Assessing Rural Community Viability: An Experimental Model

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Governors, legislators, COG Directors, county commissioners and other assorted public decision makers are confronted with the textbook definition of an economic problem – the allocation of scarce public resources to an increasingly larger and more demanding set of communities. Although New York City and its problems grabbed the headlines, the budget crunch is just as acute but not as visible in most rural communities. Scarce funds and/or public services must be targeted in these rural communities if the public is to receive maximum benefits per dollar expended. The general objectives of a New Mexico State University rural community viability research project – the basis for this paper – were to develop a model for assessing the relative viability of rural communities, and then using the model results, to specify alternatives for modifying a community's relative status. Past rural development programs treated single community problems according to statutory prescription. Knowledge of relative viability and the causes of current viability status would permit rural development investors to target dollars and services. One community might need funds to improve its utility system before it could become more viable. Another might discover current land holding patterns inhibit growth and, therefore, changes in the status of public lands would be a first objective in improving community viability. Given a quantitative measure of relative viability and an understanding of the related factors, public decision makers will be much more responsive to each community as they allocate public funds or services. Politically sensitive outcomes might be the withdrawal of some public programs if a community is not viable or reallocation of funds toward the more viable to obtain more "bang for the buck."

The focus of this paper is on an experimental model which will be the basis for assessing relative community viability. Reference is made to past research in community taxonomy and community viability, but emphasis is on a combined statistical procedure which yields a differentiation of communities with respect to relative viability. Results are presented for all communities (29) in New Mexico with population from 2,500 to 50,000 except those communities created for government purposes, i.e. Los Alamos and various air bases. Data were unavailable for smaller towns.

Procedure

Attempts to categorize communities into distinct typologies is far from new in the social sciences. Numerous analytical devices have been employed to achieve this objective. Among the earliest was factor analysis. The premise behind such an approach was that the factors would represent unique dimensions of community structure and therefore a community which had a large factor score on a specific factor belonged to a community group typified by that factor. However, since it was possible for communities to rank highly on more than one factor, the groupings thus devised did not necessarily represent disjoint sets. This approach has been taken by several researchers [Price pp. 449-455; Jonassen and Peres; and Hadden and Borgatta].

Other approaches have attempted to identify non-intersecting groups through cluster analysis [Bruce, pp. 48-53; Bruce and Witt, pp. 238-245; and Kernan and Bruce, pp. 15-18]. Finally, some

