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Rural and Urban Difference

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Regional Poverty in Michigan: Rural and Urban Difference

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Abstract

This paper examines the relationship between the quality of local labor force and variation in regional poverty outcomes among Michigan areas. A regional poverty model is derived from the household production model for that purpose. The US Census 2000 data on small geographical areas of Michigan (Census Block Groups) is used for the analysis. It is found that the difference in regional poverty is explained primarily by differences in quality and quantity of labor available to a household. Second, heterogeneity of the model is detected with respect to a degree of urbanization. Also, the relation between average income and regional poverty is found to be nonlinear and distribution of income playing a major role in explanation poverty. Higher poverty rates in rural areas tend to persist over time.

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A. General Objective and Motivation

Poverty attracts a lot of attention from researchers and policy makers (Glennerster, 2002; Lipton & Ravallion, 1995). However, many issues related to poverty are still to be investigated. One of them is what drives the differences in income levels and poverty rates between rural and urban areas and within the labor markets. This variation is much larger than a variation across larger geographic regions like a state.

Differences in regional characteristics (historical, natural and human made as well as quality of local labor) are viewed as a source of the variation of poverty across small geographic areas. The general objective of this paper is to derive a relationship between those characteristics and regional poverty rates within the same institutional and legal framework. The second objective is to highlight some important issues of econometric analysis of a regional poverty model, namely an aggregation error, nonrandom characteristics of local population and endogenaity of some household and regional characteristics due to poverty coping behavior.

The following hypotheses are tested in response to the general objectives:

1. There is a significant difference among the regions in the way in which regional poverty responds to the same shocks (heterogeneity).
2. Average income growth and income distribution are related to regional poverty reduction non-linearly.
3. Quality of labor has stronger impact on poverty outcomes than other regional characteristics.
4. Regional poverty is persistent even after controlling for the labor market conditions and characteristics of labor.

Census 2000 data on the smallest spatial unit – a portion of Census Block Group[1] (10 km^2 on average) –is used for cross-sectional analysis of poverty in Michigan regions. It is found that the distribution of household characteristics explains a major portion of regional poverty variation. It is also found that there is a significant heterogeneity of regional poverty between rural and urban areas. In other words, regional poverty responds differently to a similar shock in rural and urban areas.

Several important features motivate the focus on regional poverty and distinguish this study from previous work. First, the model for analysis is derived from a budget constraint for a household without placing restrictions on its production behavior[2]. It implies that the distribution of individual income in a region is in part an outcome of people's choices from the options they face. This behavior is conditioned by individual characteristics and constraints (capacity), such as education, health, working experience, as well as by incentives provided by the local environment, such as wages, risks of unemployment, etc. Better understanding of that behavior can contribute to better policy design.

Second, a variance in the legal system, other institutional and macroeconomic factors are excluded as a potential source of difference by considering just one state. Third, a careful treatment of aggregation error, endogenaity and non-randomness of household characteristics is provided. The aggregation problem is due to heterogeneity of households within a region and regions over a state. The edogenaity of some household and regional characteristics (such as migration, household size) is suspected because they may reflect the outcomes of poverty coping strategies at a household level. A selective migration causes a systematic variation in unobservable

[1] See Appendix 3 for definitions
[2] See discussion of the household production model in Appendix 4.

characteristics of individuals and households, which may covary with regional poverty outcomes and be a source of a bias.

It should be noted upfront that the result of this work characterizes a long-run equilibrium. A short-run dynamics may be quite different. Similarly, the question how the equilibrium in poverty outcomes and the explanatory variables has been obtained is beyond the scope of this research.

The rest of this paper is laid out as follows: Part B of this report provides a discussion of characteristics of Michigan regions to motivate further analysis. This description provides preliminary evidence of correlation between characteristics of the labor force and labor markets and regional poverty outcomes. Part C provides a review of previous studies of regional poverty. A simple analytical model and details of the estimation procedure are specified in part D. This procedure is implemented and results are presented in Part E. Part F provides a more in-depth analysis of regional poverty deriving an extended model of regional poverty. The estimation results of extended model and policy implications are presented in Part F. The results provide elasticities[3] of poverty outcomes with respect to characteristics of regions and households that can be used for further cost-benefit analysis of alternative poverty reduction and economic development programs. Part G concludes the paper.

B. Descriptive Statistics and Preliminary Evidence

The poverty rate in Michigan was below the national average (10.5% vs. 12.4%)[4] in 1999. Still, out of a population of nearly ten million, more than one million people in the State have income below the poverty line.

[3] Elasticities refer to by how many percent a poverty rates will change in response to one percent change in an independent variable, holding other variables constant.

[4] Based on Census 2000, Summary File 3.

The highest poverty rates were in the cities of Benton Harbor and Highland Park (around 40% of households). But, smaller spatial units used in our analysis have poverty rates in a range from zero up to one hundred percent of households. Most of the rural areas in the northern and central parts of the State have household poverty rates above 15% (Figure 3), and many communities have a long history of poverty.

Parts of Census Block Groups[5] are used as a unit of analysis[6]. Those units combine the Blocks within the groups, which are not crossed by any administrative or statistical area borders. This choice of the State and units of analysis have a number of benefits. All the units are within the same formal institutional and legal framework, and share some common political and historical background.[7] The units of analysis – portions of Census Block Groups – include relatively homogenous population by the boundary design, which reduces somewhat the aggregation error. The State is somewhat isolated from the direct impact of conditions in neighboring states by natural barriers of the Great Lakes that surround it.

A wide range of poverty outcomes among Michigan regions (see Figure 3) is observed together with detailed characteristics of the population from the Census 2000 that is used as the principal data source for the analysis (descriptive statistics are presented in Appendix 2).

To make a comparison between urban and rural areas, the whole state is split in two parts. The southern part includes Michigan metropolitan and metropolitan

[5] Detailed description of different spatial units used in this analysis is presented in Appendix 3.

[6] The full sample of Michigan Census Block Groups (parts) from the Census 2000 Summary File 3 includes 13,707 spatial units. The study sample excludes 530 observations with no land area, 885 units with no population, 26 with no housing units, two areas with no reported income and one with no households. Also excluded are communities with unusual demographic characteristics. Among them, 67 had no adult of working age, 88 areas had no male or female adult of age above 25 years, 34 had average number of working age male or female adults more than 10 per household and six units had average number of dependants per household more than five. In addition, 50 observations with no worker over 16 years are excluded. The resulting sample has 12,018 spatial units with on average 1,339 inhabitants in 508 households.

[7] Still, there may be some unobserved variables that may bias the results. This issue is discussed later in part D.

adjacent areas (Beale Codes 0, 1, 2, 3, 4, 6 and 8). The northern, relatively rural, part includes Michigan non-metropolitan counties (see a map of Michigan urban/rural areas in Figure 1). Those two parts of the State have different migration and commuting patterns as well as the structure of regional economies. Southern Michigan is heavily industrialized (see a map in Figure 2) and also contains some of Michigan's best farmland. The northern half of the State has poorer soils and a shorter growing season. Forests are the dominant land use. Mining has been a major employer in the Upper Peninsula, but has been declining.

Urbanized areas are put in a separate category for each part of the State. A region is defined as urbanized if it is located inside Urbanized Areas or Urbanized Clusters[8] defined by the Census Bureau. This way the territory of the State is divided into four mutually exclusive groups. The first is the southern urbanized area, which is referred to here as the **Metropolitan Area**. This category includes all seven Michigan metropolitan areas[9], which are: Benton Harbor; Detroit-Ann Arbor-Flint; Grand Rapids-Muskegon-Holland; Jackson; Kalamazoo-Battle Creek; Lansing-East Lansing; Saginaw-Bay City-Midland. The non-urbanized part of southern Michigan is called **Metropolitan Adjacent** area and contains farms and sparsely populated residential areas.

The northern half of the state is also subdivided into two groups. One includes urbanized areas and is referred to as **Rural Towns**. It includes northern cities (none are more than 20,000 population) such as Alpena, Cheboygan, Escanaba, Gaylord, Grayling, Hancock-Houghton, Marquette, Sault St. Marie, and Traverse City, plus many smaller towns. The rest of non-urbanized northern area of the State and is called

[8] For official definition see the Census Bureau web site http://www.census.gov/geo/www/ua/ua_2k.html

[9] The largest urbanized areas, together with adjacent areas that have a high degree of economic and social integration are called metropolitan areas. For official definition see the Census Bureau web site http://www.census.gov

Rural. Tourism plays an important role in northern Michigan (see Figure 2). This area is a site for second homes and retirement. These people have good incomes, but do little for those in poverty except provide seasonal jobs. A major concern is that the northern part of the State is "very dependent upon unearned income and government earnings [such as public administration, education, social services]" (Erickcek & Watts, 2003), (see Figure 2) which all together contributed more than 30 percent of the total personal income in 2000.

About 19 percent of Michigan's total population resides in southern Metropolitan Adjacent areas, while nearly seven percent reside in the rural area (Table 1).

Table 1. Descriptive statistics of Michigan urban and rural areas

	Regions	Land area, % of total	Population, % of total	Households, % of total	Share of the Census Block Groups (observations)
Northern Part	**Rural**	54.5%	6.7%	7.0%	15.8%
	Rural Towns	0.4%	3.2%	3.5%	4.3%
Southern Part	**Metropolitan**	5.5%	71.4%	72.0%	56.4%
	Metropolitan Adjacent	39.6%	18.7%	17.5%	23.8%

Data: Census, 2000

Spatial distribution of poverty is also different between Michigan areas (Appendix 2). Metropolitan adjacent areas have the lowest poverty rate (6.3%), while the highest rate is in rural towns (14% on average). Urban poverty is concentrated in a small number of municipalities, while a large number of rural communities have poverty rates above the state average. Still, there is much variation within the northern and central parts.

Also, average household income is much lower in rural towns ($41,875 per year) while metropolitan adjacent areas have the highest income ($61,371 on average). The variance of income, however, is the highest in metropolitan areas while

the lowest variance is in rural towns. The last fact in combination with the lowest average income scales up the poverty problem in rural towns.

Quick comparison of regional characteristics maps (Figures 3-8) shows that the areas with higher poverty have lower wages, higher unemployment, lower number of working age adults per household (amount of labor force), lower education (quality of labor) and larger number of people with disabilities per household. Descriptive statistics (Appendix 2) supports this conclusion. Unemployment rate is higher on average in rural areas (7.8%), followed by rural towns (7.3%).

The age structure of the population also differs between urban and rural areas (see Figure 10). Similar to the national tendencies (Levernier et al., 2000), rural areas in Michigan have a higher share of retirees (age 65 and over) than the other regions.

The above comparison of Michigan regions can be augmented by results of a benchmark study by Erickcek and Watts (2003). They found that the growth in per capita income from 1990 to 2000 was greater in the rural counties than in the metropolitan and metropolitan adjacent counties. This suggests that over time, rural and urban differences will narrow. Keep in mind, however, that more rural areas start from a much lower base and growth may not be sustainable. Population growth is highest in the metropolitan adjacent counties.

The context for these different rates of growth is the following. Industry and population has been leaving the metropolitan areas for the nearby suburbs in southern Michigan. Some people in urbanized areas have moved to northern Michigan because of its natural beauty and more relaxed life style—most are retirees. Some small business has also moved because the owners prefer a less urbanized style of living. While great in terms of percentage growth for the northern area, the absolute numbers are still small.

Automobile manufacturing is the dominant industry in Michigan, locate primarily in metropolitan areas. The auto companies have outsourced many parts to small manufacturers across the state with lower wages providing employment outside the metropolitan areas. (Earnings per worker in the rural regions were approximately 60% of metro core counties.) This trend is now extending to firms outside of the US. Low wages in rural areas can't compete with still lower wages in poorer countries. Many non-auto firms such as Electrolux that were located in a relatively rural area have closed and moved abroad. Thus, it seems questionable whether the 1990-2000 percentage growth rates in relatively rural areas can be maintained[10].

Even if county population, employment, and per capita income grow, it does not necessarily mean that the percentage of households in poverty will decrease. Some may still be left behind. It is with this in mind that the research design and method to follow was conceived to explicitly look at explanations of poverty rates among sub-county areas (census blocks).

The factors mentioned above, as well as some others, can be causes or consequences of poverty. A theoretical model of regional poverty is needed to draw any conclusion about causal relations between regional characteristics and poverty outcomes. The next section presents a review of previous studies on regional poverty.

C. Background and Previous Studies

Literature on poverty and income distribution defines three groups of factors associated with the outcomes. The first group includes individual and household characteristics such as education, health, working experience, household composition, assets endowment etc. Many studies in development and labor economics provide

[10] However, the BEA data on per capita income growth dos not provide evidence that there is a significant difference in growth rates between metro and non-metro areas.

examples that higher quality of labor is associated with higher productivity and income, holding other factors fixed (see Shimeles et al., 2000; Strauss and Thomas, 1995, 1998; Schultz, 1988 as examples). This type of study laid the groundwork for individual-targeting policies, such as job training, improvements in education and healthcare.

A second group of studies includes regional characteristics such as climate, industrial structure of the economy, conditions of the labor and other markets, history of settlement and migration etc. A few recent studies explore the impact of these regional factors on income and poverty (e.g. Levernier et al., 2000; Partridge and Rickman, 2003; Blank, et al., 1993; Powers and Dupuy, 1994; Triest, 1997). Rebecca Blank (1993) analyzing poverty trends in the US found that wage disparities and changes in family composition are the major driving forces of cross-state differences in poverty rates. However, for smaller regions, migration plays the key role in explaining this dynamic (Madden, 2003) due to different mobility and preferences among different income groups (Goetz, 1999).

In support of Blank's results, Partridge and Rickman (2003) found that the relation between employment growth and poverty reduction depends on the composition of households in a region, industrial structure, and the employment rate. Job growth reduces poverty more rapidly under higher initial employment and for industries experiencing growth on a national level. They also found a high persistence in regional poverty over time.

The impact of the labor market differs over time and space. Changes in the industrial structure of local economies (such as plant or mine closings) increase regional poverty in the short run, but they have small long run effect (Levernier et al., 2000). The latter can be explained by response patterns in migration, unemployment,

wages and prices to employment shocks (Blanchard et al., 1992). Rural areas suffer more from "skills mismatches," which is explained by "higher geographical isolation of their residents" (Levernier et al., 2000). Bartik (2001) develops that idea further arguing for a large-scale labor demand program targeting poor regions.

Ravallion and Datt (2002) bring similar evidence from India. The effect of economic growth on regional poverty reduction depends on the industrial structure of the local economy, educational level of the population, living standards and quality of medical care (proxied by infant mortality).

A study by Jalan and Ravallion (2002) considers condition of the local infrastructure in explaining consumption growth in China's regions. They found that under-provision of infrastructure such as roads and medical services corresponds to geographical poverty traps preventing local residents from generating sufficient income.

Levernier et al. (2000) paid more attention to the distribution of individual characteristics such as education and gender. They found that education is a key factor in poverty reduction and the effect is stronger in non-metropolitan areas. It was also found that higher labor force participation of women is associated with a lower poverty rate.

The level of education and labor force participation are the result of individual decisions (are endogenous). However, those decisions are conditioned by expectations, school quality, conditions of labor market, and infrastructure. Galster (2003) provides some evidence to this point by taking a closer look at small-region poverty characteristics. Reviewing several recent studies, he found strong neighborhood specific effects on individual poverty outcomes, which works through

behavioral norms, expectations and information sharing standards common for a neighborhood.

The third group of factors explaining differences in poverty rates includes macroeconomic conditions such as variations in law (including anti-discrimination) and other cultural institutions, aggregate socio-economic characteristics, terms of trade, foreign exchange and interest rates (see World Development Report 2000/2001 as an example). Results of such a level of analysis are used as a justification for macro-level policy interventions including those focused on income growth and poverty reduction.

All the factors, mentioned above, explain the difference in income and poverty outcomes among individuals, regions and countries. However, exploring differences between rural and urban areas within one state, the first two groups play the major role.

