A CONTINUOUS MULTI-DIMENSIONAL MEASURE OF RURALITY: MOVING BEYOND THRESHOLD MEASURES

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Abstract. This paper introduces the Index of Relative Rurality, a continuous measure of rurality. The index is based on four dimensions: population size, density, percentage of urban residents, and distance to the closest metropolitan area. The index varies from 0 (most urban) to 1 (most rural). Compared to existing means of measuring rurality, the index is continuous and thus does not suffer from problems that arise when using arbitrary thresholds to separate discrete categories. This shift away from often ill-defined categories of rural and urban, to measuring the *degree* of rurality will shed new light on a wide array of rural issues ranging from rural poverty to economic growth. This paper shows that the Index of Relative Rurality makes an invaluable contribution to the debate on what is rural and what is urban. Three properties of the index are particularly beneficial for both research and policy: rurality is treated as a relative attribute, making it possible to investigate trajectories of rurality over time; sensitivity to small changes in one of the defining dimensions; applicability to different spatial scales.

1. Introduction

Low population density, abundance of farmland, and remoteness from urban agglomerations are characteristics that people typically associate with rural places. In fact, people frequently use the term "rural" to collectively express their perception of place characteristics that—in one way or another—typify rurality. However, rurality remains an elusive concept. As Weisheit et al. (1995) state so eloquently:

> "*Like concepts such as "truth," "beauty," or "justice," everyone knows the term rural, but no one can define the term very precisely*" (Weisheit et al., 1995).

In contrast to the colloquial use of "rural" and "urban," researchers and policy makers must rely on a precise definition. However, there is no consensus about how to define the concept of rurality or about how to measure it. Moreover, the existing measures are ill suited, if not flawed. As Isserman (2005) pointed out, rural research and rural policy are based on ill-defined distinctions between rural and urban. He criticized the common use of the metro/non-metro distinction (Office of Management and Budget 2000, 2003) as a proxy for—or even worse—as synonymous with a rural/urban distinction. A similar

criticism applies to the Rural Urban Continuum Code defined by USDA's Economic Research Service. Although its name and numeric coding suggest a "continuous" and monotonic increase of rurality on a nine-point scale, this suggestion may actually be a dangerous illusion it hides the initial distinction between metro and non-metro counties.

To remedy these shortcomings, Isserman (2005) suggested a rural-urban density typology. It assigns counties to one of four categories based on four criteria: percentage of urban residents; total number of urban residents; population density; and population size of the county's largest urban area. Yet, just as the metro/nonmetro distinction and its derivatives, Isserman's typology also falls into what I refer to as the "threshold trap" that pigeon holes counties, thereby potentially separating similar counties and joining dissimilar counties.

To overcome the "threshold trap," I suggest a continuous multidimensional measure of rurality, the Index of Relative Rurality. It does not answer the question 'Is a county rural or urban?' but instead addresses the question 'What is a county's degree of rurality?' In this paper, I critically discuss the problems and advantages associated with the suggested measure. In addition, the paper investigates the proposed index for an array of operationalizations, utilizing different sets of variables and link functions. For each operationalization, the analysis will assess temporal persistence and spatial scale dependency of rurality in the U.S. The analysis will also focus on discrepancies in assessed rurality due to different operationalizations, and their impact on estimated relationships between rurality and indicators of development.

The paper is organized in five sections. Following the introduction, the background discussion briefly reviews the existing rural-urban typologies. The third

section introduces the proposed Index of Relative Rurality, and discusses its advantages and shortcomings. In the fourth section, the index is used to analyze variations in rurality across space and time. The fifth section presents an application of the index to analyze the relationship between rurality and educational attainment. The final section summarizes the results of the analysis and derives a set of policy-relevant conclusions and directions for future research.

2. Background

This section briefly reviews the commonly used approaches to defining what is urban or rural, including the urban/rural distinction defined by the U.S. Census Bureau; the Metropolitan, Micropolitan, and Noncore County classification of the Office of Management and Budget; the Urban-Rural Continuum Code of the Economic Research Service; and Isserman's (2005) Rural-Urban Density Typology.

Urban Areas. The U.S. Census Bureau defines an urban area as a contiguous area of census blocks or block groups that has, in its core, a population density of at least 1,000 persons per square mile and has a total population of 2,500 or more residents.[1] Two types of urban areas are distinguished: urbanized areas and urban clusters (Figure 1). An urbanized area has at least 50,000 residents; an urban cluster has at least 2,500 residents but fewer than 50,000 residents. All territory outside of urban areas is defined as rural. All persons residing in an urban area are referred to as urban residents. All persons residing outside an urban area are referred to as rural. In the year 2000, 79.4% of the U.S.

[1] Note, this is a simplified representation of the delineation of urban areas. In particular, there are a variety of additional criteria that define the core and the outer boundaries of urban areas, and additional criteria that ensure the contiguity of an urbanized area (that is, an urban area is not allowed to contain "holes"). For the detailed definition and criteria of urban areas see: http://www.census.gov/geo/www/ua/uafedreg031502.pdf

population lived in urban areas in the year 2000. Ten years earlier, the share of the population living in urban areas was about 4 percentage points lower. However, when comparing the 2000 data to the 1990 data, it is important to keep in mind that the 1990 and 2000 definitions of "urban" slightly differ.

—Figure 1 about here—

Core Based Statistical Area. Core Based Statistical Areas (CBSA) are defined by the Office of Management and Budget (OMB).[2] They consist of one or more counties that jointly form a contiguous area. Two types of counties are distinguished (Figure 2). First, central counties are counties in which at least 50% of the population lives in an urban area of 10,000 residents or more. Every CBSA must have at least one central county. Second, outlying counties are counties that are added to the CBSA because they have strong commuting ties with the central counties of the CBSA. Specifically, in an outlying county at least 25% of the employed residents must work in the central county (counties), or at least 25% of its labor force must reside in the central county (counties).

—Figure 2 about here—

Two types of CBSAs are distinguished. First, CBSAs that include an urban area with at least 50,000 residents are called metropolitan statistical areas (MSA). Principle cities include the largest city of the CBSA plus additional cities that meet specified size criteria. Core Based Statistical Areas are named after their principal city (cities). Second, CBSAs that include an urban area with at least 10,000 urban residents but fewer than 50,000 are labeled Micropolitan Statistical Areas (MiSA). Counties not belong to either a metropolitan or a micropolitan statistical area are referred to as "Noncore" counties.

