Area-level Effects and Household-level Effects of Household Poverty in the Texas Borderland & Lower Mississippi Delta: Multilevel Analyses

Dudley L. Poston, Jr.*

Bruce A. Robertson*

Carlos Siordia*

Rogelio Saenz*

Joachim Singelmann**

Tim Slack**

Kayla Fontenot**

***Texas A&M University**

****Louisiana State University**

Spatial Location Matters:

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Texas Borderland & Lower Mississippi Delta:

United States, 2006

Introduction

In 1967, at the height of America's War on Poverty, the National Advisory Commission on Rural Poverty (1967) issued its report, *The People Left Behind*. In this report, the Commission noted that not only were rural poverty rates substantially higher than those in urban areas, but that those places characterized by the greatest economic distress were in the rural South and Southwest and, with the exception of Appalachia, were characterized by high concentrations of racial and ethnic minorities. It is now more than 40 years after the report was issued, and, sadly, the observations of the Commission remain unchanged. The two poorest regions in the United States were then, and still are today, the Texas Borderland, characterized by a highly concentrated Latino population with a strong immigrant presence (primarily of Mexican descent), and the Lower Mississippi Delta, characterized by a highly concentrated black population (see Figure 1).[1]

In this paper we examine the micro-level and area-level effects of poverty among households located in the Texas Borderland and Mississippi Delta regions. We estimate a series of multilevel regression models predicting the log odds of a household being in poverty. We

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[1] For the remainder of this paper the Texas Borderland will be referred to as the "Borderland" and the Lower Mississippi Delta will be referred to as the "Delta."

hypothesize that the log odds of a household being in poverty is best explained by both the characteristics of the household head, and the characteristics of the area, i.e., the Public Use Microdata Area (PUMA), in which the household is located. Our major contribution is our demonstration that various areal characteristics have statistically significant effects on the likelihood of households being in poverty, after taking into account the effects on poverty of relevant household characteristics. Spatial location matters when it comes to predicting poverty of the households in the Delta and Borderland. Since we also show that poverty levels are higher in the Borderland than in the Delta, we control in our regression models for region of residence (Borderland or Delta).

We use micro-level data for the households from the 2006 American Community Survey, and area-level data for the 44 Public Use Microdata Areas (PUMAs) in which the households are located, obtained mainly from the 2000 U.S. Census. It is hoped that our research will broaden the understanding of the relationships between individual level and area level characteristics and the likelihood of a household being in poverty, and show the importance, statistically and with regard to policy, of spatial location.

Prior Studies

While a significant body of poverty research has accumulated over the last half century, one of the newest developments concerns the importance of place, i.e., location, in understanding socioeconomic stratification and, more specifically, poverty. In particular, social scientists have observed enduring links between geographic location and poverty (Friedman and Lichter 1998; Glasmeier 2002; Lobao 1990; Lobao and Saenz 2002; Lyson and Falk 1993; Massey and Denton 1993; Massey and Eggers 1990; Rosenbaum et al. 2002; Rural Sociological Society Task Force

on Persistent Rural Poverty 1993; Saenz and Thomas 1991; Tickamyer and Duncan 1990; Weinberg 1987). For example, research has identified pockets of persistent poverty in the United States, including Appalachia, the Mississippi Delta, the Ozarks, the Texas Borderland, and Native American reservations. With the exception of Appalachia and the Ozarks, these places are the homes of concentrated populations of rural racial/ethnic minorities, who face escalated racial/ethnic inequality and socioeconomic hardships due to the historical legacies of these locations (Saenz 1997a; Snipp 1996; Swanson et al. 1994).

While some empirical attention has focused on persistently poor regions of the country, there continues to be an absence of comparative research examining the conditions of racial and ethnic minority groups in such places, particularly Latinos and blacks. There is a body of research that focuses on the Latino population along certain parts of the Texas border (Davila and Mattila 1985; Fong 1998; Maril 1989; Saenz and Ballejos 1993; Tan and Ryan 2001), and there is research that focuses on the black population in the Delta (Allen-Smith et al. 2000; Duncan 1997, 2001; Kodras 1997) and in the Black Belt (Allen-Smith et al. 2000; Falk and Rankin 1992; Rankin and Falk 1991; Wimberley and Morris 2002). Yet, we find little research that has estimated models of the poverty experiences of Latinos and blacks living in persistently poor areas (for an exception based on a brief descriptive piece, see Shaw 1997), and, moreover, research focusing on the importance of spatial location in predicting poverty.

The research in our paper will allow us to assess the extent to which there are commonalities in the relationships between selected area-level predictors and household-level predictors and poverty rates in the cross section. The characteristics (independent variables) of the households and PUMAs that we use in our paper are drawn from the poverty literature and encompass a variety of dimensions (e.g., Hirschl and Brown 1995; Singelmann 1978), namely,

economic structure, family/household structure, demographic structure, human capital, and poverty concentration. In the larger paper we are now writing that will be finished by the time of the conference meeting, we will review this literature in more detail. For example, we know that poverty at the aggregate level is negatively associated with the prevalence of manufacturing (or industrial structure) (Brady and Wallace 2001), employment (Cotter 2002; Slack and Jensen 2002), population growth, and educational attainment (Saenz 1997a), while poverty is positively associated with the prevalence of households with unmarried/unpartnered females (Albrecht et al. 2000; Goe and Rhea 2000; Lichter et al. 2003; Lichter and McLaughlin 1995). Several of these relationships are addressed in our paper.

