Areal Delineations for Rural Economic Development Research

By Clark Edwards and Robert Coltrane

A number of possible geographic delineations can be used for areal allocation of population, income, employment, and other social and economic characteristics, in a rural development indicator system. This paper shows that estimates of statistical parameters vary for alternative geographic aggregations and for alternative delineations at a given level of aggregation, and that estimates of statistical parameters for alternative delineations vary as the level of structural disaggregation of variables used in the analysis is varied. Nine delineations and 12 characteristics were used to examine the statistical consequences of alternative delineations.

Key words: Areal delineation; rural economic indicators.

The geographic location of economic activity may be as important a variable in an analysis of rural economic development problems as price and quantity. Thus, economic indicators and situation statements for rural development purposes need to account for location in geographic as well as economic space.

One way to locate activity in space is to pinpoint the latitude and longitude at which it occurs. Another is to reference the general geographic area in which the activity occurs, such as by city, county, or State. Such areas are treated as if they were points for the purposes of economic analysis. Analyses using the areal system of location presuppose a delineation of geographic space into suitable areas.

There are numerous ways to delineate geographic space into areal units. However, statistical results describing economic and social characteristics differ according to the way units are delineated. The United States is divided into over 3,000 counties. Means, variances, correlation coefficients, and related statistical parameters for specific variables computed for counties, and for successive levels of aggregation of the counties into multicounty areas, State areas, and multi-State areas, can be expected to vary. This holds both for alternative levels of geographic aggregation and for alternative delineations at a given level of geographic aggregation.

In addition to geographic aggregation, another consideration is structural aggregation. An example of structural aggregation would be measuring total population as opposed to distribution of population by age, sex, and race. The areal delineation becomes critical when the analyses require structural disaggregation of variables. Consequently, the results of economic analysis, and subsequent policy recommendations for rural development, may vary among research projects.

One can conceive of a continuum of areal observational units, beginning with the Nation as a single unit and disaggregating geographically through the four census regions to nine census divisions, 50 States, 500 multicounty areas, 3,000-plus counties, and less-than-county units. At each level of disaggregation, one might have alternative delineations. For example, the 500 multicounty areas might be delineated in two or more different ways.

The optimal choice of an areal delineation depends upon the objective in view. In this paper, the comparison of alternative delineations is made from the point of view of analyzing rural development problems. Other points of view, such as implementation of political programs or health programs, might as easily be taken as the primary objective. The burden of this paper is not on how to choose the optimal delineation given an objective, but rather to show that, whatever the objective in view, the statistical results are a function of the delineation used.

From the point of view of rural economic development, up to a point, increasing levels of disaggregation of areal observational units are likely to reveal additional local development problems. However, if the disaggregation is carried to county and less-than-county levels, the observational units may be fractured into areas that do not contain the entire local economic development problem and/or means to help solve the problem. This suggests that analytic units which comprise less than a State but more than a county may be optimal, subject to considerations of the concepts as to what comprises a functional economic area. This point is discussed further in the appendix.

Alternative Delineations and Specific Variables

Nine delineations and 12 specific economic indicators were selected for the purpose of examining the consequences of alternative regional delineations. The nine delineations are for the 48 contiguous States and the District of Columbia. Listed in order of the number of observational units defined, they are:

1. 3,068 counties (COUNTY)
2. 509 governor delineated districts (A-95)[1]
3. 507 State Economic Areas (SEA)
4. 489 Rand McNally Basic Trading Areas (MCBTA)
5. 472 Basic Economic Research Areas (BERA)
6. 171 Office of Business Economics Regions (OBE)
7. 119 Economic Subregions, which are aggregates of State Economic Areas (SUBSEA)
8. 49 Rand McNally Major Trading Areas, which are aggregates of the Rand McNally Basic Trading Areas (MCMTA)
9. 49 States including the District of Columbia (STATES)

These nine delineations range from individual counties through States. Counties were used as building blocks in forming each delineation. The logic underlying the delineations varies from functional economic considerations, through homogeneity criteria, to political subdivisions. A more detailed discussion of these alternative delineations is in the appendix.

The 12 specific economic and social indicators are:

1. Percentage of population urban, 1960 (URBAN)
2. Percentage of population farm, 1960 (FARM)
3. Percentage of employment white-collar, 1960 (WH COL)
4. Percentage of employment finance, insurance, and real estate, 1960 (FIRE)
5. Income per capita, 1960 (IN/CAP)
6. Percentage of families, 1960, with 1959 income less than $3,000 (POVERT)
7. Percentage of housing units sound, 1960 (HOUSE)
8. Percentage of persons age 25 and over with high school or more education, 1960 (EDUCAT)
9. Percentage of commercial farms with sales greater than $10,000, 1964 (COMFRM)
10. Retail sales per capita, 1963 (RS/CAP)
11. Bank deposits per capita, 1960 (BD/CAP)
12. Local government expenditures per capita, 1962 (GE/CAP)

