ECONOMIC FACTORS INFLUENCING THE LEVEL OF ECONOMIC DEVELOPMENT OF MULTICOUNTY AREAS

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Economic development is an elusive, multidimensional concept. Identification of the interdependencies and interactions underlying the development process seem to call for appropriate multivariate analysis. Principal component and factor analyses were used in a study of socioeconomic interdependencies associated with economic development in multicounty areas in the 48 contiguous States [1]. This paper summarizes some results from that study and explains the use of a mathematical identity relating factor analysis to principal component analysis. This identity explains the level of economic development in terms of alternative levels of factors.

THE LEVEL OF ECONOMIC DEVELOPMENT

Twelve variables were postulated to collectively measure the level of economic development in the early 1960's for 489 multicounty areas in the continental United States (Table 1).[1] Multicounty areas were selected for observation units rather than cities, counties, or States because development problems are not usually aligned geographically with these political delineations. Principal component analysis was employed to reduce the 12 variables to a single continuous variable called an index of economic development.[2] The weights derived from principal component analysis and used in the index construction are in the second column of Table 1. An index number for a given multicounty area is the sum of 12 products; where the products were obtained by multiplying the weights by the 12 respective standardized variables for the given multicounty area. The index was scaled so that the mean for all areas was 100.

Principal component analysis assigns weights in such a manner that the variance of the development index is maximized. In this study the first principal component explained approximately 56 percent of the variance of the 12 variables. Two variables have negative weights; the percentage of families with less than $3,000 income, and the percentage of farm population. Hence the level of economic development of an area is lowered when an area has a relatively large farm population or a relatively large amount of poverty or both. The variables with the largest positive weights are income per capita and the relative amounts of sound housing. Both of these variables are popular measures of economic well-being and seem to warrant a relatively heavy influence in the calculation of the index of economic development.

Figure 1 shows the geographic distribution of the index of economic development by multicounty areas. The majority of areas which had the highest level of development (an index value of 120 or more) were adjacent to and included such large cities as New York, Cleveland, Washington, D.C., Dallas, Denver, Las Vegas, Seattle, Miami, and most large cities in California. Those areas with the next highest level of development (110-119) seemed either to be (1) located near the group of areas with index values of 120 or more, or (2) geographically set apart from other urban centers. Examples of areas in this latter category include Minneapolis-St. Paul, Minn.; Indianapolis, Ind.; Pittsburgh, Pa.; Des Moines, Iowa;

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[1] The Multicounty delineations were made by Rand McNally Company and Company [2].

[2] The taxonomy of principal components is a matter left to the discretion of the researcher. Hence, applying the term "economic development" to the first principal component is subjective. However, the term is used here only in a relative sense and implies the statement, "area A is less developed than area B."

Table 1. WEIGHTS USED TO CONSTRUCT INDEXES OF ECONOMIC DEVELOPMENT GENERAL BUSINESS ACTIVITY, AND AGGLOMERATION

Attribute (1)	Economic Development (2)	General Business Activity (3)	Agglomeration (4)
Retail sales per capita, 1963	.2935	.8222	.2234
Percentage of commercial farms with sales greater than $10,000, 1964	.2337	.8185	- .0199
Local government expenditures per capita, 1962	.2673	.7731	.1741
Percentage of housing units sound, 1960	.3424	.7369	.5289
Percentage of persons age 25 and over with high school or more education, 1960	.3083	.7330	.3924
Percentage of families, 1960, with 1959 income less than $3,000	- .3264	- .7284	- .4728
Income per capita, 1960	.3566	.7264	.6001
Bank deposits per capita, 1960	.2635	.5890	.3804
Percentage of employment white-collar, 1960	.2975	.3749	.7794
Percentage of population urban, 1960	.2826	.2915	.8185
Percentage of employment finance, insurance, and real estate, 1960	.2481	.2745	.6961
Percentage of population farm, 1960	- .2060	- .0144	- .8357

Omaha, Nebr.; Tucson, Ariz.; Albuquerque, N.M.; and Salt Lake City, Utah.