Hypotheses

Our multilevel analyses are conducted with data for over 26,000 households located in 44 PUMAs in the Texas Borderland and Lower Mississippi Delta. We test an assortment of substantive hypotheses examining the effects of household and PUMA characteristics on the log odds of a household being in poverty. The main contribution will be our demonstration that spatial location matters. Certain characteristics of the PUMAs in which households are located will be shown to have statistically significant effects on household poverty, after taking into consideration the individual-level characteristics of the households.

Regarding the characteristics of the households (i.e., level-1) that we expect to be related to poverty, we consider five independent variables, all pertaining to the head of the household, namely, sex, educational status, socioeconomic status, age, and whether the head is a minority member (Latino if residing in the Borderland, African American if residing in the Delta). Following earlier literature, we expect that educational attainment, socioeconomic status, and age

should each be negatively associated with the log odds of being in poverty; and that sex of the head (males =1, females =2), and whether the head is a minority (yes =1, no =0) should be positively associated with the log odds of poverty.

Regarding the characteristics of the PUMAs (i.e., level-2) that we expect to be related to poverty, we consider five independent variables, namely, the percentage of the PUMA working age population employed in finance, insurance, and real estate (FIRE); the percentage of the PUMA population with less than a 9th grade education; the percentage of the PUMA population in poverty; the percentage of the PUMA population living in rural areas; and the percentage of households in the PUMA that are headed by a female with no husband present. Based on earlier literature, percent FIRE and percent rural are expected to be negatively related with poverty; and the other three PUMA variables are expected to be positively related with poverty.

Data and Method

The two study regions of the Texas Borderland and the Lower Mississippi Delta are defined as follows. The Borderland stretches from El Paso in the West along the Rio Grande River to Brownsville in the East (see Figure 1). Following Saenz (1997b), we include all 41 counties in this region whose largest city is within 100 miles of the U.S.-Mexico border. The Delta is defined according to the geography delineated by the Lower Mississippi Delta Development Commission, as established by the U.S. Congress in the 1980s (now the Delta Regional Authority). Our analysis focuses on the core Delta area made up of counties in the states of Arkansas, Louisiana, and Mississippi (Figure 1). In these three states, 133 counties belong to the Delta area.

Our household data are drawn from the 2006 American Community Survey, made available through the Integrated Public Use Microdata Series (IPUMS) of the Minnesota Population Center. The American Community Survey is an annual survey of the U.S. population and is now conducted in place of the long form questionnaire in the decennial census. The ACS is based on a series of monthly surveys that are then assembled on an annual basis. A key strength is continuous measurement. This characteristic of the ACS results in the provision of more accurate and time-sensitive data than was the case with the decennial census (ACS 2006; Garcia 2008).

The ACS data are collected via three methods: 1) monthly mail outs from the National Processing Center, 2) telephone non-response follow-ups, and 3) personal visit follow-ups. Each housing unit in the U.S. is assigned a month during which it is at risk of receiving a mail out survey, and the interview may be conducted in that eligible month or in the following two succeeding months.

The ACS questionnaire includes 25 housing and 42 population questions. "The ACS is designed to produce detailed demographic, housing, social, and economic data every year. Because it accumulates data over time to obtain sufficient levels of reliability for small geographic areas, the Census Bureau minimizes content changes" (ACS 2006: 52).

The household data we use in this paper are drawn from this ACS nationally representative sample of households in the United States. The data are referred to as microdata because they provide information on persons and households rather than data in aggregated tabular form (Ruggles et al. 2008; Garcia 2008). They are based on a 1 in 100 national sample of the U.S. population. The 2006 ACS sample contains information on over 1,344,000 households

and 2,970,000 persons. The data we use in this paper are for households located in the 44

PUMAs comprising the Texas Borderland and the Mississippi Delta (Figure 1).

Since the ACS microdata do not have geographical identifiers for most of the Borderland

and Delta counties owing to issues of confidentiality, the level-2 units used in our paper are at

the next highest level of geography, namely that of the PUMA; in our study a PUMA is

comprised of one or more counties in the Borderland or in the Delta. Thus we have data for 10

PUMAs in the Borderland and 34 in the Delta. Most of the Borderland or Delta PUMAs are

defined geographically solely in terms of counties identified by us (see earlier discussion) as

comprising the Borderland or Delta regions. A couple of the PUMAs, however, contain one or

more counties in the Borderland or Delta and one or more not in the Borderland or Delta.

The Delta and Borderland areas, so defined, are among the poorest regions in the United

States (see Table 1). In fact, most of the counties in the two regions are designated as "persistent

poverty" counties (i.e., 20 percent or more of residents were poor as measured in each of the last

four censuses, 1970, 1980, 1990, and 2000). In 2000, all but 7 of the Delta counties had poverty

rates exceeding the national average; the same was true of 40 of the Borderland counties.

Indeed, of the nation's 100 poorest counties, 48 are located in one of these two regions (16 in the

Borderland and 32 in the Delta).