These 12 variables cover a broad spectrum of economic and social attributes. Some are measures of inputs to the development process, others are outputs, while some fill both roles simultaneously. Still other variables play neither role but function as characteristics that differentiate the development process of one region from the process of another region.[2]

The nine delineations vary from highly disaggregated (3,068 counties) to highly aggregated (48 States and the District of Columbia). Similarly, one can look at each of the 12 variables separately or aggregate them, even into a single index. Two general approaches to determining differences in statistical properties of the alternative delineations were undertaken. In the first, the 12 variables were combined into a single index reflecting the general level of economic development of an area. In the second, properties of each variable, and relationships among the variables, were compared for alternative delineations.

Statistical Properties When Specific Variables Are Aggregated

The 12 variables were aggregated into a single index of economic development by means of principal component analysis. The procedure assigns weights to each variable. The resulting index can be used to rank areal observational units. That is, counties can be ranked from 1 to 3,068, and States from 1 to 49, in terms of the level of economic development.[3]

Principal component weights for each of the 12 specific variables were calculated for each of the 9 delineations (table 1). Results obtained for each delineation showed that the principal component computations are not very sensitive to variations in delineations. The difference between each coefficient and the comparable BERA coefficient was calculat-

[1]The governors had, at the time of writing, delineated 487 regions in 39 States. ERS has filled in delineations for the remaining 9 States.

[2]For further discussion of the specific and general roles such variables play in an economic indicator system for rural development, see: Clark Edwards and Robert Coltrane. Economic and Social Indicators of Rural Development from an Economic Viewpoint. Paper presented at Annual Meeting, Southern Agr. Econ. Assoc., Richmond, Va., Feb. 1972.

[3]For a detailed discussion of an index of this type, see: Clark Edwards, Robert Coltrane, and Stan Daberkow. Regional Variations in Economic Growth and Development with Emphasis on Rural Areas. U.S. Dept. Agr., Agr. Econ. Rpt. 205, May 1971.

Table 1.—Specific variables and their weights used to construct an index of economic development for alternative subregional delineations

Specific variables	Principal component weights								
	COUNTY	A-95	SEA	MCBTA	BERA	OBE	SUBSEA	MCMTA	STATES
URBAN.......	0.2686	0.2894	0.2954	0.2822	0.2780	0.2792	0.2907	0.2927	0.3050
FARM	−.2178	−.2161	−.2459	−.2027	−.2194	−.1957	−.2268	−.2080	−.2398
WH COL	0.3211	0.3157	0.3156	0.2964	0.3119	0.3110	0.3153	0.3040	0.3197
FIRE	0.2744	0.2707	0.2782	0.2458	0.2527	0.2570	0.2810	0.2719	0.2859
IN/CAP	0.3530	0.3476	0.3421	0.3580	0.3569	0.3503	0.3307	0.3231	0.3412
POVERT......	−.3413	−.3343	−.3253	−.3296	−.3403	−.3283	−.3169	−.3041	−.3222
HOUSE	0.3498	0.3392	0.3353	0.3438	0.3444	0.3349	0.3265	0.3225	0.3345
EDUCAT......	0.3280	0.3091	0.3038	0.3100	0.3112	0.3042	0.2938	0.2852	0.2612
COMFRM	0.2094	0.2176	0.1988	0.2380	0.2312	0.2358	0.2305	0.2814	0.1932
RS/CAP	0.2897	0.2845	0.2934	0.2888	0.2766	0.2905	0.2943	0.3097	0.2858
BD/CAP	0.2503	0.2555	0.2630	0.2672	0.2657	0.2667	0.2702	0.2390	0.2562
GE/CAP	0.2014	0.2447	0.2303	0.2618	0.2329	0.2733	0.2650	0.3002	0.2839

ed.[4] The average of the absolute differences ranged from less than 0.01 for the A-95 areas to about 0.03 for the Rand McNally Major Trading Areas (MCMTA). We do not know of a test of significance for the differences among principal component weights computed from correlation matrices from different populations. Instead, the specific variables were aggregated into an index for individual multicounty areas and a test was made of the ranks to determine if they were significantly different.

To do this, each of the nine sets of weights in table 1 was applied to the 472 observational units in the BERA delineation. This gave nine alternative indexes for the BERA delineation. A test of rank differences between the nine indexes failed to discriminate significantly among the alternative delineations. The smallest rank correlation coefficient, indicating the largest difference in ranks, computed between the BERA's ranking with its own set of weights and with an alien set of weights, was .9992 (table 2). This ranking was the one associated with weights derived from State data. The widest single variation in ranks was found in an instance where a State vector placed an area 42 ranks away from where the county vector placed it.

