COST-SIDE EQUALIZATION
AND
THE VIRGINIA PUPIL TRANSPORTATION FUNDING FORMULA

by

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Dissertation submitted to the Faculty of

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

in

Educational Administration

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May, 1990

Blacksburg, Virginia

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(ABSTRACT)

This is a study designed to determine whether the 1988-89 method of distributing state pupil transportation funds in Virginia met generally accepted standards of quality for such distribution methods, and whether the method of distributing pupil transportation funds served to enhance fiscal equalization in Virginia by properly taking into account cost factors that vary among the Commonwealth's local school districts?

Relevant literature was examined to identify generally accepted standards of quality for pupil transportation funding formulae and to identify cost factors that are generally accepted as exerting an influence on the costs of operating a local pupil transportation program. Second, information and data were gathered to provide measurements of generally accepted evaluative criteria and generally accepted cost factors that had previously been identified.

It was concluded that the Virginia pupil transportation funding formula, as proposed by the Joint Legislative Audit

and Review Commission and adopted by the General Assembly, meets generally accepted standards for efficiency, objectivity, and reliability, but fails to meet standards for simplicity and equity. It was also concluded that the Virginia pupil transportation funding formula does not enhance fiscal equalization through proper consideration of cost factors that vary among local school districts in Virginia.

Five recommendations were offered. First, the current Matrix System method of recognizing costs for purposes of state pupil transportation fund distribution should be replaced by one of three formulae developed through the study, all three of which are substantially more accurate than the Matrix System in approximating existing costs. Second, an effort should be made to provide a comprehensive but understandable description of the method of state pupil transportation fund distribution in Virginia. Third, the methods used in the body of the study should be duplicated by a state agency with ready access to accurate and current data pertaining to pupil transportation costs and cost factors in Virginia. Fourth, the Pupil Transportation Division of the Virginia Department of Education should be more directly involved in the administration of state pupil transportation funds. And fifth, the practice of basing current pupil transportation fund distribution on data more than one year old should be discontinued.

ACKNOWLEDGMENTS

The completion of this study being but the final hurdle of a two year doctoral program, it seems appropriate to acknowledge help in getting to the hurdle as well as getting over it. My time at Virginia Tech has been replete with instances of special people being especially, unexpectedly helpful, to the point that I have been embarrassed at times for lack of a suitable response.

I thank Dr. Wayne Worner and Dr. Kenneth Underwood for taking the time to pry me out of North Dakota to undertake my doctoral studies. I thank them also for ongoing support during the time my family and I have been in Virginia. I thank Dr. Worner and his wife Kathie for the personal attention they have given my family during the past two years. I thank Dr. Worner for being an exceptional classroom teacher, a characteristic that sometimes goes unremarked in the abundance of his other virtues.

I thank Woody Barwick, a fellow student of similar age and circumstance, for befriending me, for reminding me of class times and homework requirements and generally assisting me through the confusion of resumed studentship, and for remembering the names of our classmates.

I thank Dr. David Parks for his powerful teaching style and for inspiring me to a genuine appreciation for theoretical studies of school administration. Dr. Parks' Theories class will remain a treasured and useful memory long after I leave Virginia Tech.

I thank Dr. Richard Salmon and Dr. Kern Alexander for showing me that I do not, after all, know all there is to know about school finance. I stand in awe of the scope and subtlety of their understanding, and their mindfulness, always, that the reason to understand is to serve children.

I regret that I somehow missed taking classes from Dr. Glen Earthman and Dr. David Alexander, but I thank each of them nonetheless for contributions to my doctoral studies. Dr. Earthman has counseled me with thoughtfulness and patience in his capacity as EDAD program leader, personally guided me in my work as a graduate assistant, and taken pains to include me in program area functions. Dr. David Alexander has been available to me and willing to provide assistance and specialized information whenever I requested it, which was often. He has also provided an example of an office messier than my own, an office from which a good deal of the literature cited in this study was spirited unbeknownst to him.

I thank Dr. Harold Dodge for making the resources of his office as Superintendent of the Montgomery County School Division available to me on numerous occasions, and for guiding my work with the Montgomery County Education Foundation.

I thank the family of Stuart Beville, since we have all been deprived of the chance to thank Stuart directly, for the experience of seeing an imagined character of my childhood in real life. Stuart Beville personified what I had imagined as the southern gentleman and the great Virginia statesman.