The basic dependent variable in this paper is the poverty status of the household, i.e.,

whether or not the household is "in poverty." Poverty status is determined by comparing the total

income of all related persons in the household "to the poverty threshold for a family of that size

and composition (as determined by U.S. Office of Management and Budget). The poverty

thresholds are revised annually and include adjustments based on inflation rates. (They are based

on) money income before taxes to determine whether a family is above or below the poverty

threshold" (Garcia 2008: 12). The thresholds are intended to represent the minimum amount of dollar income required for a household of a particular size and composition to provide for the basic necessities of food and housing.

Table 2 presents the official poverty thresholds according to household size and the number of children in the household for the year of 2006. For example, according to these threshold data, a household containing three adults and two children would require a minimum annual money income of $24,662 to be able to provide for its basic food and housing requirements.

How is the poverty statistic for a specific household determined? Suppose that a hypothetical household has five related members, namely, a father, mother, grandmother, and two children. Assume that the father's annual income is $5,000, the mother's, $10,000, and the grandmother's, $10,000; assume the two children produce no money income. The household's total money income is $25,000. The poverty threshold for a five person family with two children is $24,662 (see Table 2). The household's income of $25,000 is divided by its poverty threshold of $24,662, yielding a quotient of 1.01. The quotient is multiplied by 100, producing a product of 101, which is the household's poverty statistic. It means that this hypothetical household has an annual money income that is 1 percent above the poverty threshold for a household of its size.

All households in our sample with a poverty statistic of 100 or less are considered to be in poverty and are assigned a value of 1 on the "poverty" variable; households with values above 100 are assigned a value of 0. We developed two additional poverty variables, namely, "deep poverty" (poverty scores of 50 or less), and "near or in poverty" (poverty scores of 150 or less). Every household in our sample of over 26,000 households thus has values of 0 or 1 on the three poverty dummy variables.

As already noted we are hypothesizing that a household's likelihood of being in poverty will be influenced by both household-level and PUMA-level characteristics. The households of the Borderland and the Delta are nested in a hierarchical structure of geographical units known as PUMAs (10 PUMAs in the Borderland and 34 in the Delta). We propose to estimate multilevel models in which characteristics of the households and characteristics of their respective PUMA regions are hypothesized to influence the log likelihood of a household being in poverty. However, we first need to determine whether there is a statistically significant amount of variation in the dependent variable, poverty status, at the level of the PUMAs, level-2. If there is not, then a multilevel analysis is not appropriate.

Multilevel analysis is only appropriate when there is a statistically significant amount of variance in the dependent variable at level-2, i.e., among the 44 PUMAs. The level-2 variance values, known as τ_{00}, for each of the three poverty dependent variables (in poverty, in deep poverty, and near or in poverty) are shown in Table 3, along with their respective $\chi 2$ values and significance levels. We see that each τ_{00} is statistically significant, justifying the multilevel analysis of each of the three poverty dependent variables.

In Table 3 we also report intra-class correlations for each of the three poverty dependent variables. The intra-class correlation is the ratio of level-2 variance (noted above, referred to as τ_{00}) to the total variance in the dependent variable, and represents the proportion of variance that occurs at level 2. In a nonlinear model, however, the variance at level-1 is heteroscedastic so cannot be used per se in the denominator. Long and Freese (2005) and Raudenbush and Bryk (2002: 334, footnote 2) recommend conceptualizing the level-1 model and its dependent variable, i.e., being in poverty (yes or no), in terms of a latent (unmeasured) variable, and to consider its variance as $\Pi^2/3$, i.e., the constant variance of the unmeasured latent variable of 3.29.

Thus the intra-class correlation, ρ, is calculated as:

$$\rho = \tau00/ (\tau00 + \Pi^2/3)$$

We report in Table 3 that the three poverty dependent variables all have statistically significant variances at level-2: for the "100% poverty" variable, 5.6 percent of its variance is at level-2, i.e., the level of the PUMAs; for the "deep poverty" variable, 5.4 percent of its variance occurs at level-2; and for the "near poverty" variable, 5.6 percent of its variance occurs at level-2. Multilevel analyses of the three poverty variables are statistically appropriate. We discuss now the kinds of statistical techniques that could be used to take hierarchical structure into account.

Traditionally, there have been two obvious and elementary procedures, both of which have problems; one involves disaggregation, and the other involves aggregation. The first is to disaggregate all the PUMA level variables down to the level of the households. The problem with this approach is that if we know that households are from the same PUMA region, then we also know that they have the same values on the various PUMA characteristics. "Thus we cannot use the assumption of independence of observations that is basic for the use of classic statistical techniques" (de Leeuw, 1992: xiv) because households are not randomly assigned to PUMA regions.

An alternative is to aggregate the household-level characteristics up to the PUMA level and to conduct the analysis at the aggregate level. In the case of our research, we could aggregate, i.e., average, the PUMA-specific household-head characteristics on age, sex, education, socioeconomic status, minority status up to the PUMA level of analysis and then conduct the analysis among the 44 PUMA units. The main problem here is that we would be

discarding all the within-group (PUMA), that is, household, variation, which could well mean that much of the variation would be thrown away before the analysis begins. Also, often the relations between the aggregate (PUMA) variables are much stronger, and could well be different from their relationships at the household level. Information is frequently wasted, and, moreover, the interpretation of the results could be distorted, if not fallacious, if we endeavored to interpret the aggregate relationship at the individual level (de Leeuw, 1992: xiv; Robinson, 1950).