The areas with index values of 100 to 109 seemed to be economically developed islands surrounded by relatively underdeveloped areas. Those areas in the 90-99 classification tended to be concentrated in the North Central, Great Lake, and Southern States.

Contiguous to many of these areas were areas with the next lowest level of economic activity, with indexes ranging from 80 to 89. These areas were mainly in the South and included many agriculturally oriented areas. Intermingled with these areas were those with the lowest level of economic development–with indexes below 80. The least developed areas were primarily in the coastal Plains, Central Appalachia, Mississippi Delta, and Ozarks regions. These areas were also agriculturally oriented, with the exception of the coal mining areas in Central Appalachia.

FACTORS AFFECTING THE LEVEL OF DEVELOPMENT

Principal component analysis was quite useful in depicting areas with different levels of economic development and their geographic distribution in the United States. However, we needed to carry the multivariate analysis further in order to identify factors associated with differing levels of economic development. Hence, we used factor analysis to discern underlying interdependence among selected variables.

Applying factor analysis to the 12 variables in Table 1 revealed two distinct factors implicit among the variables; general business activity and agglomeration. Together the two factors explained 70 percent of the variation in the 12 variables among the 489 multicounty areas.

The third and fourth columns of Table 1 contain the weights derived from the factor analysis and

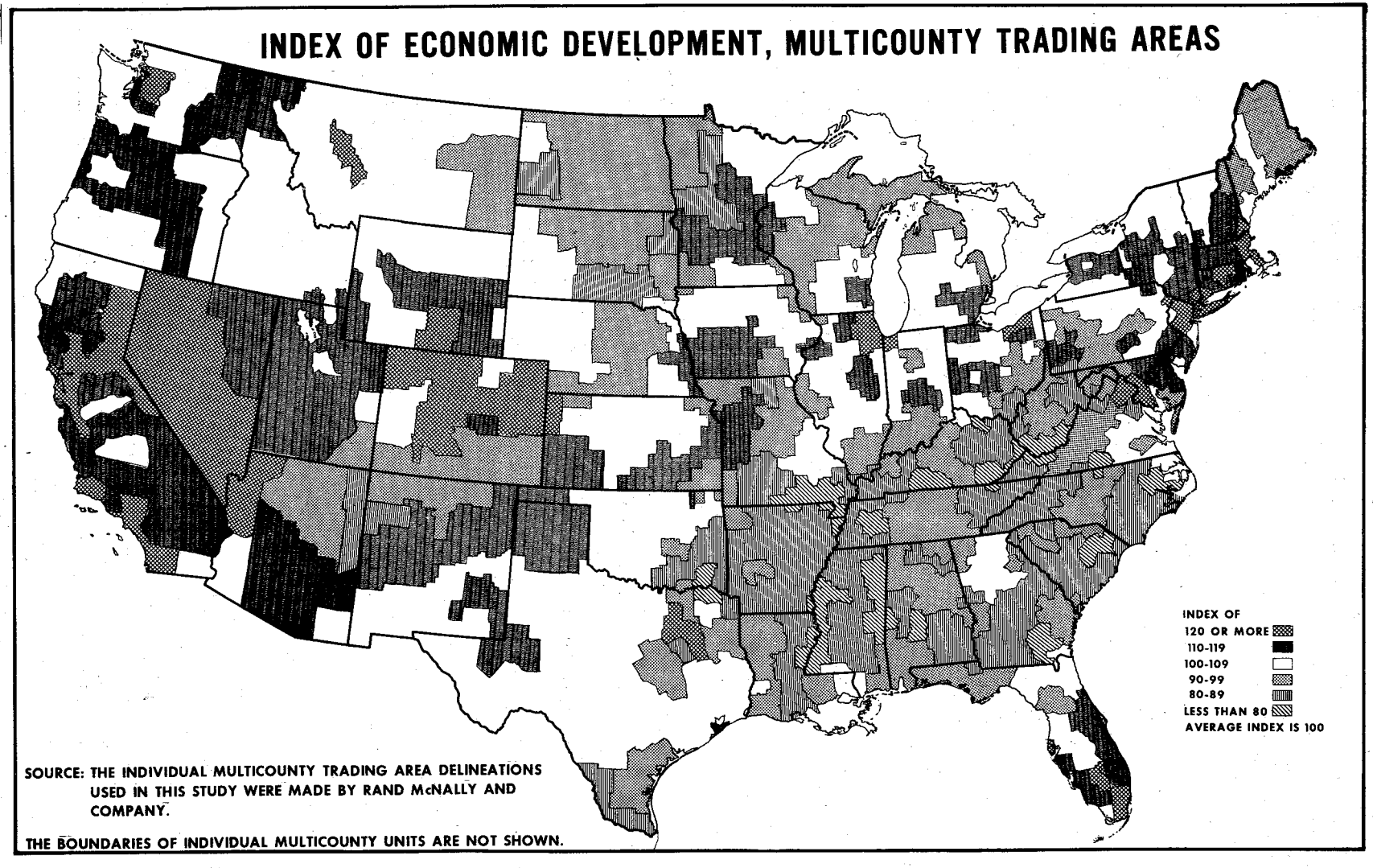
INDEX OF ECONOMIC DEVELOPMENT, MULTICOUNTY TRADING AREAS
INDEX OF
120 OR MORE
110-119
100-109
90-99
80-89
LESS THAN 80
AVERAGE INDEX IS 100
SOURCE: THE INDIVIDUAL MULTICOUNTY TRADING AREA DELINEATIONS USED IN THIS STUDY WERE MADE BY RAND McNALLY AND COMPANY.
THE BOUNDARIES OF INDIVIDUAL MULTICOUNTY UNITS ARE NOT SHOWN.

