Food Insecurity and Educational Achievement

Spatial Error Regression Model

Simone Angioloni
PhD Candidate
Department of Agricultural and Applied Economics
University of Georgia,
308 Conner Hall, Athens, GA. 30602
706-542-0855
Email: sangiol@uga.edu

Glenn C.W. Ames
Professor
Department of Agricultural and Applied Economics
University of Georgia,
314 Conner Hall, Athens, GA. 30602
706-542-7890
games@uga.edu

Jack E. Houston
Professor
Department of Agricultural and Applied Economics
University of Georgia,
312 Conner Hall, Athens, GA. 30602
706-542-0755
jhouston@uga.edu

Subject area: Research and Quantitative Methods

Food Insecurity and Educational Achievement

Spatial Error Regression Model

Abstract

This research investigates factors that affect the academic achievement for the 5th grade pupils in Georgia public schools in 2008-2009 school year. A spatial error regression model was used to examine these relationships. Findings confirm a strong inverse relationship between poverty, as exhibited by participation in the National School Lunch Program, and academic achievement. The family composition, as measured by percent of single parent households, had a negative relationship with academic achievement measures. Moreover, evidence was found of a positive and significant relationship between racial diversity and educational achievement.

Introduction

Education is a crucial factor to stimulate the social and economic progress, and it is influenced by demographic and socio-economic elements. Food insecurity has been shown to be especially detrimental to children's mental and educational development. Food insecurity refers to limited or uncertain availability of, or inability to acquire, nutritionally adequate, safe, and acceptable foods due to financial resource constraint (Bickel *et al*. 2000). One problem arising from food insecure households is that children in these homes are at increased risk for academic and negative socio-emotional behavior (Cook & Frank 2008). The federal government's response to inadequate sources of food includes food assistance programs. These programs attempt to alleviate hunger and address the negative effects that hunger and malnutrition have on an individual's health, educational development, and growth. Programs aimed at assisting children in particular include the National School Lunch Program (NSLP) and the School Breakfast Program (SBP). The NSLP exists in almost all public schools in the U. S. (Estey and Ciambella 2005). In Georgia, the NSLP subsidizes the

cost of lunch for over one million students (FRAC 2013). Participation in NSLP and the School Breakfast Program (SBP) provides significant ramifications on educational achievement. Several studies (*e.g.*, Alaimo, Olson and Frongillo 2001; Meyers *et al*. 1988) have indicated that children who are hungry are less likely to be ready to learn and more apt to exhibit behavioral problems than children that arrive at school with adequate nutrition. Schools where 40% or more of the students get free or reduced price lunches also qualify for Title I federal funds to pay for special programs to close this achievement gap. The first objective of this study is to identify the key associations between NSLP participation and academic performance of 5th grade students in Georgia. Many educators argue that there is a strong inverse relationship between poverty/food insecurity, as exhibited by participation in NSLP, and achievement test scores in reading and mathematics at those levels.

Educational achievement can also be affected by other demographic factors.

Racial "peer effects" suggest that diversity improves at least some students' school performance. Coleman et al. (1966) and the U. S. Commission on Civil Rights (1967) found that African-American students' racial isolation in segregated schools lowered their academic achievement. Jenckes et al. (1972) found that desegregation increased black children's school performance by two to three percent. Guryan (2004) estimated that half of the decline in the black dropout rates was due to the desegregation. In addition, black third graders perform substantially worse when surrounded by other black students than when they are in classes that are primarily white (Hoxby 2000).

However, recent academic research in economic developments seems to suggest that diversity might negatively affect educational achievement. Easterly and Levine (1997) found a negative relationship between the degree of ethnolinguistic fractionalization and the number of school

years in a county. Alesina et al. (1999) found that racial diversity was associated with a lower school spending for instructional purposes. Hall and Leeson (2010) studied the 9th grade in the Ohio districts. Their evidence found a negative relationship between racial diversity and educational achievement, but this seems not to be the result of public spending in education. Consequently, the second objective of this study is to investigate whether a relationship between school performance and racial diversity is present, and if so, in which direction.

Regarding the expenditure per pupil at school and central administrative level and the educational achievement, previous academic research did not find any significant evidence. Hall and Leeson (2010) did not find any evidence of the relationship between school spending per student on the math score for the Ohio 9th grade at district level. The only evidence was for the largest school district, but the relationship was negative.