[4]The BERA delineation was chosen as the basis for comparison because it most closely follows the logic of functional economic areas. That is, from the point of view of economic development, for reasons external to the objective of this paper, the BERA delineation is considered useful. The purpose of this paper would have been met equally well with some other areal delineation chosen as the basis for comparison.

Statistical Properties When Specific Variables Are Not Aggregated

The nine delineations were compared for differences in descriptive properties of each variable and for differences in estimated relationships among variables. To examine descriptive properties, the mean, variance, and degree of skewness of a specific variable were compared among delineations. To examine relationships, correlation and regression coefficients were compared among delineations.

Descriptive Properties of Specific Variables

The analysis displayed quite a bit of variation in the first, second, and third moments for each specific variable for alternative delineations. In the two sections below, we discuss the variations in the first and third moments. The second moment was used in constructing some of the statistical tests.

Means.—Table 3 lists the mean and standard error of the mean for each of the 12 specific variables for the BERA delineation. For the other eight delineations, table 3 shows for each variable the extent to which the mean differed from the BERA mean using the BERA standard error as a unit of measurement. For example, the BERA mean for percentage of population urban was 50.15. The COUNTY mean for the same variable was 31.8 percent, 20.43 standard errors smaller than the BERA mean.

Table 2.—Test of difference in ranking of multicounty areas by weights derived from alternative delineations using the BERA delineation as a base

Item	COUNTY	A-95	SEA	MCBTA	OBE	SUBSEA	MCMTA	STATES
Rank correlation coefficient	0.99982	0.99992	0.99973	0.99978	0.99969	0.99980	0.99946	0.99917
Rank of coefficient	2	1	5	4	6	3	7	8
Maximum single deviation from BERA rank	15	7	14	12	13	13	19	27
Rank of deviation	6	1	5	2	3.5	3.5	7	8

Table 3.—Indicator of differences in means of specific variables for alternative delineations using the BERA delineation as a base

Specific variables	Standard errors from BERA[a,b]								BERA	
	COUNTY	A-95	SEA	MCBTA	OBE	SUBSEA	MCMTA	STATES	Mean	Standard error
URBAN. . . .	−20.43	−2.71	4.68	2.55	7.37	4.88	15.72	13.98	50.15	0.8994
FARM.	14.89	2.00	−5.17	−4.01	−4.35	−2.44	−11.11	−9.62	15.11	0.5152
WH COL . . .	−18.77	−2.45	2.59	1.38	6.08	2.90	6.84	13.70	35.99	0.2639
FIRE	−13.55	−0.56	4.87	1.82	8.97	7.48	19.12	18.06	2.90	0.0466
IN/CAP . . .	−12.13	−2.38	1.98	1.20	3.15	−0.18	8.39	10.01	1,550.88	16.3949
POVERT . . .	12.73	2.28	−1.59	−2.01	−2.19	1.52	−4.67	−7.88	28.27	0.5758
HOUSE . . .	−13.68	−2.36	2.59	2.44	3.53	−0.10	7.59	9.09	64.88	0.5869
EDUCAT . . .	−6.73	−2.31	−2.21	−1.30	1.18	−4.35	2.29	5.35	39.34	0.4010
COMFRM . .	−5.48	−2.35	−2.28	−1.81	−0.95	−3.52	−2.91	1.02	41.69	0.7880
RS/CAP . . .	−15.13	−3.02	−3.67	−1.68	−0.55	−4.66	−0.90	3.76	1,263.54	11.0108
BD/CAP . . .	−9.45	−1.34	0.11	−0.01	2.77	2.50	8.22	13.53	931.50	16.9974
GE/CAP . . .	−5.62	−4.24	−3.85	−3.03	−1.82	−5.16	−1.44	0.05	197.83	2.9215
Total of absolute values . . .	148.59	28.00	35.59	23.24	42.91	39.69	89.20	106.85	—	—
Mean of absolute values . . .	12.38	2.33	2.97	1.94	3.58	3.31	7.43	8.90	—	—

[a]A mean less than 1.96 standard errors from BERA is not significantly different at the .05 level. A mean less than 2.59 standard errors from BERA is not significantly different at the .01 level.

[b]Computed with the formula, $\frac{\bar{x}_j - \bar{x}_{BERA}}{\text{standard error}}$.

An indicator of the degree of closeness of a vector of means to the BERA means was constructed as the sum of absolute values of differences from the BERA means. The Rand McNally Basic Trading Areas (MCBTA) had means which, on average, were closer to the BERA means than any other delineation. The sum for the MCBTA's totaled 23.24, an average of 1.94 standard errors. The A-95 and SEA delineations also have means very close to the BERA means, so BERA, MCBTA, A-95, and SEA delineations would be expected to give about the same average picture of the levels of the specific variables. The sizes of the indicators for the COUNTY, STATE, and MCMTA delineations suggest altogether different average pictures.