Figure 1

subsequently used to identify the general business activity factor and agglomeration factor. The variables are listed in order of importance in their contribution to general business activity (factor one). The eight variables heavily weighted on factor one are either current measures of income and spending, such as retail sales and income per capita, or a reflection of high levels of general business activity such as quality of housing, education level, and level of spending of local governments. The negative weight on the percentage of families with less than $3,000 income, indicates that a large inequity of distribution of income detracts from the level of general business activity.

The large weights on the last four variables in the fourth column of Table 1 indicate these variables are associated with agglomerative relationships in the local economy. Agglomeration economies develop when people and economic activity cluster in urban areas [3]. This factor is a measure of urbanity or conversely, rurality. The percentage of population on farms has a large negative weight while the percentage of urban population has a large positive weight. The other two variables are descriptions of the occupational and industrial mix: percentage of white-collar employment and percentage of financial service workers. High values for these variables in an area are associated with high degrees of agglomeration.

RELATIONSHIP OF GENERAL BUSINESS ACTIVITY AND AGGLOMERATION TO DEVELOPMENT

Using the weights in columns (3) and (4) in Table 1, an index of general business activity and an index of agglomeration were computed in the same manner as the level of economic development index. These indexes were also scaled so that areas would have a mean of 100. Figure 2 is a scatter diagram of the two indexes and shows that general business activity and agglomeration generally move together; an increase in general business activity is accompanied by an increase in agglomeration. However, there is some room for substitution between the factors at a given level of development.

