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AUTHOR Teeter, Thomas A.; And Others
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ABSTRACT

The purpose of this paper is to review the relative contribution of selected school-related variables to the output of the Arkansas public schools, as measured by Science Reading Associates (SRA) achievement test scores. Multiple step-wise regression and Pearson correlation were used to analyze the data. The most important finding was that very little of the variance in student achievement scores was related to variables commonly considered to be important in the educational process. Average teachers' salaries, class size, school district size, average expenditures per pupil, amount spent on transportation, and local effort taken either individually, or as a group, never account for more than 12 percent of the total variation in student achievement scores. (BW)

FACTORS RELATED TO STUDENT ACHIEVEMENT IN ARKANSAS SCHOOLS : 1981 AND 1982

Prepared by

Thomas A. Teeter, Ed.D.

Robert H. Bradley, Ph.D.

Ralph B. Shull, Ph.D.

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The analysis and opinions expressed herein are solely those of the authors.

FACTORS RELATED TO STUDENT ACHIEVEMENT IN ARKANSAS SCHOOLS: 1981 AND 1982

Introduction

The purpose of this paper is to review the relative contribution of selected school-related variables to the output of the public schools. For the purposes of this paper, SRA (Science Research Associates) achievement test scores will be used as the output measure. Much of the public discussion has centered on ways to spend money; otherwise known as "inputs." It seems appropriate to investigate the relationships between the inputs and the outputs of public education. It is the authors' opinion that these variables should be scrutinized as to the contribution that they make in maximizing SRA scores.

One of the larger public policy questions is simply this: "How much contribution do various school-related variables make towards increasing SRA scores per dollar spent?" This type of question addresses two important issues. These issues are, respectively, effectiveness and efficiency. Effectiveness refers to the directness which a specific input increases public school output--SRA scores. Efficiency addresses the contribution of an input per dollar. Since modifications to the public schools will be very expensive and may require a tax increase in order to be funded, it is important that new tax dollars are spent

on items that truly will contribute directly to the quality of education.

The key measure for the output of public schools used in this study is SRA scores. This measure is called a "proxy" measure because it "stands for" the total output of the public schools. SRA scores were also used because of the authors' interest in mastery of the fundamental skills necessary to educational success. Clearly, there are other outputs to the public schools of Arkansas. Some of these outputs are: the inculcation of values, increased love of learning, socialization, acquisition of job-related skills, and many others. The SRA scores are principally directed towards basic comprehension in language arts, mathematics, and reading. These scores, expressed in national percentiles, represent basic competency in fundamental skills.

VARIABLES INCLUDED IN THE STUDY

The variables included in this study were chosen because of either their topical nature and/or because of their potential impact on the quality of education. They are as follows:

1. SRA Composite Scores, 4th, 6th, 8th, and 10th grades
2. Rating of School

3. Average Daily Attendance, i.e., district "size"
4. Percent Change in Average Daily Attendance
5. Local Tax Receipts
6. Total Transportation Cost
7. Average Daily Transported
6. Current Expense per Average Daily Attendance
9. Total Current Expense
10. Capital Outlay, Operations
11. Capital Outlay, Buildings
12. Debt-Service, Non-Bond
13. Debt-Service, Bond
14. Number of Teachers, 1-12
15. Number of Teacher, Kindergarten
16. Total Amount Paid Teachers, 1-12
17. Total Amount Paid Teachers, Kindergarten
18. Average Teachers' Salaries
19. Total Amount Paid Certified Personnel
20. Average Salary, Certified Personnel
21. Wealth Deciles
22. Per Pupil Market Value
23. Class size--a computed proxy variable for overall district class size
24. Average Number of Certified Personnel per Student
25. Average Transportation Cost
26. Total Cost
27. Total Cost less Transportation

28. Average Total Cost

29. Average Total Cost Excluding Transportation

30. Local Effort

31. Instructional Cost

METHODOLOGY

The primary statistical device used in this study was multiple step-wise regression. Pearson correlation was also extensively used. SRA scores for the 4th, 6th, 8th, and 10th grades were styled as "dependent" variables. The other variables, Average Daily Attendance, Average Teacher Salaries, etc., were considered for the purposes of this study as "independent" variables.

