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by
Richard A. March and Dennis K. Smith**

Abstract

Three multivariate indices, based on the findings of previous

studies, and a simple income based index of economic well-being

were computed and compared for Virginia counties and cities. These

four indices were found to be highly correlated--leading to the

conclusion that multivariate techniques need to be oriented to

considering variables relating to specific elements of growth and

development and not to incorporating large masses of intercorrelated

data. For general measurement purposes, a simple income-based measure

of economic well-being is a more efficient and just as valid measure

as the more complex multivariate indices.

Introduction

The measurement of local economic development and growth is important to decision-makers in the formulation of and the evaluation of the impacts of public programs upon regional economic conditions. Regional differences in economic development may indicate that, if reduction in regional inequality is viewed as a societal goal, public investment might be better concentrated in particular regions and program areas as opposed to others.

The selection of measures of economic development and growth is a difficult process. A large body of secondary data is available for assessing particular aspects of economic development, however, the interrelationships between these aspects often is not clear. Multivariate statistical techniques have been utilized to combine several variables into indices of economic development and growth. Some of these indices are termed multidimensional measures of development -- representing a "better" measure than a single variable. Other indices reflect attempts to measure "economic and social well-being" -- a broad concept which is not clearly defined.

Several different indices of economic well-being were computed and compared for Virginia "localities" using factor analysis (March).[1] The focus of the study was on the difficulties involved in the choice of variables to be analyzed rather than looking at the complex

statistical questions involved in choosing between factor analysis and principal components analysis and among the variety of orthogonal or oblique factor rotations which are possible to use in constructing the indices (Harris, Harmon, Cattell).

Methodology for Construction of
Economic Well-Being Indices

Four multivariate indices of economic well-being were constructed and compared. Orthogonal factor analysis with Varimax rotations was the statistical technique utilized to construct the indices (Harris, Chappel, Gorsuch). Several of the studies on which the indices are based used principal components analysis, however, factor analysis was chosen as the standard statistical procedure (except when only two variables were involved in the analysis), so that differences in scores of a locality on the indices could be attributed to differences in variable selection rather than differences in analytic technique.

Three of the four indices constructed using data for Virginia localities were based on the variables used in indices developed in previous studies (Chappell, Edwards, Coltrane, and Daberkow, Kerns and Jansma). The fourth index was a linear combination of the variables of per capita income and change in total personal income. These indices will be presented and discussed in terms of "Economic Well-Being -- Index I, Index II, Index III, and Index IV." The variables used to construct the indices included a broad range of measures of economic growth and development conditions in 99 geographic units or localities delineated in Virginia for this study.

Economic Well-Being Index I

The first index of economic well-being was based on the study of Edwards, Coltrane, and Daberkow conducted in 1971. Using their 12 economic development index variables for Virginia localities, a factor was extracted which was identified as a general measure of "economic affluence." The factor loadings on the 12 variables are shown in Table 1.

An economic growth index was also constructed based on the Edwards, Coltrane, and Daberkow study. This index was constructed by taking the first principal component of two variables -- change in population and change in per capita income.[2/] It was hypothesized that a positive relationship would exist between these two variables. The analysis, however, yielded a negative correlation ($r = -0.29$). This negative correlation raised the question as to which end of the scale of values was to be labeled as "positive" economic growth. The decision was made to consider economic growth as that end of the continuum associated with high values of population growth.

The relationship between the economic growth index and the economic affluence index was examined by computation of simple correlation and rank correlation coefficients. The Spearman rank correlation coefficient between the economic growth index and the economic affluence was $+0.671$; the simple correlation coefficient was $+0.632$. Both measures are significant at the .001 level. A principal components analysis was used to condense these two indices into a single measure of economic well-being (Index I) with scores for each Virginia locality computed in the study. (March, pp. 35-37).

Table 1. Factor Loadings on the Economic Affluence Index Based on the Edwards, Coltrane, and Daberkow Economic Development Index Applied to Virginia Localities. a/

	Variable	Factor Loading b/
X_1	Per capita income, 1969	0.88913*
X_2	Percent of families with incomes less than $3,000, 1969	-0.84553*
X_3	Percent of population age 25 or over with high school or more education, 1970	0.88048*
X_4	Percent of population urban, 1970	0.81754*
X_5	Percent of population farm, 1970	-0.72055*
X_6	Percent of employment white collar, 1970	0.88690*
X_7	Percent of farms with sales over $10,000, 1969	-0.01727
X_8	Bank deposits per capita, 1970	0.07866
X_9	Local government expenditures per capita, 1973	0.75444*
X_{10}	Retail sales per capita, 1972	0.55275*
X_{11}	Percent of housing units structurally sound with all plumbing facilities, 1970	0.91721*
X_{12}	Percent of employment in finance, insurance, and real estate, 1970	0.24099

a/Clark Edwards, Robert Coltrane, and Stan Daberkow, Regional Variations in Economic Growth and Development with Emphasis on Rural Areas, Agricultural Economics Report No. 205. Washington, D.C.: ERS, USDA, 1971.

b/A salient loading at the .01 level of significance is indicated by an asterisk.