Georgia ranks 36th in spending per student among U. S. states (Shearer 2014). The school funding from the State was cut by $7.6 billion since 2002, the largest cuts were during the Great Recession. In addition, the legislature shifted some expenses to local taxpayers (retirement budget and health care). As a result, 95% of the schools reported increased class sizes since 2009, and 71% of them cut their school class days down from the standard 180 days. Consequently, the third hypothesis of this study is the effectiveness of the school spending as 'public good channel'.

Food Insecurity in Georgia

As the nation's economy declined during the Great Recession (2007 to 2009) and slow recovery, an increasing number of Georgians lived on the financial edge, where even a small change in a family's employment situation could immediately plunge them into poverty. Major cities in the state had poverty rates at critical levels, including Athens-Clarke (33.8%) and Atlanta (22.6%),

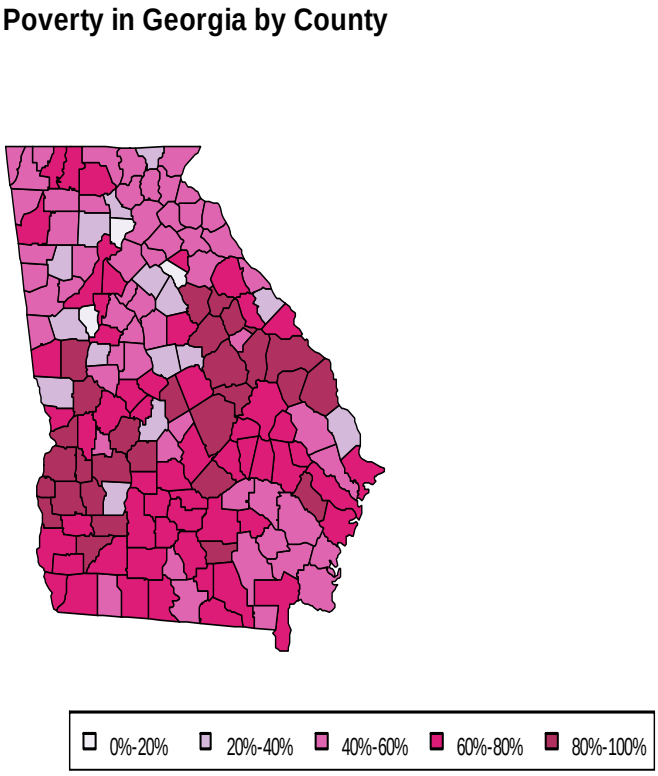
(U.S. Census 2010). These areas demonstrated high levels of food insecurity among children, especially among the working poor, as Georgia's unemployment rate increased rapidly over this period.

As the unemployment rate climbed, along with gas prices, food prices, and housing costs, "getting-by", especially for households with children, meant relying on low-cost foods or cutting the size of meal portions. Against this backdrop, the importance of subsidized or free school meals becomes obvious (Bradford & Medora 2008), especially because food insecurity and poverty are highly correlated. Other factors that have been associated with an increased likelihood of experiencing food insecurity include low levels of education, living in a single parent household, and living in a Hispanic-headed household (Hamilton *et al*. 1997). Dunifon and Kowaleski-Jones (2004) concluded that family income is significantly and negatively associated with continuous food security. They also indicated that black children are more likely to be marginally food insecure and that paternal education is associated with a reduced likelihood of marginal food insecurity.

The state of Georgia has a particularly troubling number of students at risk for decreased academic performance due to food insecurity. While 46% of the households in Georgia qualify for free lunch, an additional 21% of households with children qualify to receive reduced-price lunches (FRAC 2012). Georgia's population is 17.9% food insecure (FRAC 2011). It is in light of these numbers that the importance of examining food insecurity's effects on the state's children is seen.

The following map shows the food insecurity distribution at county level in Georgia defined by the average of the percentage of students eligible for the NSFP. The map indicates how the clusters are distributed. The food insecurity is more present along the central South-West North-East direction (dark purple areas) and less in the North counties (bright purple areas).

Figure n. 1.