I thank Dr. Lawrence Cross for bringing everyday sense to the tangled and torturous meanings of statistical research.

I thank John Rickman and Buster Bynum of the Virginia Department of Education, Kenneth Moore of the Virginia Employment Commission, and Stuart Layne of the Virginia Department of Transportation, for being unfailingly tolerant of my requests for information.

I thank Paulette Gardner for assisting me with the technical requirements of this study, and Paulette Gardner and Dee Weeks for providing a two-year supply of correct answers.

I am flattered to be able to present this dissertation for the approval of a committee consisting of Dr. Richard Salmon, Dr. David Alexander, Dr. Harold Dodge, Dr. David Parks, and Dr. Wayne Worner. I thank my committee members for enduring with me through the tests leading to my final defense, for guiding and coaxing me in my efforts, and for the privilege of listing their names herein. I thank Dr. Richard Salmon, my advisor and the chairman of my committee, for his considerable help in conceptualizing and moving forward with this study, and for kindnesses unincumbent upon a graduate advisor.

I thank my children, Dacota and Jackson, for adjusting like troopers to a huge upheaval in their lives.

And I thank my wife, Darlene, simply for going over the hurdle with me, this one and all the others.

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Chapter 1

INTRODUCTION

In 1846, Horace Mann stated in his Tenth Annual Report to the Massachusetts Board of Education:

> I believe in the existence of a great, immutable principle of natural law . . . which proves the absolute right of every human being that comes into this world to an education; and which, of course proves the correlative duty of every government to see that the means of that education are provided to all (Horace Mann League, Tenth Annual Report, 1952, p. 112).

Later, in his Twelfth Annual Report to the Massachusetts Board of Education, Mann encapsulated and immortalized his principle of natural law as follows:

> Education, then, beyond all other devices of human origin, is the great <u>equalizer</u> [underlining added] of the conditions of man--the balance-wheel of the social machinery . . . and, if this education should be universal and complete, it would do more than all things else to obliterate factitious distinctions in society (Horace Mann League, Twelfth Annual Report, 1952, p. 59-60).

Thereafter, efforts to attain Horace Mann's vision of public education have come to be known as the "equalization of educational opportunities," or simply as "equalization." By 1923, Strayer and Haig were to define the concept of equalization as follows:

> In its most extreme form, the interpretation is somewhat as follows: The state should insure equal educational facilities to every child within its borders at a uniform effort throughout the state in terms of the burden of taxation; the tax burden of education should throughout the state be uniform in relation to taxpaying ability, and the provision for schools should be uniform in relation to the educable population desiring education (Johns, 1972, p. 8).

Equalization, then, has become an educational ideal defined primarily in fiscal terms and pursued primarily at the state level. The task of equalization involves identifying the cost of what is considered a desirable and sufficient level of education by the people of a state, and then ensuring that all children within the state are provided the means to that which has been identified (Barr, 1960).

One might suppose that equalization could be realized in a rather straight-forward manner, simply by imposing a uniform state-wide program of education and funding the full cost through state sources. This supposition would be correct, but a conflict arises: the concept of equalization runs afoul of existing structures in public elementary and secondary education.

Responsibility for the daily and routine administration of public schools has been substantially delegated to local school authorities throughout the United States. If all costs of a uniform program of education were underwritten by state government, the incentive for instructional innovation and cost efficiency would be largely removed at the local level. Therefore, states have generally opted to fund only part of the cost of education, and equalization is elicited (or not) through the state's method of fund distribution (Furno and Magers, 1981).

The idea of statewide equalization presumes, of course, that fiscal inequalities exist among local educational agencies. The presumed inequalities are of two kinds: (1) unequal fiscal capacity or revenue-raising ability from one local unit to the next, and (2) unequal factors that require one local unit to incur higher costs than another simply to provide a program of equal quality (Garms, Guthrie and Pierce, 1978).

This study was directed toward the cost side of equalization rather than the more commonly discussed and studied revenue side of equalization. More specifically, the study focused upon state governmental efforts to compensate for unequal pupil transportation cost factors that exist among local school districts in the Commonwealth of Virginia.

NEED FOR THE STUDY

A comprehensive independent study of the Virginia pupil transportation program was last completed in 1981 by Clyde H. Burnett, Jr., who used revenue and expenditure data from the 1978-79 school year. Based upon the findings of his study, Burnett proposed an alternative funding formula for pupil transportation with limited and uncomplicated use of transportation cost factors. The formula was proven, through statistical analysis, to be superior to the existing method of fund distribution in terms of approximating actual costs. Unfortunately, there is no evidence that Burnett's proposed formula was given serious consideration for implementation, although a significant change in Virginia's method of distributing pupil transportation funds occurred concurrent with recent overall changes in state funding mechanisms for elementary-secondary education.