Economic Well-Being Index II

The second index of economic well-being was based on the study
of the Tennessee Valley Region by Chappell. This study was similar
to the Edwards, Coltrane, and Daberkow study in that a 22 variable
set was utilized to construct an economic development index and a
15 variable set was utilized to construct an economic growth index.
Using the 22 variable data set, a factor was extracted which was
identified as a measure of "economic affluence." The factor loadings
of the 22 variables on the economic affluence index are shown in
Table 2.

The factor loadings of the 15 variables on the factor extracted
based on the Chappell economic growth index are shown in Table 3.
The simple correlation coefficient between the economic affluence and
economic growth indices based on Chappell's work was +0.400 (significant
at the .001 level). The economic growth index was combined with the
economic affluence index by means of principal components analysis to
form Economic Well-Being Index II with scores computed for each Virginia
locality (March, pp. 48-50).

Economic Well-Being Index III

Using 24 "financial need" variables patterned after the Kerns
and Jansma study in Pennsylvania, a third economic well-being
index was developed for Virginia localities. No distinction was made
between economic growth and economic development as both time-series
and cross-sectional variables were included in the index. A factor
associated with economic affluence was extracted from the 24 variable

Table 2. Factor Loadings on The Economic Affluence Index Based on the
Chappell Economic Development Index Applied to Virginia Localities[a]

	Variable	Factor Loading[b]
X_1	Percent of population urban, 1970	0.82294*
X_2	Percent of population farm, 1970	-0.61311*
X_3	Percent of employment white collar, 1970	0.92535*
X_4	Percent of population negro	-0.23076
X_5	Percent of population age 65 and over, 1970	-0.69054*
X_6	Percent of population voting in the 1972 Presidential election	0.02282
X_7	Percent of families earning under $3,000, 1969	-0.76933*
X_8	Percent of families earning $15,000 or over, 1969	0.89144*
X_9	Percent of population non-movers, 1965-1970	-0.86860*
X_{10}	Median school years completed by population age 25 and over, 1970	0.84687*
X_{11}	Labor force participation rate, 1970	0.44831*
X_{12}	Average family size, 1970	0.14920
X_{13}	Percent of employment outside locality of residence, 1970	-0.03814
X_{14}	Non-worker to worker ratio, 1970	-0.15940
X_{15}	Value of mineral industries shipments and receipts, 1972	0.01664
X_{16}	Local taxes per capita, 1972	0.85442*
X_{17}	Percent of farms with sales of $10,000 or more, 1969	0.18161
X_{18}	Average value of farm products sold per farm with sales of $2,500 or more, 1969	0.20606

Table 2. Continued.[a]

Variable	Factor Loading[b]
X_{19} Percent of farmland in harvested crop- land, 1969	0.05772
X_{20} Per capita government expenditures on natural resources, 1971-72	0.03114
X_{21} Percent of farms with sales under $2,500, 1969	0.00925
X_{22} Percent of market value of all farm products from livestock, poultry and other products, 1969	0.11731

[a] V. Glenn Chappell, "The Identification and Evaluation of Factors Affecting Economic Growth in the Tennessee Valley Region, 1950-1960," Unpublished Ph.D. Dissertation, University of Tennessee, Knoxville, Tennessee, 1970.

[b] A salient loading at the .01 level of significance is indicated by an asterisk.

Table 3. Factor Loadings on the Chappell Economic Growth Index Applied to Virginia Localities. a/