Racial diversity in Georgia

The State of Georgia is one of the most racially diverse in U. S. The state diversity index provided by U. S. Census Bureau measures the probability to meet a person of a different race. In 2000, it was 50.7% for Georgia, ranking it 7th at national level, while Atlanta was the 8th urban area most racially differentiated. With respect to 1990, the racial diversity index for Georgia increased by 0.09 (U. S. Census Bureau).

In regard to the relationship between poverty and racial composition, Table 1 indicates the average racial share of students for food insecurity quartile. The share of white students is the largest one (44%), followed by black students (39%), Hispanic students (11%), and Asian students (2%).

Table 1 suggests some insight with respect to the racial fractionalization and the average living standards of different ethnic groups in Georgia. The share of white and Asian student decreases as the food insecurity becomes more intense, while the share of black and Hispanic students increases from the first to the fourth quartile of food insecurity.

Table 1. Average Racial Shares of Students in the 5th Grade in Georgia 2008-2009 for Food Insecurity[a]

Food Insecurity Quartile	White	Black	Hispanic	Asian	Multiracial	Native American	Total
1	67%	17%	7%	5%	4%	0%	100%
2	58%	28%	7%	2%	4%	0%	100%
3	39%	43%	13%	2%	4%	0%	100%
4	12%	68%	16%	2%	2%	0%	100%
Total	44%	39%	11%	2%	4%	0%	100%

[a] Food insecurity is the percentage of students eligible for the NSLP. Source: Georgia Department of Education.

Hall and Leeson investigated the racial fractionalization and the school performance for the 9th grade students in the public school in Ohio in 2010. They analyzed school district level data and they found a negative and significant relationship between educational achievement (percent of students who passed the math test) and the racial diversity. In particular they defined the racial fractionalization index for the *i-th* school district as:

$$racial\ fractionalization\ index = 1 - \sum_{j=1}^{m} \pi_{ij}^2 \qquad (1)$$

where π_{ij} is the share of the racial group *m* in the *i-th* school district.

However, in this study we have school racial data and the analysis is performed at this level.

At county level, the average racial fractionalization index in Georgia ranges from 0.0582 (Talbot County with one elementary school constituted by 97% of black students) to 0.6702 (Evans County, one elementary school with 38% of black students, 38% of white students and 20% of Hispanic students).

Despite the fact that the Georgia State ranks 7th in the racial diversity at the national level, the racial fractionalization index suggests that there are major differences within the state. For six equally distributed races, the index is equal to 0.83; for four equally distributed races (Asian, black, Hispanic, and white cover 96% of the student population) the index should be equal to 0.75. The empirical average of the racial fractionalization index, at county level, is equal 0.41.

Theoretical Framework

In this study, we test two main hypotheses. First, since children experiencing hunger have lower math scores and are more likely to have to repeat a grade than those who are not hungry (Alaimo, Olsen, & Frongillo 2001), the hypothesis to be tested is that there is a strong inverse relationship between poverty and food insecurity, as exhibited by participation in NSLP, and achievement test scores in reading and mathematics. To measure student achievement, an "achievement score" and an "exceeding standards" score were used as the dependent variables at each grade level, in this case the 5th.

The NSLP explanatory variable represents the percent of total students eligible to participate in the NSLP in each school system in Georgia, and is a proxy for poverty/food insecurity. Another factor included in the analysis is county expenditures per student full time enrollment (FTE), as school expenditure variables are hypothesized to have positive relationships with the dependent variables – "achievement" and "exceeds standards".

Second, the racial fractionalization seems to play an ambiguous role with respect to the educational achievement measures. Racial diversity could positively affect the academic performance of through the "peer effects" since the students may be positively stimulated by their classmates.

However, there is evidence that the racial diversity negatively influences the school performance, since different students have different needs, different expectations and the school organization may not be able to satisfy all of them. The second major hypothesis in this study tests is that there is a relationship between racial composition of the class and educational achievement. The racial fractionalization index is defined according to the formula given in (1).

This study also includes explanatory variables that are representative of human growth, as well as socioeconomic status of students. To illustrate the human capital factor, the percentage of the county population with college degrees was included as an explanatory variable. Lastly, measurement of single parent households is included to capture their hypothesized associations with educational achievement.

