Model County-level Poverty Rate in Georgia Using Spatial Analysis Method

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Abstract:
Conditionally Auto-regression is employed to investigate the determinants of county-level poverty rates in Georgia 2011, and also examine whether those poverty rates are spatial correlated. The results indicate that annual income, white person percent, and elder percent have positive effects, while there is no significant spatial correlation.

Key Words: Conditional Auto-regression, socio economic factors, demographic factors

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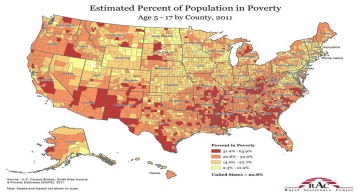
Introduction

▪Poverty is a state of privation because of a lack of the acceptable amount of money or material possessions (Zweig, 2004).

▪Various governmental or nongovernmental programs are trying to reduce poverty and its bad effects. Therefore, identifying the determining factors of poverty rate is of great important to guide the policy and other poverty-reducing programs.

▪Previous studies, however, assume that the county level poverty rates are independent of each other. But in fact, the poverty of one county may be affected by its neighbor counties. Therefore, totally ignoring the potential spatial correlation is likely to bias the results, and further convey less precise or even incorrect messages to public sectors.



Objective

▪Conditional Auto-regression (CAR) model is employed to investigate the determinants of poverty rate considering the potential spatial correlation.

▪The objectives of the study are to identify the factors determining the county level poverty rate, and further to examine whether the poverty rates are spatial correlated, using a county-level data set in Georgia in 2011.

Data

▪The data set about county-level poverty rate in 2011 in Georgia is from United States Census Bureau and United State Department of Agriculture. There are totally 159 observations, and each observation represents one county in Georgia. In the data set, the dependent variable, we are interested, is the percent of total population in poverty in each county in 2011.

▪The explanatory variables include income, college rate, percent of elderly, and percent of white person in each county of Georgia. Here, income is the median household annual income; college rate is the college degree completion rate; percent of elders is the percent of adults above 65 years old.

Method

▪Conditional Auto-Regression (CAR) Model

The conditional autoregressive model (CAR) is appropriate for situations with first order dependency or relatively local spatial autocorrelation. In our study, we want to check whether the poverty rate of one county is related to its neighbors who share a common border. Therefore, CAR model is a suitable method to examine the spatial correlation in our study. Suppose the conditional expected value and variance of poverty rate is as follows:

$$E[Y_i \mid y_j, j \neq i] = \vec{\beta}^T \vec{x}_i + \gamma \sum_{j=1}^{n} w_{ij}(y_i - \vec{\beta}^T \vec{x}_j)$$

$$Var[Y_i \mid y_j, j \neq i] = \sigma^2$$

$$i=1, 2, \ldots 159$$

where Y_i are the poverty rate in the ith county of Georgia; beta is the coefficient vector of the explanatory variables; x is the covariate variable vector in the ith county; gamma is the spatial parameter; w_{ij} captures the neighborhood relationship (=1, if the ith county and the jth county are neighbors;=0, if not); sigma-square is the conditional variance parameter.

▪Inference

After analysis using CAR model, we need to test whether the parameter capturing the spatial dependence and the coefficients are significantly different from zero. Basically, T-test is employed to test the significant of parameters in our model. According to the test results, we can identify the significant determinants of the poverty rate; also quantify their effects on the poverty rate. In addition, if the spatial parameter is significantly different from zero, then the poverty rates are spatial correlated; if not, we cannot reject the statement that there is no spatial correlation between the poverty rates.

Results

▪Descriptive Statistics Summary

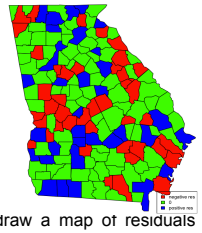
The summary of descriptive statistics is displayed in Table 1. According to the results, among 159 counties in Georgia, the lowest poverty rate is 23.2% in Forsyth, while the highest poverty is 42.2% in Terrell. The variable poverty rate has the mean 23.20% and a 6.88% standard deviation. College completion rate in Georgia has the lowest value 4.6% in Brantley, and the highest value 48.1% in Fulton, with the mean 13.9% and the standard deviation 8.33%. The variable percent of elders has the range from 3.7% to 30.9%, and the minimum and maximum are in Chattahoochee and Towns respectively.

Table 1: Descriptive Analysis Summary

Variable	Mean	Std. dev.	Min	Medium	Max
Dependent variable					
Poverty Rate	23.20	6.88	8.00	23.30	42.20
Independent variable					
College Rate	16.16	8.33	4.60	13.90	48.1
Percent of Elders	13.89	3.79	3.70	13.90	30.90
White Person Rate	68.37	17.22	25.40	68.40	97.70
Unemployment Rate	10.78	2.27	6.10	10.60	20.10
Income	38,797	10,515.58	25,480	35,244	85,137

OLS results and residual map

▪OLS results indicate that the dependent variable poverty significantly decreases with natural logarithm of income, percent of elders, white person percent, while it positive correlates square of natural logarithm of income. R square equals to 0.86, and F test of the model is significant. They are both indicating the model fits data well.



▪However, we draw a map of residuals from previous regression analysis to see if any spatial correlation in the residuals. From the residual map above, red color indicates the negative residuals, while blue indicates the positive residuals. It seems the residuals with the same sign are clustered, but the patterns is not very obvious. Therefore, we need to do further study using Conditional Auto-regression to check and test the potential spatial correlation.

Table 2: Results of CAR model

Variables / Coef.	Coefficient	Standard Error	T statistics
Intercept	1460.03	329.31	4.43***
Age 65 Rate	-0.31	0.06	-4.97***
White Rate	-0.05	0.01	-3.44***
lincome	-243.26	61.79	-3.94***
lincomesq	10.21	2.90	3.53***
Gamma	0.04	0.04	0.83
Sigmasq	6.57	0.74	8.88***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

CAR Model and Inference

▪The results above indicate that the dependent variable poverty rate significantly decreases with natural logarithm of income, percent of 65 years old and above, white person percent, while it positive correlates square of natural logarithm of income. However, the special correlation parameter γ is not significant, suggesting there is no significant spatial correlation among the residuals.

Conclusion

▪From the analysis, we know that annual income, the percent of white person, and the percent of elders are the significant factors determining the poverty rate in Georgia's counties. As the annual income increases, the poverty rate decreases correspondingly, which is consistent to pervious studies that increasing income is an efficient way to reduce poverty rate. The percentage of white person increases, then the poverty rate decreases. It suggests the counties with higher percent of non-white person usually have higher poverty rate, indicating the government and public sectors should pay more attention to the counties with higher proportion of non-white residents. Also, the counties with higher proportion of elders are found to have relative low poverty rate. Generally, the life of the person above 65 years old mostly depended on the retirement pay, although the retirement pension is not very high but is enough to grantee their basic live.

▪In addition, the study finds out that there is **no significant spatial correlation** among the poverty rate in Georgia counties after controlling for the important covariates including income and some demographic factors.

References

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