	Variable	Factor Loading b/
X_1	Change in population, 1960-1970	0.80040*
X_2	Change in median family income, 1959-1969	0.07233
X_3	Change in median rural family income, 1959-1969	-0.00303
X_4	Change in median rural farm family income, 1959-1969	-0.09369
X_5	Change in local taxes per capita, 1962-1972	0.11992
X_6	Change in median value of owner-occupied dwelling units, 1960-1970	0.55956*
X_7	Change in percent of housing structurally sound with all plumbing, 1960-1970	-0.41757*
X_8	Change in percent employed in agriculture, 1960-1970	-0.07763
X_9	Change in retail sales per capita, 1962-1972	-0.16498
X_{10}	Change in value of farm land and buildings per farm, 1959-1969	0.07051
X_{11}	Change in value added by manufacturing per capita, 1962-1972	0.12482
X_{12}	Change in number of farms, 1959-1969	0.27383
X_{13}	Change in total personal income, 1962-1972	0.87226*
X_{14}	Change in per capita government expenditures, 1961-1973	0.10348
X_{15}	Bank deposits per capita, 1970	-0.23284

a/V. Glenn Chappell, "The Identification and Evaluation of Factors Affecting Economic Growth in the Tennessee Valley Region, 1950-1960," Unpublished Ph. D. Dissertation, University of Tennessee, Knoxville, Tennessee, 1970.

b/A salient loading at the .01 level of significance is indicated by an asterick.

data set. The factor loadings of the 24 variables on the economic affluence index are shown in Table 4. This index was used to form Economic Well-Being Index III with scores computed for each Virginia locality (March, pp. 55-57).

Economic Well-Being Index IV

The fourth economic well-being index was constructed by taking the first principal component of the two variables of "per capita income, 1972" and "change in total personal income, 1962-1972". The simple correlation between the two variables was +0.36 (significant at the .001 level). This was the least complex economic well-being index computed and was labeled as Economic Well-Being Index IV with scores computed for each Virginia locality (March, pp. 59-61).

An Analysis of the Relationship Between the Four Economic Well-Being Indices

Using the weights derived from the factor analysis, scores for each of the ninety-nine Virginia localities (counties, cities, or aggregations of adjacent counties and independent cities) were computed on each of the four indices. The extent to which the four indices measured the same characteristics was analyzed by means of computing simple and rank correlation coefficients between the indices.[3] The correlation analysis results are shown in Table 5. On the basis of the correlation coefficients, the four indices are measuring similar phenomena. The three multivariate Indices I-III do not exhibit a higher correlation among themselves than with the simple income-based Index IV.

Table 4. Factor Loadings on the Economic Affluence Index Based on the
Kerns and Jansma Financial Need Index Applied to Virginia
Localities a/

	Variables	Factor Loadings[b]
X_1	Population, 1970	0.74466*
X_2	Population per square mile, 1970	0.60585*
X_3	Population change, 1960-1970	0.21354
X_4	Local government expenditures per capita, 1973	0.79367*
X_5	Local taxes per capita, 1973	0.71614*
X_6	Percent of housing units structurally sound with all plumbing facilities, 1970	0.54232*
X_7	Market value of real estate per capita, 1970	-0.07453
X_8	Revenue capacity per capita, 1970	0.19026
X_9	Local tax effort (Revenue from local sources ÷ revenue capacity per capita), 1973	0.87994*
X_{10}	Median family income, 1970	0.49531*
X_{11}	Percent unemployed, 1973	-0.00905
X_{12}	Percent of population under age 18, 1970	-0.08830
X_{13}	Percent change in per capita government expenditures, 1968-1973	-0.05574
X_{14}	Per capita local government capital outlay, 1973	0.26524*
X_{15}	Male labor force participation rate, 1970	0.28446*
X_{16}	Female labor force participation rate, 1970	0.13740

Table 4. Continued.[a]

Variables	Factor Loadings[b]
X_{17} Percent of population rural, 1970	-0.67926*
X_{18} Assessment ratio, 1970	0.75701*
X_{19} Average effective true property tax rate, 1970	0.88085*
X_{20} Net debt local government per capita, 1973	0.16847
X_{21} Per capita income, 1969	0.55736*
X_{22} Percent of families with income less than $3000, 1970	-0.25989*
X_{23} Median school years completed, 1970	0.46288*
X_{24} Percent of population age 65 or over, 1970	-0.32227*

[a] Waldon R. Kerns and J. Dean Jansma, Criteria for Determining Economic Priorities in Awarding Sewage Facility Construction Grants, Institute for Research on Land and Water Resources Research Publication No. 68. University Park, Pa.: Pennsylvania State University, 1971.

[b] A salient loading at the .01 level of significance is indicated by an asterisk.

Table 5. Pearson Product Moment and Spearman Rank Order Correlation
Coefficients between the Four Economic Well-Being Indices
Constructed for Virginia Localities a/

		Index			
Index b/		I	II	III	IV
I	P	1.000	0.775	0.885	0.676
	S	1.000	0.722	0.884	0.561
II	P	0.775	1.000	0.745	0.849
	S	0.722	1.000	0.778	0.770
III	P	0.885	0.745	1.000	0.753
	S	0.884	0.778	1.000	0.697
IV	P	0.676	0.849	0.753	1.000
	S	0.561	0.770	0.697	1.000

a/ The Pearson Product Moment correlation coefficient is denoted by
P and the Spearman Rank Order correlation coefficient is denoted by S.

b/ All of the correlation coefficients are statistically significant
at the .001 level.