Given the above problems, we employ in our paper a statistically correct multilevel model, specifically a hierarchical generalized linear model (HGLM) (Bryk et al., 1996), to assess the likelihood of households in the Borderland and Delta being in poverty. The specific question we are able to address with a multilevel model is to what extent do the human capital characteristics of the household heads themselves, as well as the areal characteristics of their PUMAs, influence their likelihood of being in poverty (see also Bryk and Raudenbush, 1992; Raudenbush and Bryk, 2002).

Using HGLM we essentially undertake regressions of regressions. We first conduct a series of separate logistic regressions of the likelihood of a household being in poverty, one regression for each of the 44 PUMAs; these are referred to as level-1, or within-region, equations. Their intercepts and coefficients are then used as the dependent variables in a set of equations across the PUMA regions, referred to as level-2, or between-region, equations. This HGLM strategy produces "approximate empirical Bayes estimates of the randomly varying level-1 coefficients, generalized least squares estimators of the level-2 coefficients, and approximate restricted maximum-likelihood estimators of the variance and covariance parameters" (Bryk et al. 1996: 128).

The level-1 structural model has five level-1 independent variables (see above discussion); there is no serious multicollinearity among these five level-1 independent variables. The basic level-1 (household) equation is as follows:

$$n_{ij} = log\ [\ \phi_{ij}\ /\ 1 - \phi_{ij}\ ] = \beta_{0j} + \beta_{1j}\ (AGE)_{ij} + \beta_{2j}\ (SEX)_{ij} + \beta_{3j}(EDUC)_{ij} + \beta_{4j}(SEI)_{ij} + \beta_{5j}(MINORITY)_{ij} + r_{ij}$$

Note that the intercept and the five slopes have been subscripted with j. Thus the six effects, β_{0j} and β_{1j} through β_{5j}, are permitted to vary across all 44 of the PUMAs of the Borderland and the Delta. They are thus treated as random.

We now turn to the level-2, or PUMA-based equations, in which we use PUMA level characteristics to predict each of the above six effects. As already noted, we use five PUMA based (i.e., level-2) independent variables, namely, the percentage of the working age population of the PUMA employed in finance, insurance, and real estate (FIRE); the percentage of the PUMA population with less than a 9th grade education; the percentage of the PUMA population in poverty; the percentage of the PUMA population living in rural areas; and the percentage of households in the PUMA that are headed by a female with no husband present; plus, we include a "borderland" dummy variable (scored 1 if the PUMA is located in the Borderland, 0 if located in the Delta). The five substantive level-2 independent variables may not all be used in the same regression equation because of serious multicollinearity. Thus we estimate three separate models, one with the less than 9th grade variable and the rural variable; another with the less than 9th grade variable and the poverty variable; and a third with the FIRE variable and single female household variable.

We show below the first set of six level-2, i.e., PUMA level, equations used to estimate

the six household level effects shown in the above level-1 equation; this first set uses the two

level-2 independent variables of less than 9th grade and rural; this set of equations is as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\ (<9th) + \gamma_{02}\ (RURAL) + \gamma_{03}\ (BORDERLAND) + u_{oj}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}\ (<9th) + \gamma_{12}\ (RURAL) + \gamma_{13}\ (BORDERLAND) + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}\ (<9th) + \gamma_{22}\ (RURAL) + \gamma_{23}\ (BORDERLAND) + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}\ (<9th) + \gamma_{32}\ (RURAL) + \gamma_{33}\ (BORDERLAND) + u_{3j}$$

$$\beta_{4j} = \gamma_{40} + \gamma_{41}\ (<9th) + \gamma_{42}\ (RURAL) + \gamma_{43}\ (BORDERLAND) + u_{4j}$$

$$\beta_{5j} = \gamma_{50} + \gamma_{51}\ (<9th) + \gamma_{52}\ (RURAL) + \gamma_{53}\ (BORDERLAND) + u_{5j}$$

Two more sets of six level-2 equations are also estimated; only the level-2 independent

variables change in the second and third sets. The second set uses the less than 9th grade variable

and the poverty variable; and the third set uses the FIRE variable and the female household

variable. These equations are not shown above.

In the level-1 model, n_{ij} is the predicted log-odds of success, i.e., the logit of being in

poverty, and it may be converted to an odds by exponentiating its coefficient. It is being

predicted by the household head's age (AGE), sex (SEX), years of schooling (EDUC),

socioeconomic status (SEI) and whether or not the head is a minority (MINORITY).

In the level-2 model shown above, each of the level-1 coefficients, i.e., the intercept and

the five logistic regression coefficients, are being predicted by two PUMA characteristics,

namely, the percent with $<9^{th}$ education, and the percent RURAL, plus a BORDERLAND

dummy used as a control (see above discussion). The level-2 equations are substituted into the level-1 equation and solved.

In the research we conducted for this paper, we estimated the above models separately for each of three poverty variables, namely, whether the household is in poverty, whether the household is in deep poverty, and whether the household is near or in poverty (see discussion above of these three poverty variables). However, the three poverty variables are positively related with each other. These relationships are shown in Table 4, a matrix of correlations of the three poverty variables with each other across the 26,425 households. The near poverty and 100 % poverty variables have the highest correlation, r = .72. The near poverty and deep poverty variables have the lowest zero-order correlation, r = .41. The three poverty variables are indeed positively related. Hence when we estimated separate multi-level models for each of the three poverty measures, we found that the macro-level and micro-level results predicting each of the three poverty variables to be sufficiently similar. Thus we present below only the results for the 100% poverty variable. The effects of the independent variables on the other two poverty variables are quite similar to those reported below for the 100% poverty variable. In the next section we present the results of our analyses.