The mathematical models of principal component and factor analysis are linear and both analyses result in linear combinations of the initial variables. A mathematical identity was derived which relates principal component and factor analysis results when communalities of unity are used in the factor analysis model. This relationship describes in mathematical form the economic structure underlying the scatter of Figure 2. The derivation of this relationship can be presented most easily in terms of simultaneous equations where the level of economic development (DEV index) of a multicounty area is postulated to be a function of general business activity (GBA index) and agglomeration (A index), and satisfies the linear relationship:

$$(DEV)_j = K + x(GBA)_j + y(A)_j, j = 1, 2, ..., 489.$$

Thus, we have three unknowns K, x, and y, where K is a constant term and x and y are coefficients. Choosing any three multicounty areas we can solve this set of simultaneous equations with the following results:

$$(DEV)_j = 141.22 + 1.3189(GBA)_j + 1.0933(A)_j.$$

The constant term in this equation results from scaling all three indexes to have a mean of 100 [1 pp. 39, 45]. Had they been scaled to zero, we would have had a system of two equations and two unknowns.

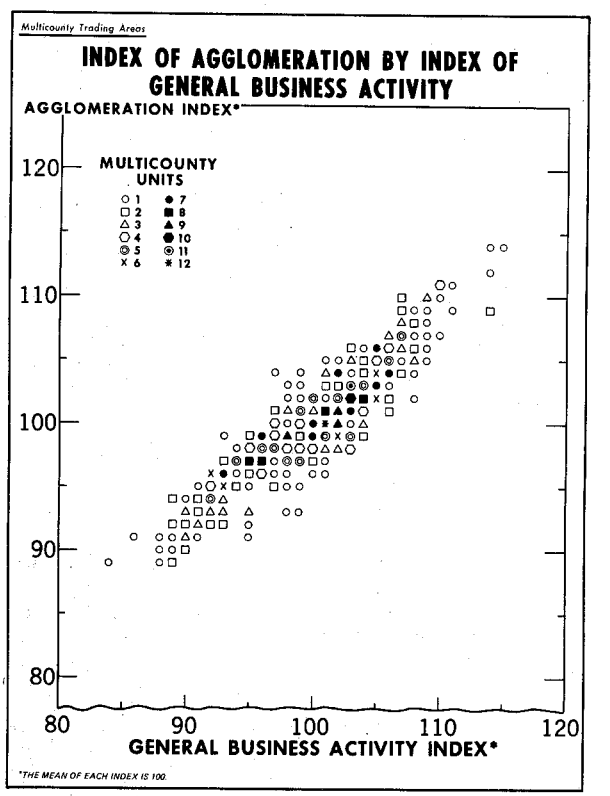

Figure 2.

The resulting equation indicates that a given level of development can be obtained with varying amounts of general business activity and agglomeration. In other words, within limits, these factors are substitutes. For example, some areas ranked below the national average on the agglomeration index, but had an above average level of general business acivity which enabled them to have a level of development above the national average. These areas were in general, sparsely settled rural, but had above average amounts of retail sales, higher than average educational attainment, a strong commercial agricultural sector and an above average per capita income. Conversely, most urban areas had a high rank on the agglomeration index, but some urban areas had a below average level of general business activity and consequently, had the same level of development as some of the more rural areas.

Figure 3 is a three-dimensional schematic representation of Figure 2. It shows the DEV index and its relation to the GBA index and A index. The equation presented above represents a plane in three-dimensional space. Figure 3 shows this plane rising from the A–GBA floor. On this plane lies an unshaded area which approximates the range of empirical variation in the indexes GBA, A, and DEV. As would be expected, the level of development slopes upward and to the right and increases numerically as the GBA index and/or A index increases. On the unshaded area is a family of lines each one of which is a line of equal level of economic development. Lines located to the upper right depict a higher level of development than those to the lower left.

