DOCUMENT RESUME

ED 090 671 EA 006 122

AUTHOR Dziuban, Charles; And Others
TITLE Fiscal Capacity and Educational Finance: Some Further Variations.
PUB DATE Apr 74
NOTE 16p.; Paper presented at the Annual Meeting of the American Educational Research Association (59th, Chicago, Illinois, April 1974)

EDRS PRICE MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS Correlation; Data Analysis; *Educational Finance; *Educational Research; *Factor Analysis; *Fiscal Capacity; Psychometrics; Research Methodology; Sampling; School District Spending; School Taxes; Statistical Analysis; Tables (Data)
IDENTIFIERS National Educational Finance Project

ABSTRACT

The school district fiscal capacity data (1962 and 1967) of the National Finance Project were analyzed for psychometric adequacy and robustness of component composition. The procedures involved: (1) the computation of the Kaiser, Meyer, Olkin Measure of Sampling Adequacy, (2) inspection of the off-diagonal elements of the antiimage covariance matrix, and (3) determination of the oblique image components. The results indicated that the matrixes were generally appropriate for factor analysis, but that several revenue variables failed to meet the criterion of psychometric adequacy. The image components, although minimally related, generally verified the originally derived patterns. (Author)

26.13

FISCAL CAPACITY AND EDUCATIONAL FINANCE: SOME FURTHER VARIATIONS

Charles Dziuban
Florida Technological University

Richard Rossmiller
University of Wisconsin

James Hale
University of New Mexico

Presented at the Annual Meeting
of the
American Educational Research Association

Chicago

April 1974

Introduction

The National Educational Finance Project's special study on *Fiscal Capacity and Educational Finance* (Rossmiller, Hale and Froreich, 1970) had as one of its major objectives:

> To identify variations in relative fiscal capacity and tax effort among school districts serving areas which display varying economic and/or demographic characteristics when alternative measures of fiscal capacity are employed.

The study was concentrated on the fiscal aspects of equalization and consideration of demand for public services only insofar as demand was reflected in expenditures by school districts and other local units of government. Citing approximately 60 studies that have been addressed to questions of tax equity, fiscal capacity and public school finance, the authors suggested that there were two basic approaches to the problem of measuring fiscal capacity. One approach utilized economic indicators, particularly measures of income from which taxes can be paid, and involved comparisons of state or local taxing jurisdictions on the basis of such indicators. The other approach involved the evaluation of tax bases which were available to a taxing jurisdiction, estimating the amount of revenue these tax bases would produce at various rates of taxation, and comparing state or local taxing jurisdictions on this basis.

Although the special study cited above was chosen to involve the economic indicator approach and analyzed revenue and expenditure data of several units of government in relation to those economic indicators, the interest of the present study is limited to those data utilized in the analysis of school district revenues and expenditures.

The original study encompassed 222 school districts sampled from across the country. A portion of the analysis included an application of factor analytic techniques to the district revenue and expenditure data for the years 1962 and

1967. The derived (normal varimax) pattern matrices were reported and interpreted for both years. Prior to any factoring procedures, the authors assessed the psychometric adequacy of their correlation matrices using Bartlett's Test of Sphericity. Although they were led to a clear rejection of the hypothesis of independence, the factoring procedures accounted for relatively small amounts of the variance (57%).

Accordingly the objectives of this study were to:

1. Further assess the adequacy of the school district revenue and expenditure variables of the Fiscal Capacity Study utilizing newer psychometric techniques.

2. To examine the fiscal capacity image components once the restriction of orthogonality had been removed.

Data Source and Methods

The data for this study were the school district correlation matrices of the eighteen revenue and expenditure variables for the years 1962 and 1967 (N=222, Tables I and II), utilized by the National Finance Project's Fiscal Capacity Study. The states which comprised the sample were: Florida, Kentucky, New York, North Dakota, Oregon, Texas, Utah and Wisconsin. School districts providing K-12 or 1-12 educational programs and which enrolled 1,500 or more pupils during the 1967-68 school year were considered for sampling purposes. The school district categories used for selection were:[1]

A. Major Urban Core City

B. Minor Urban Core City

C. Independent City

D. Established Suburb

E. Developing Suburb

F. Small City

G. Small Town or Agricultural Service Center

---

[1] For a complete description of the sampling procedure see Rossmiller, Hale & Froreich, 1970.