The literature on regional poverty, however, has some large gaps. First, there is a need for a structural model to explain the role of different factors in determining the regional poverty rate. Second, migration patterns should be controlled in a more systematic way (Goetz, 1999; Madden, 2003). Third, once the focus is on regional analysis, the distributional functions of population characteristics should be properly controlled to account for heterogeneity and potential aggregation error.

It is common to disregard spatial dependence in unobservable characteristics of regional poverty. Moreover, there is circularity between regional characteristics and individual outcomes, which is not consistently addressed in the literature.

Nevertheless, a focus on regional analysis provides an array of important policy implications. Several alternatives for poverty-reduction intervention exist. Thus, a solid ground for comparison of those alternatives is needed.

D. Simple Regional Model: Design and Estimation

To test the hypothesis about the impact of regional characteristics of poverty, stated earlier, and to extend previous studies, the following procedure is proposed and will be described in this section. First, a simple regional model is derived from the poverty definition function for individual households by aggregating it over the regional population. Obviously, an average level of income is associated with poverty in a region, but it may be offset by income inequality and the relationship may not be linear and may vary from region to region.

Using this simple model, we focus on difficulties of estimation procedures, which arise due to unobservable covariates, non-randomness of population characteristics, heterogeneity and aggregation error, as well as potential endogenaity of household and regional characteristics. Later, in the following parts, we use the estimation procedure described here to analyze a more complex model of regional poverty.

Poverty is a multidimensional phenomenon[11]. However, the quite narrow definition[12] of poverty provided by the U.S. Census Bureau is used for the purposes of the analysis. According to the definition, a person is considered as poor ($p_i=1$) if he or she lives in a household i with total monetary income (y_i) below a poverty line. The line[13] (known also as a poverty threshold) depends on total size of a household (h_i). The thresholds are based on food budgets adjusted for non-food consumption[14] and inflation. The same thresholds are used throughout the United States (do not vary

[11] For discussion on poverty definition see Duclos, J-Y (2002), Ravallion, M. (2001).
[12] More details at http://www.census.gov/hhes/poverty/povdef.html
[13] See Appendix 1 for the Census Bureau Poverty Thresholds in 2000.
[14] For history of development of the poverty threshold see "The Development of the Orshansky Thresholds and Their Subsequent History as the Official U.S. Poverty Measure," by Gordon M. Fisher.

geographically). As a result, a poverty status of a household *i* and its members can be described by the following function:

$$p_i=f(y_i, z(h_i))+ \varepsilon_i \qquad \text{(Function 1)}$$

where ε_i is an individual idiosyncratic error independent across households. Because the Census Bureau uses the same definition procedure for all households, the definition function f(.) does not vary across households. However, the poverty status of some households can be assigned with an error due to reporting a household income or a household structure with an error.

Aggregation

To explore a distribution of poverty outcomes in a region we aggregate the individual poverty status function (1) over the regional population. This kind of procedure was used often in macroeconomics (Forni and Lippi, 1997, 1999) in an attempt to bring a behavioral background (micro foundations) to aggregate macroeconomic models. By doing this we establish a relation among poverty distribution (P_j) in a region *j* and distribution of income (Y_j) and household characteristics (H_j) within a region (Function 2). The regional poverty function (F_d) may be specific to a subpopulation *d* due to heterogeneity in the functional form.

$$P_{dj}=F_d(Y_j, z(H_j))+s_j+m_j+P90_j+e_d+e_j \qquad \text{(Function 2)}$$

The vectors s_j, m_j and $P90_j$ are controls respectively for a size of a region, migration and past shocks, defined later. The expression e_d+e_j is a composite error term. The use of these variables is justified and explained later in this part.

Aggregation[15] requires a careful treatment for two reasons. First, an impact of individual idiosyncratic error (ε_i, Function 1) on the regional outcome is diminishing with the number of observations over which the aggregation is made (Forni and Lippi, 1997). As Forni and Lippi show in an example (Chapter 1.3, pp.13-14), the individual error becomes insignificant in explaining variation of regional outcomes for clusters of 20 to 400 observations[16]. This range depends on the degree of correlation among the common shocks and the explanatory power of the model (R^2). However, if the error term ε_i covaries among individuals, the error converges to some constant as the size of population increases (Forni and Lippi, 1997) which stays as the regional error denoted by e_k+e_j in Formula 2. The covariation may be due to common unobservable factor such as conditions of the labor market, local infrastructure, and common historical or cultural background.

As the residual impact of individual idiosyncratic error depends on the size of the population over which the aggregation is done the size should be controlled econometrically. The size of a regional population and its area are included in the model for that purpose and are denoted in the model by vector (s_j).

Second, heterogeneity of units of analysis can lead to erroneous and meaningless results. This problem occurs when a reaction of some units of observation on the explanatory factors is functionally different from reaction of other units. Aggregation of those responses produces some third function, which is a weighted sum of the background two.

The heterogeneity problem has two implications for our analysis. One is related to aggregation of an individual model to a regional level model. Second is related to cross-regional analysis. As Forni and Lippi argue (1997) the simplest

[15] For careful theoretical treatment of aggregation see Forni and Lippi, 1997, 1999.
[16] Under assumption that the individual error has a finite variance.

solution to this problem is to disaggregate the population to a meaningful number of homogeneous sub-populations and estimate the model separately for those subgroups. Another approach is to model carefully heterogeneity of parameters within the same econometric model.

It is hard to argue from theoretical point of view what would be a source of heterogeneity in the simplistic regional model we have derived by now (Function 2). However based on common wisdom we try a few disaggregation methods: by degree of rurality (using four sub-regions defined in previous sections), by income level (based on quintiles of average income) and by economic base (based on dominant source of employment). Also, the significance of disaggregation results is tested.

Even though we can disagreggate the observations on a regional level, there is no guarantee that a region as a unit of observation does not combine two or more functionally different subpopulations contaminating the estimation results. To address this problem several steps are taken. First, the smallest spatial units in the publicly available Census 2000 data set are used (parts of Census Block Group). Those units combine relatively homogeneous population by design. Second, the distributions of income and household structure are controlled more carefully by including first two moments (mean and standard deviation) as regressors[17] where data allows. Third, a different weight is given to observations with different degree of heterogeneity (Forni and Lippi, 1997). A standard deviation of household income within a region is used as a proxy for heterogeneity and the weights are equal to the inverse of the standard deviation[18].

[17] By taking this step we may introduce a multicollinearity in our model if for the true distributions the first two moments coincide or are linearly related (like for Poisson or Chi-square distributions). This issue deserves a separate discussion on its own rights. However, as the following results indicate, this possibility does not cause serious problems in our case.

[18] This weighting is somewhat different from the standard procedure of weighting the aggregate data (Wooldridge, 1999) where a population size is suggested. However if a size of population correlates

Nonrandom Observations

The second serious problem with regional data is related to selective migration (Goetz, 1999; Madden, 2003). The issue is that groups of people or households with common unobservable characteristics select common areas of residence causing correlation of individual unobservable factors over space, which does not disappear with aggregation. The problem arises whenever those unobservable individual factors or unobservable regional factors impacting migration correlate with regional poverty outcomes. This correlation causes bias in estimation results.

To correct for selective migration, Strauss and Thomas (1995) include the factors determining migration patterns into the analytical model. In this study, those are a share of retirees in a local population (to control for destination of retirees' migration) and a dummy variable for minor civil divisions with a college or university (to control for migration of students). In the Census data set, however, migration is partially observed for the Block Groups, so share of in-migrants in local population is included into the model. The vector of controls for migration is denoted by (m_j) in the model.

Past Dependence

Third, the existence of shocks to local income, infrastructure or markets in the past may persist over time. To deal with this problem a county poverty rate from the previous Census (1990) is included in the model (Partridge & Rickman, 2003) and denoted by ($P90_j$).

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positively with degree of heterogeneity (which is true in our case) the standard procedure will give more weight to units with greater aggregation error.

Omitted Variable Bias

Fourth, even though we use several controls for unobserved covariates, the results may suffer from omitted variables bias due to unobserved conditions of the local labor market (k). To deal with those problems a multilevel structure of error is imposed (Degraff et. al., 1997) and a spatial fixed effect estimation procedure is used (Levernier, et al., 2000). Following this procedure we have included dummy variables for the local labor markets in the model. The markets are proxied by a commuting zone (Tolbert and Sizer, 1996), which include several counties tied by commuting patterns of their residents.

By including the dummies we are differencing out all observable and unobservable factors that are constant within the local labor market. As a result, the common error term e_k vanishes and deviation of characteristics of the census block group (including poverty outcome) from average characteristics of commuting zones is used for analysis. In addition, correlation of remaining error (e_j) within a minor civil division (city or township) is allowed and controlled by a cluster robust estimation procedure.

Simultaneity Bias

Finally, the endogeneity problem with household and regional characteristics may remain due to simultaneity bias. In particular, the migration outcomes may be endogenous to poverty (i.e. an outcome of regional poverty or poverty coping strategies). For example, an area with lower poverty may attract more migrants. On the other hand, people in better-off areas may have better opportunities to support larger families. A two-stage estimation procedure (Foster & McLanahan, 1996; Wooldridge, 2001, 2003) is a potential remedy for the endogeneity problem. The

potential instruments come from higher order spatial statistics and ten-year lags[19] of potentially endogenous variables as well as being informed by literature.

In a summary, we control several sources of bias in a simple regional poverty model, which are due to heterogeneity of population and aggregation error, non-random population characteristics, past dependency, unobserved regional covariates as well as simultaneously determined factors. The procedure, described above, makes us confident in an assumption that the remaining regional error (e_j) does not correlate with explanatory variables, and estimation results are unbiased.

To check whether all the steps are necessary, we should look at the statistical significance of the vectors of the control variables in the estimated results as well as running a test for endogenaity (Foster & McLanahan, 1996; Wooldridge, 2001, 2003). If statistical significance is detected and the controls correlate with other explanatory variables, omission of the controls would bias the results. Finally, a simple test for heterogeneity of parameters of a regional model is presented in Appendix 5.

E. Simple Model: Results and Implications

The simple regional poverty model (Function 2) is estimated using the procedure described in the previous section and the results are presented on Tables 3 through 5. The natural logarithm of the regional poverty rate[20] is used as a dependent variable throughout the paper. It follows that all the coefficients estimated present a percentage change (elasticity) in the poverty rate due to changes in the independent variables.

[19] From Census 1990
[20] Percentage of the total households with income below the poverty threshold is used as regional poverty rate

First, we check for a potential endogenaity of household size and migration. For that purpose we use higher order spatial data[21] on migration and the deviation of household size within a region and its square as well as the ten-year lags[22] of the deviation, migration and average number of adults per household. Those instruments do not belong to the theoretical model and survive through the over-identification test.

However, the test for endogeneity provides a negative result meaning that the endogeneity problem is not significant. It also implies that instrumenting procedure is inferior to simple OLS procedure with spatial fixed effect. The latter is used to estimate the results presented in this section. Also, we want to highlight that the spatial fixed effect model used for estimation describes the variation in poverty rates within the labor markets (commuting zones).

Second, we test for significance of differences among the results for different sub-populations using a procedure described in Appendix 5. The results of the test are presented on Table 2. The table includes the F-statistics for the interaction terms of the variables with sub-regional dummies. They indicate that the estimates of the poverty model are significantly different among the sub-populations.

For example, a distributionally neutral increase in average income is in general associated with poverty reduction (coefficients on income are negative, Table 3). However, this relation has a nonlinear form for urbanized areas (coefficient on the squared term is significant, Table 3), while it is linear for metropolitan adjacent areas and not significant for rural areas (Figure 11). This difference is statistically significant (F-statistics on income and its square is large and significant at higher than ten percent significance level, Table 2).

[21] The higher order spatial contemporaneous variables are constructed out of respective county level statistics by subtracting the summary for township, to which a block group belongs.
[22] County level data from Census 1990 is used for the ten-year lags of the higher order statistics without transformations.

The model is estimated separately for sub-populations divided by the level of urbanization/rurality (Table 3), by level of income (Table 5) and by industrial base (Table 4). The difference among the sub-populations is somewhat higher among urban/rural sub-regions described previously (F-statistics for all the interactions, the Total Difference in Table 2, is the highest).

Table 2. Significance of the difference in parameters among sub-populations, F-statistics

Parameters of the model	Rural/ Urban Sub-region	Industry Base	Income Level
Total Difference:	15.79***	10.97***	11.29***
Income[A]	2.98**	2.18*	1.93*
Income[A] Squared	2.51*	2.44*	8.26***
Standard Deviation of Income[A] Within a Region	5.59***	4.17***	3.05**
Standard Deviation of Income[A] Squared	5.77***	1.33	3.17***
Income[A] * Standard Deviation	5.11***	0.10	0.58
Average Household Size	0.96	2.38*	1.07
Standard Deviation of Household Size Within a Region	6.18***	2.17*	3.35***
In-Migration	2.45*	3.44**	0.22
Share of Retirees	0.26	2.47*	2.10*
College Town (dummy)	0.70	5.78***	3.42***
County Poverty Rate in 1990	4.33***	1.66	1.30
Population	76.40***	11.22***	22.33***
Area	10.37***	4.79***	2.76**
Constant	2.36*	2.44*	3.27*

F-statistics is presented for sub-population specific parameters (interactions).
* significant at 10%; ** significant at 5%; *** significant at 1%

[A] Natural logarithm of Average Household Income
All coefficients are subject to rounding error

However the subpopulations (sub-regions) presented in tables 3 to 5 are not totally independent. A lot of significant cross-tabulation[23] is detected among all of them. And so the results presented in tables 3 to 5 do not present independent dimensions of heterogeneity. Moreover we would not speculate on the source of the heterogeneity of the function (it is rather a topic of a separate research). Our purpose

[23] Chi-square test returns a significant cross-tabulation difference for all possible combinations. For example, majority of manufacturing dependant regions located in metropolitan and metropolitan adjacent areas. It follows that the effect of the last two sub-regions reflects tendencies in manufacturing dependant regions and vice verse.

is to show that there is a heterogeneity, which cannot be ignored without a cost. For that reason we focus primarily on the results for rural/urban sub-regions (Table 3).

Table 3. Elasticity of poverty rate—Simple Model: by Urban/Rural factor

	Rural	**Rural Towns**	**Metropo-litan**	**Metro. Adjacent**
	Poverty[A]	**Poverty[A]**	**Poverty[A]**	**Poverty[A]**
Income[B]	-1.33 (0.73)	-10.62 (2.91)***	-5.12 (3.55)***	-1.99 (1.88)*
Income[B] Squared	-0.02 (0.27)	0.37 (2.16)**	0.13 (1.88)*	-0.01 (0.14)
Standard Deviation of Income[B] Within a Region	3.09 (14.91)***	3.43 (11.24)***	3.88 (10.42)***	4.46 (16.91)***
Standard Deviation of Income[B] Squared	2.38 (9.96)***	2.93 (6.98)***	1.11 (2.51)**	3.20 (11.82)***
Income[B] * Standard Deviation	-2.02 (9.61)***	-3.25 (11.40)***	-2.04 (8.08)***	-2.21 (19.81)***
Average Household Size	-0.01 (0.13)	0.03 (0.99)	0.14 (1.80)*	0.003 (0.23)
Standard Deviation of Household Size Within a Region	0.22 (3.74)***	0.44 (3.04)***	-0.12 (1.45)	0.02 (0.49)
In-Migration	0.003 (2.19)**	0.002 (0.72)	0.005 (2.19)**	0.000 (0.06)
Share of Retirees	-0.003 (1.27)	-0.006 (3.24)***	-0.005 (1.69)*	-0.004 (3.01)***
College Town (dummy)	0.16 (1.37)	0.27 (2.63)***	0.27 (5.10)***	0.11 (0.92)
County Poverty Rate in 1990	0.20 (2.58)**	-0.10 (0.51)	0.08 (1.70)*	0.15 (3.11)***
Constant	3.07 (0.29)	-43.28 (2.11)**	-13.80 (1.69)*	1.93 (0.34)
Spatial Fixed Effect	Yes	Yes	Yes	Yes
Controls for a region size	Yes	Yes	Yes	Yes
Observations	1870	517	6771	2853
R-squared	0.84	0.92	0.95	0.88

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%;
*** significant at 1%

[A] Natural logarithm of regional poverty rate
[B] Natural logarithm of Average Household Income
All coefficients are subject to rounding error

The negative term on average income implies that one percent increase is associated with large reduction in regional poverty holding other factors fixed. This reduction may be as large as ten times in rural towns to something not significant in rural area (for regions with average parameters of income distribution). For better understanding this result we should refer to the descriptive statistics (Appendix 2). One percent of average income is in the interval from $604 in metropolitan adjacent

areas to $419 in rural towns. Large elasticity of poverty with respect to income implies that a majority of poor households have income just below the poverty line, which is not true for rural areas where the moderate growth is not associated with poverty reduction.