[2] See http://www.whitehouse.gov/omb/bulletins/b03-04.html

Noteworthy is the distribution of the urban and rural populations (as defined by the U.S. Census Bureau) across the three types of counties. The Noncore counties are not entirely composed of rural residents yet are also home to slightly more than 2% of the urban population. In 1990, one out of five Noncore residents was classified as urban. In 2000, one out of four Noncore residents was classified as urban resident. Similarly, the metropolitan counties are not entirely urban. Although the metropolitan counties house the vast majority (over 85%) of the urban population, over 20% of their residents are classified as rural residents. This seeming contradiction is due to the definition of metropolitan areas. Metropolitan areas do not simply single out the most urbanized areas but also include primarily rural counties that are functionally linked —through commuter flows—with the highly urbanized central counties of the MSA. Similarly, there are several Noncore counties that have a substantial portion of urban residents but they barely miss the required thresholds to become a micropolitan county. As the Office of Management Budget states: "The CBSA classification does not equate to an urban-rural classification; Metropolitan and Micropolitan Statistical Areas and many counties outside CBSAs contain both urban and rural populations." (Office of Management and Budget 2000, p. 82236).

The Rural-Urban Continuum Code. Although the tri-part classification of counties into Metropolitan, Micropolitan and Noncore counties is not intended to mirror a classification of counties by their degree of rurality, it is nevertheless used as the foundation for the so-called rural-urban continuum code (RUCC). The RUCC allocates counties to nine categories. It does so in three steps (Figure 3). First, counties are distinguished by whether or not they belong to a metropolitan statistical area. Second,

metropolitan counties are further differentiated into three groups using the size of the MSA to which they belong as the distinctive criterion; non-metropolitan counties are further differentiated into six groups using the size of their urban[3] population and adjacency to a metropolitan area as the distinguishing criteria. Third, numerical values (from 1 to 9) are assigned to the nine categories, with categories 1 to 3 representing metropolitan counties, and categories 4 to 9 representing non-metropolitan counties.

—Figure 3 about here—

The name (Rural-Urban *Continuum* Code) as well as the numeric coding suggest a "continuous" and monotonic increase of rurality on a nine-point scale. However, this suggestion may actually be a dangerous deception as it hides the initial distinction between metro (code 1 to 3) and non-metro counties (code 4 to 9). As a result, similar counties may be classified as different, whereas counties that are very dissimilar may be grouped together in the same category. The same criticism applies to the urban-influence code which is also a refinements of the metro / nonmetro dichotomy. It is measured on a scale from 1 to 12, with increasing numbers meant to reflect a decreasing urban influence.

The Rural-Urban Density Typology. To address the shortcomings outlined above, Isserman (2005) recently offered an alternative classification system, the so-called 'Rural-Urban Density Typology.' It utilizes thresholds for four variables — percentage of urban residents; total number of urban residents; population density; and population size of the county's largest urban area—to define 1,790 rural, 1,022 mixed rural, 158

[3] The distinction between "urban" and "rural" is based on the definition of urban areas as provided by the U.S. Census Bureau. http://www.census.gov/geo/www/ua/ua_2k.html

mixed urban, and 171 urban counties. Table 1 shows the four categories and their defining thresholds.

—Table 1 about here—

Undoubtedly, Isserman's typology is a major improvement over the classifications based on the metropolitan/non-metropolitan differentiation. By avoiding the misleading metro/non-metro classification Isserman's typology does a much job at identifying the extremes. That is, the "urban status" of urban counties are unquestioned[4] and the "rural status" of counties that Isserman labels "rural" are unquestioned. The typology does, however, do a less satisfactory job in separating the two mixed categories. In fact, a closer look at which of the 'mixed counties' are assigned to either 'mixed rural' or 'mixed urban' highlights the problems with threshold based typologies.

Threshold based typologies utilize thresholds to define a finite number of categories. Often they are quite appealing just because of their simplicity. Yet, a number of criticisms can be voiced against such approaches. First, all thresholds are "debatable". Typically, we use "ball park figures" such as "500 persons per square mile" or "90% urban residents." To a certain extent, these thresholds are arbitrary and reflect our preference for "round numbers." I still have to come across a categorization using thresholds such as 321, 577, or even 1.338. Second, thresholds create "artificial" similarities and dissimilarities. For example, a dichotomous categorization based on just one variable and one threshold— say greater or smaller than 500—will group together objects with values of 32 and 499, but separate an object with value 499 from an object

[4] It should be noted though that counties labeled 'urban' according to Isserman's typology may still include a substantial portion of undeveloped land or farmland.

with value 501. Third, in the case of rurality, the objects to be classified are spatial units, such as counties or census districts. Yet, unfortunately, threshold based categorization are not independent of the spatial scale. Thus, Isserman's typology (or, more precisely, the thresholds he used) can only be applied to counties. When using a different spatial scale, e.g., census districts, ZIP code areas, or PUMAs, new sets of thresholds need to be selected.

3. Defining the Index of Relative Rurality

Most certainly, rurality is not the only concept that is difficult to quantify. One of the reasons for this difficulty is rurality's multidimensionality. However, defining a measure that is responsive to a concept's multiple dimensions, is not a new problem. For example, the Human Development Index (HDI) is a multidimensional measure on a continuous scale from 0 to 100. It measures a country's average achievement along three basic dimensions of human development: a long and healthy life, measured by life expectancy at birth; knowledge, as measured by adult literacy and school enrolment; standard of living, as measured by GDP per capita (PPP). The three dimensions are joint additively and scaled so that the index varies from 0 to 100.

To develop a continuous, multi-dimensional measure of rurality, I follow a similar approach as that used in the definition of the Human Development Index. The approach involves four steps: (1) identifying the dimensions of rurality; (2) and selecting measurable variables to adequately represent each dimension; (3) re-scaling the variables onto a comparable scale; (4) selecting a function that links the re-scaled variables in a function that reduces multidimensionality into one-dimensionality, i.e., $f(\cdot): \Re^n \rightarrow \Re^1$.

