr>
<tr>
<td>Reduced$_Meal</td>
<td>-0.4707315</td>
<td>0.03945933</td>
<td>-11.92953</td>
<td>0.0000000</td>
</tr>
</tbody>
</table>
Results: Grade 5 Proficiency

- Spatial Weight : ABQ_ES_AYP_Scores_04-06_sel.gal
- Dependent Variable : Grade_5
- Mean dependent variable : 45.7328
- S.D. dependent variable : 15.8451
- Lag coefficient. (Rho) : 0.11861
- Number of Observations : 83
- Number of Variables : 4
- Degrees of Freedom : 79
- R-squared : 0.775549
- Log likelihood : -285.185
- S.E of regression : 7.50681

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>z-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Lag</td>
<td>0.1186098</td>
<td>0.08207464</td>
<td>1.445146</td>
<td>0.1484170</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>72.99909</td>
<td>5.969793</td>
<td>12.22808</td>
<td>0.0000000</td>
</tr>
<tr>
<td>Enrollment</td>
<td>-0.01057688</td>
<td>0.00398783</td>
<td>-2.652286</td>
<td>0.0079950</td>
</tr>
<tr>
<td>Reduced$_Meal</td>
<td>-0.4657184</td>
<td>0.03828291</td>
<td>-12.16518</td>
<td>0.0000000</td>
</tr>
</tbody>
</table>
Results: Reading Proficiency

- Spatial Weight: ABQ_ES_AYP_Scores_04-06_sel.gal
- Dependent Variable: Reading
- Mean dependent variable: 55.1388
- S.D. dependent variable: 15.5705
- Lag coefficient (Rho): 0.0962956
- Number of Observations: 83
- Number of Variables: 4
- Degrees of Freedom: 79
- Lag coefficient: 0.0962956
- R-squared: 0.799442
- Log likelihood: -279.028
- S.E of regression: 6.97306

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>z-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Lag</td>
<td>0.0962956</td>
<td>0.07294631</td>
<td>1.320089</td>
<td>0.1868055</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>82.15085</td>
<td>5.926905</td>
<td>13.86067</td>
<td>0.00000000</td>
</tr>
<tr>
<td>Enrollment</td>
<td>-0.008761601</td>
<td>0.003700134</td>
<td>-2.367915</td>
<td>0.0178886</td>
</tr>
<tr>
<td>Reduced$_Meal</td>
<td>-0.4758448</td>
<td>0.03471009</td>
<td>-13.70912</td>
<td>0.00000000</td>
</tr>
</tbody>
</table>
Results: Math Proficiency

- Spatial Weight : ABQ_ES_AYP_Scores_04-06_sel.gal
- Dependent Variable : Math
- Mean dependent variable : 40.402
- S.D. dependent variable : 14.8316
- Lag coefficient (Rho) : 0.244109
- Number of Observations : 83
- Number of Variables : 4
- Degrees of Freedom : 79
- Log likelihood : -302.279
- S.E of regression : 9.18572

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>z-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Lag</td>
<td>0.2441089</td>
<td>0.1025697</td>
<td>2.379932</td>
<td>0.0173158</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>55.96954</td>
<td>6.762024</td>
<td>8.27704</td>
<td>0.0000000</td>
</tr>
<tr>
<td>Enrollment</td>
<td>-0.009529536</td>
<td>0.004883451</td>
<td>-1.951394</td>
<td>0.0510101</td>
</tr>
<tr>
<td>Reduced$_Meal$</td>
<td>-0.3495093</td>
<td>0.04479889</td>
<td>-7.80174</td>
<td>0.0000000</td>
</tr>
</tbody>
</table>
Results: Science Proficiency

- Spatial Weight : ABQ_ES_AYP_Scores_04-06_sel.gal
- Dependent Variable : Science
- Mean dependent variable : 58.4312
- S.D. dependent variable : 15.6125
- Lag coefficient (Rho) : 0.113911
- Number of Observations: 83
- Number of Variables: 4
- Degrees of Freedom: 79
- R-squared : 0.820923
- Log likelihood : -274.577
- S.E of regression : 6.60681

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>z-value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Lag</td>
<td>0.1139105</td>
<td>0.06734686</td>
<td>1.691401</td>
<td>0.0907602</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>85.7427</td>
<td>5.751032</td>
<td>14.9091</td>
<td>0.0000000</td>
</tr>
<tr>
<td>Enrollment</td>
<td>-0.01243312</td>
<td>0.003517584</td>
<td>-3.534563</td>
<td>0.0004085</td>
</tr>
<tr>
<td>Reduced$_Meal$</td>
<td>-0.4711527</td>
<td>0.0326414</td>
<td>-14.4342</td>
<td>0.0000000</td>
</tr>
</tbody>
</table>
Reading Proficiency

% Reading Proficient, 2004-2006, grades 3-5

% Students on Meal Program
Math Proficiency

% Math Proficient, 2004-2006, grades 3-5

% Students on Meal Program
Science Proficiency

% Science Proficient,
2004-2006, grades 3-5

% Students on Meal Program
Conclusions

- Strong spatial neighborhood clustering effects are revealed for math proficiency.
- Elementary school student performance in standardized tests is strongly and negatively correlated to:
  - Proportion of students in free/reduced meal program (proxy for local poverty rate)
  - School enrollment size
- Regression Model $R^2$ values range from 0.615 to 0.821
Results

- The end result of high R-square value obtained is also an indication that despite aggregation, a clear relationship could be established between student performance, % students on meal program and class (enrollment) size.
Conclusions

- Ongoing correlations on race/income/achievement data in the geography of schools and neighborhoods point to structurally embedded race and class barriers obstructing the educational mobility of lower ses students and students of color.

- Educators and planners can benefit from seeing the geographic patterns that link neighborhoods, schools and population characteristics and from the perspective which demographers offer.

- Demographers have both civic responsibility and agency to provide useful data to community planners and educators for community development.
Data Sources

- Median Household Income and Poverty Rate Data from 2005-2009 American Community Survey Census Data
- Median Home Price from Census Data

- School Data:
  - Ethnicity Data from APS Research, Deployment and Accountability/HL/0109: Albuquerque Public Schools, 2008-09 Student Demographics
  - Proficiency data from Albuquerque Public Schools and NM Public Education Department
  - School boundary and location data from City of Albuquerque GIS website http://www.cabq.gov/gis
Thank you!

- Questions?
- Please contact
  - Nomalanga, nneferta@unm.edu, or
  - Srini Vasan, svasano1@unm.edu, or
  - Xiaomin Ruan, xmruan@gmail.com.