Multiple step-wise regression is a statistical procedure which tests independent variables for their relative contribution towards explaining variations in the dependent variable. The independent variable possessing the greatest "explanatory" power is included first in the regression equation, the independent variable explaining the second most variation is included second, etc. Those variables explaining little or no variation (and not statistically signficant) are not included in the regression equation. Frequently, those variables are as important to a public policy discussion as are the variables which withstand statistical examination. Another technique used in this study is known as Chi-Square

analysis. This is a nonparametric technique that allows data to be subdivided into classes as determined by the researcher and then checked for statistical significance.

Regression and Correlation Techniques and Statistical Significance

Correlation analysis is useful in explaining the relationship between two variables. For instance, if the correlation is a positive 1.0, then when one independent value changes by a single unit, the dependent value changes by a like amount. If there is no correlation, then a change of one in the independent variable is expected to result in a zero change in the dependent variable. Simple correlations usually must have a minimum value of 0.7 or more to be considered useful. Since regression techniques automatically produce "results," there remains the question of whether such results are statistically meaningful.

Statistical significance, crudely put, means the chance that a particular statistic assumes a given value by chance. For instance, a probability of .01 means that in only one percent of the cases the value would occur by chance. For a variable to be useful, it must have generally a correlation of 0.7 or better and be statistically significant.

All variables in this study were analyzed utilizing these techniques. The majority of the data used in this

study were obtained from a single basic source: the Arkansas Department of Education (albeit several publications as noted where appropriate later in the report). (The data on wealth deciles and per pupil market value were computed by The Center for Urban and Government Affairs, University of Arkansas at Little Rock.) The selection of these sources is important because it implies a common reporting format, relatively consistent data editing, and compilers having no particular interest in achieving a given outcome from the data. The data is limited to the academic years, 1981 and 1982. These are the only years for which SRA scores are reported state-wide on a district by district basis. The authors used the two available years of data in their analysis in order to ascertain the stability of the results among years. By concentrating on only a single year, "gremlins" in the data can lead to strange results that may not reflect the "real" world.

CAVEATS

As in all macro-studies, those studies using highly aggregated data, there are some limitations to the study of which the reader must be aware. By comparing (regressing) these variables against a selected output measure, one is assuming that the entire force of aselected variable

(average expenditures per student, for example) is directed towards that one output measure (SRA 4th grade scores, for instance). Clearly this is untrue. This causes the resulting analysis not to be sharp as ultimately desired. The alternative is worse. Given the paucity of output measures for public education, if such an assumption is not made, there is little chance for subjecting these input variables to quantifiable review.

The SRA score limitations must be remembered as well. It is conceivable that some school districts are very serious in their approach towards these examinations while others have a more relaxed attitude towards test results. Some school districts focus their attention on the fundamental skills while others direct their efforts towards content not directly measured by SRA tests.

Ascertaining the expenditures directed toward a specific outcome at a specific grade level cannot be done given the highly aggregated expenditures reported by school districts. It would produce a better study if the cost of the fourth, sixth, eighth, and tenth grades could be separated by grade from the total cost figures given for a particular district. Likewise, it would be better if the number of teachers actually assigned to a specific grade were identified with their students by SRA scores by school district, etc. Obviously, the finer the data, the greater the potential for discriminating analysis. However, at this

point in time, the data that the authors would like to have does not exist in usable form. Hence, we are limited to using data more highly aggregated than ultimately desirable. However, much "good" remains. The present study is a necessary first step in evaluating the impact of selected variables on output or performance in Arkansas school districts.

A final caveat remains. The validity of the conclusions presented in this report are limited to the numerical range of the variables studied. Frequently, there is a tendency to extend the content of the analysis to situations which were not encountered in the original data set in the belief that "scientific" analysis proves the point for all time. It does not.

RESULTS OF THE STUDY

The most important study result is presented first. The authors realize that this provides as little dramatic impact as the radio program which advertised the next week's fare with the following ad: "Tune in next week and find out if Cain kills Able." Nonetheless, this result provides a necessary context for the remainder of the study results. NONE of the variables popularly discussed and therefore included in this study have much value in explaining SRA test score results. The public policy implications of this are obvious: By spending additional amounts of money for such items, very little in the way of immediate SRA score improvements are likely results. This is not to say that spending additional monies for these inputs will have no results at all. However, it is unreasonable to expect major increases in SRA results from such expenditures. A second important implication is that other variables, such as parental expectations and support, socioeconomic status, curriculum composition, etc., are likely more discriminating predictors of academic success on achievement tests.