Each step of the procedures involves a series of subjective decisions that will affect the outcomes. Thus, defendable justifications for each step need to be part of the approach. It should be kept in mind, though, that—due to the elusive nature of the rurality concept—it will ultimately be impossible to assess the "precision" of the measure.

Four dimensions of rurality are included in the rurality index: population size, population density, extent of urban (built-up) area, and remoteness. Scholars and policy makers alike will undoubtedly agree that, ceteris paribus, places with small populations are more rural than places with large populations. Similarly, they will agree that, ceteris paribus, places with low density are more rural than places with high density; places with few built-up areas are more rural than heavily built-up places; and remote places are more rural than less remote places. I would further like to mention that the four dimensions have also been used in existing definitions. Population size and population density are the two dimensions that enter the rural/urban distinction of the U.S. Census Bureau. Isserman's typology uses those two dimensions plus urban area extent (as measured by %urban). The rural-urban continuum code and the urban influence code use all four dimensions, with remoteness being measured by adjacency to a metro area.

Are there additional dimensions or rurality? In the past, it may have been defendable to include the reliance on agriculture as a key dimension. However, today agriculture accounts for such a small share of economic activities overall as well as in rural areas, that it no longer qualifies as a key dimension. Similarly, many social characteristics (e.g., traditional) often associated with rural areas are —at best—outcomes but not defining dimensions of rurality.

The selection of variables that can adequately represent each dimension is of course very much dependent on data availability. I chose simple measures that can be easily replicated and updated. They include the logarithm of the population size, the logarithm of population density, the % of the population living in an urban area (as defined by the U.S. Census Bureau), and the distance to the closest metropolitan area. . The logarithmic transformations for population size and density corrects for their skewed distributions (abundance of small populations and low densities and rare occurrence of large populations and high densities.

The re-scaling of the variables is the least problematic step. Basically, one needs to insure that the four variables are measured on compatible scales and that the resulting index is independent of the units of measurement. That is, the index should be independent of whether population density is measured, for example, in persons per square mile or persons per square kilometer. In addition, the scale should be bounded, ranging for example from 0 (lowest rurality, most urban) to 1 (highest rurality, most rural).

Finally, an important step is the selection of a link function. This function should reflect how the four dimensions jointly determine the rurality of a place. Do the four dimensions contribute evenly to rurality? Is population size more important than density? Is low population size only important in combination with remote location? In the absence of any theoretical guidance on to how to answer these questions, I chose the most simple link function, namely the unweighted average re-scaled to the 0-1 scale. The resulting index—the Index of Relative Rurality —is not an absolute measure because it

places the rurality of a spatial unit within the wider context of the rurality of all spatial units considered. It is thus a comparative index.

There are several advantages to such an approach. First, aside from data availability constraints, the measure is not confined to a particular spatial scale, such as counties. Instead, it can also be applied to groups of counties, which increasingly form the basis of regional development efforts, as well as to smaller scales such as townships or census tracts. Second, rurality becomes a relative measure that can be used to investigate the trajectories of rurality over time. Third that is responsive to the multi-faceted nature of rurality and is sensitive to even small changes in one or several of the defining variables.

The index has three valuable properties that promise to make important contributions to the debate on what is rural, and to our understanding of changes in rurality over space and time. First, it is a continuous measure that captures the multi-faceted nature of rurality and will be sensitivity to even small change in one of the defining dimensions. Threshold based typologies, in contrast, only result in a change of category—say from rural to mixed rural—if the change in the defining variables is big enough to move beyond the threshold. Second, the sensitivity of the index to small changes in the defining variables will allow us to investigate the trajetories of rurality over time. Finally, assuming data availability, the index can be applied to different spatial scales without having to define (and justify) a new set of thresholds. This is an important advantage over traditional classifications and will be particularly beneficial for designing and evaluating regional development strategies. Development efforts increasingly recognize that a regional perspective offers substantial advantages over local

initiatives. For example, to facilitate regional development efforts, the state of Indiana was recently divided into 11 Economic Growth Regions with each being composed of several counties. These growth regions are not homogeneous and often include metropolitan as well as non-metropolitan counties. Thus, assessing a region's rurality will be difficult if not impossible with the traditional rural/urban classifications. It can, however, be assessed via the Index of Relative Rurality.

4. The Index of Rurality across Space and Time

Figure 5 shows the Index of Relative Rurality for counties in the continental U.S. for the year 2000.[5] Not surprising, the lowest rurality scores (i.e., highly urban counties) are found along the coasts as well as around the urban centers along the Great Lakes. The top-5 most urban counties include three counties of the New York Metro area (Kings, Queens and New York, NY), Cook County (Chicago, IL) and Los Angeles, CA. Particularly interesting is the upward trend in rurality scores as one moves from the Midwest to the Great Plains. In fact, counties east of the Mississippi tend to have low to medium levels of rurality, while extreme rurality (IRR>0.8) that is so prevalent in the Great Plains is almost absent. The top 5-most rural counties include Daniels County, MT, plus four counties in Nebraska: McPherson, Blaine, Logan and Thomas. The most rural county east of the Mississippi is Keweenaw, MI with an index value of IRR=0.895.

—Figure 4 about here—

This pattern of rurality has barely changed during the 1990s. Calibrating the index for 1990 and calculating the differences between 1990 and 2000 shows that, overall, counties have become slightly more urban over time. The average Index

[5] The index is available upon request for all counties in the continental U.S., 1990 and 2000.

declined from 0.514 in 1990 to 0.497 in 2000. Yet, for the most part the changes are small and few counties changed their relative standing. Overall, for 397 counties the Index decreased by more than 0.05. On average, these 397 counties lost 0.08 on the rurality scale. Only 47 counties increased their rurality by more than 0.05. On average, these 47 counties increased their rurality by +0.086. The remaining 2,664 counties changed their rurality by less than ±0.05 with an average of –0.010. The scattergram of the IRR 1990 and IRR 2000 (Figure 5) convincingly shows this persistence, with the slope parameter for the trend line being slightly greater than 1 and indicating the slight trend towards decreasing rurality..