The relation between the average income and poverty in regions divided by industry base (Table 4) merits comment. A larger poverty reduction effect is observed in regions where educational, health and social services dominate, while no statistical relation is observed in manufacturing dominated regions. The difference among those sub-regions is statistically significant.

This result may have two implications. One is that most of the households in poverty are not related to manufacturing, and its growth may have a weaker poverty reduction effect compared with industries like construction or retail trade where majority of unskilled labor is employed. Alternatively, a poverty gap may be much larger in manufacturing related areas so that a moderate increase in the average income does not translate into a poverty reduction.

As mentioned before, the significance of the square term for the average income implies that the relation between growth and poverty reduction is not linear, however the non-linearity is significant for urbanized areas only. The positive sign indicates that larger growth would have less significant poverty reduction effect holding distribution and other factors fixed.

As we can see on Table 2, the response of regional poverty to income growth is different among the sub-regions and other sub-populations (Tables 3 to 4). The primary source of that difference is a difference in sources of income.

Similarly, a change in the income distribution is related to poverty reduction non-linearly holding average income and other factors fixed. The results imply that

increase in standard deviation (inequality) of income by one percent is associated with increase in poverty by more than three times and this effect increases quadratically. The positive terms on standard deviation and its square implies that the regions with more unequal distribution of income have higher poverty holding other factors fixed (for regions with average characteristics of central tendency in income distribution).

Turning it around, a transfer of $402 (one percent of the standard deviation in rural areas) from the upper to the lower part of the income distribution would decrease rural poverty by three times. So that the average income neutral redistribution policies (taxes, subsidies) will have large poverty reduction effect and this effect is increasing with the size of redistribution. However this effect is declining as the average income increases. Again, it makes perfect sense – more affluent regions have fewer people in poverty.

The effect of income distribution on poverty is somewhat different among the sub-regions and this difference is statistically significant. Also, it is worth mentioning that the result on income inequality is somewhat biased downward. As we use the inverse of the standard deviation of income as weights, regions with higher deviations contributed less to the results.

The negative term on the interaction between average income and the standard deviation implies that income growth has a larger poverty reduction effect in regions with more unequal income distribution, whereas change in inequality of income distribution on poverty is less positive (closer to zero) in regions with higher average income. The interaction term is larger in magnitude for rural towns meaning that those regions are more sensitive to the distributional background of growth. The difference among the regions is statistically significant.

From a policy stand point, the nonlinearity implies that there is a limit when distributionally neutral growth policies are effective for poverty reduction purposes, but this limit is higher for regions with more diverse income (interaction term is negative).

This conclusion makes sense because more unequal regions may have more poor people, holding average income constant. Moreover, there is always a limited number of poor in a small region and so, at some point, distributional neutral growth brings income of everybody above the poverty line. Growth will have no impact on poverty reduction after that point.

The result on the household size suggests that the average size plays an insignificant role in explaining regional poverty with the exception of metropolitan areas. However this difference is statistically insignificant.

In contrast, the standard deviation of household size has a positive association with regional poverty in rural areas and rural towns while it is insignificant in metropolitan and metropolitan adjacent areas (difference is statistically significant). There are several ways to interpret the relation between household size and poverty and we return to this issue later in this paper when the household structure will be modeled more carefully in the extended model.

Regarding the set of control variables included in the model, all of them were significant, supporting our concern about the problems with regional data specified earlier.

Some results on the control variables have an economic interpretation. Michigan regions with higher in-migration have a higher poverty rate (estimated coefficient is positive), which is consistent with findings in the literature. This kind of relation is explained by the fact that in-migrants tend to have better ability and quality

of labor and out-compete local population leaving them in low paying jobs (even if there is some job growth). But the positive association of in-migration with poverty is statistically significant in non-urbanized rural and metropolitan areas whereas no significant relation is detected for other areas. This difference is statistically significant. Alternative interpretation of this relation may be based on the proportion of full and part-time jobs in urban and urban areas. Also, a difference in expected wage between the areas may play a role in explaining this result (Harris&Torado, 1970).

Practically, the impact of in-migration is quite small. An increase in the share of in-migrants by one percentage point increases regional poverty rate by less than one percent.

The relation between poverty and in-migration depends on the industry base of a region (Table 4). While being positive for most of the sub-regions it turns significant in manufacturing related areas and negative in educational, health and social services related areas. It may imply that manufacturing regions attract more migrants who out-compete local population while in service-related areas in-migrants may create additional demand, stimulating growth of local economies.

In addition, in-migration of retirees, often with independent and higher sources of income, controlled by the share of people over 65 in a local population, significantly reduces the percentage of a region's households in poverty[24]. This effect is practically small. An increase of share of retirees in a local population by one percentage point is associated with reduction in poverty rate by around one percent. The difference among the regions is not significant.

[24] Note that adding wealthier people to a region can reduce the percentage of households in poverty without necessarily doing anything for those in poverty.

Table 4. Elasticity of poverty rate—Simple Model: by industry base

	Manufacturing	Educational, health and social services	Other single industries[C]	Mix[D]
	Poverty[A]	Poverty[A]	Poverty[A]	Poverty[A]
Income[B]	-1.08 (0.45)	-8.27 (4.89)***	-6.96 (2.56)**	-3.55 (2.28)**
Income[B] Squared	-0.08 (0.70)	0.28 (3.58)***	0.23 (1.81)*	0.06 (0.82)
Standard Deviation of Income[B] Within a Region	4.46 (15.10)***	3.97 (14.60)***	3.27 (7.44)***	3.76 (15.05)***
Standard Deviation of Income[B] Squared	1.79 (4.57)***	1.74 (4.55)***	2.55 (5.33)***	2.24 (7.35)***
Income[B] * Standard Deviation	-2.30 (8.33)***	-2.06 (10.56)***	-2.30 (10.21)***	-2.09 (11.92)***
Average Household Size	-0.01 (0.24)	-0.15 (2.69)***	-0.04 (1.09)	0.06 (1.08)
Standard Deviation of Household Size Within a Region	-0.15 (2.06)**	0.14 (1.07)	0.23 (2.82)***	0.06 (1.21)
In-Migration	0.004 (2.83)***	-0.003 (1.63)	0.000 (0.32)	0.003 (1.39)
Share of Retirees	-0.017 (6.26)***	-0.008 (3.22)***	-0.005 (3.49)***	-0.004 (2.04)**
College Town (dummy)	0.13 (3.25)***	0.27 (5.05)***	0.47 (3.06)***	0.45 (6.40)***
County Poverty Rate in 1990	0.06 (1.34)	0.11 (1.95)*	0.11 (0.94)	0.09 (1.54)
Constant	11.38 (0.86)	-31.94 (3.38)***	-27.70 (1.77)*	-6.17 (0.71)
Controls for a region size	Yes	Yes	Yes	Yes
Spatial Fixed Effect	Yes	Yes	Yes	Yes
Observations	3901	2258	748	5104
R-squared	0.80	0.95	0.87	0.91

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
[A] Natural logarithm of regional poverty rate
[B] Natural logarithm of Average Household Income
[C] Other dominated industries include: Agriculture, forestry, fishery, hunting and mining; Arts, entertainment, recreation, accommodation and food services; Construction; Professional, scientific and management services; Retail and whole sale trade; Public administration. However, none of those industries dominates in significantly large number of regions.
[D] Regions where non of the industries employs more than 20% of population
All coefficients are subject to rounding error

Presence of a college in a city or township is associated with a more than 20 percent higher poverty rate. This result is significant and higher for urbanized areas, however the difference among the regions is not statistically significant. The presence of voluntary low income students should not be confused with poverty of working

population. However, this finding suggests that this share of population requires some social protection. The fact that college and graduate students have to face low income may pose a barrier in achieving higher level of education. Alternatively, a definition of poverty should be adjusted.

A significant result is observed for persistence of poverty over time. One percentage point of poverty rate for a county in 1990 is associated with almost 20 percent higher poverty rate for the Census Block Groups in rural area. It is around 15 percent in metropolitan adjacent areas and around eight percent in metropolitan areas. Past dependency is not significant for rural towns. The difference among the regions is statistically significant. Persistence of regional poverty implies that its sources do not disappear over time. This result can serve as a call for a more active role of government in poverty reduction.

The controls for the aggregation error and fixed unobservables at the labor market turned out to be statistically significant. It implies that neglecting of those problems can bias the results.

The model explains around 90 percent of variation (R-squared) of regional poverty for Census Block Groups of Michigan.

The disaggregation of the regions by income level (Table 5) and industry base (Table 4) provide similar results with exceptions mentioned above. However, the result are less significant when disaggregated by income level. It implies that the average income level is not the primary source of regional heterogeneity. The only result from Table 5 that we would like to mention is regarding the income inequality. Redistribution (changes in standard deviation of income) has stronger association with poverty reduction in more affluent regions. While a distributional neutral growth (change in an average income) becomes less significant.

Table 5. Elasticity of poverty rate—Simple Model: by income quintiles

	$6,154 - 37,433	**$37,433.1 – 45,453.5**	**$45.454 – 54,362**	**$54,372 – 68,405**	**$68,409<**
	Poverty[A]	**Poverty[A]**	**Poverty[A]**	**Poverty[A]**	**Poverty[A]**
Income[B]	-16.10 (2.99)***	36.75 (0.35)	-163.75 (1.24)	-48.68 (0.54)	-6.74 (3.22)***
Income[B] Squared	0.71 (2.70)***	-1.84 (0.37)	7.43 (1.22)	2.06 (0.51)	0.21 (2.34)**
Stand. Deviation of Income[B] Within a Region	2.86 (4.28)***	2.89 (4.91)***	4.03 (15.43)***	4.66 (16.06)***	4.64 (18.30)***
Stand. Deviation of Income[B] Squared	1.14 (2.12)**	1.31 (3.41)***	2.08 (5.55)***	2.54 (6.86)***	2.42 (9.58)***
Income[B] * Stand. Deviation	-1.69 (3.58)***	-2.57 (1.60)	-3.14 (3.31)***	-3.40 (5.97)***	-1.89 (13.59)***
Average Household Size	0.07 (0.81)	0.02 (0.47)	0.07 (2.91)***	0.03 (1.51)	-0.01 (0.68)
Stand. Deviation of Household Size Within a Region	0.12 (1.14)	0.03 (0.34)	0.06 (0.74)	-0.06 (0.72)	-0.19 (4.35)***
In-Migration	0.002 (0.91)	-0.000 (0.06)	0.001 (1.22)	0.001 (0.54)	0.000 (0.31)
Share of Retirees	-0.002 (0.76)	-0.008 (3.03)***	-0.010 (4.80)***	-0.009 (4.66)***	-0.004 (2.03)**
College Town (dummy)	0.56 (5.39)***	0.29 (5.70)***	0.18 (5.08)***	0.16 (3.12)***	0.18 (2.79)***
County Poverty Rate in 1990	0.08 (0.83)	0.18 (2.74)***	0.07 (1.76)*	0.08 (1.61)	-0.02 (0.35)
Controls for a region size	Yes	Yes	Yes	Yes	Yes
Spatial Fixed Effect	Yes	Yes	Yes	Yes	Yes
Constant	-84.38 (2.68)***	221.46 (0.37)	-891.17 (1.22)	-245.70 (0.50)	-22.78 (2.15)**
Observations	2403	2404	2402	2403	2399
R-squared	0.89	0.86	0.84	0.78	0.80

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%;
*** significant at 1%

[A] Natural logarithm of regional poverty rate
[B] Natural logarithm of Average Household Income
All coefficients are subject to rounding error

The difference among poverty rates in metropolitan, metropolitan adjacent, rural town and rural areas represented by a constant intercept stays statistically significant even after controlling for distribution of income and household size. Urban areas are relatively better off (have a lower intercept). This result contradicts the observations on unconditional regional poverty. However, without more details we can only speculate on the reasons for the relation.

The non-linearity of the association between income and poverty plus the positive association of in-migration and poverty suggest that attracting new

employment and raising average income may not help the existing poor. Distribution is the key.

Moreover, significant heterogeneity of the regions opens a room for regional-specific approaches to poverty reduction policies. On the other hand, there is much less room for a generalized cross-regional analysis, which under heterogeneity may produce some occasional or meaningless result. The implication for policy is that there is no "one size fits all" solution and that regional specifics of response should be considered while designing poverty reduction regional policies.

We haven't tried to detect the sources of the heterogeneity and we do not argue that the rural/urban split is the best way to avoid the aggregation problem. Our point is that the procedure described in this chapter produces economically meaningful results and is robust to many sources of bias. Also we show a way of dealing with this problem as well as a simple test for detecting it.

Now we turn to more sophisticated regional model and apply the procedure described above.

F. Extended Regional Model: Design and Estimation

The simple regional poverty model presented earlier was a suitable test ground for the analytical approach based on aggregation of individual function and for accompanying econometric procedure. However, more rigorous treatment of household income is needed to assess the relationship between poverty and different individual and regional characteristics discussed in literature. In this part, a household income function is derived from a household production model (Singh, et. al., 1986). This model shows the relation between poverty and household characteristics, conditions of the labor market, and other factors. The income function is plugged into

the poverty definition (Function 1) and aggregated over a small geographical area. The resulting model is estimated using the procedure described in Part D. Results are presented in Part G.

The Census technical definition of poverty used in the paper helps to identify the poor and helps to assess the difference in poverty rates among Michigan regions. However, it does not help to identify all the dimensions of poverty, its causes and consequences.

To study regional difference in income distribution and poverty in more detail, background factors for the income function are needed. For that purpose the following household income function is derived from a household production model (Singh, et. al., 1986) (see Appendix 4 for details on derivation). This model identifies income as a behavioral outcome to the exogenous incentives (prices) and individual capacity (education, assets, health).

$$y_i^* = r_j a_i + w_j t_i + \pi_{ij}^*(w_j, r_j, k_j, c_{ij}, h_i) + v_{ij} \qquad \text{(Function 3)}$$

Where y_i^* is an optimal household income level; *r* is a rate of return on physical assets (*a*), *w* is a vector of wage rates on the local labor market for a stock of labor (*t*) of given quality for a household *i* residing in area *j*. The last component of the income function (*v*) is a vector of subsidies, transfers and taxes.

Function π^* denotes a real economic profit of a household production, which depends on interest and wage rates, costs (*c*) and a vector of prices (*k)* and other conditions of a region that limit production opportunities of a household. Profit is also conditioned on a set of household characteristics (*h*) including expectations, beliefs and preferences. The profit component absorbs a majority of variation of the income within a region. It turns that under equal external to a region conditions and independent distribution of a household characteristics a real loss of some household

becomes a profit of the other one. For example, a decision of one household not to participate in the labor market or not to apply for a particular job opens opportunity for others holding quality of labor the same. Individual unobservable characteristics responsible for such choices include productivity, managerial ability or preferences.

When the income function (3) is aggregated over a small region the regional income model takes the form:

$$Y_j^* = r_j A_j + w_j T_j + \pi_j^*(w, r, k, c, H) + V_j \qquad \text{(Function 4)}$$

Where Y, A, T, π , H and V are regional distributions of corresponding individual household's parameters. If the unobservable characteristics of individual households are independent within a region, the aggregation procedure makes the sum of regional profit converge to zero. A cross regional difference in the income is the result of different stocks of human and physical capital (setting aside transfers for a moment). However, if the unobserved characteristics are not independent due to some factors, the regional profit converges to some constant. Those factors could be determinants of selective migration, conditions of infrastructure, etc. If the constant is positive, a region has an advantage in comparison with other regions driven by those regional factors. A similar point holds for a negative profit, which puts the region at a relative disadvantage. Government transfers are supposed to reduce those differences among the regions. However, in practice they may become a source of the differences.