A proportional random sample of school districts was drawn independently for each category with the exception of Category A, where the sample included all thirteen cities. Subsequent to the data collection one district was eliminated from Category E since virtually all revenue was reported from federal sources.

Revenue from:

1) The State
2) Federal Sources
3) Other Governmental Agencies
4) Property Taxes
5) Other Local Taxes
6) All Other Sources

Expenditures for:

7) Transportation
8) Capital Outlay
9) Debt Services
10) Community Services
11) Administration
12) Instruction
13) Attendance Services
14) Health Services
15) Fixed Charges
16) Operation and Maintenance
17) All Other Purposes
18) Long Term Debt

The Correlation matrices were subjected to two additional tests for psychometric adequacy. (Bartlett's Test of Sphericity was used in the original study). The first test was the application of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy M.S.A. (Kaiser and Rice, 1974). The overall index for a correlation matrix is:

$$M.S.A. = \frac{\sum\sum_{j \neq k} r_{jk}^2}{\sum\sum_{j \neq k} r_{jk}^2 \quad \sum\sum_{j \neq k} q_{jk}^2}$$

where the r^2's are the squares of the off-diagonal elements of the original correlations and the q^2's are the squares of the off-diagonal elements of the anti-image correlation matrix $SR^{-1}S$. The limits of the index are 0 M.S.A. · 1 and it provides evidence of whether or not a sample correlation matrix is appropriate for factor analytic procedures. Kaiser (1970) reported that holding the other things constant, M.S.A. appears to improve as:

1. The number of variables (P) increases.
2. The number of subjects (N) increases.
3. The general level of correlation increases.
4. The "effective" number of factors decreases.

The presently used calibration for the index is:

In the .90's - Marvelous

In the .80's - Meritorious

In the .70's - Middling

In the .60's - Mediocre

In the .50's - Miserable

Below .50 - Unacceptable

There was also developed an index for individual variables:

$$\text{M.S.A. } (j) = \frac{\sum_{k \neq j} r_{jk}^2}{\sum_{k \neq j} r_{jk}^2 + \sum_{k \neq j} q_{jk}^2}$$

This index gives an indication, to quote Kaiser, of the degree to which a variable "belongs to the family" psychometrically.

The second test involved the inspection of the off-diagonal elements of the anti-image covariance matrix $S^2R^{-1}S^2$. The diagonal matrix S^2 has the elements $\left[\text{diag } R^{-1}\right]^{-1}$. Psychometric theory suggests that as a correlation matrix becomes appropriate for factor analysis the elements of $S^2R^{-1}S^2$ for $j \neq k$, the covariances of the unique parts of the data should be close to zero. Kaiser (1963) has summarized as follows:

> The preceding material suggests that G, the image covariance matrix might well be a good approximation to $R-U^2$, the so called reduced correlation matrix (actually the covariance matrix of the common parts of the tests). How can we tell if this approximation is good? Most simply by looking at the off-diagonal elements of the anti-image covariance matrix Q (or $S^2R^{-1}S^2$) ...In this case if our N is essentially infinite, we have a comprehensive selection of tests from the universe of tests. If on the other hand Q is not near diagonal, we know that the approximation is poor. However, when this occurs, we have evidence that factor analysis is not appropriate for the data at hand. We may not have covered the universe under consideration or that the factor analytic model may not even apply as N.

For the purposes of this study elements of $S^2R^{-1}S^2$ which were not zero to the first place were considered to be contributing to the non-diagonality of the matrix.

Upon determining the psychometric quality of the matrices, they were, as in the original study, analyzed utilizing image analysis. The Guttman (1953) procedure is based upon the image covariance matrix $(G) = R + S^2R^{-1}S^2 - 2S^2$. Components were extracted corresponding to the eigenvalues greater than one. The transformation techniques, however, differed from those used in the original fiscal capacity study (normal varimax) in that direct oblimin procedure was used ($\Delta = 0$ Quartimin). The essential difference was that the factors were now correlated subsequent to rotation. Pattern coefficients equal-to or greater-than .3 were utilized for interpretation purposes.

Results

The measures of sampling adequacy for the overall matrices and individual variables are presented in Table III. The overall M.S.A.'s revealed that the 1962 and 1967 correlation matrices were virtually equivalent in psychometric adequacy (.75 and .76). This finding put them in the generally acceptable range for factor analysis.