A SCHEMATIC REPRESENTATION OF THE RELATIONSHIP BETWEEN THE INDEX OF AGGLOMERATION (A), INDEX OF GENERAL BUSINESS ACTIVITY (GBA) AND THE INDEX OF ECONOMIC DEVELOPMENT (DEV)

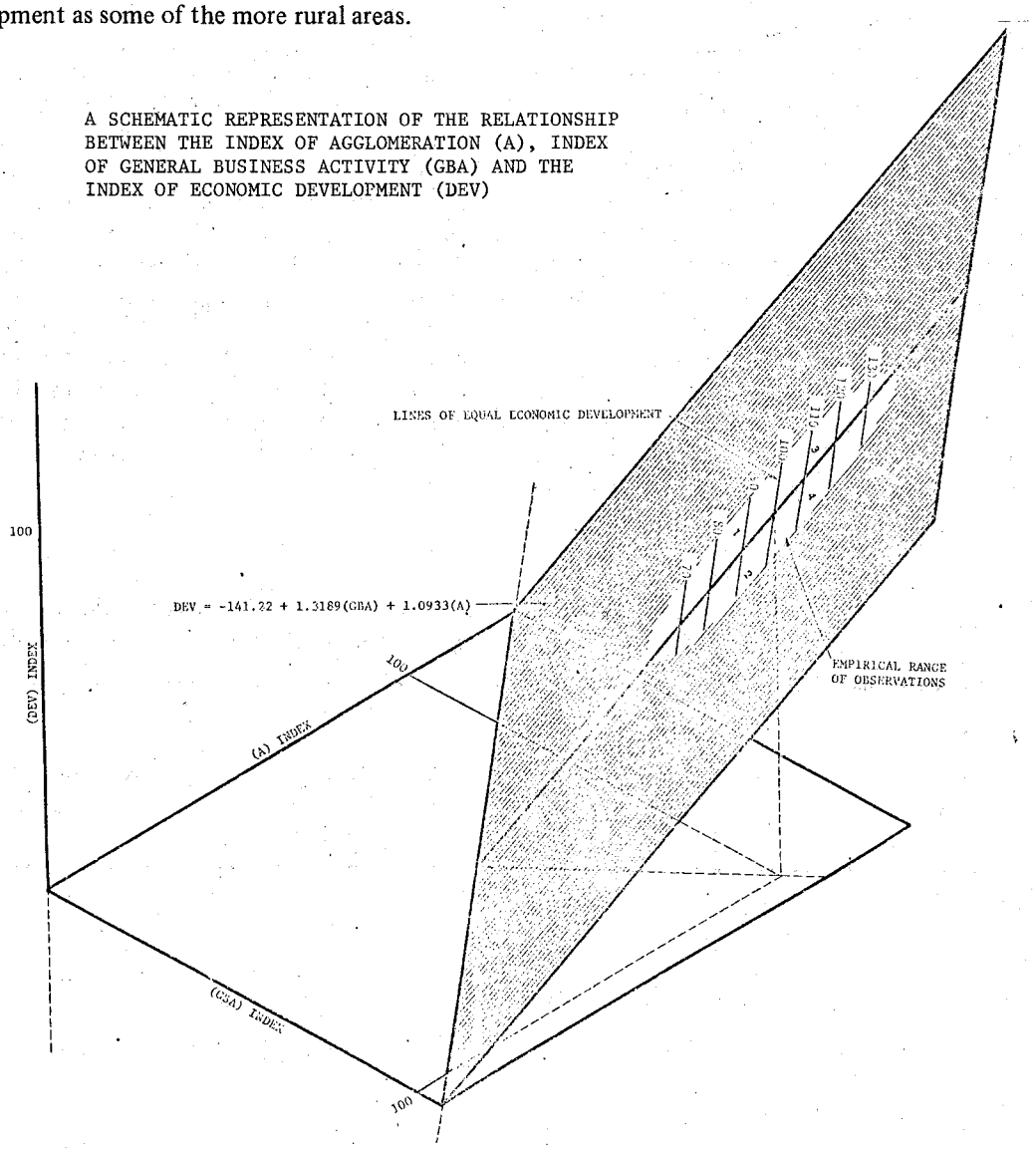

Figure 3.

EXAMPLES OF ALTERNATIVE FACTOR COMBINATIONS

Four multicounty areas were selected to demonstrate how to interpret Figures 2 and 3, and to show how the two major factors, general business activity and agglomeration, combine to determine the level of economic development. Indexes for these four areas are listed in Table 2 and indicated on Figure 3 as numbers 1 through 4. The four areas were paired to represent two levels of economic development and the members of each pair had different levels of general business activity and agglomeration.