The change in Virginia's pupil transportation funding formula was intended, at least ostensibly, as an attempt to equalize educational opportunities in Virginia by addressing transportation cost factors that vary among school districts (JLARC, 1987). This was done in a funding environment characterized by a good deal of confusion, a result of alterations enacted by Virginia's General Assembly that affected all components of the state's school funding mechanism. Compounding the confusion was an apparent decision by policy makers to restrict access to data and limit discussion of alternative distribution methods under consideration.

In assessing the effects of changes in Virginia's overall school funding structure, Verstegen and Salmon (1990) employ language startlingly reminiscent of Horace Mann's reference to education as the great equalizer:

> . . . although the goals propelling the major restructuring of school finance enacted in the 1988 General Assembly and implemented in local schools during the 1988-89 school year were laudable, this research has shown they have not been met. For children living in less affluent school divisions, an equal educational opportunity remains a cruel illusion reserved for those who begin life with greater economic advantage, an advantage reinforced and strengthened by their elementary and secondary schools (p. 22).

Payments for pupil transportation comprise a significant portion (more than $33,000,000 in categorical aid alone in 1986-87) of total state aid to Virginia's public school districts (Salmon, Dawson, Lawton and Johns, 1988). Under the concept of zero-fund, funds expended for pupil transportation are diverted from other uses, including direct expenditures for instruction. Consequently, the question of whether or not pupil transportation funds are accurately and equitably distributed is very important to the Commonwealth of Virginia.

Hence, this study addressed the need to: (1) reexamine the issues raised by Burnett in 1981, (2) update the Burnett study as appropriate, and (3) determine whether the method enacted by the General Assembly of determining pupil transportation costs, effective for school year 1988-89, had moved Virginia a step closer to the ideal articulated by Horace Mann more than a century ago.

STATEMENT OF THE PROBLEM/PURPOSE OF THE STUDY

The problem addressed by this study was related to a larger question being widely debated at the time the study was undertaken, the question of whether or not Virginia's method of distributing funds for elementary-secondary education had served to equalize educational opportunities in the Commonwealth. Although the method of distributing state pupil transportation funds had been altered for the avowed purpose of enhancing fiscal equalization, and although funds had been distributed using the altered method for the 1988-89 school year, a study had not been conducted to ascertain whether an equalizing effect had indeed been realized.

Therefore, the purpose of this study was to answer two questions related to the above-stated problem, and to address a third question if either of the first two questions was answered in the negative.

The first question: When the method of distributing state pupil transportation funds was altered in Virginia, were generally accepted standards of quality for such distribution methods given proper consideration?

The second question: Did the altered method of distributing pupil transportation funds serve, in fact, to enhance fiscal equalization in Virginia by properly taking into account cost factors that vary among the Commonwealth's local school districts?

The third question: What alternative method of distributing pupil transportation funds might better serve to meet generally accepted standards as well as enhance fiscal equalization in Virginia?

DEFINITION OF TERMS

Most terms used in this study are defined within the text of the study. Those few which are not defined, and which would not be understood as a matter of common knowledge, are defined below:

ADA of Transported Pupils

ADA means Average Daily Attendance and refers to the average number of pupils actually in school on an average school day, while ADM means Average Daily Membership and is synonymous with average enrollment. ADM is a larger number than ADA for any given school, of course, and is used in the distribution of all state funds except categorical (see below) pupil transportation funds. ADA is used in distributing categorical pupil transportation funds.

ADA of Pupils Transported means the average number of pupils transported daily on state-approved school buses in a school system (Virginia Department of Education, Regulations, 1989). Throughout this study, the "ADA" prefix is not used but is assumed to be understood in references to numbers of pupils transported.

State Basic Aid

State Basic Aid is the major funding mechanism comprising the state's share of basic operational costs required to meet Standards of Quality (see below) required by the Commonwealth of Virginia (Virginia Education Association, 1990). To compute State Basic Aid entitlements, the cost of meeting state Standards of Quality is calculated for each school district, the school district's share of the state one-cent sales tax dedicated to public elementary-secondary education is deducted, and state and local shares of remaining costs are then determined through application of the Local Composite Index (see below). After application of the Local Composite Index, the state share of total costs is paid to the school district as State Basic Aid (Baliles, 1988).