Conclusions

A major conclusion of the study was that terms such as "growth"
and "development" are ambiguous and any attempt to operationalize
these concepts through multivariate statistical methods needs to be
based on variables specifically related to the elements of growth
and development which are under consideration in a given study. Studies
using the multivariate framework which incorporate large masses of
data exhibiting relatively high intercorrelations suffer from what
Marchand has termed "redundancy" (Marchand, pp. 117-127). The findings
of the study support the conclusions Marchand reached in his study
of the use of multivariate techniques in economic regionalization:

> The use of a large data set and of powerful multivariate methods
> in a regionalization study is certainly not justified if
> the only goal is to build a regional map. Most of the
> information retrieved and treated will necessarily go into
> the watebasket. . . . If (the analyst) used more sophisticated
> methods and more data, he should analyze carefully the
> result of every step of the method: interpretation of the
> correlation matrix, of the loadings on the principal components
> and on the rotated factors, mapping of the various factor
> scores, etc. This does not mean that regional maps should
> not be built anymore; one wonders, on the contrary, if
> drawing various maps for the same region by using numerous
> sets of variables and various clustering procedures would
> not be a good way to get out of the dilemma." (Marchand 1975,
> p. 127).

In terms of this study, there does not appear to be "one right
set" of variables to include in an economic well-being index, and there
is no "one right way" to assign weights to the variables included in
an index. For policy purposes a simple income-based measure of well-
being is probably just as valid a measure as the more complex multi-
variate well-being indices. However, multivariate statistical methods

properly applied, can be useful tools for studying the process and pattern of regional economic growth and development.

The purpose for which a particular study is undertaken will help to delimit the variables to be included in the analysis. The purpose for which an analysis is made will also determine the emphasis to be placed on factor loading or component coefficients (weights of variables on factors or components) as opposed to factor scores or component scores (scores of individuals on factor or components). Largely because of its origins in the psychological sciences and its concern with the structure of the mind and of abilities, the interpretation of factor scores is of relatively minor importance in much of the literature. If the purpose of a study is to measure some aspect of economic growth or development then the scores of individual localities on the factors may be the most important part of the output.

Two functions of multivariate statistical analysis as applied to regional economic development studies must be distinguished. The first function is largely descriptive and serves to answer the question: "What are the major dimensions which are defined by a given data set?" This approach may be particularly useful in hypothesis formulation as it is more concerned with the overall pattern of the factor matrix than with the scores of individual localities.

The second approach is more of a "social indicators" approach with primary attention being placed upon the scores of individual localities. The user of multivariate methods should have clearly in

mind which objective is of most concern in the particular investigation. If the first objective is of most importance, there is a justification for including large masses of data to reveal patterns within the data and suggest hypotheses. If the second objective, measuring the level of well-being is of most importance, a smaller set of variables will generally serve as well as larger sets.

FOOTNOTES

[1] In 1970, there were 96 counties and 38 independent cities defined in Virginia. A continuous process of annexation, emergence of new independent cities, and consolidation of counties and cities presents severe data problems for both time-series and cross-sectional analyses. In an attempt to minimize these data problems, independent cities were aggregated with their county of geographic location in most cases. These aggregations were not always possible, thus resulting in three geographic units in addition to the 96 counties -- a total of 99 geographic units termed "localities" in the study.

[2] In the construction of their economic growth index, Edwards, Coltrane, and Daberkow used the following two variables: (1) change in population and (2) change in total employment. In this study, "change in per capita income" was used in place of "change in total employment." The per capita income variable was used because of the traditionally high correlation between changes in employment and population and because it is believed that a study of economic growth should include a measure of income change.

[3] The rankings of Virginia localities by each of the four Economic Well-Being Indices is reported in Appendix A, Table A-1.