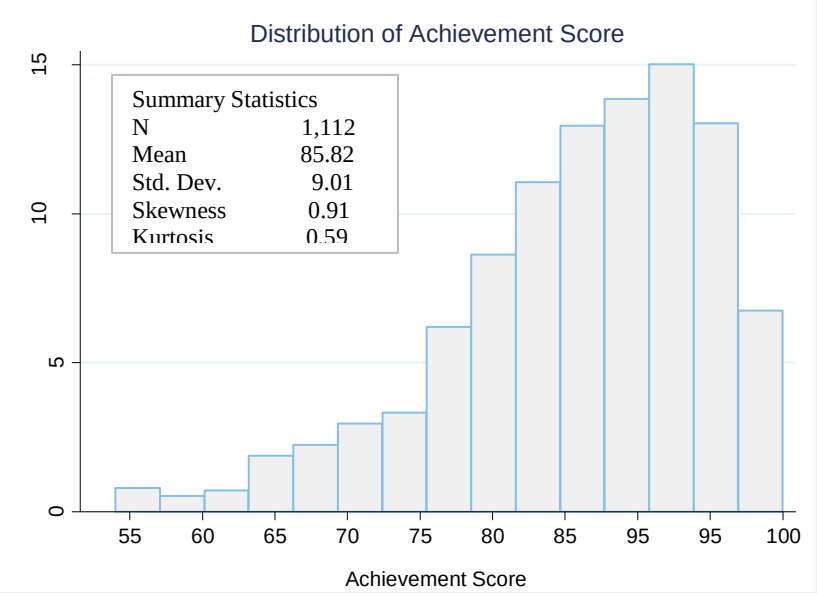
Data and Methodology

Achievement data were taken from the Georgia Department of Education and Governor's Office of Student Achievement, as reported in the "2008 Georgia Report Card for Parents" (Georgia Public Policy Foundation 2009). The Report Card provides information to help parents make informed decisions about the quality of public education in Georgia based on data for the 2008/9 school year. This analysis was performed at the school level for the fifth grade data. There are 1,283 elementary schools included in the analysis of fifth grade students from Georgia's 159 counties. Data on the *NSLP* and *College* variables came from the USDA-ERS Food Environment Atlas (2011) and the U.S. Census Bureau (2009), respectively. Data on spatial

coordinates of the schools in the Georgia state were taken from the website http://georgia.hometownlocator.com. Due to missing observations, the final dataset counts 1,112 schools. Notice that key variables were missing for a county with only one elementary school and thus it was dropped from the analysis (158 counties instead of 159 counties).

Following Ames et al. (2013), a generalization of Poisson regression was used to model the percentage of those achieving standards employing. The GLM framework was used for two primary reasons, with the first being that the outcomes of interest were non-normal. The "achievement" outcome is a count variable, distributed Poisson, as negative values are impossible and results are bounded by a maximum score. Typical log-transformations for non-normal count data have been shown to be ineffective (O'Hara and Kotze 2010). Specifically, with count data, transformations have been shown to have biased results and can lead to impossible predictions, such as a negative number of individuals achieving the academic standard of interest. Use of Poisson distribution was supported by histogram of the outcome variables (see Figure 2), which reflected non-normality.

Figure 2. *Histogram of Achievement Score, Fifth Grade*



Let $Y_1, \ldots, Y_n$ be independent random variables with *Yi* denoting the number of events (i.e., number of students achieving an academic standard and achievement score). These events are out of n_i chances of success (i.e., FTE and possible achievement score). The expected value of the *Yi* is:

$$E\,Y_i = \mu_i = n_i \tag{2}$$

where θ_i is some covariate pattern. The generalized linear model is, therefore:

$$E\,Y_i = \mu_i = n_i\, exp x_i^T \beta \tag{3}$$

A natural link function for such an expression is the log-link:

$$log\ \mu_i = log\ n_i + x_i^T \beta \tag{4}$$

Typically, n_i is termed the "offset" and is a known constant, incorporated into the estimation procedure. Therefore, the natural log of the outcome was modeled as a linear function of the predictors. In particular, the dependent variable is defined as a function of school predictors and county predictors:

$$\log(num\_achiv\_score_{ij}) = log\ FTE_{ij} + \beta_0 + x1_{ij}^T \beta_1 + x2_j^T \beta_2 + \varepsilon_{ij} \tag{5}$$

where β_0 is the common intercept, $x1_{ij}$ is a vector of school predictors (poverty rate, school spending per full time equivalence, racial fractionalization index), $x2_j$ is a vector of county level predictors (central school spending per full time equivalence, percentage of teachers with 30 or more years of experience, percentage of single parent families, unemployment rate, percentage of families with the head of family has a college degree, percentage of adults with college degrees).