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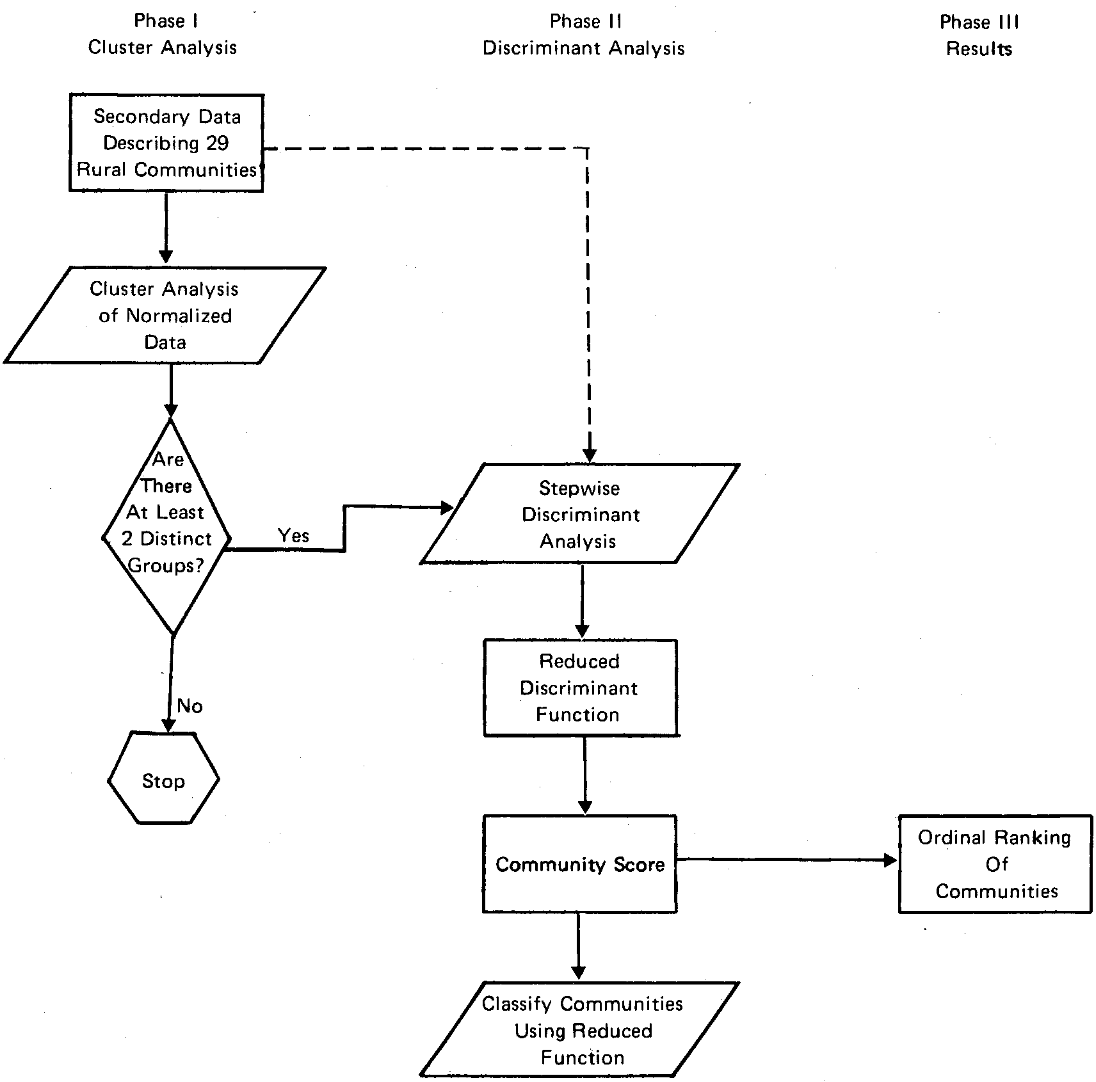
studies have used objective or subjective measures to place communities in groups and then employed discriminant analysis to provide a classification function [Bean, Poston, and Winsborough, pp.20-32; Bromley, pp. 319-322]. The validity of such groupings was then indicated by the function's probability of misclassification.

The experimental community taxonomy procedure used in the New Mexico Community Viability Study is outlined in figure 1. In the first phase, the initial step was an accumulation of secondary data describing the sample communities. Viability was defined as a community's ability to attract and hold mobile resources. Based on this definition, and on previous work in the area of community viability [Beers, pp. 13-24; Hodge, pp. 87-115; Keele, pp. 3-10; McGranahan, pp. 61-77; Swackhamer, pp. 3-10; and Williams] variables were selected measuring economic, demographic, locational, resource, infrastructure, and political factors. The focus in the selection process was on causal and/or manipulatable factors to facilitate the formulation of policy recommendations based on the results of the model. However, a few descriptive characteristics were included because of their hypothesized importance in differentiating communities. The following variables were analyzed in the model: employment dispersion among

Fig. 1. Community taxonomy procedure, New Mexico Community Viability Study, 1976



industrial sectors measured by the standard deviation of the numbers employed among sectors; employment specialization based upon the index

$$\frac{3(WC) + 2(BC) + (AG)}{3}$$

where WC, BC, and AG are percentages of the labor force detailed as white collar, blue collar, and agricultural; importance of agriculture as measured by the percent of community and hinterland in irrigated acreage; relative importance of various sources of community general fund revenue, using the percent of revenue obtained from gross receipts tax, gasoline taxes, property taxes, and federal revenue sharing; basic industry employment, measured by the proportion of the employed labor force in basic industries; transportation-communications complexity as measured by Guttman scaling; per capita assessed valuation; availability of community land for new industry; distance to a central place of 100,000 or more population; per capita water availability, measured by municipal water rights in acre-feet per year per person; source of water for irrigation, percent from surface sources only; proportion of community and hinterland in private ownership; and voter participation, reflected by the percent of registered voters who voted in 1974 general elections. These variables, in the majority of cases, standardize out population size by use of percent, per capita, and index forms. These forms shift focus toward community structure, thus minimizing the direct effect of size on subsequent analysis.