Skewness.—Indicators of differences in skewness of specific variables for alternative delineations, using the BERA delineation as a base, are shown in table 4. The coefficient of skewness was calculated according to the formula:

$$a = \frac{1}{N} \Sigma \left(\frac{x_j - \bar{x}_j}{s_{x_j}} \right)^3$$

If the sample comes from a normal population, it is distributed with a mean of zero and a standard deviation of:

$$s_a = \left(\frac{6}{N} \right)^{1/2}, \text{ when } N \text{ is large.}$$

The ratio, a/s_a, measures the number of standard deviations the observed coefficient of skewness is from zero. This ratio is tabulated for the BERA delineation in table 4. For example, the BERA coefficient of skewness for percentage of population urban was 1.06 standard deviations above zero. A coefficient above zero suggests a distribution that is skewed to the right. However, a ratio less than 1.64 rejects the hypothesis of skewness at the .05 level for large N. So the percent urban variable is apparently not skewed significantly. Following these rules, eight of the 12 variables are skewed in the BERA delineation. Of these, the quality of housing variable is skewed to the left; the other seven, to the right. The four variables that appear to be normally distributed are percent urban (URBAN), income per capita (IN/CAP), percent with a high school education (EDUCAT), and percent of commercial farms with sales over $10,000 (COMFRM).

The differences between BERA's ratio of the coefficient of skewness to its standard deviation and the ratio for each of the other eight delineations are shown in table 4 for each of the 12 specific variables. For example, while the BERA coefficient of skewness for the percentage of population urban was 1.06 standard deviations above zero, the comparable coefficient for the counties was 9.32 standard deviations above zero, 8.26 standard deviations higher than BERA. This means this variable was significantly skewed to the right for counties whereas it appeared not to be skewed for the BERA's.

Table 4.—Indicator of differences in skewness of specific variables for alternative delineations using the BERA delineation as a base

Specific variables	Differences in skewness from BERA[a]								BERA[b]
	COUNTY	A-95	SEA	MCBTA	OBE	SUBSEA	MCMTA	STATES	
URBAN	8.26	0.74	-0.36	1.80	0.06	-0.76	-1.47	-0.97	1.0648
FARM	5.05	-1.02	1.00	.56	-3.37	-4.25	-6.90	-6.82	7.9503
WH COL	11.80	1.52	-0.03	1.33	-1.28	-3.50	-3.82	-3.86	3.6380
FIRE	22.70	1.35	0.32	2.45	-6.09	-8.48	-10.92	-10.93	11.7838
IN/CAP	12.12	1.29	-0.75	-.08	-0.30	-0.35	-1.12	-1.01	1.0382
POVERT	.42	-1.47	0.35	-.07	-3.76	-4.88	-6.34	-5.94	7.0275
HOUSE	-1.47	.16	-1.26	-.49	2.48	2.82	3.54	3.33	-4.0106
EDUCAT	3.70	.11	.44	1.50	.99	.68	.97	.90	1.1535
COMFRM . . .	4.82	-.17	.78	.66	.40	.52	-.04	-.68	-0.2130
RS/CAP	-.40	-1.81	-2.76	2.45	-1.18	4.17	-3.05	-1.82	2.7240
BD/CAP	47.06	22.81	3.95	.64	-2.92	-5.10	-12.87	-12.75	15.8740
GE/CAP	36.94	-.63	.38	-.34	-3.61	-4.25	-6.45	-5.56	7.2408
Total of absolute values	154.74	33.08	12.38	12.37	26.44	39.76	57.49	54.57	–
Mean of absolute values	12.90	2.76	1.03	1.03	2.20	3.31	4.79	4.55	–
Standard deviation[c] . .	.0447	.1089	.1086	.1109	.1844	.2199	.7946	.7946	.1127

[a]Differences in skewness from BERA was computed with the formula, $\frac{a_j}{s_{a_j}} - \frac{a_{BERA}}{s_{a_{BERA}}}$, where a = coefficient of skewness and s_a = standard deviation.

[b]The number of standard deviations (s_a) the coefficient of skewness (a) is from zero. This was computed with the formula, $\frac{a_{BERA}}{s_{a_{BERA}}}$.

[c]The standard deviations (s_a) were computed with the formula, $s_a = \sqrt{6/N}$ when N was greater than 200. When N was less than 200, the values for s_a were interpolated from appendix table A6, page 552 in Snedecor and Cochran, Statistical Methods, Iowa State University Press, Ames, Iowa, 6th edition, 1967.

An indicator of the degree of closeness of a vector of coefficients of skewness to the BERA vector was constructed. This indicator was the sum of the absolute value of differences from the BERA coefficients. This sum totaled 12.37 for Rand McNally Basic Trading Areas (MCBTA) and 12.38 for State Economic Areas (SEA), an average difference of only 1.03 standard deviations. The variables in the OBE and A-95 delineations were also close to BERA in terms of skewness. The COUNTY variables had by far the greatest average difference from BERA in skewness.