Categorical Funding

Categorical Funding refers to funding that is provided to serve a limited purpose, as opposed to funding that may be used with a good deal of discretionary power on the part of local officials. In terms of this study, categorical funding generally refers to funding provided by the state of Virginia explicitly to offset pupil transportation expenditures at the local level.

Joint Legislative Audit and Review Commission

The Joint Legislative Audit and Review Commission (JLARC) is an ongoing commission charged by the General Assembly with responsibility for a variety of governmental studies. JLARC was recently directed to study and make recommendations regarding the financing of Virginia's public schools. The first report of this study (JLARC I) was released in 1986. This report focused upon methods of estimating the cost of implementing Standards of Quality that had been established by the General Assembly. The second report (JLARC II) was released in 1987 and was alleged, by JLARC, to be a design for equalizing the state school finance system (Virginia Education Association, June, 1989).

Local Composite Index

The Local Composite Index (LCI) is a number between zero and one, with a ceiling of .80, computed for each school district in Virginia. A detailed description of LCI computations is included as Appendix A. Once computed, the LCI is used as an indicator of the relative fiscal capacity of the various school districts. School districts with lower LCI's, for example, are presumed to have less fiscal capacity than those with higher LCI's and therefore are presumed less able to support public education at the local level. In actual use the LCI is a ratio expressive of a school district's share of total costs involved in meeting state-imposed Standards of Quality, and the state's share of Standards of Quality costs is therefore expressed by the ratio 1-LCI. The result is that the state assumes a greater responsibility for Standards of Quality costs in school districts with lower LCIs. Therefore, the revenue side of equalization is realized in Virginia to the extent that Standards of Quality costs are accurately determined and LCI computations are a valid measure of fiscal capacity (JLARC, 1987).

School Division

Local educational agencies are called School Divisions in Virginia. The more common term is school "districts," which was used in this study to avoid confusion.

Standards of Quality

Standards of Quality (SOQ) are operations standards for Virginia's public elementary-secondary schools as prescribed by the Virginia Board of Education and subject to revision by the General Assembly (Baliles, 1988).

METHODS OF RESEARCH

In order to address the questions posed by the problem engendering this study, the following research methods were employed:

(1) Literature related to pupil transportation programs in Virginia and other states was reviewed. Sources were examined for:

(A) Evaluative criteria that are generally accepted as indicative of quality in a pupil transportation funding formula.

(B) Citations of variable cost factors that are generally accepted as worthy of consideration in building pupil transportation funding formulae.

(C) An understanding of the evolution and present condition of Virginia's pupil transportation funding formula.

(2) Data and written operating procedures were gathered from the Virginia Department of Education and other state agencies pertaining to:

(A) Features of Virginia's method of administering the distribution of pupil transportation funds that would evidence either satisfaction of or failure to satisfy the evaluative criteria identified through the literature review.

(B) Actual costs of pupil transportation operations reported by school districts for the 1985-86 school year, the year from which statistics were used to build and drive the current pupil transportation funding formula.

(C) 1988-89 cost projections generated by the present pupil transportation funding formula for use in distributing 1988-89 state pupil transportation funds to local school districts.

(D) Quantitative local measurements of the variable cost factors pertaining to local school districts in Virginia.

(3) Using evaluative criteria identified through the literature review and features of Virginia's distribution method identified through data-gathering procedures, a determination was made as to whether the present method of distributing pupil transportation funds does or does not meet each of the evaluative criteria.

(4) Using Pearson Product-Moment correlation analysis, actual costs during the base year of operation were compared to costs predicted by the state funding formula to determine the extent to which the current funding formula accurately accounted for variance in transportation costs among school districts.

(5) Using correlation analysis, cost-factor measurements were compared to actual costs in the base year to determine the degree to which each cost factor was or was not related to the variance in actual costs among school districts.

(6) Using stepwise multiple regression analysis

with actual costs as the dependent variable and cost factor measurements as independent variables in various combinations, regression formulae were generated to predict actual costs.

(7) Using correlation analysis, outcomes of the state formula and outcomes of multiple regression formulae were compared to actual costs to determine which formula accounted for a greater proportion of variance in actual costs during the base year.

(8) Differences between actual costs and state formula predicted costs, and alternative formulae predicted costs and state formula predicted costs were calculated to determine which individual school districts were "gainers" and which were "losers" as a result of the state's use of the current formula.