Subtracting *Log(FTE)* from both sides, we have the regression equation:

$$\log(num\_achiv\_score_{ij}) = \beta_0 + x1_{ij}^T \beta_1 + x2_j^T \beta_2 + \varepsilon_{ij} \tag{6}$$

Since the data were clustered in counties, we should expect some kind of unobserved heterogeneity effect. Traditional linear regression methods provide consistent estimates of the coefficients, but wrong standard errors because they do not consider the correlation induced in the error term (Greene 2012).

To account for this, we employ a spatial error model. The motivation for applying a spatial error model is driven by data specification issues. When the data are aggregated at county level, the error structure will tend to show systematic spatial pattern (Anselin 2002). From equation (6), the error term ε is defined as:

$$\varepsilon = \rho W \varepsilon + u \quad (7)$$

where ρ is the spatial autocorrelation coefficient, W is the contiguity matrix that defines the spatial structure and u is the uncorrelated error.

The local spillover effects are handled by defining the structure of the contiguity matrix. Spatial weights based on the empirical distance are usually built in two ways. One solution is to define a cut-off distance beyond which no spatial correlation is assumed. For counties or urban census tracts data, this solution is not generally employed, because if the cut-off distance is too small, there will be some islands (i. e., observations without neighbors) and if the distance is too large some observations will have too many neighbors. A common solution is to constrain the neighbor structure to the closest *k-nearest* neighbors, thereby precluding islands and forcing each unit to have the same number of neighbors. In this study, the contiguity matrix W is defined with respect to the tenth closest neighbor. This choice is motivated by the general fit of the model. The weights are equal to 0.1, since the rows are standardized.

Results

Model results are shown in Table 2. The overall fit of the model is good (the likelihood ratio test strongly rejects the null hypothesis of insignificant model); there is also presence of spatial autocorrelation, since the Moran's *I* on the achievement score is 20.03 with a p-value equal to 0 and the spatial coefficient (rho) is highly significant.

Regarding the significance of the covariates, the poverty rate variable, the single parent variable, and the racial fractionalization variable are significant at 1%. The percentage of households with the head of family with a college degree is significant at 10%.

With regard to the interpretation of the parameters, we have to consider the exponential transformation required by the log-linear model. A unit increase of the poverty rate decreases the percent of the achievement score by 0.76. A unit increase of the single parent percentage reduces the educational achievement by 0.90. A unit increase of the racial fractionalization index increases the school performance by 1.04 percent. Also, a positive relationship between the percentage of households with a college degree and educational achievement was found, indicating that the higher the percent of the population with college degrees, the higher the rate of children achieving the academic standard (1.20). This supports previous findings, which show parental education has a positive relationship with academic achievement (Dunifon *et al.* 2004; Hamilton *et al*. 1997).

Table 2. Spatial Error Model Output Maximum Likelihood Estimation. School Year 2008-2009

Dependent variable Independent variable	Log % achievement score Coefficient (SE)
Poverty rate	-0.27*** (0.01)
School spending	0.00 (0.00)
Central Spending	0.00 (0.00)
% teachers with 30 year experience	0.10 (0.15)
% single parent families	-0.11*** (0.04)
Unemployment rate	0.82*** (0.22)
% hosueholds graduate	0.18* (0.09)
% college graduate	-0.06 (0.05)
Racial fractionalization	0.04*** (0.01)
Intercept	-0.22*** (0.08)
Rho	0.38*** (0.05)
Obs.	1112
Variance Ratio	0.50
Test on the overall fit of the model LR chi2(1) Prob.>chi2	41.88 0.00
Test on spatial coefficient =0 Wald test chi2(1) Prob>chi2	47.40 0.00

*** = 1% significance
** = 5% significance
* = 10% significance

Conclusions and implications

Regarding the outcomes of interest, percent of students achieving academic standards, there was a significant inverse relationship with poverty/NSLP eligibility rates for 5th grade students in Georgia. These findings support previous work and the Georgia Public Policy Foundation Reports.