Simple correlation results are presented first, and then multiple stepwise regression results are reported.

Simple Correlation Results

In general, weak relationships to SRA scores (low correlates) were found with regard to the variables displayed the Tables 1 and 2. None of the variables included in this study produced a correlate of .7 or better. As a matter of fact, none of the correlations even reached 0.4.

Table 1

Selected Variables: Simple Correlation with SRA Composite Scores: 1981 and 1982 (Statistically Significant at the .05 level)

Variable	Grade	Correlations		Significance	
		1981	1982	1981	1982
Average Salary,					
Cert. Personnel	4	.2109	.2383	.000	.000
	6	.1907	.1920	.000	.000
	8	.1784	.2202	.000	.000
	10	NA	.2452	NA	.000
Average Teachers' Salaries	4	.1608	.2644	.001	.000
	6	.1986	.1734	.000	.000
	8	.1934	.1982	.000	.000
	10	NA	.2353	NA	.000
Class size	4	.1525	.2721	.002	.000
	6	.2192	.1508	.000	.002
	8	.1955	.1378	.000	.004
	10	NA	.1819	NA	.000

Table 1, Continued

Variable	Grade	Correlations		Significance	
		1981	1982	1981	1982
Local Effort	4	.2105	.0792	.000	.067*
	6	.1657	.0034	.000	.474*
	8	.1355	.1190	.005	.017
	10	NA	.0688	NA	.097*
Local Tax Receipts	4	.1000	.0756	.029	.076*
	6	.0961	.0717	.034	.087*
	8	.0843	.1060	.055*	.022
	10	NA	.1169	NA	.013
Current Expense per ADA	4	-.1574	-.1166	.001	.013
	6	-.1425	-.0120	.003	.410*
	8	-.2821	-.0528	.000	.159*
	10	NA	-.1123	NA	.010
Average Instructional Cost	4	-.1656	.0233	.001	.330*
	6	-.1650	.0871	.001	.049
	8	-.2726	.0695	.000	.094*
	10	NA	.0360	NA	.248*

Table 1, Continued

Variable	Grade	Correlations		Significance	
		1981	1982	1981	1982
Average Daily Transported	4	.0934	.1138	.038	.015
	6	.0948	.0791	.036	.067*
	8	.1108	.1437	.018	.003
	10	NA	.1512	NA	.002

* Indicates that a particular statistic is not statistically significant at the 0.05 level for that variable and that year.

Source: Calculated from Arkansas Department of Education data, ANNUAL STATISTICAL REPORT OF THE PUBLIC SCHOOLS OF ARKANSAS: 1982; Wealth Deciles and Per Pupil Market Value, Center for Urban and Governmental Affairs, University of Arkansas at Little Rock.

Table 2

Selected Variables: Simple Correlation with SRA Composite Scores: 1981

(Not Statistically Significant at the .05 level)

Variable	Grade	Correlation		Significance	
		1981	1982	1981	1982
Average Daily Attendance	4	.0916	.0959	.041*	.035*
	6	.0838	.0615	.056	.122
	8	.0859	.1088	.051	.020*
	10	NA	.1219	NA	.010*
School Rating	4	.0263	-.1253	.309	.009*
	6	.0497	.0265	.176	.308
	8	.0469	-.0736	.151	.082
	10	NA	-.0409	NA	.220

Table 2, Continued

Variable	Grade	Correlation		Significance	
		1981	1982	1981	1582
Per Pupil Market					
Value	4	.0656	NA	.107	NA
	6	.0337	NA	.261	NA
	8	-.0274	NA	.085	NA
Wealth Decile	4	-.0260	NA	.311	NA
	6	.0767	NA	.073	NA
	8	.0844	NA	.054	NA

* Indicates that a particular statistic is statistically significant at the 0.05 level for that variable and that year.

Source: Calculated from Arkansas Department of Education data, ANNUAL STATISTICAL REPORT OF THE PUBLIC SCHOOLS OF ARKANSAS: 1982; Wealth Deciles and Per Pupil Market Value, Center for Urban and Governmental Affairs, University of Arkansas at Little Rock.