The anti-image covariance matrices $S^2R^{-1}S^2$ (Tables IV and V) revealed 44 (approximately 11%) off-diagonal elements to be non-zero to the first place for the year 1962 and 29 (approximately 09%) off-diagonal elements to be non-zero to the first place for 1967. Dziuban and Shirkey (1973) have demonstrated that the Armstrong and Soelberg (1968) anti-image covariance matrix, which was one of the worst of all possible psychometric situations, exhibited approximately 37% non-zero off-diagonal elements. They also demonstrated that matrices of known psychometric quality exhibited approximately 10% non-zero elements. This might be taken as further evidence that the sample correlation matrices at hand were appropriate for factor analysis.

Examination of the individual M.S.A.'s, however, revealed that for both years several revenue variables failed to achieve acceptable levels of psychometric adequacy. In fact it appeared that federal and other-source revenue were the only two which approached acceptability. Conversely, of the 12 expenditure variables, only expenditures for administration failed to meet the minimally acceptable level.

With an interpretability criterion of $|.3|$ the image pattern for the 1962 data yielded five interpretable components (Table VI). The first was related to expenditures for fixed charges and maintenance; the second state revenue and expenditures for transportation; the third debt and community service; the fourth revenue from other local taxes and expenditures for administration; the fifth (component VII) revenue from local property tax and expenditure for instruction. The 1967 solution (Table VII) yielded only two interpretable components. The first was state revenue and expenditures for transportation, instruction, attendance services, fixed charges and maintenance; the second was revenue from local property tax and expenditure for debt and attendance service. In both cases the component patterns closely resembled the original orthogonal solutions although they more closely approximated simple structure. In both cases the components were minimally correlated, the highest R was -.44 for the 1962 data and -.34 for the 1967 matrix.

Conclusions

The first conclusion to be drawn from this study is one that was observed during the original investigation. That is, applications of psychometric techniques to economic data yielded results which proved robust with respect to the methods used.

The second conclusion is that although analysis of the overall matrices for the two study periods put them in a generally acceptable range for factor analysis, the M.S.A.'s of the individual revenue variables leave much to be desired. And, in view of the fact that only one expenditure variable (administration) failed to meet the minimally acceptable level, leads one to conclude that revenue and expenditure variables do not, in Kaiser's words, "belong to the same family" psychometrically.

Consequently, it may be that in the formulation of effective school finance models revenue and expenditure variables should be considered as separate sets. They indeed may be representative of different domains which can be obscured under combination. We are not advocating that revenues and expenditures are independent of each other. In fact the largest canonical correlation among the 1962 variables was .90 (x^2 = 604.09, DF. = 72) and .95 (x^2 = 750.12, DF = 72) for the 1967 data - They are highly correlated. We do suggest, however, that one may wish to consider some alternative analysis strategies such as analyzing revenue and expenditure data sets separately or at least as two separate test batteries. We intend to perform such computations to determine if within data set factors make any more sense than those between sets.

REFERENCES

Armstrong, J. Scott and Peer Soelberg. "On the Interpretation of Factor Analysis." Psychological Bulletin, 1968, 70, 361-364.

Dziuban, Charles D. and Edwin Shirkey. "On the Psychometric Adequacy of Correlation Matrices." American Educational Research Journal (In Press).

Guttman, Louis. "Image Theory for the Structure of Quantitative Variates." Psychometrika, 18, 277-296.

Kaiser, Henry F. "A Second Generation Little Jiffy." Psychometrika, 1970, 35, 401-416.

Kaiser, Henry F. "Image Analysis" in Problems in Measuring Change, Chester W. Harris (Ed.), Madison: University of Wisconsin Press, 1963.

Kaiser, Henry F. and John Rice. "Little Jiffy Mark III." Educational and Psychological Measurement, 1974 (In Press).

Rossmiller, Richard A., James A. Hale, and Lloyd E. Froreich. "Fiscal Capacity and Educational Finance: Variations Among States, School Districts, and Municipalities." Madison: Department of Educational Administration (National Educational Finance Project Special Study No. 10). September, 1970.