Results

We present in Table 5 descriptive data for the dependent variables, and the level-1 and level-2 independent variables. Among the 26,425 households in the Borderland and Delta, 6.5 percent of them are in deep poverty, 18.1 percent of them are in poverty, and 29.8 percent of them are in or near poverty. When we calculate the means for the households separately for the

Borderland PUMAs and the Delta PUMAs (table not shown), we find that for the three poverty measures, the rates for the Borderland households are 3, 7 and 10 percentage points, respectively, higher, than the rates for the Delta households.

Among the more than 26 thousand households, 45 percent of them are headed by females; the household heads on average are 51 years of age, they have 10.5 years of completed education, and a Duncan SEI score of 33.2. Almost 40 percent of them are minorities (Hispanics in the Borderland or African American in the Delta) (Table 4).

Regarding the level-2 independent variables measured for the 44 PUMAs, on average 4.8 percent of the labor force is engaged in fire, insurance and real estate (FIRE), 27.4 percent of their populations on average have less than a 9th grade education, 12.3 percent are in poverty, and almost 40 percent are rural. Finally, the PUMAs on average have 22 percent of their households headed by females with no husbands present.

The first multilevel regression we estimated only uses the five level-1 independent variables, plus the PUMA level-2 Borderland dummy variable. These results are shown in Table 6. We see, first, that poverty on average is higher in Borderland households than in Delta households (an observation made by us earlier). The odds ratio for the "Texas PUMA" variable (γ_{01}) is 1.63 and is statistically significant. The odds of Texas Borderland households being in poverty are 63 percent greater than the odds of Delta households being in poverty. The direct effects of the five household-level (level-1) independent variables, $\gamma_{10}, \gamma_{20}, \gamma_{30}, \gamma_{40},$ and γ_{50} are all statistically significant and in the directions predicted. For instance, for every one additional year of education of the household head, γ_{30}, the odds of the household being in poverty drop by 16 percent. If the household head is a minority, γ_{50}, the odds of the household being in poverty are 104 percent higher than if the household head were not a minority. The age of the household

head, γ_{10}, is shown to be negatively associated with the household being in poverty, and

households with female heads, γ_{20}, have a greater likelihood of being in poverty than households

headed by males. Finally, the more Duncan SEI units of the household head, γ_{30}, the less likely

the household will be in poverty. These household (level-1) relationships are what one would

expect based on prior literature about the micro-level effects of poverty.

The major question to be addressed in this paper concerns the extent to which spatial

location matters with regard to having an effect on the likelihood of being in poverty. That is,

after taking into account the effects on poverty of the household-level (level-1) characteristics

(just discussed and reviewed), do spatial characteristics of the PUMAs (level-2) in which the

households are located have statistically significant and independent effects. Does space matter

with regard to predicting the occurrence of poverty, after controlling for the individual household

(level-1) effects?

We wish to ascertain whether and the degree to which five PUMA-level characteristics

have an effect on the likelihood of households being in poverty, after controlling for the effects

on poverty of the household characteristics. These five PUMA based (i.e., level-2) independent

variables are the percentage of the working age population of the PUMA employed in finance,

insurance, and real estate (FIRE); the percentage of the PUMA population with less than a 9th

grade education; the percentage of the PUMA population in poverty; the percentage of the

PUMA population living in rural areas; and the percentage of households in the PUMA that are

headed by a female with no husband present. We have also already noted that it is not possible to

use all five of these substantive level-2 independent variables in the same regression equation

because of serious multicollinearity. We thus estimate three multilevel models, using three

different pairs of the five PUMA-level independent variables.

We present in Table 7 the regression results of the first multi-level model. It contains as independent variables the already mentioned five household variables, plus the two PUMA characteristics of the percentage of the PUMA with less than a 9th grade education, and the percentage of the PUMA population living in rural areas. The 9th grade education variable is hypothesized to be positively associated with poverty, and the rural variable negatively related. Also, in the equation we control for the fact that poverty is higher in the Borderland than in the Delta by including a dummy variable noting whether or not the PUMA is in the Texas Borderland (1 = yes).

Of the two PUMA level effects, γ_{01} and γ_{02}, the less than 9th grade education variable has the hypothesized positive and statistically significant effect; the γ_{01} odds ratio is 1.06. For every 1 percent increase in a PUMA's percentage of the population with less than a 9th grade education, the average odds of households being in poverty are increased by 6 percent. The effect on poverty of the rural variable is not statistically significant.

In the above paragraphs we considered the direct effects of the PUMA-level variables on the average likelihood of households being in poverty. Another way to consider the effects of the PUMA variables is to examine their indirect effects. That is, we may ascertain whether a PUMA-level variable has an effect on the slopes of one or more of the five household-level variables. These indirect effects are referred to as cross-level interactions (CLIs). There are several such CLIs shown in Table 7.