Average Salary of Certified Personnel

Certified Personnel of the public schools includes teachers, administrators, and support professionals (counselors, etc.). The results of the study indicate that average salaries of certified personnel have a generally low but statistically signficant correlation with performance on SRA tests. Thus, the availabiity of well-trained educational personnel may contribute in small measure at least to student achievement.

There is a high positive correlation between "average salary of certified personnel" and "average teachers salaries." The simple correlate for these variables is 0.86. We prefer to use average salaries of certified personnel in preference to average salary of teachers because it is a more comprehensive measure.

Average Teachers' Salaries

There is a priori reason to believe that there may be a relationship between the quality of teachers attracted to the schools and the compensation received by teachers. Generally speaking, the higher paid teachers have more education and more years of experience than do lower paid teachers. The average salaries of teachers has a low correlation with performance on SRA scores. While the variable is statistically significant, it explains a very low amount of variation in the dependent variable. One

important reason for this result may be the fact that there are frequently multiple applicants for teaching positions. There is no doubt that good teachers are an essential prerequisite for quality education. Nevertheless, in today's job market in Arkansas, variations in teacher salaries do not contribute much in the way of understanding how to increase the competency of students in basic skills. The relationship between teacher salaries and salaries of other certified personnel and student outcomes is not necessarily causal--giving all teachers large increases tomorrow will not increase SRA test scores.

Local Tax Receipts and Local Effort

Local tax receipts are used as a proxy measure for local support of school systems. Strong local support should be expected to have a positive impact on schools. Indeed, a positive, but low, correlate is present between student performance in basic skills and local tax receipts. One of the frustrations present in a study such as this is finding a suitable measure for public support of schools. One of the limitations of local tax receipts as a proxy for local support is that it is highly related to the size of school district (0.92).

In an attempt to overcome the limitations of local tax receipts as a proxy for local support, "local effort" was derived by dividing local tax receipts by total costs

(includes all expenditures by local school districts). In general, communities that provide stronger local support for education are repaid by higher average achievement scores. It must be emphasized that this is a weak, but positive relationship.

Class Size

• "Class size" is a proxy variable for the average size of classes by school district. It is derived by dividing average daily attendance by number of teachers, K through 12. This statistic may be properly thought of as an overall measure of the number of students per teacher. Overall statistics, such as this, tend to blur distinctions relative to the actual size of classes, i.e., it includes both the small specialized classes as well as the "normal" size classes. The average or mean class size would typically underestimate the number of students present in most of the classrooms in the district. Furthermore, mean class size is likely to be substantially lower than the maximum class size for a district. Clearly, it would be better to have the size of each class for the district and then compute an average. Nonetheless, "class size" is statistically significant and does explain a small amount of variation in SRA scores.

Current Expense per Average Daily Attendance

This has been a very controversial varfable in recent months. In fact, the Arkansas Supreme Court has issued an opinion requiring equalization of current expenditures per average daily attendance (ADA). As in the case of the other variables previously discussed, it has a small negative correlation with SRA scores. A factor potentially causing this negative relationship may be overhead expenses. Even small districts must still maintain a school superintendent, some office staff, and incurr some basic administrative and support expenses. A small number of students per grade level can be associated with high per unit costs. It can then be argued that small school districts have high per student costs because these school districts have small numbers of students per teacher. It is possible that this results in relatively inefficient school districts. Increasing the average size of school districts should, all other things being equal, put a relatively larger percentage of district resources in to the teaching function.

Average Instructional Cost

"Average instructional cost" was computed by dividing current expenditures less transportation by ADA. The rationale for this measure was that riding in a bus per se

adds little to performance in basic skills. In the authors' opinion, adjusting current expenses per ADA in this manner sharpens the focus on expenditures for classroom activities. This measure, like current expenditures for ADA, has a low negative correlation with SRA performance. The reasons for this are essentially the same as those discussed in the above section. In essence, we believe that there are inefficiencies associated with the very small school districts.

As shown in Table 3, there is a strong tendency for schools spending large amounts per capita on instructional costs to be associated with SRA test scores below the 40th percentile. Presumably, this reflects the higher average cost associated with smaller district size rather than additional amounts spent on instruction producing negative results. Similar results were obtained for 6th and 8th grade analyses. The essence of the matter is this: the composition of spending is as important as the level of spending.