The cluster analysis grouped observations by similar characteristics. Defining the 29 communities as 29 groups, Ward's hierarchical clustering algorithm was used to reduce the 29 groups to one. Ward's algorithm reduces groups from n to one in a manner that minimizes the loss of information associated with each grouping and permits quantification of that loss in a form that can be readily interpreted. Loss of information is expressed as an increase in the error sum of squares for characteristics of communities as they are clustered with other communities or groups. A large increase in error sum of squares at any step in the clustering process indicates combination of dissimilar groups. If there is no marked change in error sum of squares when all n groups have been reduced to one, then all 29 observations are probably members of the one remaining group. If the largest increase in error sum of squares occurs when the last two groups are joined, then there are two definable groups, and so on. Note in figure 1, that a requirement for moving into Phase II of the analysis is the identification of at least two distinct groups.

The objective of using stepwise discriminant analysis was to reduce the number of characteristics for describing rural communities and to generate a reduced discriminant function for general use in defining the relative position of a community vis a vis all other communities. Discriminant analysis yields one or more linear combinations of the discriminating variables; if the analysis is used to distinguish between two groups, then one discriminant function will be formed. If there are n groups, the analysis will yield n-1 discriminant functions. The functions take the form:

$$D_{im} = d_{i1}Z_{i2} + d_{i2}Z_{m2} + \cdots + d_{ip}Z_{mp}$$

where D_{im} = discriminant score, community m, using discriminant function i.

D_{ip} = weighted coefficient, discriminant function i, characteristic p,

Z_{mp} = characteristic (p) of the community (m) being classified.

Results

Cluster analysis indicated the existence of two distinct groups of communities. In the last step of the clustering process, the joining of two groups was accompanied by a marked increase in the error sum of squares, suggesting that these are two somewhat distinct groups. The communities in Group 1, evaluated by the researchers to be the more viable group based upon the discriminant analysis (see fig. 1) are: Alamogordo, Artesia, Carlsbad, Clovis, Farmington, Gallup, Hobbs, Las Cruces, Lovington, Portales, Roswell, Silver City and Santa Fe. Group 2 consists of Aztec, Bayard, Belen, Clayton, Deming, Espanola, Eunice, Grants, Jal, Las Vegas, Lordsburg, Raton, Socorro, Truth or Consequences, Tucumcari and Tularosa.

Stepwise discriminant analysis revealed that nine variables were significant in differentiating between the two groups of communities: Transportation-communication complexity; percentage of general fund revenue from gross receipts tax, and from gasoline taxes; percentage of labor force in basic industries; per capita assessed valuation; employment dispersion among industrial sectors;

percentage of the community and its hinterland in irrigated acreage; percentage of general fund revenue obtained from federal revenue sharing; and employment specialization. Table 1 presents these variables with their respective F–values and standardized discriminant function coefficients. The F–values are important for policy evaluation because they reflect the relative significance of each variable in discriminating between the two viability groups. The discriminant coefficients indicate the relative weights and direction of contribution of the variables in the calculation of discriminant scores for each community.

The ordinal ranking of communities by discriminant scores is shown in table 2. The communities are numbered rather than named in the ordinal ranking, because this ranking is not considered a final product by the research team. Future plans are to include more viability factors in the model and to enlarge sample size.

In general, Group 1 communities, compared to Group 2, are characterized by a greater degree of transportation-communication complexity, a greater percentage of general fund revenue obtained from gross receipts tax, and a lower proportion from gasoline taxes and from federal revenue sharing, a higher per capita assessed valuation, a greater dispersion of employment among industrial sectors, a larger proportion of the community and its hinterland in irrigated acreage, and a greater degree of employment specialization. These findings suggest that transportation and communication service availability, revenue sources, diversity and type of economic activity, importance of agriculture, and community wealth are the most important viability factors in New Mexico.