TABLE I

CORRELATION MATRIX

REVENUE AND EXPENDITURE DATA FOR THE YEAR 1962

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1																		
2	-05																	
3	-39	03																
4	-11	-21	01															
5	04	-07	-10	-06														
6	00	-08	17	27	01													
7	53	-08	-06	07	12	13												
8	10	-66	-06	41	-05	22	30											
9	05	-13	16	37	03	19	26	27										
10	40	-16	-12	49	01	23	45	54	48									
11	05	-08	-07	04	37	02	14	-01	12	04								
12	-04	-04	01	46	-13	18	06	15	03	15	-07							
13	16	-04	00	16	-04	04	07	04	07	10	-10	05						
14	-14	27	-10	-32	22	-18	-07	-18	-17	-28	29	-10	-14					
15	62	-19	-28	45	11	21	33	23	20	52	14	21	18	-28				
16	43	-10	-10	29	08	12	25	14	17	36	07	11	12	-21	57			
17	04	-11	12	51	04	22	08	18	22	23	05	17	11	-26	29	28		
18	32	-14	-10	61	-01	20	21	27	23	49	09	40	17	-32	66	46	39	

TABLE II
CORRELATION MATRIX
REVENUE AND EXPENDITURE DATA FOR THE YEAR 1967

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1																		
2	-05																	
3	-16	-04																
4	06	-41	-01															
5	08	02	03	-03														
6	08	-10	14	18	05													
7	60	29	-05	23	17	03												
8	22	-13	-01	15	-13	20	24											
9	48	-36	-19	53	10	16	55	37										
10	45	-38	-15	41	05	16	52	52	74									
11	-07	15	-03	04	-06	01	-07	-06	-10	-11								
12	49	-10	-03	38	02	13	32	20	37	39	07							
13	61	-20	07	67	08	21	45	15	56	40	-01	62						
14	-05	-25	-12	02	22	01	-20	-16	-07	-14	14	-08	03					
15	77	-17	-12	33	-4	14	48	17	47	46	-02	58	76	02				
16	75	-19	03	51	16	23	53	17	56	41	-08	57	89	05	84			
17	21	-25	26	37	04	25	23	05	20	19	-02	24	46	-07	32	42		
18	-13	34	22	-12	24	02	-05	-10	-06	-14	-01	-08	-15	27	-21	-11	-13	

TABLE III

MEASURES OF SAMPLING ADEQUACY FOR THE 1962 AND 1967 CORRELATION MATRICES

Variables	1962	1967
Revenue		
State	.54	.69
Federal	.74	.69
Other Governmental Agencies	.51	.33
Property Tax	.67	.59
Other Local Taxes	.55	.39
Other Sources	.85	.72
Expenditures		
Transportation	.72	.87
Capital Outlay	.81	.74
Debt Service	.80	.83
Community Services	.83	.78
Administration	.58	.48
Instruction	.72	.91
Attendance Services	.74	.82
Health Services	.77	.53
Fixed Charges	.79	.87
Maintenance	.92	.80
All Other Purposes	.79	.90
Long Term Debt	.89	.53

Overall M.S.A.'s 1962 = .75

1967 = .76

TABLE IV
ANTI-IMAGE COVARIANCE MATRIX ($S^2R^{-1}S^2$)
REVENUE AND EXPENDITURE DATA FOR THE YEAR 1962

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1																		
2	-02																	
3	14	-04																
4	14	03	09															
5	01	05	02	-07														
6	03	00	-11	01	-02													
7	-16	03	-11	-01	-09	-03												
8	02	-04	05	-06	04	-07	-10											
9	00	02	-11	-07	01	-03	-06	03										
10	-07	01	00	-08	-02	-02	-06	-17	-17									
11	03	09	00	01	-20	-01	-08	01	03	0C								
12	00	-02	-02	-13	07	-07	-07	03	13	04	07							
13	-07	-01	-06	-07	01	00	02	02	02	04	00	02						
14	04	-20	16	08	-10	06	00	00	-34	09	-18	-11	04					
15	-14	02	02	-08	-07	-07	05	02	01	01	-04	00	01	02				
16	-06	-01	-06	-01	-04	01	01	02	-01	-01	02	02	01	01	-08			
17	-05	02	-10	-13	06	-05	01	-01	-04	C7	-01	05	01	06	03	-06		
18	-04	-02	-03	-08	01	02	04	01	-01	-02	-05	-11	00	05	-08	-05	-03	

TABLE V

ANTI-IMAGE COVARIANCE MATRIX ($S^2R^{-1}S^2$)