Thus, the comparisons of means, variances, and coefficients of skewness show that the descriptive properties of a specific variable are a function of the delineation. The BERA, MCBTA, A-95, SEA, and OBE appear to have similar descriptive properties.

Relationships Among Specific Variables

So far, it has been shown that generating aggregative economic indicators, such as simple rankings of regions in terms of level of economic development, is not particularly sensitive to alternative delineations. However, descriptive properties of specific variables, such as the mean, variance, and skewness, are sensitive. In this section, we examine whether relationships among variables, such as simple correlations and single equation regressions, are sensitive to alternative delineations.

Correlations.—Indicators of differences in simple correlation coefficients for specific variables, using the BERA delineation as a base, are shown in table 5. Simple correlation coefficients were calculated among the 12 variables for each delineation. That is, for each delineation, each variable was correlated with 11 other variables. The 99-percent confidence limits were calculated for each BERA correlation coefficient. Finally, it was determined whether each corresponding coefficient for the other eight delineations fell within the confidence limits for the BERA coefficients. The number of correlation coefficients for each specific variable that were outside the confidence interval for the comparable BERA coefficients is shown in table 5.

Five of the 11 correlation coefficients for the percent urban variable in the COUNTY delineation fell outside the 99-percent confidence limits for the BERA coefficients. For the percent urban variable, the SUBSEA delineation had the most coefficients (11) that were significantly different, while the OBE delineation had only one coefficient falling outside the confidence limits.

An indicator of the degree of closeness of the correlation coefficients for the eight alternative delineations to BERA was constructed by summing the number of coefficients for each delineation that was significantly different from BERA. This total for the Rand McNally Basic Trading Areas (MCBTA), with double counting removed, was 10. This indicates that the correlation matrices for the Rand McNally Basic Trading Areas and for BERA are relatively similar. The governors' districts under A-95 and the Office of Business Economics delineation (OBE) also had correlation matrices similar to the BERA matrix. The State Economic Area (SEA) matrix was quite dissimilar to the BERA matrix with 33 coefficients, or half of the 66 computed, significantly different. Thus, while the SEA delineation earlier showed little difference from BERA's in terms of descriptive properties of each variable such as central tendency, here it shows considerable difference in terms of structural interrelationships. This is probably because the SEA's were delineated on the basis of homogeneity of specific attributes, whereas the BERA's were delineated on the basis of functional economic considerations. Hence, both have about the same descriptive content but are structurally dissimilar. The delineation that showed the greatest difference in the correlation matrix from the BERA matrix was the Economic Subregions (SUBSEA), where 59 of the 66 elements were significantly different (table 5).

The problem of correlation coefficients varying among areal units was discussed by King.[5] He cites several studies that also discuss the problem. King quotes Yule and Kendall[6] as saying that "correlations will . . . measure the relationships between the variates for specified units chosen for the work. They have no absolute validity independently of those units, but are relative to them." We agree with Yule and Kendall in general, but we find that measures of relationships between variables have some validity for other observational units delineated with similar criteria. For example, we might be able to use MCBTA correlations, but not SEA correlations, to analyze BERA units. Or, stated another way, one could expect about the same results using either MCBTA or BERA correlations, but quite different results using SEA correlations.

Regressions.—Stepwise regressions on the 12 variables further demonstrate that estimates of economic structure are a function of the regional delineation. The right-hand column of table 6 shows the order in which each specific variable entered a stepwise regression, using the BERA delineation. In this regression, income per capita was treated as the dependent variable to be explained by the other 11 variables. The intensity of poverty (POVERT) was the first variable to enter the BERA regression; the percent with a high school education (EDUCAT) was the last to enter. Also shown

[5] Leslie J. King. Statistical Analysis in Geography. Prentice-Hall Inc., Englewood Cliffs, N.J., 1961, pp. 154-7.

[6] G. V. Yule and M. G. Kendall. An Introduction to The Theory of Statistics. Hafner Publishing Co., New York, N.Y., 1950, p. 312.

Table 5.—Indicator of differences in simple correlation coefficients for specific variables for alternative delineations using the BERA delineation as a base

Specific variables	Number of correlation coefficients that were significantly different from comparable coefficient in the BERA delineation[a]							
	COUNTY	A-95	SEA	MCBTA	OBE	SUBSEA	MCMTA	STATES
URBAN	5	5	9	4	1	11	8	9
FARM	2	0	7	2	0	9	5	8
WH COL	1	4	6	5	2	10	7	7
FIRE	2	3	9	2	1	11	6	10
IN/CAP	3	3	6	1	3	9	8	8
POVERT	3	2	4	1	2	10	7	6
HOUSE	0	1	7	2	3	11	9	8
EDUCAT	2	1	4	0	1	7	6	4
COMFRM	2	0	0	0	0	9	10	5
RS/CAP	8	4	7	0	5	11	10	9
BD/CAP	2	0	4	0	1	9	3	5
GE/CAP	4	1	3	3	7	11	11	2
Total with double counting removed	17	12	33	10	13	59	45	44

[a] The number of correlation coefficients falling outside the 99-percent confidence limits of the BERA correlation coefficients. For each delineation, the maximum number for each variable is 11 and the maximum number for each column total is 66.