—Figure 5 about here—

The temporal persistence of rurality is not surprising, at least within the ten-year horizon portrayed here. Expected is also that the few counties that do experience a change in rurality are not randomly distributed across the U.S. but instead exhibit very distinct spatial patterns of concentration. These patterns reflect the ongoing urbanization and urban sprawl in the western U.S. as well as the de-population in some of the interior east of the Rocky Mountains. As shown in Figure 6, counties that become more urban are concentrated in the western half of the United States, as well as along the entire East Coast and spreading inward, including the Carolinas and Pennsylvania, Ohio, Indiana, and Michigan. On the other hand, counties that become more rural, are almost exclusively located west of the Rocky Mountains and concentrated in the Great Plains and South. The bottom map of Figure 6 highlights the 397 counties with a drop in rurality of 0.05 or more. Their occurrence reaches from the Pacific to an almost sharp line just east of the Rocky Mountains, almost vanishes in the Great Plains, and picks up

again east of the Mississippi. The 47 counties for which rurality increased by more than 0.05, on the other hand, fill the void in the center of the country, between the Rocky Mountains and the Mississipi, as well as in some southern states. Nine counties of strongly increasing rurality are located in Alabama, six in Oklahoma, five in Iowa, three each in Kansas, Kentucky, Missouri and Texas, two in Louisiana, Maine, and North Dakota, and one each in California, Florida, Michigan, Minnesota, Mississippi, Montana, South Carolina, Tennessee and Wisconsin.

—Figure 6 about here—

Figure 7 shows the estimated changes in rurality as a function of longitude. Declining rurality is strongest along the coasts and is estimated to approach zero (at a decreasing rate) as one moves from the coasts towards the interior of the country. In the southern portion of the United States—defined as counties south of a line from Philadelphia-Indianapolis-Denver to Northern California (latitude: 39.6^{o}N)— variations in rurality change are even more pronounced than in the North as one moves from the coasts to the interior.

—Figure 7 about here—

Finally, while rurality levels remain —for the most part—unchanged, there is a tendency for counties that are part of a metropolitan area to decrease their rurality. In contrast, nonmetropolitan counties show a weaker decline in rurality than their metropolitan counterparts. Table 2 shows the average percentage change in rurality by rural-urban continuum code. Metropolitan counties (RUCC=1,2, or 3) become more urban. Nonmetropolitan counties show weaker declines or, in the case of the very small nonmetropolitan counties (RUCC=8 or 9), even positive changes on average. If this

trend —i.e., metropolitan counties becoming more urban and nonmetropolitan becoming more rural—continues, it will lead to a greater polarization between rural areas and urban agglomerations.

—Table 2 about here—

5. Example: Rurality and Educational Deprivation

This section presents an analysis of educational deprivation across the counties of the continental U.S. The analysis is meant to exemplify how the index of relative rurality can be advantageously utilized when assessing rural-urban differences in social indicators such as education.

In this illustrative example, we use two variables, namely the percentage of adults (persons of age 25 or older) without a high school degree, and the percentage of adults with at least a bachelor's degree. Using a metro/nonmetro distinction, or the more detailed rural-urban continuum code, analyzing the systematic relationships between rurality and the education variables, we typically compare means across categories.

—Table 3 about here—

Not surprisingly, Table 3 shows that, on average, the percentage of adults without a high school degree is higher in nonmetro counties, and the percentage of adults with at least a bachelor's degree is lower in nonmetro counties than in metro counties. Between 1990 and 2000, the percentage of adults with a very poor education decreased substantially while the percentage of adults with a college education rose. Moreover, the metro-nonmetro gap for the poorly educated decreased, whereas the metro-nonmetro gap for the college educated increased.

—Table 4 about here—

Table 4 further suggests that the relationship between educational attainment and rurality is non-monotonic. That is, with increasing rural-urban continuum code, the percentage of poorly educated adults first increases (up until code 4) and then oscillates as the code is further increased. The same sort of erratic behavior is observed for the percentage of college educated adults. Clearly, since the categories of the rural-urban continuum code are discrete categories that do not perfectly reflect a continuous increase of rurality with increasing code, the oscillations in average attainment levels may simply be an outcome of the rather arbitrarily chosen threshold. It should be noted that, even when controlling for the influence of other covariates in a multivariate setting, this basic threshold problem will persist.

The index of relative rurality does not share this threshold problem. It is continuous and thus allows us to inspect the association between rurality and educational attainment level more thoroughly. Figure 8 shows scattergrams of the index of relative rurality and the education variables for 1990 and 2000. What becomes immediately obvious is that the relationship between educational attainment level and rurality is indeed nonmonotonic, but not erratic. For the percentage of highly educated adults, rurality (expressed as a second order polynomial) can explain one third of the variation. Very consistently for both 1990 and 2000, the percentage of well-educated adults decreases with increasing rurality at a decreasing rate. It reaches a minimum at IRR=0.666 in 1990 and at IRR=0.639 in 2000. If rurality is even further increased, the percentage of highly educated adults increases. This representation between rurality and educational attainment levels also allows a fresh look at the changes over time. Overall, the percentage of college educated adults in U.S. counties has increased. However, as the

fitted curves demonstrate, this upward shift comes along with a steeper slope for the very low rurality scores, leading to increasing disparities in the educational attainment levels over time. This example nicely shows that using the continuous measure rather than the discrete categorizations allows us to trace even small changes in the association between education and rurality over time.

Variation in the proportion of poorly educated residents is not that easily explained with rurality alone. Fitting a second order polynomial shows that—on average—the proportion increases with increasing rurality up to a maximum at IRR=.606 and IRR=0.573 in 1990 and 2000, respectively. Increasing rurality even further, will result in a decline in the average percentage of poorly educated residents. However, the fit is very poor, with rurality only explaining 14% of the variation in 1990, and less than 10% in 2000. Prime reason for this poor fit is the he variation in the percentage of poorly educated for medium rurality levels. This strongly hints at factors other than rurality that play an important role in influencing variations in the magnitude of the lowest stratum of the educational attainment scale.

6. Conclusions

Rural policies need a good understanding of what is rural. The discussion above shows that the rural classifications currently in use, namely the metropolitan/non-metropolitan distinction and the rural-urban continuum code are inadequate to identify and delineate rural America. Isserman's rural-urban density typology is a major improvement. Yet, its reliance on thresholds continues to create artificial separations and artificial similarities.