REVENUE AND EXPENDITURE DATA FOR THE YEAR 1967

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1																		
2	-01																	
3	08	10																
4	11	08	09															
5	06	02	04	08														
6	04	02	-01	03	-02													
7	-06	09	00	01	-09	09												
8	00	-06	-06	01	12	-11	00											
9	-05	04	06	-07	-04	-03	-05	-02										
10	-04	05	-01	-05	-05	-02	-05	-17	-12									
11	-01	-09	-01	-05	02	-05	-06	00	02	04								
12	-02	-03	02	-01	-01	-00	03	-02	03	-05	-08							
13	-03	-05	-07	-07	-00	00	00	01	-00	03	00	06						
14	01	-06	13	-01	-14	00	13	03	01	00	12	09	-01					
15	-01	01	06	-04	06	03	02	04	00	-06	03	-05	-02	-02				
16	-05	01	-03	-03	-06	-04	-01	-02	01	03	04	02	-04	-02	-06			
17	01	05	-14	-02	-01	-10	-02	05	03	-01	-01	01	-02	02	00	-02		
18	01	-21	-20	-05	-09	00	-06	04	-08	01	05	-07	04	-17	04	-02	05	

DERIVED PATTERN MATRIX (QUARTIMIN) REVENUE AND EXPENDITURE DATA FOR THE YEAR 1962*

TABLE VI

	I	II	III	IV	V	VI	VII	VIII	IX	X
1	-24	-46	-06	04	-25	00	-11	-13	06	00
2	-00	00	-01	02	00	30	00	00	00	00
3	03	01	03	06	45	00	-02	02	00	-05
4	-02	21	22	06	-04	-15	35	-10	-17	-11
5	00	00	-03	-41	-03	-02	-04	01	-03	-02
6	-01	-01	03	-03	08	-01	04	-03	-01	-25
7	01	-58	04	-05	03	-02	02	-10	-01	01
8	13	-13	23	08	-13	-04	06	02	-16	-16
9	-02	-04	47	-05	07	-03	-01	-04	-02	-04
10	-05	-19	34	09	-18	-13	01	-04	-09	-14
11	-02	-04	04	-41	00	00	03	00	03	01
12	01	-01	-03	03	00	00	51	-00	00	-01
13	01	00	00	01	00	00	00	-24	00	00
14	06	03	15	-26	-01	23	-02	08	11	10
15	-31	-10	05	-07	-28	-10	10	-16	00	-12
16	-31	-10	05	-03	-08	-05	02	-12	-05	06
17	-11	04	04	-09	16	-06	13	15	-19	-04
18	-23	-01	09	-01	-13	-11	31	-12	-05	-07
Eigenvalues	11.6	5.7	2.6	2.2	1.6	1.44	1.2	1.1	1.1	1.0

*Decimals Omitted

DERIVED PATTERN MATRIX (QUARTIMIN), IMAGE SOLUTION
REVENUE AND EXPENDITURE DATA FOR
THE YEAR 1967*

TABLE VII

	I	II	III	IV	V	VI	VII	VIII	IX	X
1	-79	-25	01	06	-12	04	04	10	-16	
2	-15	-28	06	00	03	30	-07	-14	12	
3	02	-01	03	02	48	03	08	03	01	
4	-09	76	-02	-04	00	-04	09	-05	01	
5	-02	-02	01	40	01	-01	01	04	-01	
6	-01	00	-01	01	05	-01	33	00	01	
7	-36	04	-09	17	-03	-05	-04	11	-31	
8	-01	-01	-30	-12	-09	08	23	07	-12	
9	-17	23	-24	13	-23	00	09	09	-21	
10	-13	15	-37	07	-22	-07	16	09	-17	
11	00	00	-00	-00	-01	-01	00	-27	-01	
12	-60	09	-16	-04	04	-02	01	-10	02	
13	-70	36	08	-01	08	02	08	00	-01	
14	-02	06	10	21	-16	13	07	-10	17	
15	-81	04	02	01	09	-07	09	04	01	
16	-78	16	11	07	02	02	11	07	-04	
17	-22	14	07	03	22	-14	18	-00	-04	
18	10	01	-09	28	14	27	-05	-04	01	
Eigenvalues	32.8	6.5	5.0	2.3	2.2	1.7	1.4	1.1	1.0	

*Decimals Omitted