Table 6.—Order in which specific variables enter a stepwise regression for alternative subregional delineations using the BERA delineation as a base for comparisons

Specific variables[a]	Differences from BERA order ($x_j - x_{BERA}$)								BERA order
	COUNTY	A-95	SEA	MCBTA	OBE	SUBSEA	MCMTA	STATES	
URBAN . . .	−6	−7	−4	0*	0*	−4	−4	−6	4*
FARM	−4	−1*	−4	−3*	−2	−4	−4	4*	7*
WH COL . . .	0*	2*	4*	0*	4*	1	0	−2	6*
FIRE	0*	0*	−8	0*	−9	0*	0*	−7	2*
POVERT . . .	0*	0*	0*	0*	0*	0*	0*	−5	1*
HOUSE . . .	2*	0*	5*	2*	−1	5*	−1	8*	9
EDUCAT . . .	8*	5*	5*	0*	6*	4	7*	4	11
COMFRM . .	1*	0	1	2*	3*	1	3	−1	10
RS/CAP . . .	−5*	0*	−4*	0*	0*	−3	−2*	1*	3*
BD/CAP . . .	1*	0*	2*	0*	−3*	2*	−4	1*	5*
GE/CAP . . .	3*	1*	3*	−1*	2*	−2*	5*	3	8*
Total of positive values . . .	15	8	20	4	15	13	15	21	—

[a]Income per capita was the dependent variable.

*Specific variables which would have been in an equation selected by stepwise regression such that each variable in the equation is significant at the .05 level.

in table 6 is a measure of the difference from the BERA order that the 11 variables entered regressions for the other delineations. For example, the percent urban variable, which entered fourth in the BERA regression, entered six steps later, or tenth, in the COUNTY regression.

An indicator of the similarity to the BERA order in which variables entered a stepwise regression for the other delineations was calculated by summing the positive differences (table 6). The regression with an ordering closest to the BERA order was the Rand McNally Basic Trading Areas (MCBTA). The A-95 areas were also fairly similar in structure to the BERA areas. The States and the State Economic Areas (SEA) show the greatest difference in economic structure from the BERA areas by this criterion. The magnitude of the difference in the SEA ordering from the BERA ordering is not surprising due to the earlier finding that the correlation coefficients were quite different. This is especially interesting considering that the descriptive properties for SEA's and BERA's were quite similar in terms of means, variances, and skewness.

As an alternative to stepwise regression, a single equation model to explain income per capita with five independent variables was fitted for each of the nine delineations. The model was:

$$\text{IN/CAP} = a + b_1\ \text{URBAN} + b_2\ \text{FIRE} + b_3\ \text{POVERT} + b_4\ \text{RS/CAP} + b_5\ \text{BD/CAP}.$$

This equation was obtained from the first five steps in the stepwise regression using the BERA areas.

Using this model, four of the nine delineations generated coefficients which were statistically significant at the .01 level for all five independent variables. One delineation, of course, was BERA. The other three were A-95, MCBTA, and SEA (table 7). Only three of the five coefficients were significant at this level for States and for Rand McNally Major Trading Areas (MCMTA).

Not only were the coefficients for BERA, A-95, MCBTA, and SEA all significantly different from zero (table 7), they were different from each other (table 8).

Conclusions.—The discussion of correlation coefficients and stepwise regressions suggested that three delineations, BERA, MCBTA, and A-95, were much alike in terms of an apparent economic structure that reflects relationships among specific variables. Structure estimated for one of these delineations might be used for analysis of relationships in the other two.

The structure estimated with the SEA delineation was different from the estimated structure of the BERA, MCBTA, and A-95 delineations. However, when the specific, five-independent-variable model was fitted for all delineations, the SEA's generated coefficients which were close to those found for the BERA, A-95, and MCBTA delineations. The SEA's gave the right answers for the wrong reasons. They have an underlying structure different from the BERA structure; 10 of the 15 correlation coefficients involved in the model were significantly different from the BERA correlation coefficients. Further, 11 independent variables entered a stepwise regression equation using the SEA units in an order different from that of the variables entered using the BERA units. Thus, it seems the SEA's were able to generate about the same estimates of structure for the five-independent-variable model as the BERA's because

Table 7.–Constant terms, partial regression coefficients and coefficients of determination for alternative subregional delineations[a]