The Index of Relative Rurality Shifting the focus from the question of "what is rural?" to the degree of rurality, offers major advantages over existing rural/urban classifications. First, rurality becomes a relative concept that can be used to investigate the trajectories of rurality over time. This opens new avenues for understanding relationships between rurality and social issues for education to poverty, unemployment, crime and other issues that are so important for the social /cultural fabric of rural America. For example, we can now address questions such as: "How does the degree of rurality change as an area becomes more prosperous?" Second, the Index of Relative Rurality is a continuous measure that is responsive to the multi-faceted nature of rurality. As such it is sensitive to even small changes in one or several of the defining variables.

Third, the Index or Relative Rurality is not confined to a particular spatial scale, such as counties. Instead, it can also be applied to groups of counties as well as to smaller scales such as townships or census tracts. This is an important advantage over traditional classifications and will be particularly beneficial for designing and evaluating regional development strategies.

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Table 1. The Rural-Urban Density Typology

		Population density [persons per square mile]	% urban	Population size of largest urban area	Total number of urban residents
Rural		<500	< 10%	< 10,000	
Urban		500+	90% +		50,000 +
Counties meeting neither the rural nor the urban criteria are classified as mixed. A population density criterion is used to differentiate between 'mixed rural and 'mixed urban'.					
Mixed	Mixed Rural	<320	Not applicable		
	Mixed Urban	320+			

Source: Waldorf (2006)

Table 2. Percent Change in IRR by Rural-urban Continuum Code

Rural-Urban Continuum Code		Number of Counties	% Change in the Index of Rurality 1990 to 2000	
			Average	Std.Dev.
1	Metropolitan Counties	413	-8.40	8.91
2		322	-7.21	6.85
3		350	-5.47	7.36
4	Non-Metropolitan Counties	218	-7.74	6.32
5		101	-5.14	5.87
6		608	-3.02	5.46
7		440	-2.71	5.81
8		232	0.06	4.08
9		424	0.15	4.54

		Index of Relative Rurality 2000			
RUCC	#	Average	Stdev	Min	Max
1	413	0.32	0.18	0.00	0.70
2	322	0.35	0.15	0.10	0.71
3	350	0.38	0.14	0.15	0.74
4	218	0.40	0.05	0.22	0.54
5	101	0.45	0.06	0.32	0.65
6	608	0.51	0.06	0.24	0.68
7	440	0.55	0.07	0.32	0.78
8	232	0.67	0.06	0.56	0.87
9	424	0.76	0.09	0.56	1.00
Grand Total	3108	0.50	0.18	0.00	1.00

UIC	#	Average	Stdev	Min	Max
1	413	0.32	0.18	0.00	0.70
2	672	0.37	0.15	0.10	0.74
3	92	0.44	0.06	0.28	0.68
4	123	0.57	0.08	0.29	0.81
5	301	0.44	0.07	0.22	0.75
6	357	0.53	0.06	0.24	0.70
7	182	0.66	0.07	0.46	0.87
8	275	0.53	0.12	0.32	0.97
9	201	0.57	0.06	0.43	0.81
10	196	0.75	0.08	0.51	0.97
11	129	0.58	0.08	0.32	0.83
12	167	0.77	0.10	0.47	1.00
Grand Total	3108	0.50	0.18	0.00	1.00

Table 3. Average Percentages of Adults without a High School Degree and Average Percentages of Adults with at least a Bachelor's Degree in Metro and Nonmetro Counties, 1990 and 2000 (standard deviation in parentheses)

% Adults without a HS Degree	1990	2000
Nonmetro	32.51 (10.35)	24.18 (8.95)
Metro	26.86 (9.38)	19.86 (7.54)
% Adults with at least a BS Degree		
Nonmetro	11.79 (4.77)	14.36 (5.71)
Metro	16.74 (8.14)	20.53 (9.46)

Table 4. Percentage of Adults without a High School Degree and Percentages of Adults with at least a Bachelor's Degree for Counties of Different Rural-urban Continuum Code, 1990 and 2000

Rural-urban Continuum Code		% Adults without a HS Degree		% Adults with at least a BS Degree	
		1990	2000	1990	2000
1	Average	25.584	18.774	18.509	23.063
	Std. Dev	9.672	7.385	9.361	10.829
2	Average	26.917	19.980	16.074	19.676
	Std. Dev	9.048	7.400	7.070	8.189
3	Average	28.317	21.037	15.278	18.328
	Std. Dev	9.139	7.679	7.085	8.058
4	Average	29.066	21.906	13.811	16.302
	Std. Dev	8.249	7.351	5.222	5.837
5	Average	26.146	20.272	16.397	19.378
	Std. Dev	9.318	8.645	5.570	6.677
6	Average	34.902	26.125	10.665	12.974
	Std. Dev	9.356	8.134	4.067	4.912
7	Average	31.655	23.908	12.385	14.919
	Std. Dev	10.835	9.537	5.046	6.204
8	Average	35.326	25.823	10.340	12.972
	Std. Dev	10.296	9.001	4.101	4.871
9	Average	31.699	22.839	11.441	14.369
	Std. Dev	11.029	9.420	4.173	5.309