A great advantage of aggregation is that it allows to separate a variation in income or poverty outcomes caused by common factors from the impact of individual factors. The common factors include characteristics of a region and macro environment, while an example of an individual factor could be an unobserved ability or preference. The regional poverty model is obtained by substituting (Function 4) into (Function 2).

We should notice right away that the income function 4 controls already for the household size (as a part of vectors T and H) and there is no need to keep a separate control for it from Function 2. Second, the poverty definition relates the poverty outcome to observed monetary income, while functions 3 and 4 explain a real economic income. Substituting one for another introduces an additional source of measurement error due to unobservable real profit. However, acknowledging this fact we leave more rigorous treatment of this issue for future research. Third, the resulting function would relate the poverty outcome to characteristics of capital and labor markets as well as the outcomes of a household production (real profit) and government policies (taxes, subsidies, etc.) Estimation of such a model would be data and computationally intensive. To avoid this difficulty, current analysis is focused primarily on the labor market conditions (term wT).

To make this analysis valid, we have to make several assumptions. First is that the characteristics of labor market do not correlate with conditions of capital market and government transfers. Economic theory treats capital and labor as substitutes. However, such a simplification is not very harmful to the analysis of the lower part of income distribution. The poor do not hold any significant amount of production assets and so the return on assets has a little explanation of poverty outcomes. As a result this assumption is not binding.

Second, a necessary assumption that the profit does not correlate with the stock of human capital is not going to hold. Evidence can be found in (Bertrand, et. al., 2004), who conclude that poor (with lower physical and human capital) pay relatively higher price for individual mistakes (wrong choices) in production activity. For that reason, poor should be more risk averse and have relatively lower profit. It follows that the profit and stock of human capital (T) correlate positively. Since the

profit has positive correlation with income, omission of the earlier causes upward bias of estimates on the capital. However if the households' unobserved characteristics are independent within a region, the region profit tends to zero after the aggregation making the bias insignificant.

Analogously, if the system of taxes and subsidies is in general progressive (more effluent subsidize relatively poor) the correlation between transfers and the stock of capital is negative. Omission of that term brings some downward bias in the estimated parameters. However, we tend to think about a reverse causation with respect to poverty status (poverty causes subsidy but not wise verse). As a result, omission of the transfers term does not make a harm to the poverty model.

As a result, the extended model for estimation takes the form:

$$P_{jd}=f(w_{jd}, T_j) +s_j+m_j+P90_j+e_d+e_j \qquad \text{(Function 5)}$$

Where $s_j+m_j+P90_j$ is a vector of controls discussed in Part D and e_d+e_j is an error term.

Regional wage rate (w_{jd}) is treated as an expected return on labor. For that reason the estimation model includes an interaction of average wage per job on the local labor market with the unemployment rate. Also we control specifics of local labor demand by including the occupational structure and a dummy variable for each labor market, proxied by a commuting zone.

The distribution of the labor force and its quality (T_j) is controlled with an average number of working age adults per household, distribution of educational attainments for population over 25 years old, number of dependant children per

household, average number of people with disabilities per household (as proxy for a health status)[25] and average age of working age adults (proxy for experience)[26].

The endogeneity problem with labor force characteristics may bias the estimation results. In particular, the number of adults, dependant children and migration outcomes may be endogenous to poverty (i.e. an outcome of regional poverty or poverty coping strategies). For example, in better-off areas people may have better opportunities to support larger families. On the other hand, an area with lower poverty may attract more migrants. A two-stage estimation procedure (Foster & McLanahan, 1996; Wooldridge, 2001, 2003) is a potential remedy for the endogeneity problem.

As it was mentioned in Part D, the potential problem of heterogeneity of the population within a unit of observation is addressed by applying weights that are proportional to a degree of heterogeneity. In the simple model the heterogeneity is proxied with the standard deviation of the income within a region. In the extended model the variation of income is partially explained with the characteristics of demand on the labor market and labor force. To take this information into account the weights are constructed out of residuals from regression of the standard deviation on explanatory variables in the extended model.

The estimation results are presented and discussed in the next section.

G. Extended Model: Results and Implications

The second model (Function 5) explains the variation in regional poverty with labor market components of the income function. Those components include

[25] A more direct measure of health status is not available. The poor might be exposed to many other health problems affecting ability to work.
[26] The poor, who suffer unemployment have less job experience and less opportunity to learn on the job.

characteristics of labor demand such as an average wage per job, unemployment rate[27] and distribution of wages (proxied with occupational structure of employment). Those factors are thought to be beyond control of individuals in a small area such as the block group. A possible critique may be that firms' location decisions are driven by characteristics of local labor force, which certainly is true. However, firms' decisions are driven by conditions of local labor market as a whole, but not a very small portion of it such as Census Block Group. For that reason, we assume that conditions of local labor market are independent of characteristics of a small community such as Census Block Group.

A second group of variables includes characteristics of the labor force such as the amount of labor and its quality. The actual quantity of labor available to a household is proxied with an average number of adults. This number interacts with the average wage on a local labor market as informed by the household income function (Functions 3, 4). The quality of labor is described with the distribution of educational attainments, experience (proxied with the average age of the working population) and number of dependant children and persons with disabilities per household. A third group includes additional controls specified in part D. This model provides more information on the income generation behavior of a local population in comparison with the simple model estimated earlier.

Table 6 presents the results for spatial fixed effect estimation procedure with instrumental variables. Columns 1 through 4 present the estimates for rural areas, rural towns, metropolitan and metropolitan adjacent areas respectively. Instruments for census block groups include county average characteristics (excluding one township to which an observation belongs) of average household size, age of a household head and average age of adult population, proportion of females and language diversity[28] (Galster, 2003). Also, a ten-year lag for counties on average number of adults per household and its interaction with an average wage are included in the instruments list together with dummies on coastal counties and a number of colleges in a county. The instruments are jointly significant at the first stage and have survived through the over-identification test. The test for endogeneity returns a

[27] Several studies (Goetz, 1999) explain poverty and migration outcomes with an expected wage on a local labor market. This expected wage equals a product of an average wage and a probability of being employed. It is equivalent to *wage*(1-unemployment rate)*.

[28] Language diversity is constructed as a sum of squared deviations of English, Spanish, other Indo-European, Asian-Pacific and Other-languages speaking linguistic groups from equal shares. This variable proxies the cultural diversity of a community.

positive result. It indicates a presence of potential bias in estimates on the number of dependent children, adults, its interaction with wage and the migration outcomes. The test for heterogeneity (Table 7) indicates that the estimated results are statistically different among the sub-regions of the State.

Labor Market (demand)

The conditions of local labor markets (demand side) are controlled by average wage[29] per job in a county in 1998 and 1999 and unemployment rate in a county of residence as well as a distribution of wages proxied with an occupational structure of a county employment. Those variables provide some limited explanation for variation of a small area (Census Block Group) poverty outcomes (see Table 8). Conditions of the local labor market are only jointly significant in explaining poverty in rural towns. The F-statistics for this group of variables is the smallest in comparison with the other groups of variables presented in Table 8.

There are a few incidences when the conditions of the labor demand are individually significant (Table 6). However, the estimates are not statistically different among the sub-regions of the State (F-statistics for the interaction terms with the sub-region dummies is small, Table 7).

Setting aside statistical significance, a higher wage is associated with some poverty reduction in rural and metropolitan adjacent areas. While in the urbanized areas (metro and rural towns) an increase in average wage is associated with increase in regional poverty rate for regions with average rate of unemployment holding other factors fixed. This finding together with the estimate on the number of adults per household is a background for nonlinear relation between poverty and average income in urbanized areas discussed in the Part E. This non-intuitive result may reflect several tendencies. Among them are availability of welfare programs, skills mismatch, labor force participation decisions etc., which are not observed in our data set.

The positive association of higher wages and poverty is increasing with higher unemployment rate in rural and metropolitan areas. This fact provides some support to the previous interpretation of the positive association of the wages and regional poverty through the welfare programs. In other words, regions with higher wages (tax base) may have more generous local welfare programs, which either attract poor from

[29] Using data from the US Bureau of Economic Analysis

Table 6. Impact of regional characteristics on poverty rate

	Rural	Rural Towns	Metropolitan	Metro. Adjacent
	Poverty[A]	Poverty[A]	Poverty[A]	Poverty[A]
Wage	-0.96 (1.16)	12.30 (1.92)*	0.33 (0.49)	-0.002 (0.00)
Wage* Unemployment	0.81 (1.71)*	-0.34 (0.73)	0.35 (0.47)	-0.16 (0.58)
Unemployment	0.38 (1.71)*	-0.12 (0.55)	0.18 (1.25)	0.07 (0.62)
Occupation Structure[G]	0.01 (1.06)	-0.02 (1.31)	-0.03 (1.58)	0.01 (1.72)*
Adults[B]	2.11 (1.22)	12.53 (2.41)**	-5.43 (2.31)**	-0.76 (0.81)
Wage* Adults[B]	10.18 (1.71)*	44.20 (3.40)***	-3.11 (0.53)	-2.24 (1.02)
Dependants[F]	1.02 (0.82)	1.81 (0.93)	0.98 (0.70)	-2.52 (4.45)***
People with Disabilities[D]	-0.05 (0.40)	0.16 (0.36)	0.71 (3.29)***	-0.38 (1.54)
Incomplete School Education[C] (%)	0.01 (2.11)**	0.01 (0.39)	0.03 (1.69)*	0.03 (2.98)***
Incomplete College Education[C] (%)	-0.01 (1.86)*	-0.06 (4.68)***	-0.02 (1.00)	-0.01 (1.35)
Bachelor Degree[C] (%)	-0.02 (1.96)*	-0.02 (0.85)	-0.06 (1.93)*	-0.01 (1.24)
Graduate Degree[C] (%)	0.04 (3.40)***	-0.03 (1.37)	0.02 (1.24)	-0.01 (0.92)
Age[E]	0.46 (4.09)***	-1.45 (2.91)***	-1.73 (1.85)*	0.01 (0.05)
Age[E] Squared	-0.01 (4.34)***	0.02 (2.91)***	0.02 (1.81)*	-0.002 (1.05)
In-Migration	0.01 (0.65)	0.04 (0.99)	0.01 (0.58)	0.02 (1.07)
Share of Retirees	-0.04 (2.29)**	-0.06 (1.74)*	-0.14 (2.24)**	-0.05 (1.53)
College Town (dummy)	0.28 (0.77)	0.99 (3.02)***	0.53 (3.19)***	0.12 (0.33)
County Poverty Rate in 1990	0.60 (1.67)*	-0.02 (0.02)	-0.58 (1.22)	0.08 (0.19)
Constant	-9.93 (3.38)***	34.74 (3.21)***	38.96 (2.11)**	6.23 (1.26)
Controls for a Region Size	Yes	Yes	Yes	Yes
Spatial Fixed Effect	Yes	Yes	Yes	Yes
Observations	1871	517	6775	2855
R-squared	0.80	0.44	0.47	0.71

Robust t statistics in parentheses
[A] Natural logarithm of regional poverty rate
[B] Average number of working age adults per household in a region
[C] For population over 25
[D] Average number of People with Disabilities per household in a region
[E] Average Age of population in a working age cohort (16 to 65)
[F] Average number of children under 16 years old per household in a region
[G] Share of production, transportation and material moving occupations
* significant at 10%; ** significant at 5%; *** significant at 1%

outside of the region or/and increase a reservation wage for those out of the labor force.

The unemployment rate by itself tends to increase the poverty rate. This effect is particularly strong in rural areas. A one percent increase in the unemployment rate is associated with an increase in poverty rate by almost 40 percent.

Share of occupations in production, transportation and material moving proxies the distribution of wages. It has positive association with poverty in non-urbanized areas (rural and metropolitan adjacent), while it is negative in the urbanized areas (metro and rural towns). Even so, it is important to control the distribution of wages; the occupation structure is not the perfect measure. It is possible that wage rate and the nature of the jobs are different between urbanized and non-urbanized areas even within the same occupation category. Better control for the wage distribution would complicate the model without contribution to the major results.

Labor Characteristics (Human Capital)

Turning to characteristics of labor, an additional adult of working age in an average household is associated with a large increase in the regional poverty rate in rural areas and rural towns (Table 6, columns 1,2). However, in metropolitan and metropolitan adjacent areas this association is negative (Columns 3, 4). The difference among the sub-regions is statistically significant (Table 7). This result implies that an additional adult in a household in metropolitan and metropolitan adjacent areas is able to provide an additional income to a household larger than the corresponding increase in a poverty threshold. Contrarily, in rural areas and rural towns an additional adult cannot provide a sufficient income to the household.

The possible sources of such difference lay beyond the difference in unemployment rate, which is controlled in our model[30]. The primary reason for this difference may be a difference in labor force participation decision, which is driven either by cultural difference or, which is more likely, by difference in a cost of labor force participation due to conditions of infrastructure such as roads, transportation and availability of childcare facilities. Other possibility is a skills mismatch.

Some support to such interpretation we can be found in the interaction of the number of adults and wages. This term is positive and significant in rural areas and

[30] Specifics of the demand on a particular labor market such as "quality of job" are controlled by the fixed effect.

rural towns but negative in metropolitan and metropolitan adjacent areas. It implies that the estimate on number of adults becomes more positive in rural areas and rural towns and more negative in other regions as a regional wage rate increases.

Table 7. Significance of the difference among the sub-regions, F-statistics

	F-statistics
Wage	0.26
Wage* Unemployment	0.71
Unemployment	0.14
Occupation structure[G]	1.75
Incomplete School Education[C] (%)	2.16*
Incomplete College Education[C] (%)	2.53*
Bachelor Degree[C] (%)	3.76***
Graduate Degree[C] (%)	3.47**
People with Disabilities[D]	5.20***
Age[E]	1.31
Age[E] Squared	1.44
County Poverty Rate in 1990	2.69**
Share of Retirees	2.58***
College Town (dummy)	2.25**
Population	15.40***
Area	1.14
Constant	2.17*
Total:	3.94***

[C] For population over 25
[D] Average number of people with disabilities per household in a region
[E] Average age of population in a working age cohort (16 to 65)

Interactions of the endogenous variables with the dummies for sub-regions are not estimated.
* significant at 10%; ** significant at 5%; *** significant at 1%

A correlation between the average number of dependants per household, measured by number of children under 16, and regional poverty rate is consistent with the poverty definition for most of the regions. It implies that one additional child in an average household corresponds to an increase in regional poverty rate holding other factors fixed. However this correlation is negative in metropolitan adjacent areas.

This variable may capture several effects. First, the number of dependants behaves as a normal good. Demand for it increases with increased income. Second, an additional dependant person increases the poverty threshold without increasing income. Third, a dependant requires spending on care, diverting resources from production activities and investments in labor quality. The observed effect represents a net result of the processes mentioned above.

Average number of people with disabilities per household is another variable describing a household composition and the amount of labor it has. Every additional

person with disabilities per household corresponds to an increase in regional poverty rate in urbanized areas. This association is negative for the rest of the State. This result implies that society does not provide full insurance to families with disabled members and people with disabilities cannot fully cover their living costs in urbanized areas. However it is possible that the nature of disabilities is different among the sub-regions due to selective migration, which is not controlled properly.

To conclude on a household structure, it worth mentioning that the reliance on family size for determining poverty status can produce a misleading result due to endogeneity of those factors. But a key finding is that there is a significant difference in the relation between the household structure and regional poverty in different regions. This difference should be addressed both in the poverty definition and in poverty reduction and economic development policies.