Subregional delineation	Relative frequency of significant variables			Constant term	Partial regression coefficients[b]					Coefficient of determination
	†	*	**		URBAN	FIRE	POVERT	RS/CAP	BD/CAP	
COUNTY	1	0	4	1,746.008	0.193 (0.143)	** 51.005 (3.357)	** −18.865 (0.238)	** 0.096 (0.011)	** 0.066 (0.009)	0.85
A-95	0	0	5	1,580.331	** 1.961 (0.405)	** 39.211 (7.156)	** −18.934 (0.637)	** 0.183 (0.030)	** 0.066 (0.017)	0.91
SEA	0	0	5	1,591.522	** (1.926) (0.366)	** 28.139 (6.275)	** −19.093 (0.620)	** 0.194 (0.030)	** 0.090 (0.017)	0.92
MCBTA	0	0	5	1,465.273	** 2.971 (0.390)	** 41.004 (6.171)	** −18.725 (0.580)	** 0.215 (0.028)	** 0.072 (0.016)	0.91
BERA	0	0	5	1,502.328	** 2.484 (0.417)	** 33.017 (7.234)	** −18.475 (0.655)	** 0.207 (0.030)	** 0.095 (0.019)	0.90
OBE	0	1	4	1,255.269	** 4.728 (0.691)	* 22.215 (11.216)	** −17.678 (1.056)	** 0.328 (0.049)	** 0.072 (0.024)	0.94
SUBSEA	1	0	4	1,367.816	** 3.489 (0.869)	17.899 (15.180)	** −16.856 (1.284)	** 0.262 (0.071)	** 0.108 (1.027)	0.95
MCMTA	1	1	3	1,107.007	* 4.179 (1.609)	−2.358 (30.600)	** −16.347 (2.632)	** 0.493 (0.157)	** 0.114 (0.039)	0.95
STATES	2	0	3	951.350	** 6.926 (1.519)	18.767 (26.727)	** −15.071 (2.275)	** 0.440 (0.092)	0.048 (0.036)	0.94

[a]Income per capita was the dependent variable.
[b]Values in parentheses directly below the partial regression coefficients are the corresponding standard errors (s_b).
*t value significant at the .05 percent level.
**t value significant at the .01 percent level.
†Not significant.

(1) the model was imposed on the SEA's, (2) the descriptive properties of the five explanatory variables were about the same as the BERA's in terms of means, variances, and skewness, and (3) there was a high correlation between some of the independent variables for the SEA delineation with some variables not in the equation; e.g., WH COL was highly correlated with URBAN and FIRE in the SEA's.

The OBE delineation had a structure somewhat similar to the BERA structure. Fifty-three of the 66 correlation coefficients computed for the OBE regions were not significantly different from the BERA

Table 8.–Test of differences in regression coefficients derived from alternative delineations using the BERA delineation as a base

Subregional delineation	Significance of differences from BERA regression coefficients				
	URBAN	FIRE	POVERT	RE/CAP	BD/CAP
COUNTY	*	—	**	—	*
A-95	*	**	**	**	*
SEA	*	**	**	**	**
MCBTA	*	*	**	**	*
OBE	—	*	*	—	*
SUBSEA	—	—	—	*	**
MCMTA	—	—	—	—	**
STATES	—	*	—	—	—

—Coefficient is more than 2 standard deviations from BERA coefficient.
*Coefficient is more than 1 and less than 2 standard deviations from BERA coefficient.
**Coefficient is less than 1 standard deviation from BERA coefficient.

coefficients. Further, the OBE data reproduced the BERA coefficients for the regression model fairly well. However, there was enough difference in the order in which the variables entered the stepwise regression model for the OBE regions to warn against applying conclusions drawn from analyzing OBE regions to problems defined for the BERA's. The States seemed to diverge most from the BERA's in terms of relationships among specific variables.

Summary

There are a number of possible geographic delineations that can be used for areal allocation of population, income, employment, and other social and economic characteristics in a rural development indicator system. In this paper, it was shown that estimates of statistical parameters vary for alternative geographic aggregations and for alternative delineations at a given level of aggregation. It was also shown that estimates of statistical parameters for alternative delineations vary as the level of structural disaggregation of variables used in the analysis is varied. Two approaches to determining differences in statistical properties of alternative delineations were undertaken. In the first, 12 variables were combined into a single index reflecting the general level of economic development of an area. In the second, properties of each variable, and relationships among variables, were compared for alternative delineations. When the 12 variables were aggregated in a single index of economic development, a test of rank differences between indexes for nine alternative delineations failed to discriminate significantly among delineations. However, when the 12 variables remained disaggregated, differences in values for means, variances, and coefficients of skewness indicated that the descriptive properties of specific variables are a function of the delineation. Finally, differences in correlations and regression coefficients suggested that estimates of economic structure vary among delineations.