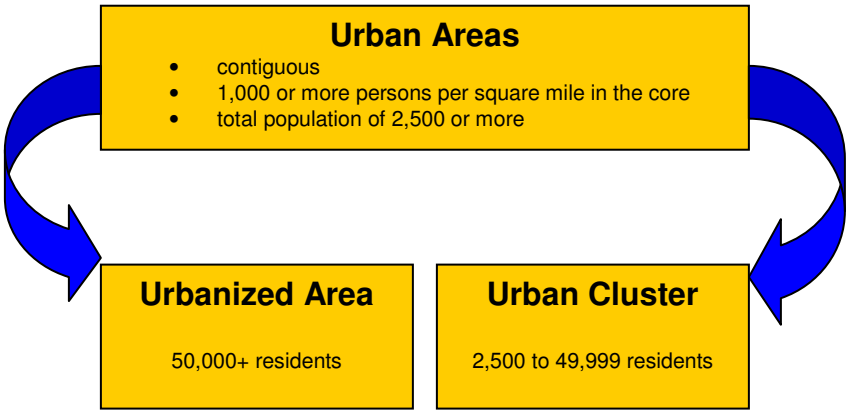


Figure 1. Definition of Urban Areas

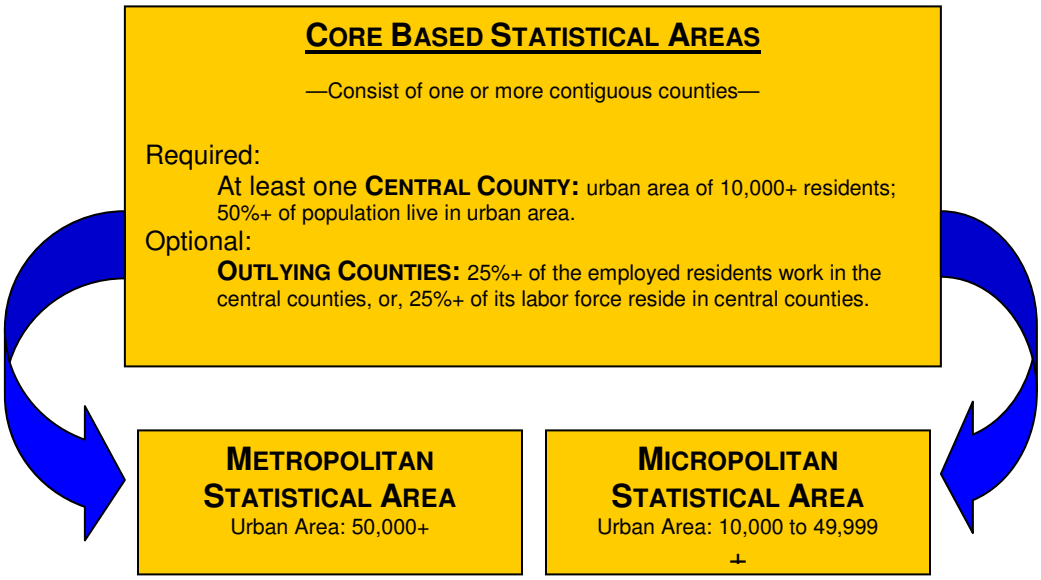


Figure 2. Definition of Core Based Statistical Areas

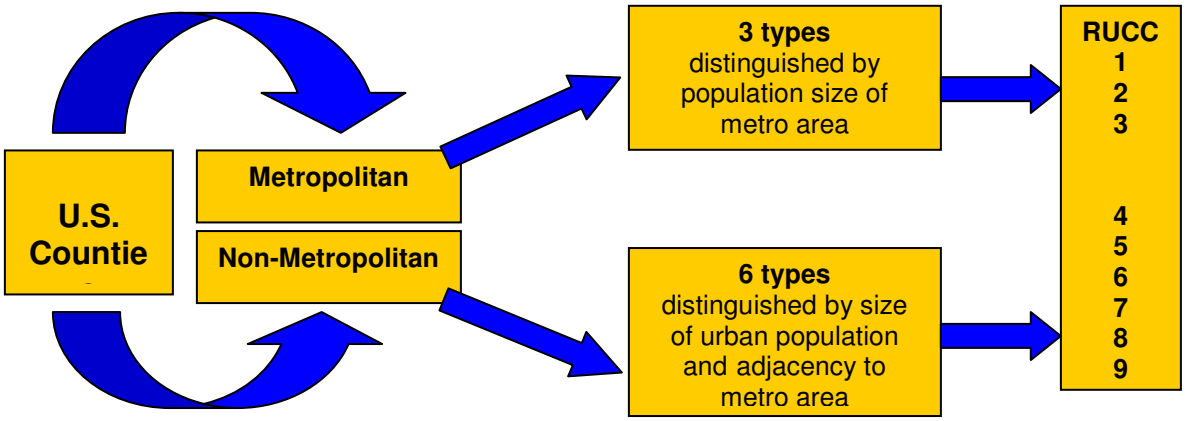
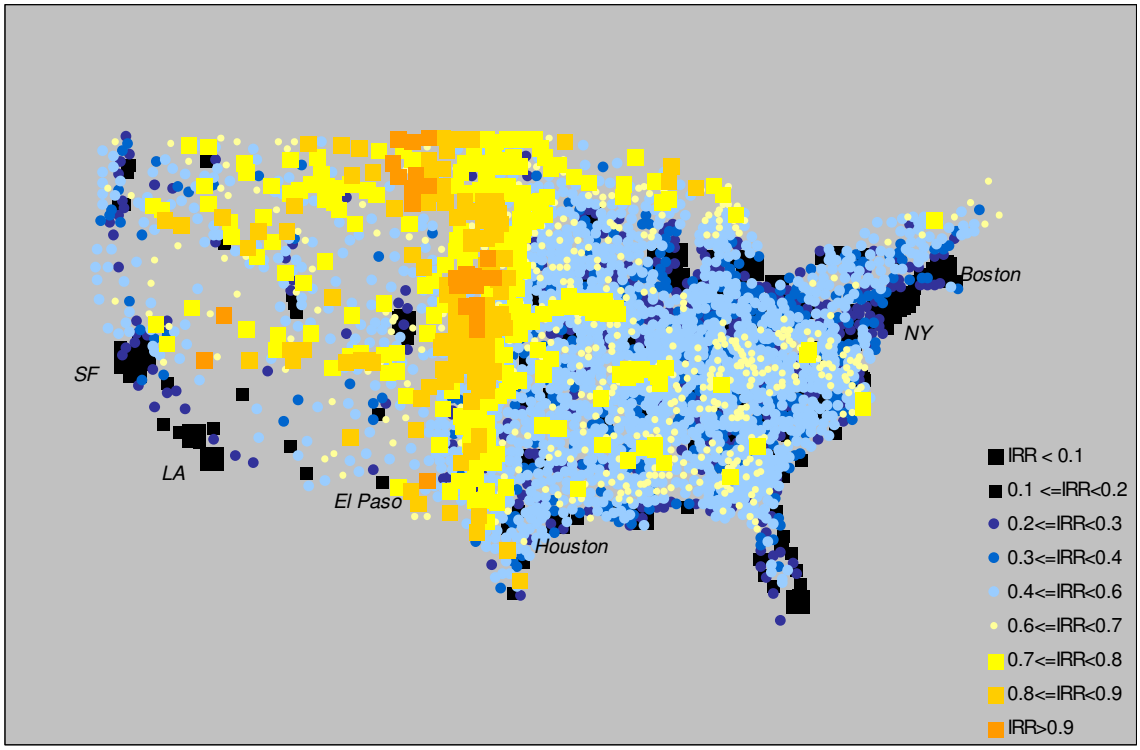