Turning to quality of labor, educational level of the local population has power to explain the regional poverty rate. A higher share of population with incomplete high school education corresponds to a higher poverty rate, reflecting relatively lower quality of the regional labor force. A one percentage point increase in the share of people with incomplete high school education increases regional poverty by approximately two percent.[31] An increase in the share of population with some college or a bachelor degree associates with poverty reduction. This effect is stronger in urbanized areas where the demand for higher quality labor is higher.

Table 8. Joint significance of the groups of factors, F-statistics

	Rural	**Rural Towns**	**Metro.**	**Metro. Adjacent**
Total:	106.33***	78.08***	661.33***	522.34***
Labor market (demand): (Wage; Wage* Unemployment; Unemployment; Occupation Structure)	1.02	2.74**	0.93	1.15
Quality of labor: (Adults; Wage* Adults; Incomplete School Education; Incomplete College Education; Bachelor Degree; Graduate Degree; Age; Age Squared; Dependants; People with Disabilities)	12.32***	7.42***	8.27***	8.97***
Controls: (In-Migration; Share of Retirees; College Town (dummy); County Poverty Rate in 1990)	2.63**	5.68***	7.09***	1.48
Controls for a region size	204.15***	55.42***	6.22***	46.46***
Spatial Fixed effect	2.37***	3.89***	2.17**	5.17***

* significant at 10%; ** significant at 5%; *** significant at 1%

[31] The northern relatively rural region has the highest rate of high school completion. It seems, that the northern schools and culture are more successful. Drop out rates are higher in the metro south. Nevertheless, significant out-migration from rural area means fewer residents with college degrees leaving behind households with lower quality of human capital. However, the model is static and does not address how adjustments are made over time and how the human capital is accumulated.

The average age of the local working age cohort (16 to 65 years old) serves as a proxy for experience. It has a different impact on the poverty in different regions. Every additional year in average age of local working cohort decreases poverty by more than 1.5 times in urban areas and this impact is decreasing (the relation has a U-shape form). The interpretation is that people with more experience can earn more. The relation between age and poverty outcome in other areas, however, has a positive sign implying that physical health of youth has a higher return than experience in rural areas (the relation has an inverse U-shape form).

Jointly, the characteristics of the labor force are statistically significant. The F-statistic for this group of variables is higher than for the other groups. The only group, which has higher joint significance, is the control variables for aggregation error (Table 8).

Control variables

A variable for the share of retirees in a local population is designed to control for their migration patterns and percentage of in-migrants controls for general migration. As in the previous simple model (Table 3) the share of in-migrants positively correlates with local poverty rate.

The share of retirees captures specifics of their migration in Michigan where some older people with non-labor income (pensions, insurances, dividends etc.) are migrating to rural areas. As in results from table 3, a higher share of people over 65 is associated with lower poverty, controlling for other factors. This effect is practically stronger in metropolitan areas and lowest in rural areas. The difference among the regions is statistically significant.

College students, who forgo current income to invest in human capital to enhance future income, represent a special case of temporary chosen poverty. A dummy variable for college towns controls for communities with a high share of students.

College towns have a poverty rate up to 90 percent higher (in rural towns) than areas with similar characteristics, but no college. This difference is significant for urbanized areas. It is higher for rural towns. The greatest number of college towns have a junior two-year college where teachers are not as well paid as in the larger four-year universities.

The results on past dependency indicate a persistency of poverty in rural areas where a one percent higher poverty rate in a county 10 years previously associates with 60 persent higher poverty rate in 1999. This kind of persistency in regional poverty is called a regional poverty trap in the literature. It may happen due to the condition of local infrastructure, topography, weather or other natural or human made factors. Low income leads to poor infrastructure that feeds back again to low income. Escaping from the trap often requires a collective action and outside help. This effect has a negative sign for the urbanized areas indicating that the efforts on urban poverty reduction undertaken during the decade are not worthless.

Controls for the aggregation error turn out to be significant indicating that heterogeneity of population inside the unit of observation is a potential problem. In fact, the significance of those variables is higher than for any other group (Table 8).

A difference in the constant intercept term among the sub-region picks up a difference unexplained by conditions of labor markets and labor quality. This difference is statistically significant and indicates that rural areas have lower poverty after controlling for quality of labor force, conditions of labor markets and migration. This finding can be explained by the fact that for most of the residents of non-urbanized areas, farming is not the major source of income. Those who rely on farming often have sufficient scale of farm to generate income above the poverty line.

The results are not without points for critique. First, unobserved covariates can't be ruled out. The spatial fixed effect procedure differences out the factors that are constant for Michigan commuting zones, however unobservable factors, which vary within the commuting zones can potentially bias the results.

An attempt to address possible endogeneity of some of the factors with an instrumental variables procedure brings its own problems. The instrumental variable procedure increases the variance of estimated parameters reducing their statistical significance. As a result, we have to consider a tradeoff between statistical significance and reducing parameter bias. There is room for improvement in estimation procedure. Endogeneity may also require a different kind of analysis—one more historical and qualitative (Schmid 2004); one that inquires of the processes behind the more readily available Census numbers.

F. Conclusion

In this paper we extend the literature and have developed a regional poverty model based on behavior of individual households and have estimated this model using Census 2000 data on small geographic regions – part of Census Block Group. While aggregating a household model to a regional level, we have to face a problem of heterogeneity of regions and households within the regions. A simple test for heterogeneity among the regions has been described and a few steps to control for heterogeneity within a region have been justified and applied.

Regarding the estimation results, a significant difference among rural and urban regions has been found in the relations between regional poverty outcomes and other characteristics of a region. Heterogeneity has been detected with respect to average income level and industry structure of the regions as well.

The relation between regional poverty outcomes and characteristics of income distribution is non-linear. The characteristics controlled were average and standard deviation within a unit of observation. The result implies that average income growth efforts are limited in their impact on poverty reduction. The strength of this relation depends on the characteristics of income distribution. The increase of average income has stronger poverty reduction effect in rural towns. On the other hand, communities with more equal income distribution have a significantly lower poverty rate holding other factors fixed. The effect of equality on poverty reduction is increasing quadratically. Our result can serve as a base in comparing the potentials of income growth vs. redistribution policies in their impact on poverty.

Improvements of labor market conditions are less powerful poverty reduction instruments than the improvement in quality of labor. However this conclusion may be valid only for the particular institutional and macroeconomic environment of Michigan.

The relation of a household structure and poverty indicate that the size of the household is of a little relevance to the outcomes. However, the composition of household reflects some poverty coping strategies, which in turn differ among the sub-regions of the state. For that reason the use of the number of dependents as a selection criterion for the poverty reduction programs may be misleading because

they represent the outcomes of those strategies. On the other hand, the results on the number of adults in a household indicate that the adults have different opportunities to earn income in metropolitan and non-metropolitan areas beyond the conditions of labor demand. It implies that development policies should target those barriers, which lower the labor market opportunities of adults. Among these barriers could be poor transportation and communication infrastructure, lower availability of care facilities for dependants, attitudes toward the labor force participation etc.

Regarding quality of labor force, the level of education plays a significant role. Incomplete high school education associates with higher regional poverty, while attainment of collage education is a strong poverty reduction factor for all areas. A policy response to this situation may be to encourage residents to achieve higher levels of education by providing grant and low interest loans for college education. However, people with more education may tend to leave rural areas leaving those with less education behind. Even though not everybody would choose to get a college degree, some minimum level of education is necessary to participate in life of modern society and use the products of technological progress. Inability to do this leads to social exclusion, which is another dimension of poverty

Experience, as another dimension of labor quality, plays a different role in urbanized and non-urbanized areas of Michigan. Rural areas lack a positive return to experience, which makes those areas less attractive for youth in a long run.

There is a high persistency of poverty in non-urbanized areas as well. This effect is stronger for the rural areas. Such a past dependency is called in a literature as a poverty trap. As the number of people in agriculture, mining and forestry has declined, some small rural communities have lost their reason for being. This result is a call for a policy intervention in some rural areas.

One of the sources of the spatial poverty traps we observed may be an organization of school education based on local finance. Poor regions could not provide enough funds for improvement of education, producing lower quality labor. Recent reforms and switching to the State funding of education may change the situation in the future. However it is too early to see the results.

Another finding is that urban regions with a higher portion of people with disabilities have higher poverty, which implies that improvement in the Social Security system is needed.

We observe in this study the results of some poverty coping strategies such as migration and choice of family composition. However, other strategies may also exist. Their analysis will improve understanding of regional poverty dynamics.

The results of this research provide a basis for further benefit-cost analysis of alternative policies, and help setting priorities of using alternative policy tools (see Nizalov and Loveridge). However, cross-sectional analysis used in this study provides us with characteristics of long run equilibrium of regional income distribution with respect to different regional characteristics. Short run dynamics may be quite different.

We observe strong heterogeneity in the regional poverty model. As a result, a policy response to regional poverty should also be selective.

Among the directions for further research can be more rigorous evaluation of social security, labor market and poverty reduction programs. Incorporating individual data on health, experience, job training, household structure, social networking and other important cultural factors may improve the results of regional poverty analysis.

Two other dimensions for regional poverty analysis can be informed from theoretical model derived in this paper. They are conditions of markets for capital and environment for self-employment, entrepreneurship and home-production. The best-known thread in the literature addressing those issues is on the microfinance projects (see Morduch (1999) for recent review). However, a quality of human capital is an important factor in those areas as well.

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Appendix 1. Census Bureau Poverty Thresholds in 2000

Table A1. Poverty Thresholds in 2000, by Size of Family and Number of Related Children Under 18 Years
(Dollars)

Size of family	Weighted average thresholds	Related children under 18 years								
		None	One	Two	Three	Four	Five	Six	Seven	Eight or more
One person (unrelated individual)	8,794									
Under 65 years	8,959	8,959								
65 years and over	8,259	8,259								
Two persons	11,239									
Householder under 65 years	11,590	11,531	11,869							
Householder 65 years and over	10,419	10,409	11,824							
Three persons*	13,738	13,470	13,861	13,874						
Four persons	17,603	17,761	18,052	17,463	17,524					
Five persons	20,819	21,419	21,731	21,065	20,550	20,236				
Six persons	23,528	24,636	24,734	24,224	23,736	23,009	22,579			
Seven persons	26,754	28,347	28,524	27,914	27,489	26,696	25,772	24,758		
Eight persons	29,701	31,704	31,984	31,408	30,904	30,188	29,279	28,334	28,093	
Nine persons or more	35,060	38,138	38,322	37,813	37,385	36,682	35,716	34,841	34,625	33,291

Source: U. S. Bureau of the Census, Current Population Survey.
Downloaded from http://www.census.gov/hhes/poverty/threshld/thresh00.html

*For example, three persons household could be three adults, two adults with a child or one adult with two kids.

Appendix 2. Descriptive Statistics of Michigan regions[+++]

Variable	*All State* Mean (Std. Dev.)	Rural Mean (Std. Dev.)	Rural Towns Mean (Std. Dev.)	Metropolitan Mean (Std. Dev.)	Metropolitan Adjacent Mean (Std. Dev.)
Number of observations (% of total)	12,018 (100.0)	1,871 (15.6)	517 (4.3)	6,775 (56.3)	2,855 (23.8)
Poverty rate, %	10.18 (10.83)	9.72 (6.05)	14.16 (10.96)	11.10 (11.96)	6.17 (5.03)
County Poverty Rate in 1990[*], %	12.85 (5.60)	15.38 (4.54)	14.22 (4.21)	12.77 (5.96)	12.02 (4.24)
Population, persons	821 (652)	354 (339)	606 (497)	1,039 (682)	649 (526)
Average Household Income, $	58,315 (26,568)	45,493 (12,117)	41,874 (13,920)	59,713 (29,066)	60,371 (18,684)
Standard Deviation of Income Within a Region, $	46,542 (27,021)	40,276 (21,499)	37,965 (23,788)	47,734 (28,415)	45,710 (22,990)
Average Household Size, persons	2.62 (0.42)	2.50 (0.31)	2.33 (0.34)	2.60 (0.44)	2.79 (0.29)
Standard Deviation of Household Size Within a Region, persons	1.36 (0.22)	1.29 (0.20)	1.26 (0.18)	1.37 (0.24)	1.37 (0.17)
In-Migration[**], %	17.3 (12.5)	20.2 (9.7)	23.2 (14.0)	17.0 (13.4)	16.4 (8.5)
Share of retirees (65 and Older), %	12.3 (7.6)	16.5 (8.1)	17.7 (9.5)	12.1 (7.7)	10.7 (5.2)
Average County Wage[***], $	33,966 (6,203)	23,816 (2,451)	24,880 (2,167)	36,461 (4,834)	29,657 (4,495)
County Unemployment[+], %	5.91 (2.01)	7.82 (2.38)	7.33 (2.15)	5.83 (1.99)	5.27 (1.27)
Working Age Adults per household, persons	1.75 (0.64)	1.62 (0.47)	1.60 (0.70)	1.74 (0.71)	1.84 (0.24)
Education[++] - Incomplete High School, %	16.9 (11.2)	17.6 (8.3)	15.0 (8.2)	17.3 (12.3)	15.1 (7.3)
Education - Complete High School, %	31.3 (11.0)	39.1 (9.0)	34.2 (10.7)	28.8 (10.7)	37.4 (8.9)
Education - Less than College, %	30.3 (7.8)	28.6 (7.3)	30.4 (7.3)	30.1 (7.9)	31.7 (7.1)
Education - Bachelor Degree, %	13.6 (9.7)	9.6 (6.4)	13.2 (8.0)	14.8 (10.4)	10.5 (6.7)
Education - Graduate Degree, %	7.0 (8.9)	5.1 (4.6)	7.3 (6.5)	9.0 (9.8)	5.3 (5.1)
People with Disabilities per household, persons	0.82 (0.41)	0.88 (0.33)	0.80 (0.35)	0.83 (0.44)	0.78 (0.30)
Dependants (children under 16) per household, persons	0.77 (0.32)	0.67 (0.25)	0.61 (0.23)	0.77 (0.34)	0.83 (0.22)
Average Age of working cohort (16 to 65), years	38.6 (3.3)	41.1 (2.9)	38.4 (4.0)	38.1 (3.3)	39.9 (2.2)
College Town (dummy)	0.33 (0.47)	0.01 (0.11)	0.37 (0.48)	0.44 (0.50)	0.02 (0.13)

[*] Census 1990

[**] As percentage of people 5 years and older leaving outside of county of current residence in 1995.

[***]Data: Bureau of Economic Analysis

[+] Data: Bureau of Labor Statistics

[++] Education for population 25 years and over.

[+++]Based on Census 2000, SF3 for Census Block Groups (parts) unless specified otherwise.

Appendix 3. Description of Spatial Units[32]

Geographic entities in United States are organized in different hierarchical structures. This difference is rooted in the purposes for geographical areas organization, such as administrative, statistical, political etc. The borders of units in different hierarchical structures normally do not cross state borders but in general do not match. In this study units of two structures are considered: administrative: state-county-county subdivisions (townships, cities); and statistical: state-county-Census Tracts-Census Block Groups-Census Blocks. Census blocks are the smallest units and do not cross a border of any other higher-level geographical unit in any hierarchy used. The data on the blocks by themselves is not publicly available, but the Bureau of Census has consolidated the Block level information up to the point that a region that is called a part of Census Block Group stays within the border of units of different hierarchical structures (does not cross any kind of border). A part of Census Block Group is considered in this paper as a unit of analysis. The data on number of units for different level of geographical hierarchy with basic statistics is presented in Table A3.

The Bureau of Census definitions

- **States** are the primary governmental divisions of the United States.
- The primary legal divisions of most states are termed ‘‘**counties**.’’
- **County subdivisions** are the primary divisions of counties. In Michigan they are referred as minor civil divisions (MCDs) and include townships, charter townships and cities.
- **Census tracts** are small, relatively permanent statistical subdivisions of a county. The primary purpose of census tracts is to provide a stable set of geographic units for the presentation of decennial census data. Census tracts generally have between 1,500 and 8,000

[32] Based on Summary File 3, 2000 Census of Population and Housing Technical Documentation. Appendix A. Census 2000 Geographic Terms and Concepts. http://www.census.gov/prod/cen2000/doc/sf3.pdf. The official Census Bureau technical documentation should be seen for more detailed description of geographical units and organization of geographical data.

people, with an optimum size of 4,000 people. The spatial size of census tracts varies widely depending on the density of settlement.