Consider, for example, the value of the logit coefficient, γ_{51}, of 0.02. This is a CLI referring to the effect of the PUMA-level (level-2) variable, percent of the PUMA with less than a 9th grade education, on the slope of the household-level (level-1) variable of minority status on poverty. The minority status slope itself, γ_{50}, has a logit coefficient value of .71. Households

headed by minorities have expected log odds of being in poverty that are 0.71 higher than that of households headed by Anglos. The CLI effect is $\gamma_{51} = 0.02$. This is the effect of the variable percent in the PUMA with less than a 9th grade education on the minority status-poverty slope. Its statistically significant value of 0.02 means that across the PUMAs, with every one percentage increase in the less than 9th grade education variable, the PUMA's slope of minority status on poverty is increased by .02. That is, the positive effect of minority status on the likelihood of being in poverty becomes stronger when the PUMA spatial variable measuring the percentage with less than a 9th grade education increases. Again, spatial location matters. But the importance here of spatial location is not with regard to its direct effect on poverty, but with respect to its indirect effect.

The results shown in Table 7 show one additional statistically significant CLI, representing the cross-level interaction of the percentage rural variable on the slope of age on poverty. As already noted, age has a very strong and statistically significant effect on being in poverty; the older the household head, the less the log odds of being poverty. The CLI of $\gamma_{12} = 0.001$ means that as the percentage of the rural population of the PUMA increases, the negative slope is decreased slightly. The other CLIs involving the substantive PUMA-level variables are not statistically significant.

In Table 8 we present the results of a second multi-level logistic regression equation; this equation differs from that presented in Table 7 in only one way; the PUMA variable measuring the percent with less a 9th grade education variable has been replaced by a variable measuring the percentage of the PUMA population in poverty. We consider first the direct effects of the two PUMA variables, percent in poverty γ_{01} and percent rural γ_{02}. The direct effect of the percentage in poverty is positive and statistically significant, $\gamma_{01} = 0.13$, with an odds ratio of 1.13. With

every increase in one percentage of the PUMA's population in poverty, the average odds of households in the PUMA being in poverty are increased by 13 percent. This is a very strong and direct effect. We show that even after controlling for the individual predictors of poverty, there remains an important effect of the poverty level of the PUMA. The poorer the PUMA, the greater the likelihood the households will be in poverty. Also, as was the case with the rural variable in the previous equation (Table 7), in the present equation it does not have a statistically significant effect.

What of the cross-level interactions? The most interesting one is the effect of the PUMA percent in poverty on the minority-poverty slope, $\gamma_{51} = 0.04$. The higher the poverty level of the PUMA, the steeper the slope of minority status on poverty. Minority households heads in poor PUMAs have a higher likelihood of being in poverty than minority heads in more well-off PUMAs. Spatial location matters.

We turn finally to a third multi-level equation. This equation introduces two new PUMA-level variables, the percent of the PUMA engaged in finance, insurance and real estate (FIRE), and the percentage of the households in the PUMA that are headed by females with no husbands present. We first consider the direct effects of these two PUMA variables. The direct effect on poverty of the FIRE variable is $\gamma_{01} = -0.18$, with an odds ratio of 0.83. With every one percent increase in FIRE in the PUMA, the average odds of households in the PUMA being in poverty drop by 17 percent. The direct effect on poverty of the PUMA variable measuring the percentage of single female-headed households is $\gamma_{02} = 0.04$, with an odds ratio of 1.04. An increase in one percent of single female-headed households in the PUMA leads to a 4 percent increase in the expected average odds of the PUMA households being in poverty. Again, after controlling for the individual household effects on poverty, these two PUMA-level variables are shown to have

statistically significant effects. Spatial location is important and significant with regard to predicting the odds of households being in poverty.

There are several significant CLIs reported in Table 9. There are two involving the FIRE variable, namely, $\gamma_{41} = 0.001$ and $\gamma_{51} = 0.07$. With every one percent increase in FIRE in the PUMA, the negative PUMA slope of Duncan SEI of the household head on poverty becomes slightly less negative, i.e., γ_{41}. And with every one percent increase in FIRE in the PUMA, the positive slope of minority status on poverty becomes less positive, that is, it drops by .07, i.e., γ_{51}. This means that increases in levels of finance, insurance and real estate in the PUMA lead to decreases in the log odds of minority households being in poverty. This is yet another indication of our general finding that space matters.

Discussion

The results reported above show the importance of spatial effects on poverty. Characteristics of the PUMAs located in the Lower Mississippi Delta and the Texas Borderland have important and statistically significant effects on the likelihood of households in the PUMAs being in poverty, even after controlling for the characteristics of the households. Many have observed that the extreme poverty that exists in the Borderland and the Delta is the product, in part, of particular historical legacies, particularly with regard to the poverty dynamics of the minority and majority populations. A very important contribution of our research is our demonstration that variation in the contextual conditions of the PUMAs in which the households are located have important effects on poverty. For too long, it has been assumed that the individual-level factors are the main predictors of poverty, and that these factors work the same way for all demographic groups, regardless of where they live. That is, some earlier research has

tended to minimize the effects on poverty of spatial location. Our major contributions is showing that place per se is important in predicting poverty.

This demonstration is especially important. Knowledge derived from our research could well be used to enhance efforts aimed at improving the quality of life in the Borderland and Delta regions. Some of the results reported in this paper broaden our understanding of the relationships between race, ethnicity, place, and poverty. Our demonstration of the statistically significant and important effects on poverty of PUMA-level characteristics could well be used by other researchers, policymakers, and local stakeholders to craft targeted strategies aimed at ameliorating poverty and increasing prosperity in the two most economically distressed rural regions of our country. For example, programs could be developed to increase the levels of economic development in some of the poorer areas of the Borderland and Delta by bringing in more financial, commercial and real estate enterprises. We know from our research that that this kind of community infra-structure development will by itself reduce in several different ways the poverty in the community.