The first pair of areas, Laredo, Tex., and Norfolk-Columbus, Nebr., represent a level of economic development below the national average (areas 1 and 2, Fig. 3). They had attained about the same level of development, but the resource mix used to reach this level was different. The Norfolk-Columbus area was more rural as shown by the agglomeration index value of 93. But the Norfolk-Columbus multicounty area had attained a higher level of general business (98) than the Laredo, Tex. area (93). The Norfolk-Columbus area ranked higher than Laredo in all components of general business activity and lower in all agglomeration related components. The Norfolk-Columbus area ranked highest in large commercial farms and in retail sales per capita, indicating that the area was strong in commercial agriculture and trade activities. The Laredo area's relatively low level of general business activity was compensated for by strong agglomerative factors reflected in a large percentage of the population living in urban places and a small percentage living on farms.

The second pair of areas represents a level of development above the national average. Galveston-Texas City, Tex. and Dodge City-Garden City, Kans. had development indexes of 111 and 110, respectively (areas 3 and 4, Fig. 3). Again these areas were selected to show the potential possibilities for trade off between agglomeration and general business activity to maintain a given level of development. The Galveston-Texas City, Tex. area was more urban, had fewer commercial farms, had more financial services, and thus, a higher agglomeration index than did the Dodge City-Garden City, Kans. area. However, Dodge City-Garden City, Kans. had higher income per capita, less poverty, a significantly higher education level, a stronger agricultural sector, more retail sales and bank deposits per capita, resulting in a higher general business activity index.

The idea of a trade off within limits between factors could also be illustrated by choosing two areas with comparable levels of either agglomeration of general business activity and observing what effect varying the remaining factor has on the level of development. The relationship between the two factors is given by the mathematical identity shown above. The trade off can be determined directly. For example, if the agglomeration index (A) is held constant, a 1.3289 unit change in the development index (DEV) results from a 1 unit change in the general business activity index (GBA).

TABLE 2.-- INDEXES OF ECONOMIC DEVELOPMENT, GENERAL BUSINESS ACTIVITY, AND AGGLOMERATION FOR SELECTED MULTICOUNTY TRADING AREAS

Area	Economic Development (DEV)	Indexes of General Business Activity (GBA)	Agglomeration (A)
Laredo, Tex. (1)	89	93	99
Norfolk-Columbus, Nebraska (2)	90	98	93
Galveston-Texas City, Texas (3) .	111	103	106
Dodge City-Garden City, Kansas (4)	110	106	101

CONCLUSION

Principal component analysis and factor analysis used separately and jointly appear to be useful tools in analyzing multidimensional aspects of economic development. This is particularly true when the variables are highly intercorrelated and a data reduction scheme is desired.

The implication of the results obtained from these two techniques is that development policies may need to vary between areas with a similar level of development. Two areas with the same level of development may have different combinations of agglomerative and general business activity factors. But the empirical results show the gap between the two factors is not large for a given area. The relative closeness of the size of the two factors suggest there are limits beyond which it is not feasible, from a cost standpoint, to expand one factor without expanding the other. Thus, an area with a relatively higher level of general business activity needs to concentrate more on expanding the level of agglomeration in such ways as improving transportation facilities, providing financial and wholesaling service, and improving the availability of central city services. On the other hand, an area with a higher level of agglomeration needs to concentrate more on expanding general business activity. This may be done in terms of improving the industrial mix, raising the education and skill level of the labor force, increasing labor force participation rates, expanding employment, and raising the level of total income.

REFERENCES

[1] Edwards, Clark, Robert Coltrane, and Stan Daberkow, *Regional Variations in Economic Growth and Development with Emphasis on Rural Areas,* USDA, ERS, Ag. Econ. Report No. 205, May 1971.

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