Table A3. Descriptive statistics of units in geographical hierarchy.(i.e. average per variable per geographic unit)

Geographical unit	Number of units	Average of total population	Average of number of households	Land area, square kilometers
State	1	9,938,444	3,788,780	147,000
County	83	119,740 (276,750)	45,648 (105,006)	1,770 (671)
Minor Civil Divisions	1569	6,334 (27,360)	2,414 (9,925)	94 (95)
Census Tract	6397	1,553 (1,697)	592 (653)	23 (52)
Census Block Groups (parts)	13698	725 (672)	276 (261)	10.7 (32)

Standard deviation in parentheses

- **Block Groups (BG)** generally contain between 600 and 3,000 people, with an optimum size of 1,500 people. BGs never cross the boundaries of states, counties. BGs never cross the boundaries of census tracts, but may cross the boundary of any other geographic entity required as a census block boundary.
- **Census blocks** are areas bounded on all sides by visible features, such as streets, roads, streams, and railroad tracks, and by invisible boundaries, such as city, town, township, and county limits, property lines, and short, imaginary extensions of streets and roads. Generally, census blocks are small in area; for example, a block bounded by city streets. However, census blocks in sparsely settled areas may contain many square miles of territory.

Appendix 4. Household Production Model

The specification of a model explaining poverty (choice of variables) is informed by the theory of household production. A household as a unit is involved in a set of activities using a stock of physical and human assets and investing in them. The purpose of those activities is to reproduce the assets (first of all human), to meet social standards, to enjoy consumption and to increase wealth (the stock of assets). In economic literature those purposes are lumped into a term "deriving utility" and a utility function *U(.)* describes a relation between the inputs (goods) and ends (utility level). A real income is considered as a constraint on utility maximization and it serves as an intermediary of that process. Observed monetary income is often considered as a proxy for the real one (though we know that income and happiness are not well correlated after basic needs are met).

A household production model (Singh et al, 1986) describes the interdependence of production and consumption activities of a household. According to the model, a household maximizes utility (equation A1) subject to a set of constraints (equations A2-A4).

$$\text{Max } U(X_h, X_m, l, H) \qquad \text{(A1)}$$

Where X_h is a vector of home-produced and consumed at home goods like agricultural products, housing, childcare etc. A vector X_m is a set of market-purchased consumption goods, l is a leisure time, H, is a set of household characteristics (often referred as taste shifters) such as age, gender, cultural or ethnic background etc .

The constraints are of the following nature. The first one (A2) is a budget constraint – expenditures must equal incomes including borrowing.

$$\text{Budget: } k_m X_m + k_n n = k_h(q - X_h) + wL_o + y \qquad \text{(A2)}$$

Where k_m is a vector of prices for market purchased goods, k_h is a vector of prices for home produced goods, w is a vector of wage rates for a stock of labor assets, L_o is number of hours working out of home (on a labor market). Vector y includes non-labor income and will

be described later (A5). Vector *q* is a set of home-production outputs. It is described by a production function (A3). And finally, k_n is a vector of prices for market purchased production inputs *n*.

$$\text{Production: } q=q(L_h, n, A_h) \qquad \text{(A3)}$$

Where *q(.)* is a household production function, L_h is a vector of a household labor inputs into a home production, *n* is a vector of market purchased production inputs, and A_h is a vector of physical assets used in household production.

The nature of the next constraint (A4) is that amount of labor (human) assets that have physical (and biological) limits *T*. Vector *T* describe those limits, which in turn is a function of household characteristics *H*. The endowment of time can be spent on leisure, home production or work off home time.

$$\text{Time: } L_h+ L_o+l=T \qquad \text{(A4)}$$

The last component of a budget constraint – non-labor income *y* – should be described separately (A5). It includes return on investments *(A-Ah)*. Where *r* is a rate of return, assuming that all the assets not used in a household production are invested. The other component *s* is a vector of subsidies, transfers and taxes, which could depend on household characteristics and income.

$$\text{Non-labor incomes: } y=r(A-A_h)+s \qquad \text{(A5)}$$

Combining equations (A2) to (A5) the budget constraint takes a form:

$$k_mX_m + k_hX_h+wl=rA+wT+k_hq(L_h, n, A_h)-wL_h-rA_h-k_nn +s \qquad \text{(A6)}$$

This expression equates a household's real expenditures to a real income. Expression

$$\pi =k_hq(L_h, n, A_h)-wL_h-rA_h-k_nn \qquad \text{(A7)}$$

is an equivalent of economic profit of a household production.

Solving a household utility maximization problem we can get the optimal household income Y^* as a following function:

$$Y^* = rA+wT+\pi^*(w, r, k_n, k_h, H)+s \qquad (A8)$$

The level of household income depends on the initial stock of capital (human and physical), and exogenous to the household factors (prices and costs) impacting a household ability to extract income out of its assets.

Our derivation is based on the assumption that a household does not hire out-of-household labor, but rather buys necessary inputs (including labor) on a market. Second, we assume perfect asset markets (both physical and human). In other words there is no cost to participate on labor or capital or other markets, and perfect information about the markets is available. Often it is not true, especially when we are considering regional poverty. This assumption can be relaxed in further projects to evaluate an impact of market imperfections such as costs of labor force participation on regional poverty.

Another issue, not addressed in the model, is the factors mobility. Capital does move to utilize low cost labor as witnessed by the textile industry moving first from New England to the south of the US, and then to Asia. But, the process has not been sufficient to eliminate rural poverty either in the south or in Asia. Likewise, labor of a given quality does migrate from low wage areas to higher wage areas as witnessed by the migration of Mexicans and Asians (and others) into the United States and the migration of people from Appalachia to industrial cities in the north. But, similarly to the case of capital, labor migration has not eliminated poverty at the source of the migration.

This suggests there are formal and cultural barriers to the equalization of factor returns. However, it is beyond the scope of this modest research project to investigate these variables. Further, a household model ignores the fact that the household is a collective unit whose decisions are negotiated among its members. Thus, the structure of the decision process of the household can affect poverty outcomes. Again, this is not investigated here.

The model developed here takes the stock of human capital as a given. It does not further inquire into how that stock was produced—how individuals and the broader community reached its investment decision. Further, the model takes the stock of local infrastructure as a given and does not inquire how the local people were able to organize to make investments or solicit them from higher levels of government.

Finally, perception of the opportunities may differ from reality, and reality is often uncertain requiring an image of the future. People in different regions may differ in the degree of self-initiative and capacity for self-organization. There are skills in collective action as there are skills in machine use and management ability.

Appendix 5.

To check whether estimates on the model for different subpopulations are statistically different a simple test is presented.

1. If a population can be divided into N mutually exclusive groups, we have to construct dummy variables for N-1 of them.
2. Those N-1 dummies and their interactions with all the variables in the model should be included.
3. The models for different subpopulations are statistically different if the dummies and their interactions with other variables are jointly significant. Similarly, we can test a difference in a response to any single exogenous shock (variable).

Figures

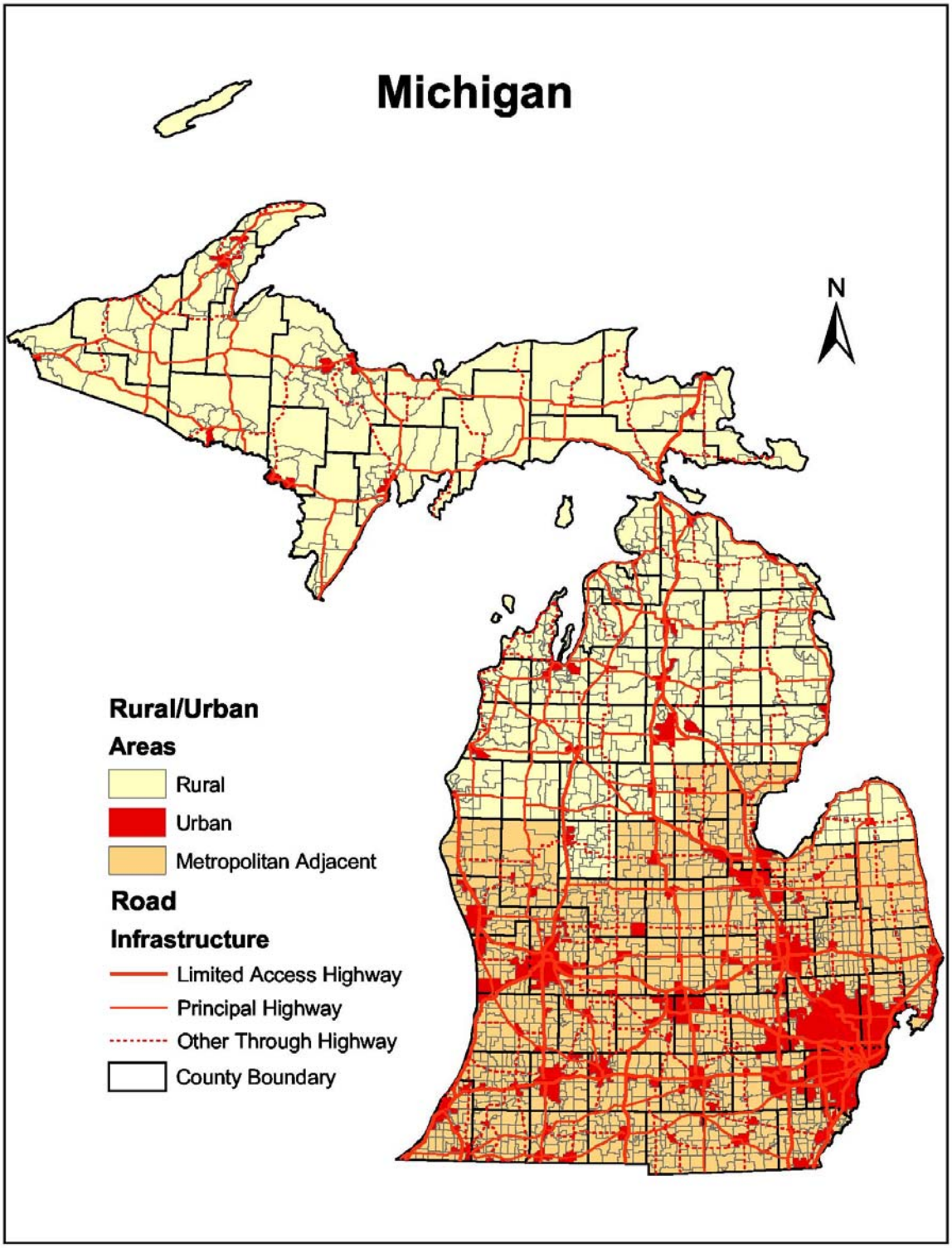

Figure 1. Michigan Urban/ Rural Areas by Census Block Groups, 1999

Data: Based on Census 2000, Census Bureau data.