Table 3

Number of School Districts Below the 40th Percentile, SRA Composite Scores, 4th Grade By Average Instructional Cost

Average Instructional Cost	Number Below 40th Percentile
Under $1,050	1
$1,050 - $1,149	11
$1,150 - $1,199	5
$1,200 - $1,349	24
$1350 and Over	30

Source: Computed from unpublished data from the Arkansas Department of Education and ANNUAL STATISTICAL REPORT OF PUBLIC SCHOOLS OF ARKANSAS: 1982

Average Daily (Number) Transported

Although the authors believe that busing per se does not add to SRA scores; it may indirectly. Busing may be a means of maintaining larger school districts than would be the case in its absence. Evidence in favor of this hypothesis is the high correlation (0.92) between average daily attendance and average daily transported. Whatever the reason may be, the average daily transported measure has a small, statistically significant and positive correlation with SRA scores. This finding is in sharp contrast to the popularly held view that busing per se reduces academic achievement.

Average Daily Attendance

Average daily attendance is used as a measure of school district size. When compared to SRA scores, it is properly included with the variables listed in Table 2. This variable was marginally statistically significant only in about half the observations during the two year period under review. It is better to consider this measure statistically insignificant in the absence of information strongly suggesting its value as an indicator. It is still useful to note that large school districts rarely have scores in the lower performance ranges (below the 40th percentile) than the smaller school districts with less than 1,000 students. Apparently, larger school districts

per se do not increase the chances of producing above median SRA results. As shown in Table 4, the value of larger districts (1,000 and over) seems to be in reducing the probability of producing less than median results.

Table 4

Number of School Districts Below the 40th Percentile, SRA Composite Scores, 4th Grade By School District Size (ADA)

School District Size	Number Below 40th Percentile
Under 500	53
500-999	18
1,000-1,999	8
2,000-2,999	0
3,000- 4,999	1
5,000 and over	1

Source: Computed from unpublished data supplied by the Arkansas Department of Education and ANNUAL STATISTICAL REPORT OF PUBLIC SCHOOLS OF ARKANSAS: 1982

School Rating

The school rating variable is composed of the following items: (1) North Central accreditation, (2) schools rated "A" by the Arkansas Department of Education, (3) schools rated "B" by the Arkansas Department of Education, and (4) schools rated "C" by the Arkansas Department of Education. North Central Association accredited schools are considered to be the highest rating followed by the Arkansas Department of Education ratings "A", "B", and "C", respectively. As show in Table 2, this variable has a low correlation that is statistically insignificant. If SRA scores in basic skills are the criterion measure, school ratings are not sufficiently robust to serve as a policy variable.

North Central Association accreditation standards are related to: (1) school organization, (2) instructional programs, (3) students activities, (4) student personnel services, and (5) school facilities. These criteria are not the subject of this investigation. If such criteria are central to other pursuits, then North Central Association and Arkansas Department of Education ratings can be useful for policy analysis.

Per Pupil Market Value and Wealth Deciles

Per pupil market value and wealth deciles are included in this report as a potential proxy measure for school

district wealth. As reported in Table 2 (for 1981 data only), this measure is statistically insignificant. Normally, statistically insignificant findings are not reported. The authors have chosen to report this measure because it may be included in future discussions as a policy variable. The most likely reason why this variable is not significant is because it is an incomplete measure. It measures the value of real property, and reported personal property. Since the value of bank accounts, savings accounts, stocks and bonds, pension fund balances, and other financial assets are exempted from personal property assessments by Arkansas Constitutional amendments, they are not included in this figure. These assets are substantial components of wealth. Wealth deciles suffer from the same deficiencies in the reporting of wealth.

In constructing new formulas for the funding of public school education, it may be desirable to account not only for the average of income within counties, but the uneveness of the distribution of income as well.

Multiple Stepwise Regression Results

The results of multiple stepwise regression underline the low correlations obtained from simple correlation analysis. A very low amount of the total variation in SRA percentiles is accounted for by the models developed by the use of multiple stepwise regression using the variables

included in this study.