Figure 3. Categorization of U.S. Counties by the Rural-Urban Continuum Code



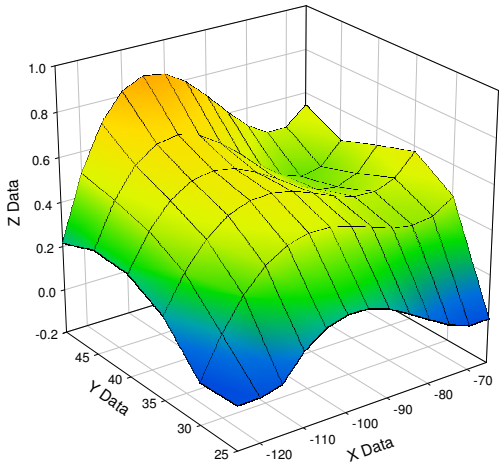


Figure 4. Index of Relative Rurality (IRR) for U.S. Counties, 2000.

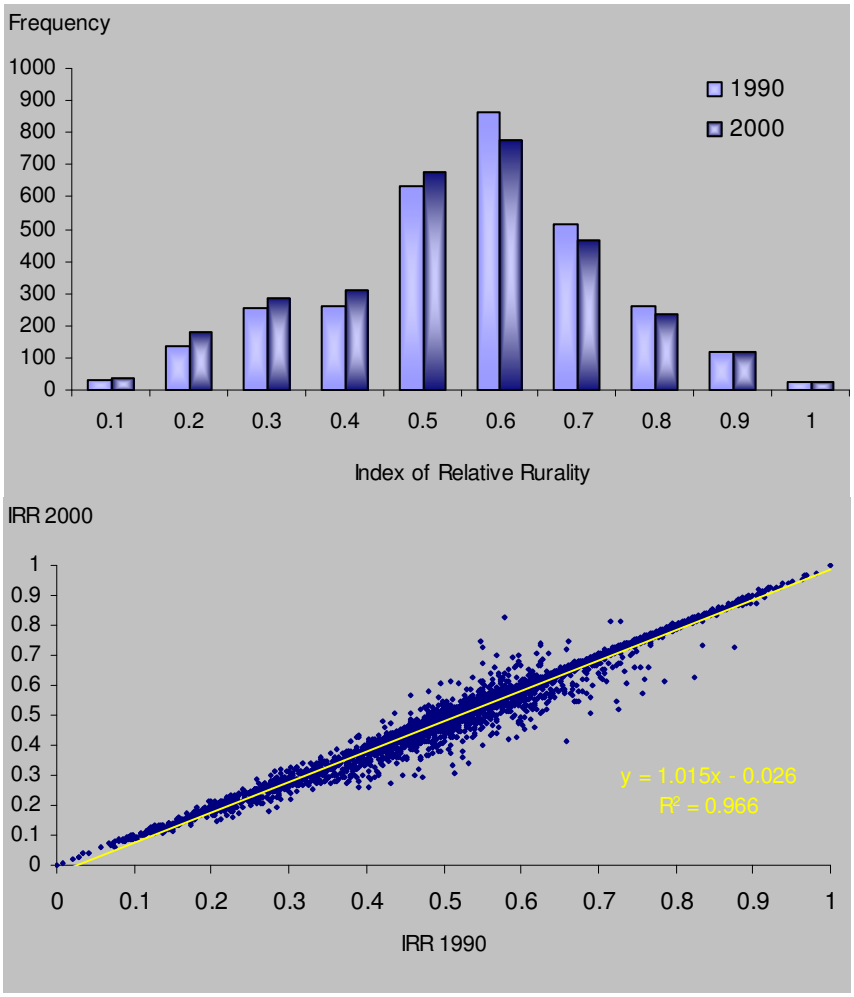


Figure 5. Temporal Persistence of Rurality in U.S. Counties
Top: Histogram of 1990 and 2000 IRR; Bottom: Scattergram of 1990 and 2000 IRR

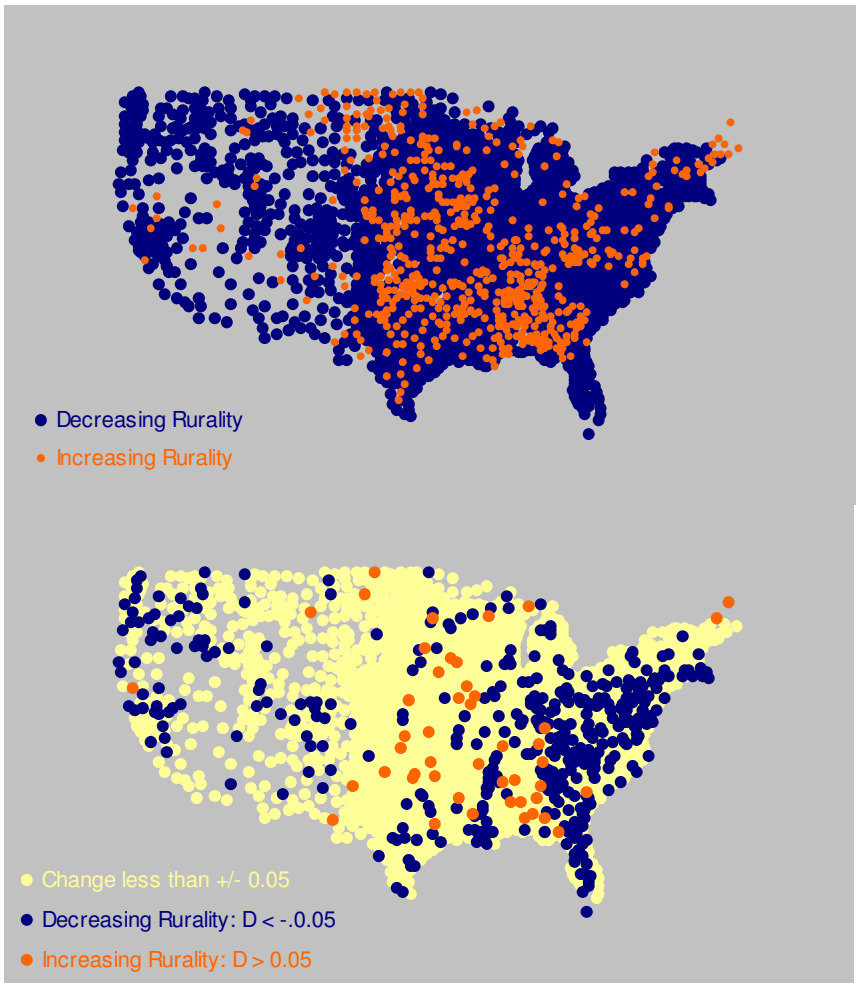


Figure 6. Spatial Pattern of Rurality Change in U.S. Counties
Top: Positive and Negative Changes. Bottom: Large (±0.05) Positive and Negative Changes.