Appendix

From the point of view of economic development, present political delineations, e.g., cities, counties, and States, do not necessarily coincide with the geography of the local economic development problem. Therefore, some aggregation of local juridsictions must be used as units of analysis for rural development purposes. Some attempts to deal with delineation problems appear to be unsatisfactory because contiguous counties are aggregated on the basis of homogeneity of economic and social problems, or on the basis of specific differentiating characteristics such as proportion of residents living outside urban areas. These approaches overlook the interdependencies of people who live, work, shop, and play within commuting range of one another. Residents outside urban centers depend on access to these centers for markets for their products or their labor; for producer and consumer goods; and for various services relative to health, education, and welfare. Urban centers depend on residents of the hinterland as consumers and for their labor.

The concept of functional economic areas has been described by Karl A. Fox.[7] An empirical effort to delineate the United States into functional economic areas was reported by Brian Berry.[8] Berry and Fox used journey-to-work patterns both in theory and in practice. Berry's delineation did an excellent job of suggesting functional economic areas for those parts of the United States which had sufficient journey-to-work activity centered on urban places reported in the 1960 Population Census. One weakness in Berry's delineation is that it did not include all areas in the Nation. Berry left out about 4 percent of the U.S. population. That amounted to more than 7 million rural people in 1960, or about 14 percent of the total 1960 rural population. What is needed is a logical set of areas covering the entire geographic area of the United States. Five such delineations are discussed below. Two of the five have delineations at two levels of geographic aggragation. These seven, plus States and counties, make up the nine alternative delineations examined in the text.

State Economic Areas.—A delineation of all 3,000-plus counties in the 48 States into 507 State Economic Areas was reported by Bogue and Beale.[9] These areas have the advantage of including the entire population and provide for useful comparisons of economic and social characteristics among areas. However, a homogeneity logic was used rather than a functional interdependence logic. The 507 State Economic Areas were aggregated into 119 Economic Subregions.

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[7] Karl A. Fox and T. Krishna Kumar. "Delineating Functional Economic Areas." In Research and Education for Regional and Area Development, Iowa State Center for Agr. and Econ. Devel., Iowa State Univ. Press, Ames, Iowa, 1966, pp. 13-55.

[8] Brian J. L. Berry. Metropolitan Area Definition: A Re-Evaluation of Concept and Statistical Practice. Working Paper No. 28, U.S. Dept. Commerce, June 1968.

[9] Donald J. Bogue and Calvin L. Beale. Economic Areas of the United States. The Free Press of Glenco, N.Y., 1961.

Rand McNally Trading Areas.—A delineation of all counties in the 48 States into 489 basic trading areas was presented by Rand McNally.[10] These multicounty areas closely approximate functional economic areas in the sense of having a dominating central city that influences the immediate urban area as well as the surrounding rural area. The logic is of trading area linkages rather than the journey-to-work logic of Fox and Berry. The 489 Rand McNally Basic Trading Areas were aggregated into 49 Major Trading Areas.

Office of Business Economics Regions.—A delineation of 171 multicounty areas was prepared by the Office of Business Economics. Three basic guidelines were used to delineate these areas: They were to include all counties; they were to be large enough so that estimates of income and other economic and social attributes would have statistical reliability; and, they were to conform to functional economic area logic to the extent that limited time and research budgets permitted. These areas are useful units of analysis for many subnational problems, but many of the areas are so large in terms of trading and commuting patterns that local development problems are often averaged out.

Governors' Delineations Under A-95.—Another altogether different line of historical development in area delineation followed from efforts by the Bureau of the Budget to coordinate development programs and planning at the Federal level. Guidelines to encourage the use of common boundaries of planning and development districts when Federal assistance is involved appeared in 1967 in Circular A-80. Subsequent circulars, particularly A-95, released in 1969, added further impetus to delineation of multicounty planning and development districts by the governors of the various States. So far, 39 governors have responded by delineating their States into 487 substate districts. Estimates by ERS as proxies of what will evolve when the other nine States delineate suggest that this process will result in possibly 509 multicounty districts covering all counties in the 48 conterminous States. The logic underlying the delineation seems to vary from careful application of functional economic logic to application of largely political considerations. In any event, these areas are about the right size on the average and they have the advantage of fitting into a political organization for policy implementation.

Basic Economic Research Areas.—The Economic Research Service has delineated all counties in the 50 States into 482 multicounty areas. There are 472 areas in the 48 contiguous States. Berry's commuting pattern and Rand McNally's trading area logic were considered in this effort. ERS also considered size of the largest city and travel conditions so that commuting from the fringe of an area to its center could be feasible whether or not commuting was reported by the Bureau of the Census. Most of the multicounty areas obtained by this procedure appear to conform closely to the idea of a functional economic area with an urban center and an interrelated hinterland. But, of course, it contains several rural areas that are sparsely populated and have villages or small towns as their "center." These areas cross State lines where functional considerations appear to warrant it.

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[10] 1972 Rand McNally Commercial Atlas and Marketing Guide. Rand McNally and Co., Chicago, Ill.