In the paper we are now writing that will be completed by the time of the conference, we address in greater detail some of the implications of the research reported in this paper.

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Table 1
Percent in Poverty for the United States, the Delta, and the Borderland

	Total Population	White	Black	Latino
United States	12.4	9.1	24.9	22.6
Delta	22.6	12.9	37.8	--
Borderland	29.5	10.0	17.2	34.0

Source: 2000 Census Summary Files

Table 2

Poverty Thresholds for 2006 by Size of Family and # of Related Children <18

Size of family unit	Weighted average thresholds	# of Related children under 18								
		None	One	Two	Three	Four	Five	Six	Seven	Eight or more
One person	10,294									
Under 65 years	10,488	10,488								
65 years and over	9,669	9,669								
Two people............................	13,167									
Householder under 65	13,569	13,500	13,896							
Householder 65 years	12,201	12,186	13,843							
Three people........................	16,079	15,769	16,227	16,242						
Four people.........................	20,614	20,794	21,134	20,444	20,516					
Five people.........................	24,382	25,076	25,441	24,662	24,059	23,691				
Six people...........................	27,560	28,842	28,957	28,360	27,788	26,938	26,434			
Seven people.......................	31,205	33,187	33,394	32,680	32,182	31,254	30,172	28,985		
Eight people........................	34,774	37,117	37,444	36,770	36,180	35,342	34,278	33,171	32,890	
Nine people +	41,499	44,649	44,865	44,269	43,768	42,945	41,813	40,790	40,536	38,975

Table 3.

One-way ANOVAs for Non-linear
Logistic Regression Multilevel Models

Model	τ_{00}	$\chi 2$	P-value	$\tau_{00}/(\tau_{00}+\Pi^2/3)$
deep poverty	0.186	344.9	0.000	0.054
100% poverty	0.194	789.3	0.000	0.056
near poverty	0.193	1057.0	0.000	0.056

Table 4.
Correlation Matrix,
Three Poverty Measures:
26,425 Households in the Borderland and Delta, U.S. 2006

	Deep-poverty	Poverty	Near-poverty
Deep-poverty	1.0000		
Poverty	0.5625	1.0000	
Near-poverty	0.4059	0.7215	1.0000

Table 5.

Descriptive data, Dependent Variables and
Level-1 and Level-2 Independent Variables:
26,425 Households in 44 PUMAs, 2006

Variable	Mean	Std. Dev.	Minimum	Maximum
Dependent variables*				
Deep poverty	0.065	0.247	0	1
poverty	0.181	0.385	0	1
near poverty	0.298	0.457	0	1
Level-1 independent variables*				
Sex of Head	1.45	0.50	1 (mal)	2 (fem)
Education (years)	10.5	3.1	1	17
Duncan SEI	33.2	28.1	0	96
Age	51.1	15.2	20	79
Black or				
Hispanic (Yes =1)	0.39	0.49	0	1
Level-2 independent variables**				
Percent FIRE	4.83	1.50	3	9
Percent < 9th gr.	27.37	7.29	11	40
Percent in poverty	12.32	4.00	4	22
Percent rural	39.92	22.80	1	84
Percent female households, with				
no Husband	22.00	6.43	11	40

* N = 26,425 households
** N = 44 PUMAs

Table 6.

**Level-1 Variables and Whether PUMA is in Texas, Predicting 100% Poverty:
26,425 Households, 44 PUMAs, Borderland and Delta, 2006**

Variable	Gamma (γ)	Logit Coef	Odds Ratio	t-ratio
Intercept	γ00	-1.91	0.15	-36.23
Texas PUMA	γ01	0.49	1.63	3.36
Age	γ10	-0.03	0.97	-23.02
Texas PUMA (CLI)	γ11	0.00	1	0.65
Sex	γ20	0.99	2.69	27.83
Texas PUMA (CLI)	γ21	-0.36	0.71	-4.34
Education	γ30	-0.17	0.84	-27.25
Texas PUMA (CLI)	γ31	0.02	1.02	1.72
Duncan SEI	γ40	-0.03	0.97	-28.49
Texas PUMA (CLI)	γ41	0.00	1	0.77
Main-Minority	γ50	0.71	2.04	15.68
Texas PUMA (CLI)	γ51	-0.20	0.82	-1.93

Table 7.