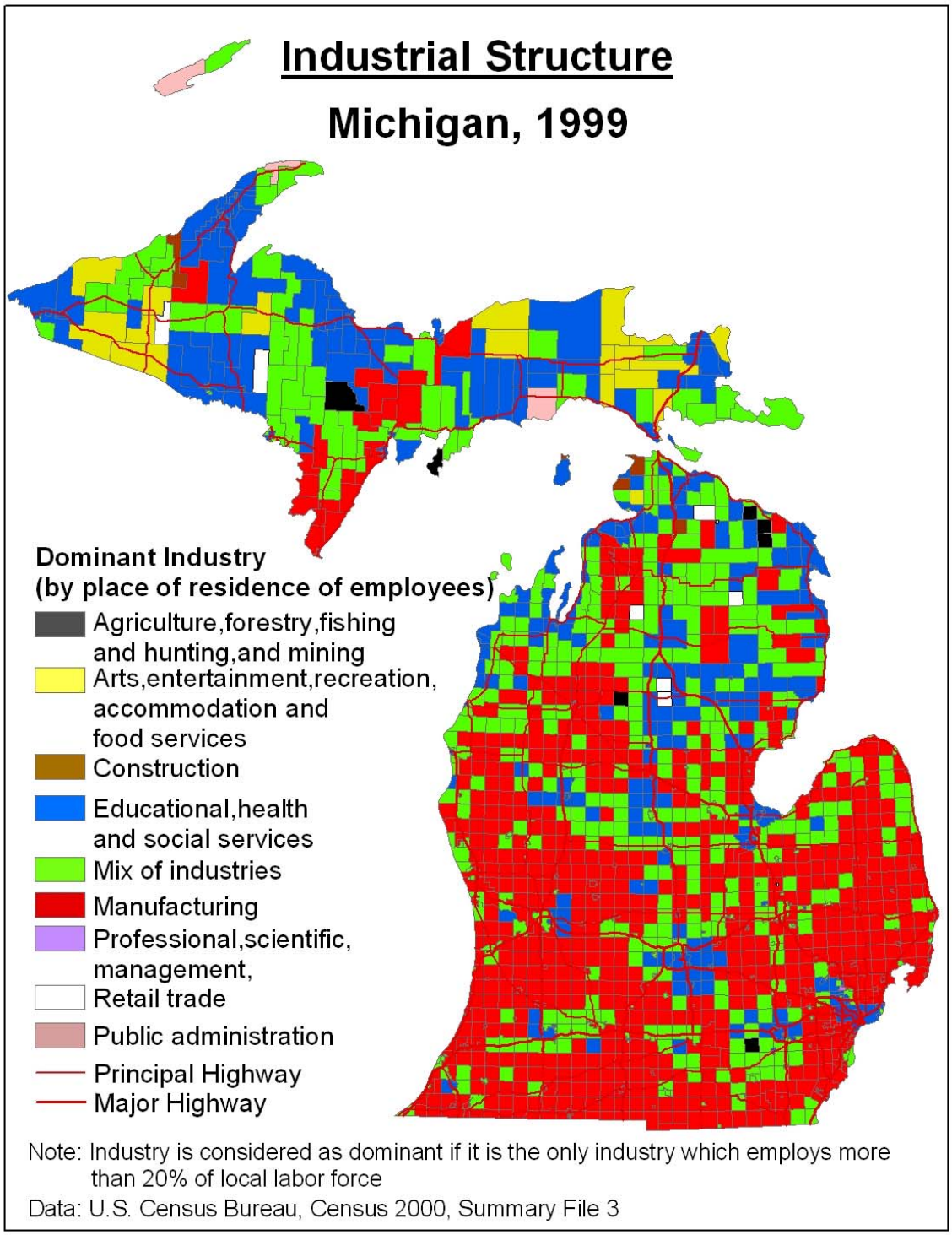

Figure 2. Dominant Industries, Michigan 1999

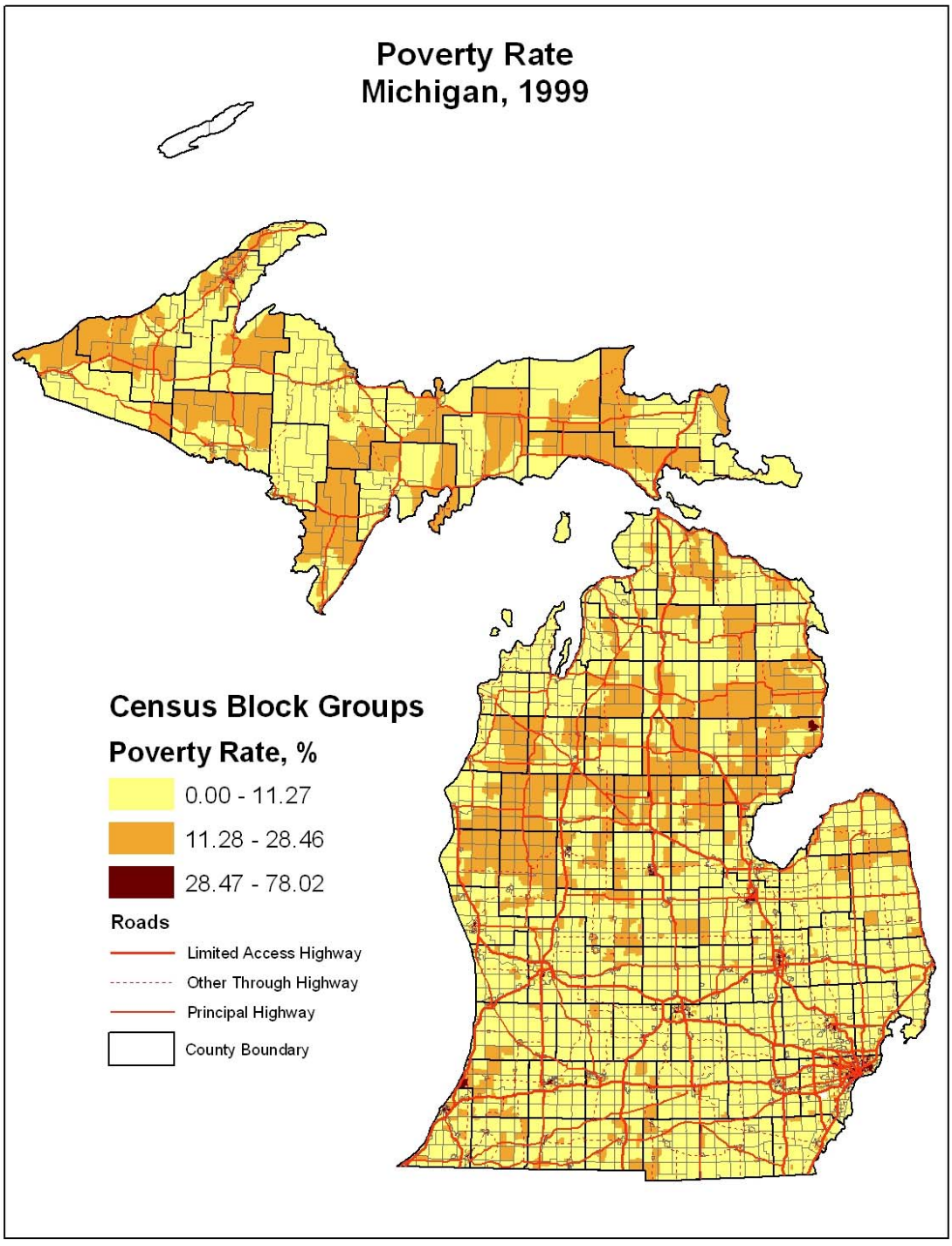

Figure 3. Poverty Rate, 1999

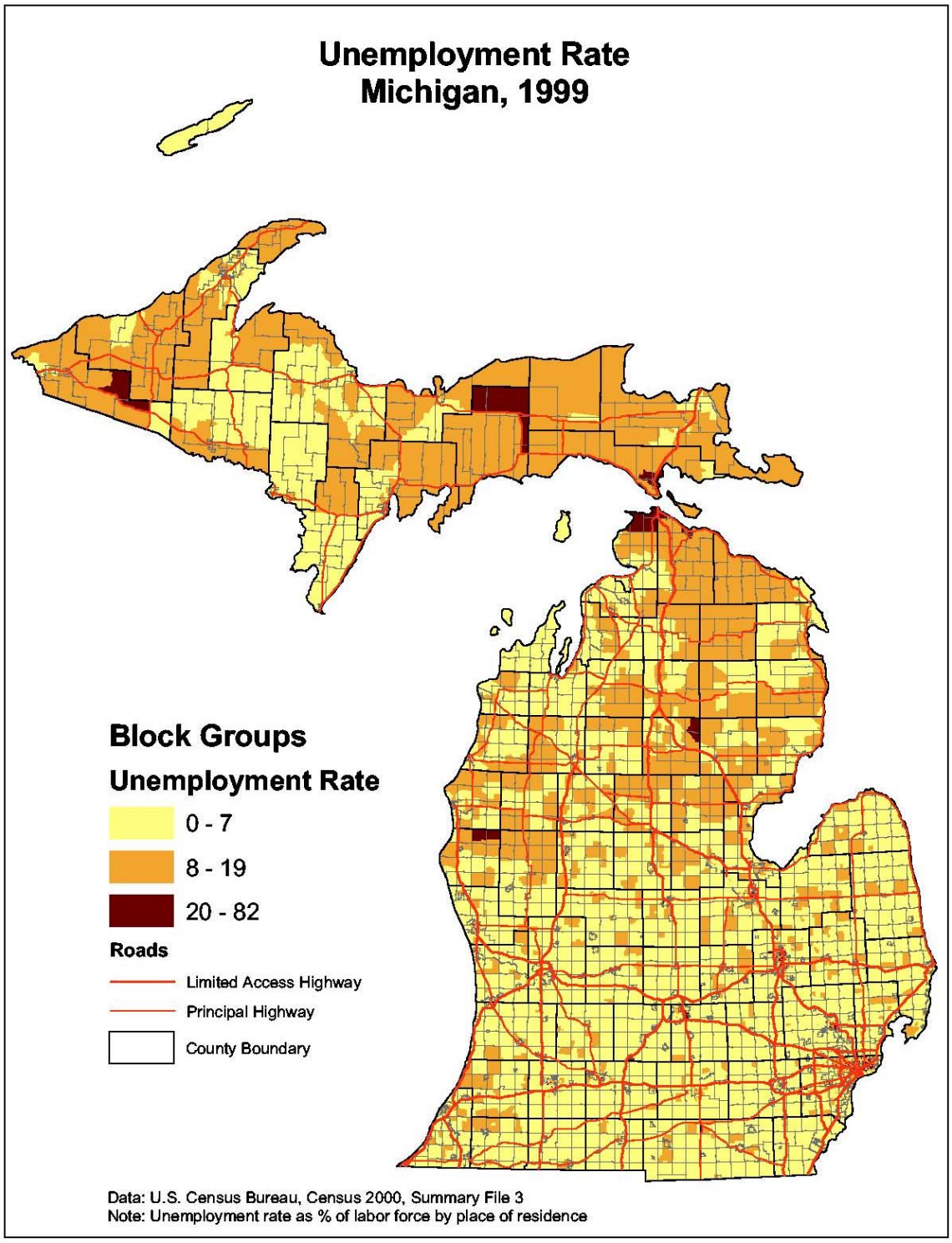

Figure 4. Unemployment Rate, 1999

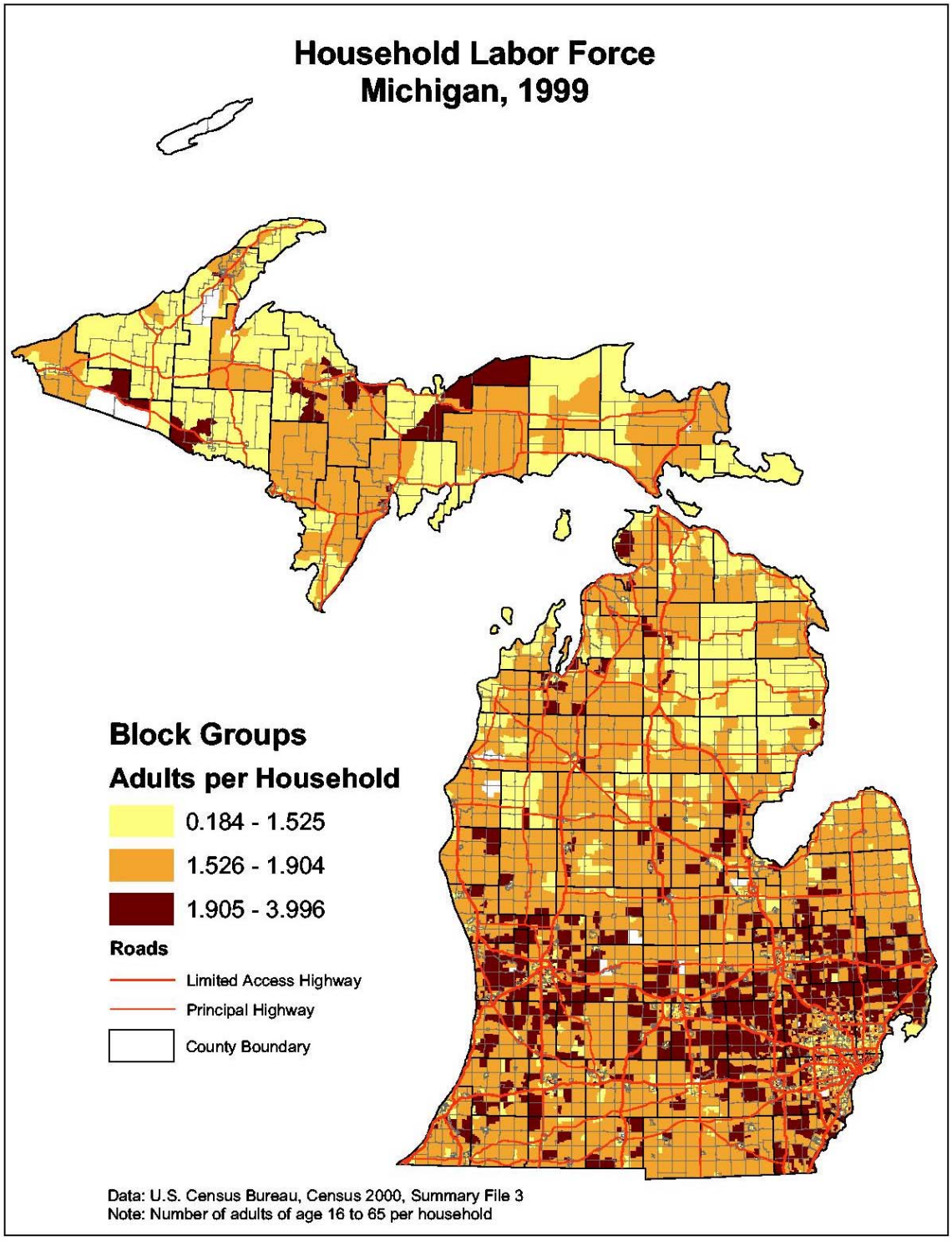

Figure 5. Number of Adults Per Household, 1999

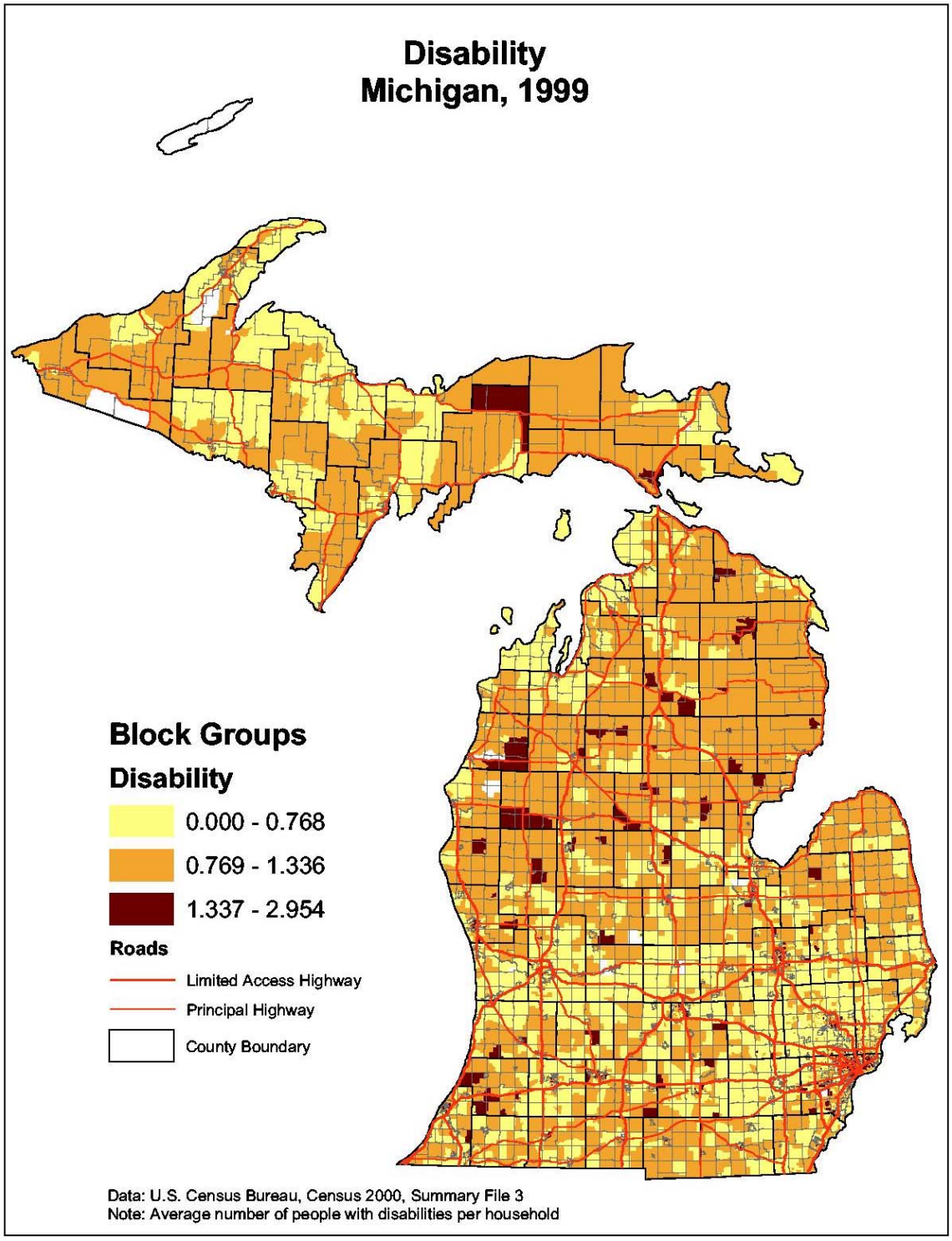

Figure 6. People with Disabilities Per Household, 1999

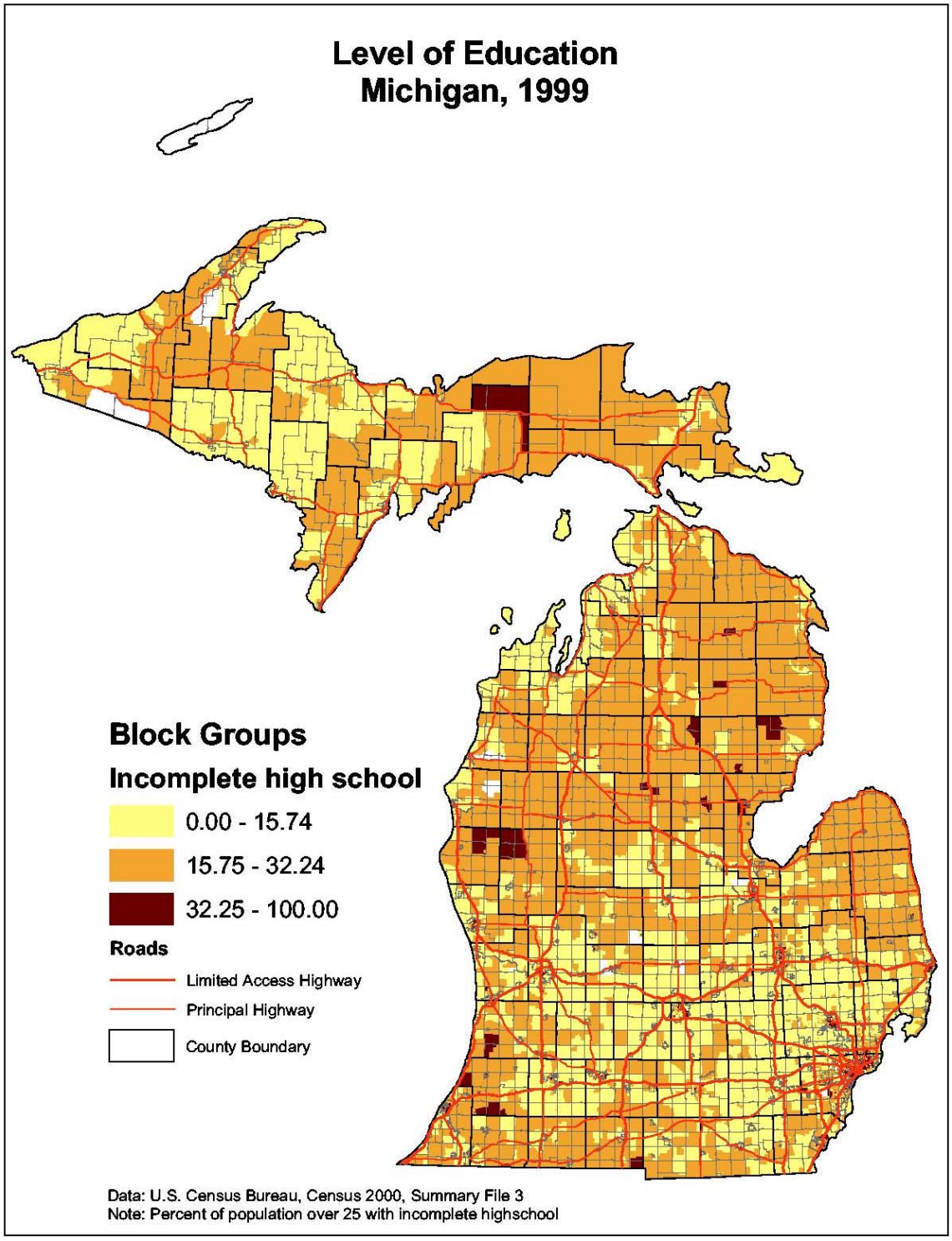