Human capital played an important role, as described by the family characteristis. The higher the percentage, at county level, of households with the head of the family with a college degree the more likely are children achieve higher educational performance, while single parent families appear to face more difficulties to assist their children.

The racial diversification index showed a positive association with the educational achievement of the 5th grade students in Georgia. This supports that part of the academic research that considered the peer-effect a stimulating factor in the educational development of children (See Hoxby, 2000; Guryan, 2004).

The expenditure per pupil at school and at central level was not significant. This study is not able to say if this is due to inefficient allocation of public resources or to insufficient amount of public funds. However, these results suggest that the public goods channel is not responsible for changing the relationship between racial fractionalization, poverty, and educational achievement.

References

Aelterman, A., and I. Rots. 2009. "Teacher Education Graduates‟ Entrance Into Teaching Profession: Development and Test of a Model." *European Journal of Psychology of Education* 24:453-457.

Alaimo, K., R.R. Briefel, E.A. Frongillo, and C.M. Olson. 2001. "Food insufficiency, family income, and health in U.S. preschool and school-aged children." *American Journal of Public Health* 91:781-786.

Alesina, A., Reza, B., Easterly, W. 1999. "Public Goods and Ethnic Divisions." *Quarterly Journal of Economics* 114(4): 1243-1284.

Ames, A. J., Ames, G. C. W., Houston, J. E., and Angioloni, S. 2013. "Food Insecurity and Educational Achievement: A Multi-level Generalization of Poisson Regression" AAEA Conference Annual Meeting 2013, Washington D. C.

Anselin, L. 2002. "Under the Hood Issues in the Specification and Interpretation of Spatial Regression Models." Agricultural Economics, 27 (2002): 247-267.

Bailey-Davis, L., Virus, A., McCoy, T., Wojtanowski, A., Veur, S., Foster, G. 2013. "Middle School Student and Parent Perceptions of Government-Sponsored Free School Breakfast and Consumption: A Qualitative Inquiry in an Urban Setting." *Journal of Academic Nutrition and Dietetics* 113:251-257.

Bickel, G. W., M. Nord, C. Price, W. Hamilton, and J. Cook. 2000. *Guide to Measuring House hold Food Security in the United States*: Revised 2000.

Bradford, K., and M. Medora. 2008. "Hungry in Montana: Factors Contributing to Emergency Food Needs." The Food Security Council, Montana Food Bank Network. Missoula, MT. http://mfbn.org/files/2010%20Hungry%20in%20Montana%20Report.pdf [Accessed June 2012].

Coleman, J. S., Cambell, E. Q., Hobson, J. C., McPartland, J. , Mood, A. M., Weinfeld, F. D., York R. L. 1966. "Equality of Educational opportunity. "Washington, DC: Government Printing Office.

Cook, J. and D. Frank. 2008. "Food security, poverty, and human development in the United States." *Annals of the New York Academy of Sciences* 1136:193-209.

Dunifon, R., and L. Kowaleski-Jones. 2004. "Exploring the Influence of the National School Lunch Program on Children". Institute for Research on Poverty, Discussion Paper no. 1277-04 http://www.irp.wisc.edu/publications/dps/pdfs/dp127704.pdf [Accessed June 20, 2012].

Easterly, D. Halcoussis, D. , Svorny, S. 2003. "School District Size and Student Performance." *Economics of Education Review* 22(2): 193-201.

Estey, J., and B. Ciambella. 2005. "The importance of the school lunch program." Unpublished, University of Rochester.

FRAC: Food Research and Action Center. 2011 (a). *Child and Adult Poverty Tables*. Washington, DC: http://frac.org/wp-content/uploads/2010/09/child_and_adult_poverty_tables_2011.pdf [Accessed April 27, 2012].

FRAC: Food Research and Action Center. 2011 (b). *Child Nutrition Fact Sheet: National School Lunch Program.* Washington, DC: http://frac.org/newsite/wp-content/uploads/2009/09/cnnslp.pdf [Accessed April 27, 2012].