The results of the analyses are found in Tables 5 and 6. The most important conclusions that can be derived from these two sets of analyses are straightforward. First, a small amount of the total variation in SRA scores (the range is 5.9 to 11.8 percent) is accounted for by the variables in the regression analyses. Second, because of the low correlates, the sequence of the reported variables changes from grade to grade. Third, some variables consistently come to the top: Class size, Average Salary Paid Certified Personnel, Local Effort, and Average Instructional Cost. Finally, it should not be forgotten that approximately 90 percent of the variation in SRA scores remains unexplained.

Table 5

1981 Stepwise Regression Results: Grades 4, 6, and 8

Step	Grade	Variables included in the Regression	Adjusted R Square
1	4	Average Salary Paid Cert. Personnel	.04182
2	4	Local Effort	.07079
3	4	Average Instructional Cost	.09067
1	6	Classize	.08705
2	6	Local Effort	.08750
3	6	Wealth Decile	.09812
1	8	Average Teachers' Salaries	.04182
2	8	Current Expenditures per ADA	.09674
3	8	Average Total Cost (excluding transportation)	.10542

Source: Arkansas Department of Education, ANNUAL STATISTICAL REPORT OF PUBLIC SCHOOL OF ARKANSAS: 1982, and Center for Urban and Governmental Affairs, University of Arkansas at Little Rock.

Table 6

1982 Stepwise Regression Results: Grades 4, 6, 8, and 10

Step	Grade	Variables included in the Regression	Adjusted R Square
1	4	Class size	.07401
2	4	Average Salary Paid Cert. Personnel	.09373
3	4	Local Effort	.10267
4	4	Average Instructional Cost	.11792
1	6	Average Salary Paid Cert. Personnel	.03711
2	6	Average Instructional Cost	.04423
3	6	Class size	.05857
4	6	Local Effort	.05906
1	8	Average Salary Paid Cert. Personnel	.04849
2	8	Local Effort	.05884
3	8	Class size	.06478
4	8	Average Instructional Cost	.07535

Table 6, Continued

Step	Grade	Variables included in the Regression	Adjusted R Square
1	10	Average Salary Paid Cert. Personnel	.05606
2	10	Class size	.06505
3	10	Local Effort	.07297
4	10	Average Instruction Cost	.08113

Source: Arkansas Department of Education, ANNUAL STATISTICAL REPORT OF PUBLIC SCHOOL OF ARKANSAS: 1982, and Center for Urban and Governmental Affairs, University of Arkansas at Little Rock.

SUMMARY AND CONCLUSIONS

The most important finding of this study is that very little of the variance in student achievement scores is related to variables commonly considered to be important in the educational process. Average teachers' salaries, class size, school district size, average expenditures per pupil, amount spent on transportation, and local effort taken either individually, or as a group, never account for more than 12 percent of the total variation in student achievement scores.

Teachers' salaries are always an important topic in Arkansas. Average teachers salaries in Arkansas are at or near the bottom of teachers' salaries nationally. There are good equity reasons for desiring to increase the salaries of the State's school teachers. Average salaries pa'd certified personnel, which includes teachers, is one of the variables most frequently surfacing in the regresssion analysis as a signficant variable.

If the public objective is primarily that of raising performance in basic skill areas, it would be better to direct additional funds to differential increases rather than across the board increases. Rewards, based on experience, performance, education, and other relevant

factors will be more cost effective and motivating.

The contribution of local effort to explaining performance on student achievement scores is very small, but positive. However, the authors' did not find a good proxy measure for the contribution of a community (monetary and otherwise) to its local school district.

School district size accounted for a small amount of the variation in student achievement scores. This small amount of explanatory power was principally due to the fact that the average performance of students in large districts was rarely below the 40th percentile. Performance in smaller districts was more variable. School district size should not be confused in with average class size or school size.

Class size, defined as the number ADA divided by the number of teachers in the district, showed a small, but consistent relationship to student achievement. Students in districts with larger average classes scored higher on the SRA tests. The authors' opinion is that this measure is an indirect measure of efficiency. This interpretation modestly favors larger school districts.

The purpose of this study was to investigate the impact of commonly discussed educational variables on student achievement. Results from the study, based on the data available, showed little impact of these variables. There is a pressing need to examine the impact of

educational variables in addition to those investigated in this study. There is also a great need to obtain more appropriate and detailed measures of the variables included in the present study. Public policy-makers are severely handicapped without such information.