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APPENDIX A

Table A-1

Economic Well-Being Indices Ranks
for Virginia Localities

	Locality	Index			
		I	II	III	IV
1.	Accomack County	81	62	78	43
2.	Albermarle County-Charlottesville City	14	10	14	18
3.	Alleghany County-Covington City-Clifton Forge City	32	72	25	52
4.	Amelia County	84	71	88	57
5.	Amherst County	39	73	52	76
6.	Appomattox County	35	59	44	86
7.	Arlington County	3	11	1	4
8.	Augusta County-Staunton City-Waynesboro City	25	47	19	42
9.	Bath County	66	67	62	28
10.	Bedford County-Bedford City	47	41	37	29
11.	Bland County	99	79	97	40
12.	Botetourt County	37	40	45	59
13.	Brunswick County	82	85	79	89
14.	Buchanan County	94	82	91	69
15.	Buckingham County	97	64	96	53
16.	Campbell County-Lynchburg City	17	50	15	27
17.	Caroline County	65	45	68	25
18.	Carroll County-Galax City	68	53	55	63
19.	Charles City County	78	90	85	73
20.	Charlotte County	63	96	89	95
21.	Chesapeake City-Norfolk City-Portsmouth City-Virginia Beach City	4	17	6	12
22.	Chesterfield County	7	12	9	10
23.	Clarke County	31	18	30	49
24.	Craig County	19	83	77	79
25.	Culpeper County	12	21	38	31
26.	Cumberland County	93	42	92	66
27.	Dickinson County	85	99	98	98
28.	Dinwiddle County	40	44	59	93
29.	Essex County	45	48	47	46
30.	Fairfax County, Fairfax City, Alexandria City, Falls Church City	2	2	2	2
31.	Fauquier County	50	7	24	7
32.	Floyd County	90	87	87	75
33.	Fluvanna County	80	46	61	32
34.	Franklin County	51	60	60	68
35.	Frederick County-Winchester City	21	29	21	36
36.	Giles County	46	95	54	81

Table A-1. Continued.

		Index			
	Locality	I	II	III	IV
37.	Gloucester County	24	19	31	34
38.	Goochland County	54	22	41	17
39.	Grayson County	91	86	90	87
40.	Greene County	60	33	67	51
41.	Greensville County-Emporia City	73	34	53	70
42.	Halifax County-South Boston City	75	80	71	84
43.	Hampton City	6	16	5	26
44.	Hanover County	22	8	32	5
45.	Henrico County-Richmond City	8	15	3	11
46.	Henry County-Martinsville City	23	39	17	24
47.	Highland County	98	88	86	83
48.	Isle of Wright County	53	36	35	20
49.	James City County-Williamsburg City	5	6	13	21
50.	King and Queen County	95	69	28	35
51.	King George County	33	13	22	16
52.	King William County	41	30	39	30
53.	Lancaster County	58	49	50	37
54.	Lee County	96	98	99	97
55.	Loudoun County	11	3	10	3
56.	Louisa County	55	68	65	77
57.	Lunenburg County	77	89	84	88
58.	Madison County	74	26	83	58
59.	Mathews County	57	28	48	13
60.	Mecklenburg County	70	75	70	74
61.	Middlesex County	61	61	74	55
62.	Montgomery County-Radford City	13	5	20	47
63.	Nelson County	77	93	95	96
64.	New Kent County	26	54	42	94
65.	Newport News City	9	20	4	15
66.	Northampton County	69	81	93	92
67.	Northumberland County	87	84	75	54
68.	Nottoway County	59	70	57	61
69.	Orange County	38	43	33	23
70.	Page County	56	65	63	45
71.	Patrick County	67	91	69	80
72.	Pittsylvania County-Danville City	42	77	26	64
73.	Powhatan County	30	58	43	72
74.	Prince Edward County	44	31	66	50
75.	Prince George County-Colonial Heights City-Hopewell City-Petersburg City	18	23	11	14
76.	Prince William County	1	1	7	1

Table A-1. Continued.

	Locality	Index			
		I	II	III	IV
77.	Pulaski County	36	32	36	62
78.	Rappahannock County	72	63	81	33
79.	Richmond County	92	56	56	38
80.	Roanoke County-Roanoke City-Salem City	15	14	8	6
81.	Rockbridge County-Lexington City-Buena Vista City	34	51	29	78
82.	Rockingham County-Harrisonburg City	27	27	27	22
83.	Russell County	89	92	82	82
84.	Scott County	81	94	94	99
85.	Shenandoah County	48	66	51	41
86.	Smyth County	49	76	64	85
87.	Southampton County-Franklin City	64	37	46	65
88.	Spotsylvania County-Fredericksburg City	16	24	12	19
89.	Stafford County	20	9	16	9
90.	Suffolk City-Nansemond City	28	25	23	90
91.	Surry County	71	38	49	91
92.	Sussex County	88	35	76	56
93.	Tazewell County	76	78	72	48
94.	Warren County	29	55	34	39
95.	Washington County-Bristol City	43	74	40	71
96.	Westmoreland County	52	52	58	44
97.	Wise County-Norton City	84	97	73	67
98.	Wythe County	72	57	80	60
99.	York County	10	4	18	8