FRAC: Food Research and Action Center. 2012. *Food Hardship in America*. Washington, DC: http://frac.org/pdf/food_hardship_2012.pdf [Accessed April 2012].

FRAC: Food Research and Action Center. 2013. *State of the States: Georgia*. Washington, DC: frac.org/wp-content/uploads/2010/07/ga.pdf [Accessed April 2012].

Frongillo, E.A., D.F. Jyoti, and S.J. Jones. 2006. "Food Stamp Program Participation is Associated with Better Academic Learning among School Children." *American Society for Nutrition.* 136(4): 1077-1080.

Georgia Public Policy Foundation. 2009. "2008 Georgia Report Card for Parents." (http://www.gppf.org) Accessed July 2011.

Georgia Public Policy Foundation. 2011. "2010 Georgia Report Card for Parents." (http://www.gppf.org) Accessed July 2011.

Greene, William, H., *Econometric Analysis*, Seventh Edition, Harlow, Essex England: Pearson Education Limited, 2012.

Gundersen, C., B. Kreider, and J. Pepper. 2011. "The Economics of Food Insecurity in the United States." *Applied Economic Perspectives and Policy*. 33(3), 281-303.

Guryan, J. 2004. "Desegregation and Black Dropout Rates." *American Economic Review* 94(4): 919-943.

Hall, J. C. and Leeson, P. T. 2010. "Racial Fractionalization and School Performance." *American Journal of economics and Sociology*, Vol 69, No. 2 (April, 2010).

Hamilton, W. L., J. Cook, W. Thompson, L. Buron, E. Frongillo, C. Olson, C. Wehler. 1997. *Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project.* Report prepared for the United States Department of Agriculture, Food and Consumer Service, Alexandria, VA.

Hinrichs, Peter. 2010. "The effects of the National School Lunch Program on education and health." *Journal of Policy Analysis and Management* 29 (3): 479.

Hoxby, C. M. 2000. "Peer Effects in the Classroom: Learning from Gender and Race Variation." Cambridge: *National Bureau of Economic Research* Working Paper No. 7867, August.

Jencs, C., Smith, M., Acland, H., Bane, M. J, Cohen, D., Gintis, H., Heynes, B., Michelson, S. 1972. "Inequality: A Re-Assessment of the Effects of Family and Schgooling in America." New York: Basic Books.

Jyoti, D.F., E.A. Frongillo, and S.J. Jones. 2005. "Food insecurity affects school children‟s academic performance, weight gain, and social skills." *Journal of Nutrition* 135: 2831-2839.

Mirtcheva, D., Powell, L. 2009. "Participation in the National School Lunch Program: Importance of School-Level and Neighborhood Contextual Factors". *Journal of School Health* 79(10):485-494.

Murphy, J.M., C.A. Wehler, M.E. Pagano, M. Little, R.E. Kleinman, J.S. Jellinek. 1998. "Relationship between hunger and psychosocial functioning in low-income American children". *Journal of the American Academy of Child and Adolescent Psychiatry* 37(2):163-170.

Nord, M. 2009. *Food Insecurity in Households with Children: Prevalence, Severity, and Household Characteristics*. EIB-56. U.S. Department of Agriculture, Economic Research Service, September.

O'Hara, R., & Kotze, D. 2010. "Do not log-transform count data". *Methods in Ecology and Evolution* 1(2):118-122.

Pogash, C. 2008. "Free lunch isn‟t cool, so some students go hungry". *New York Times*. March 1, 2008: http://www.nytimes.com/2008/03/01/education/01lunch.html?pagewanted=all&_r=0 [Accessed May 2013].

Pollitt, E. 1990. *Malnutrition and infection in the classroom.* Paris: UNESCO

Raudenbush, S. W., & Bryk, A. S. 2002. *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Shearer, L. 2014. "Schools at a breaking point after years of cuts?" *Athens Banner-Herald*. January 13, page 1.

U.S. Census Bureau. 2009. *America Community Survey: ACS Demographic and Housing Estimates: 2009* (5-year estimates).

U.S. Department of Agriculture, Economic Research Service. 2011. *Food Environment Atlas*. http://www.ers.usda.gov/foodatlas/ [Accessed July 2012].