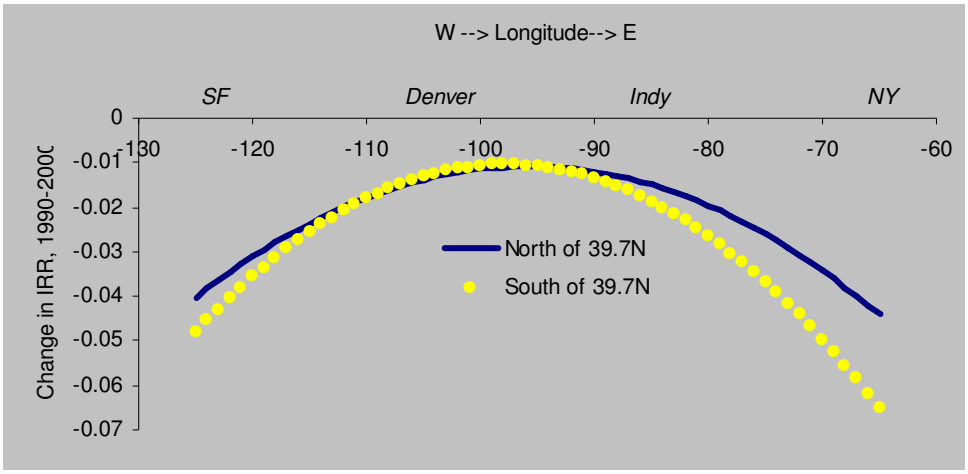


Figure 7. Rurality Change in U.S. Counties 1990-2000 as a Function of Longitude

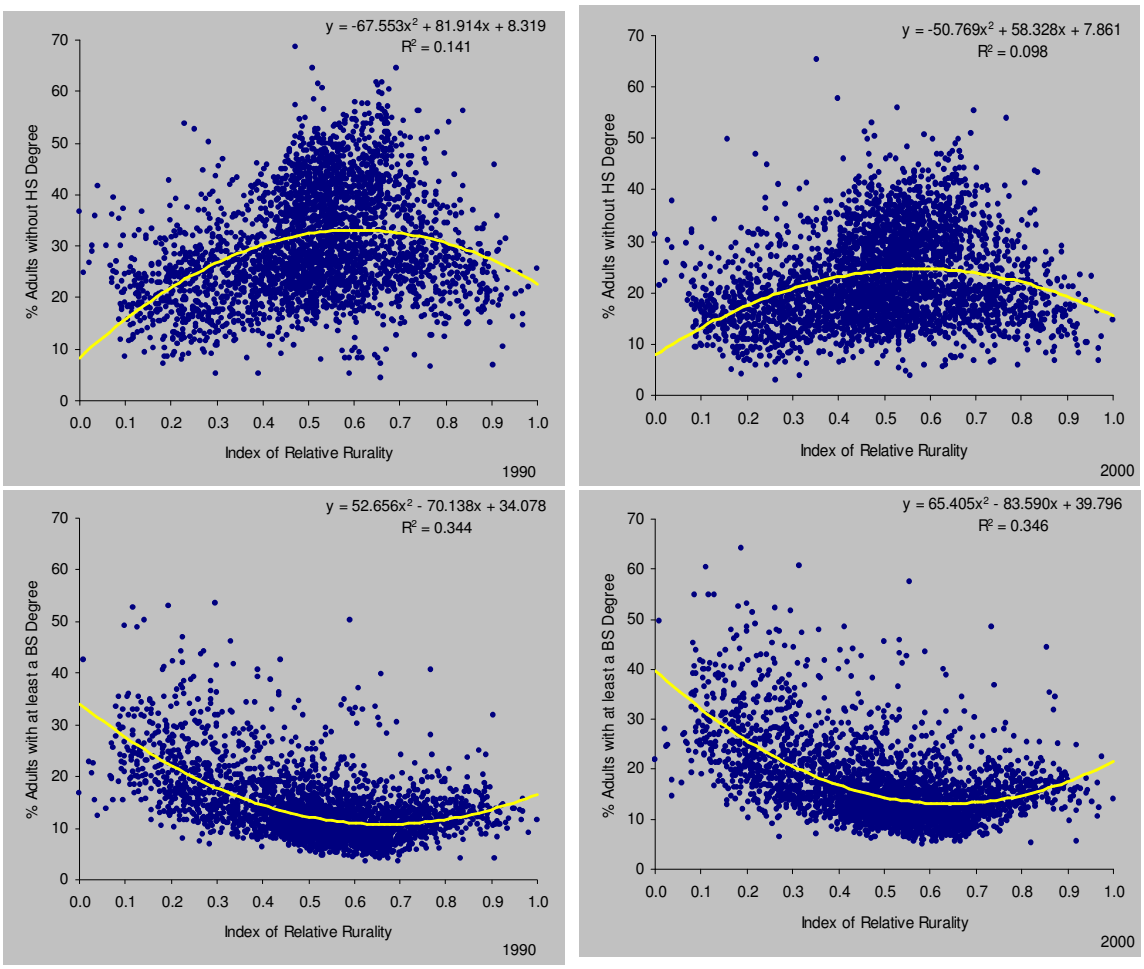


Figure 8. The Association between Rurality and the Percentage of Adults without a HS Degree (top) and the Percentage of Adults with at least a Bachelor's Degree (bottom), 1990 and 2000.