Level-1 & Level-2 Variables and Whether PUMA is in Texas, Predicting 100% Poverty: 26,425 Households, 44 PUMAs, Borderland and Delta, 2006

Variable	Gamma (γ)	Logit Coef	Odds Ratio	t-ratio
Intercept	γ00	-2.00	0.13	-57.46
%<9th grade	γ01	0.06	1.06	11.19
% Rural	γ02	0.00	1	-1.02
Texas PUMA	γ03	0.69	2	8.75
Age	γ10	-0.03	0.97	-24.71
%<9th grade (CLI)	γ11	0.00	1	-0.3
% Rural (CLI)	γ12	0.00	1	2.68
Texas PUMA (CLI)	γ13	0.01	1.01	1.81
Sex	γ20	1.04	2.84	28.88
%<9th grade (CLI)	γ21	0.00	1	0.09
% Rural (CLI)	γ22	0.00	1	0.68
Texas PUMA (CLI)	γ23	-0.32	0.73	-2.85
Education	γ30	-0.18	0.83	-25.21
%<9th grade (CLI)	γ31	0.00	1	0.85
% Rural (CLI)	γ32	0.00	1	1.27
Texas PUMA (CLI)	γ33	0.04	1.04	2.25
Duncan SEI	γ40	-0.03	0.97	-26.03
%<9th grade (CLI)	γ41	0.00	1	-0.09
% Rural (CLI)	γ42	0.00	1	0.85
Texas PUMA (CLI)	γ43	0.00	1	1.03
Main-Minority	γ50	0.71	2.03	14.81
%<9th grade (CLI)	γ51	0.02	1.02	2.64
% Rural (CLI)	γ52	0.00	1	0.28
Texas PUMA (CLI)	γ53	-0.11	0.9	-0.97

Table 8.

Level-1 & Level-2 Variables and Whether PUMA is in Texas, Predicting 100% Poverty: 26,425 Households, 44 PUMAs, Borderland and Delta, 2006

Variable	Gamma (γ)	Logit Coef	Odds Ratio	t-ratio
Intercept	γ00	-2.01	0.13	-72.35
% INPOV	γ01	0.13	1.13	17.95
% Rural	γ02	0.00	1	0.61
Texas PUMA	γ03	-0.06	0.94	-0.76
Age	γ10	-0.03	0.97	-23.54
% INPOV (CLI)	γ11	0.00	1	-1.27
% Rural (CLI)	γ12	0.00	1	2.84
Texas PUMA (CLI)	γ13	0.01	1.01	2.05
Sex	γ20	1.05	2.85	27.55
% INPOV (CLI)	γ21	0.00	1	0.05
% Rural (CLI)	γ22	0.00	1	0.76
Texas PUMA (CLI)	γ23	-0.35	0.7	-1.85
Education	γ30	-0.19	0.83	-25.2
% INPOV (CLI)	γ31	0.00	1	0.17
% Rural (CLI)	γ32	0.00	1	1.32
Texas PUMA (CLI)	γ33	0.04	1.04	1.58
Duncan SEI	γ40	-0.03	0.97	-26.12
% INPOV (CLI)	γ41	0.00	1	-0.72
% Rural (CLI)	γ42	0.00	1	0.84
Texas PUMA (CLI)	γ43	0.00	1	1.04
Main-Minority	γ50	0.70	2.01	14.45
% INPOV (CLI)	γ51	0.04	1.04	2.45
% Rural (CLI)	γ52	0.00	1	0.61
Texas PUMA (CLI)	γ53	-0.33	0.72	-2.53

Table 9.

Level-1 & Level-2 Variables and Whether PUMA is in Texas, Predicting 100% Poverty: 26,425 Households, 44 PUMAs, Borderland and Delta, 2006

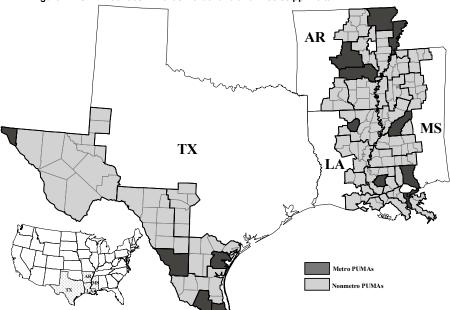| Variable	Gamma (γ)	Logit Coef	Odds Ratio	t-ratio
Intercept	γ00	-1.99	0.14	-46.81
% FIRE	γ01	-0.18	0.83	-5.56
% fem HH, no H	γ02	0.04	1.04	5.08
Texas PUMA	γ03	0.63	1.89	5.24
Age	γ10	-0.03	0.97	-23.56
% FIRE (CLI)	γ11	0.00	1	-1.6
% fem HH, no H (CLI)	γ12	0.00	1	-2.01
Texas PUMA (CLI)	γ13	0.00	1	0.16
Sex	γ20	1.03	2.8	29.77
% FIRE (CLI)	γ21	-0.01	0.99	-0.3
% fem HH, no H (CLI)	γ22	0.00	1	0.4
Texas PUMA (CLI)	γ23	-0.36	0.69	-4.05
Education	γ30	-0.18	0.83	-25.88
% FIRE (CLI)	γ31	0.00	1	0.33
% fem HH, no H (CLI)	γ32	0.00	1	0.31
Texas PUMA (CLI)	γ33	0.03	1.03	2.09
Duncan SEI	γ40	-0.03	0.97	-27.49
% FIRE (CLI)	γ41	0.00	1	-3.23
% fem HH, no H (CLI)	γ42	0.00	1	-0.62
Texas PUMA (CLI)	γ43	0.00	1	0.35
Main-Minority	γ50	0.70	2	14.6
% FIRE (CLI)	γ51	-0.07	0.93	-2.43
% fem HH, no H (CLI)	γ52	0.01	1.01	1.83
Texas PUMA (CLI)	γ53	-0.15	0.86	-1.28

Figure 1. PUMA Counties in Texas Borderland and Mississippi Delta

Metro PUMAs

Nonmetro PUMAs