Figure 7. Share of Population with Incomplete School Education, 1999

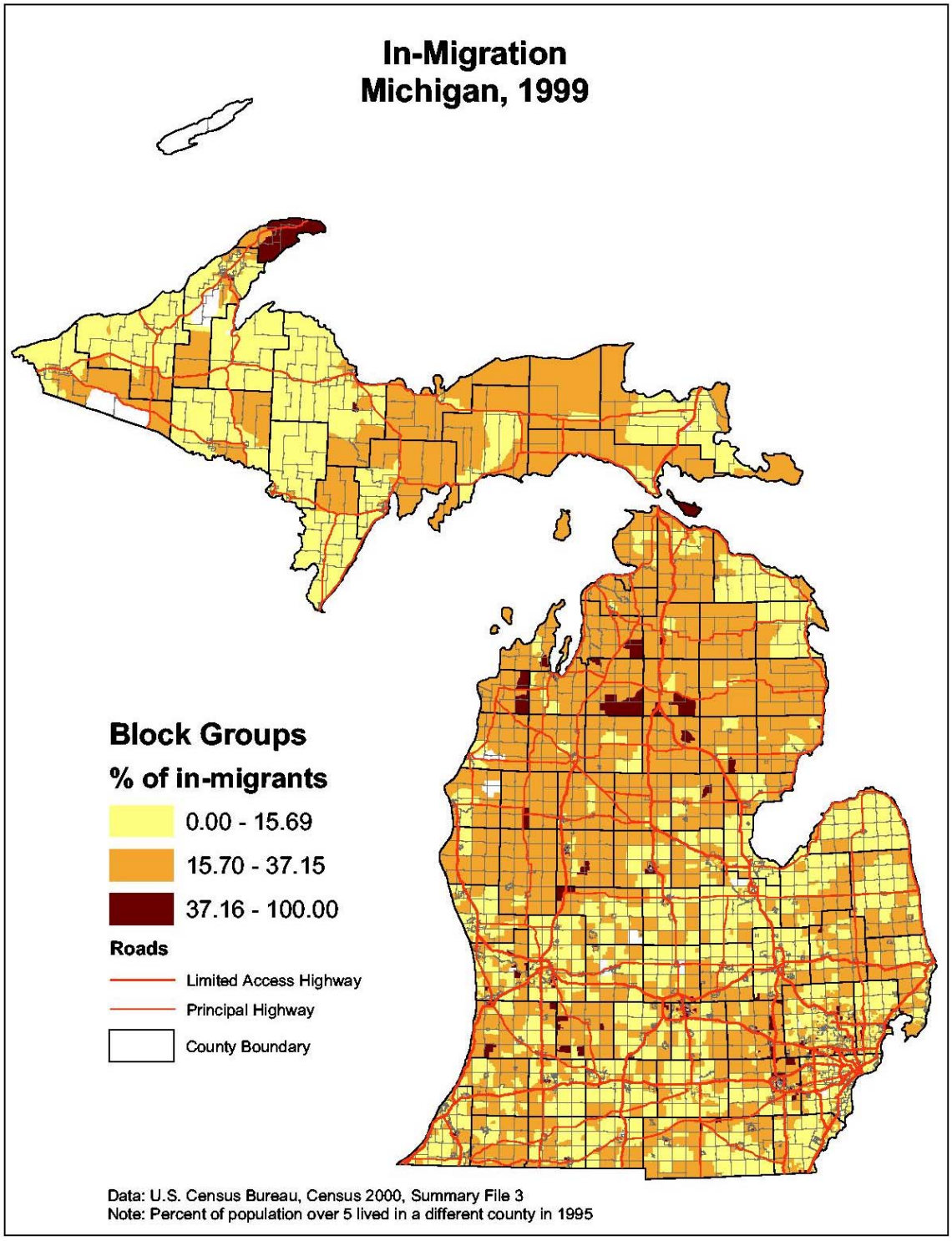

Figure 8. Share of In-Migrants, 1999

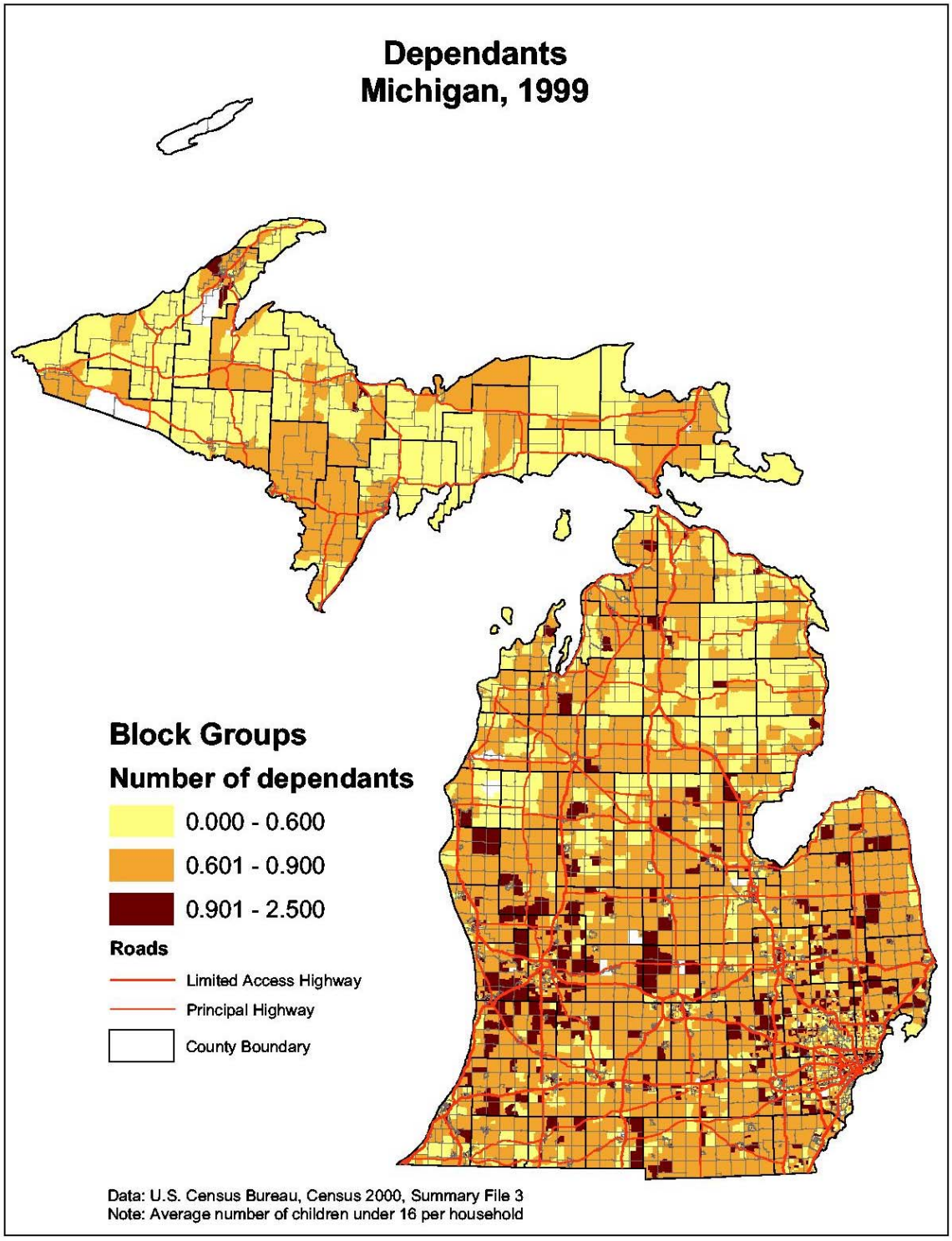

Figure 9. Number of Dependants per Household, 1999

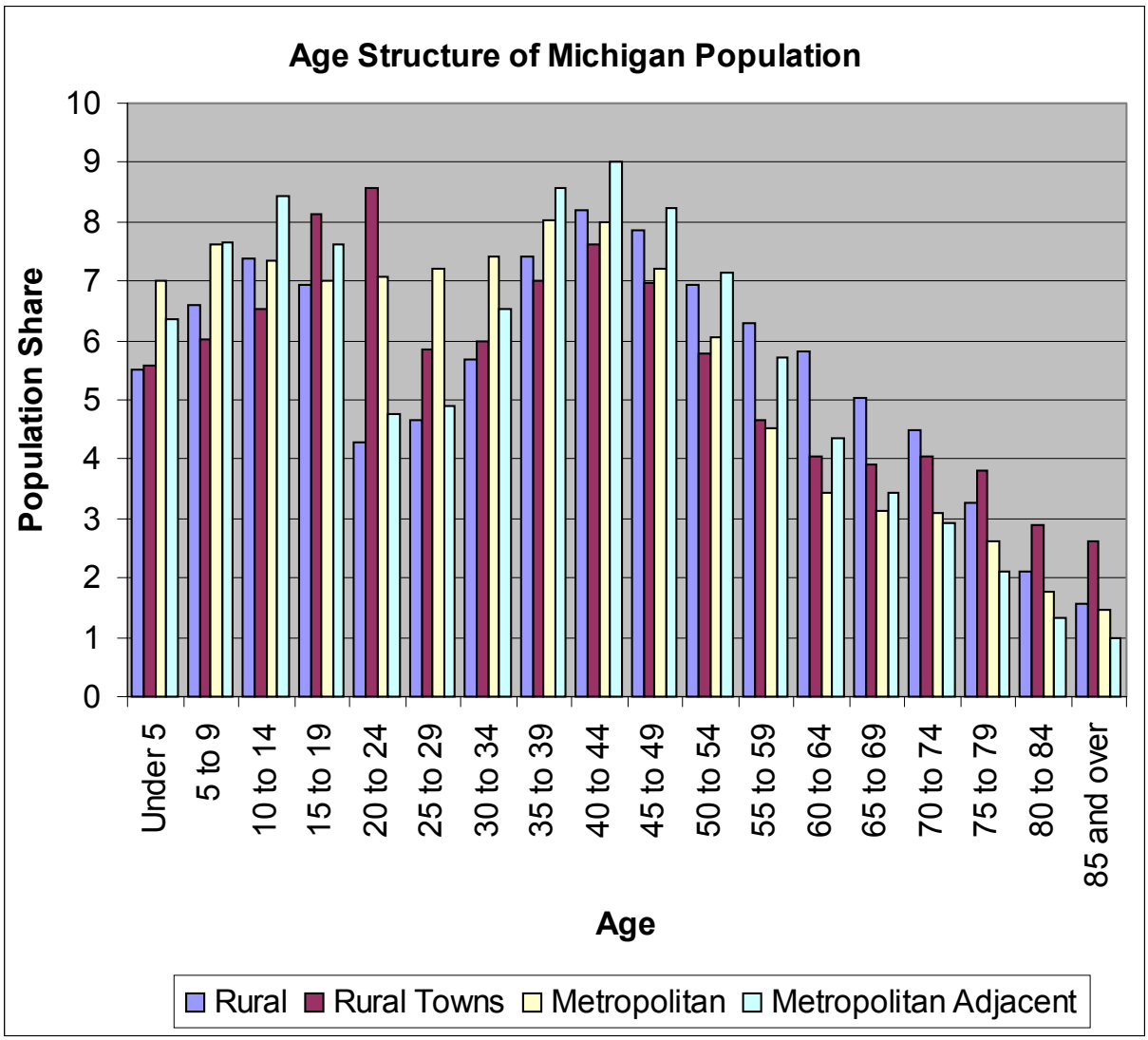

Figure 10. Age Structure of Michigan Population, 1999

Data: Based on Census 2000, Census Bureau data.

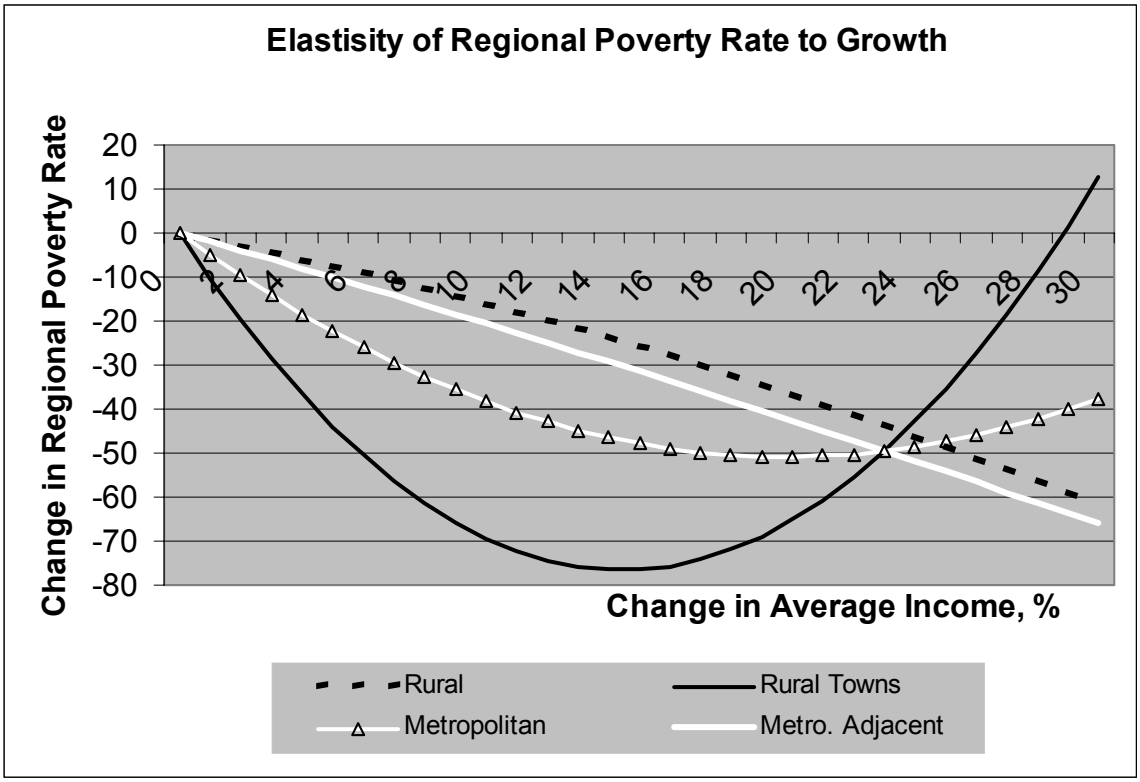

Figure 11. Average Income Elasticity of Regional Poverty, Michigan, 1999

Data: Estimation results.