Even though the variables were constructed to minimize the effects of community size, the two groups consist of larger and smaller communities respectively. However, three cities in Group 2 are larger than cities in Group 1. The apparent relationship between size and viability grouping does not directly reflect size since the rank correlation between population size and viability score is

Table 1. Significant variables, F-values, and standardized discriminant function coefficients, stepwise discriminant analysis, viability study, New Mexico, 1976

Variable	F-Value	Standardized Discriminant Coefficient
Transportation-communications complexity	22.65	0.38
Percentage of general revenue fund from gross receipts tax	19.82	0.36
Percentage of general revenue fund from gasoline taxes	19.68	-0.38
Percentage of labor force in basic industry industry	17.98	0.44
Per capita assessed valuation	12.36	0.32
Employment dispersion among industrial sectors	8.19	0.31
Percentage of community and h hinterland in irrigated acreage	6.41	0.20
Percentage of general fund revenue from federal revenue sharing	5.25	-0.19
Employment specialization	2.32	0.14

Table 2. Ordinal ranking of communities, viability study, New Mexico, 1976

Group and Community	Discriminant Score
Group 1	
1	1.651
2	1.555
3	1.254
4	1.191
5	1.163
6	1.001
7	0.997
8	0.969
9	0.946
10	0.875
11	0.794
12	0.648
13	0.506
Group 2	
14	-0.499
15	-0.591
16	-0.622
17	-0.676
18	-0.712
19	-0.750
20	-0.760
21	-0.773
22	-0.784
23	-0.788
24	-0.845
25	-0.907
26	-0.920
27	-1.123
28	-1.161
29	-1.639

0.22 and -0.07 with Groups 1 and 2, respectively. Only when the two groups are combined does the correlation increase (to 0.75) indicating that Group 1 has higher average size and viability score than Group 2. This leads to the (perhaps) obvious statement that the more viable (and larger) communities have a different composition than the less viable (and smaller) communities.

The success of the reduced discriminant function depends on its ability to reclassify communities into the original groups. Using the nine variables shown in table 1, 100 percent of the communities were reclassified into the two groups revealed by cluster analysis. This outcome suggests the model is useful in reducing the number of variables needed to differentiate viability groupings.

This analysis will be extended to communities from 2,500 to 50,000 population in the Four Corner states. If this experimental model is successfully retested with the larger number of observations, it will serve as the basis for a generalized scorecard which will be used at the community level to assess community strengths and weaknesses, and derive strategies to alter weaknesses.

References

Bean, Frank D., Dudley L. Poston, Jr., and Halliman H. Winsborough. "Size, Functional Specialization, and the Classification of Cities," *Southwestern Social Science Quarterly*, Vol. LIII, No. 1 (June 1972): 20-32.

Beers, Howard W. "Social Components of Community Development," *Rural Sociology*, Vol. XXIII (1958): 13-24.

Bromley, D. W. "The Use of Discriminant Analysis in Selecting Rural Development Strategies," *American Journal of Agricultural Economics*, Vol. LIII (August 1971):319-322.

Bruce, Grady D. "The Ecological Structure of Retail Institutions," *Journal of Marketing Research*, Vol. VI (February 1969):48-53.

Bruce, Grady D., and Robert E. Witt. "Developing Empirically Derived City Topologies: An Application of Cluster Analysis," The *Sociological Quarterly*, Vol. XII, No. 1 (Winter 1971):238-245.

Hadden, Jefferey K., and Edgar F. Borgatta. *American Cities: Their Social Characteristics*, Chicago, Rand McNally and Company, 1965.

Hodge, Gerald. "The Prediction of Trade Center Viability in the Great Plains," Papers and Proceedings of the Regional Science Association (Philadelphia), Vol. XV (1965):87-115.

Jonassen, Christen T. and Sherwood H. Peres. *Interrelationships of Dimensions of Community Systems: A Factor Analysis of Eighty-Two Variables*, Columbus, Ohio State University Press, 1960.

Keele, David L. "Economic Growth Outside Metropolitan Areas: The Tenth District Experience," *Federal Reserve Bank Kansas City Review*, June 1969, pp. 3-10.

Kernan, Jerome B., and Grady D. Bruce. "The Socioeconomic Structure of an Urban Area," *Journal of Marketing Research*, Vol. IX (February 1972): 15-18.

McGranahan, Donald. "The Interrelations Between Social and Economic Development," *Social Science Information*, December 1970, pp. 61-77.

Price, Daniel O., "Factor Analysis in the Study of Metropolitan Centers," *Social Forces*, Vol. XX (May 1942) 449-455.

Swackhamer, Gene L. "Concepts of Rural Economic Development," *Federal Reserve Bank Kansas City Review*, December 1969, pp. 3-10.

Williams, Anne S. *Viability Factors and Alternative Community Systems for Sparsely Populated Regions*, Missoula, Montana State University Press, May 1972.