(9) Using cross-tabulation tables and Chi-square procedures, gainers and losers from the state formula were tracked against cost factor measurements. The purpose of this analysis was to determine which cost factors, if any, were significantly (in a statistical sense) ignored through use of the current state formula.

LIMITATIONS OF THE STUDY

This study did not set out to assess the operational quality of the Virginia pupil transportation system. It dealt only with Virginia's method of distributing state funds for pupil transportation.

Neither did this study attempt to address the broad question of fiscal equalization in Virginia. In this regard, the study dealt neither with the entirety of state funding for elementary-secondary education nor with the revenue side of fiscal equalization. It dealt only with the question of whether or not fiscal equalization was enhanced through appropriate consideration of cost factors in Virginia's pupil transportation funding formula.

Although the study assessed the outcomes of a funding formula that was implemented during the 1988-89 school year, the 1988-89 school year is pertinent only in that regard. Funds disbursed under the new formula were not based upon pupil transportation data (such as numbers of pupils transported) derived from the 1988-89 school year (John Rickman, Virginia Department of Education, personal communication, March 5, 1990). Indeed, the formula itself was built using data three years removed from the 1988-89 school year (JLARC, 1987). According to the above-referenced sources, both the formula and the numbers used to determine payments for 1988-89, 1989-90, 1990-91, and 1991-92 were derived from the 1985-86 school year. In other words, 1991-92 payments will be based upon six year old data.

Furthermore, it was found that data pertaining to pupil transportation operations in Virginia during the 1988-89 school year were not yet available at the time this study was being completed. Students had been transported during the 1988-89 school year, of course, and 1988-89 transportation expenditures had been made by local school districts, and all pertinent data had been reported to the Virginia Department of Education. The Department of Education, however, had not yet completed necessary audit procedures and cross-checked with other State Department of Education reports for accuracy and consistency (Buster Bynum, VDE, personal communication, March 1, 1990).

Due to the above limitations, it was felt that a fair analysis of the new distribution formula should be based upon the same data inputs that were used to build and drive the formula. As much as possible, expenditure and cost-factor data were derived from the 1985-86 school year rather than from school year 1988-89, the year in which funds were first disbursed under the new formula.

Although pupil transportation funds are expended for practices other than the transportation of pupils on state-approved school buses, such expenditures and the associated state funding were not included in this study. Examples of practices excluded from this study are: (1) payments by local school districts to parents or to other school districts in lieu of transportation services provided directly by the local school district, (2) expenditures to provide public school pupils free access to public transit systems, and (3) expenditures to provide special, non-school bus transportation arrangements for handicapped pupils. The study was limited to consideration of operational costs and related funding for the transportation of pupils on state-approved school buses, which comprised 97% of total recognized transportation costs and the same percentage of state pupil transportation funding for 1988-89 (Virginia Department of Education, 6-88).

Data pertaining to 1985-86 pupil transportation operations and data pertaining to 1988-89 funding (based upon 1985-86 operations) were obtained from two separate offices in the Virginia Department of Education. Unfortunately, the two sets of data were not perfectly consistent. When inconsistencies were present and could not be logically explained and adjusted, the relevant school districts were excluded from the study.

Of 131 school districts providing pupil transportation services during the 1985-86 school year, 12 school districts were excluded from the study. It was considered very unlikely that study results were affected by these exclusions, since 1988-89 state-generated cost projections for the remaining 119 school districts, before adjusting for inflation, were very nearly identical to aggregate 1985-86 operating costs for the same school districts. Actual 1985-86 operating costs for the 119 school districts were $113,782,000, as compared to $113,776,000 of projected costs. The 12 excluded school districts transported a total of 11,942 ADA pupils during the 1985-86 school year, or 1.6 percent of all pupils transported in the Commonwealth.

ORGANIZATION OF THE STUDY

Chapter 1 of this study introduces the concept of fiscal equalization and its relationship to pupil transportation funding. Also in Chapter 1, the need for an examination of Virginia's pupil transportation funding formula is noted, the purpose of this particular examination is defined, the questions addressed by this study are stated, potentially confusing terms are defined, research methods used to address the questions of this study are outlined, limitations of the study are acknowledged, and the organization of the study is delineated.

Chapter 2 consists of an examination of literature pertinent to the three questions posed in Chapter 1.

In Chapter 3, Question Number One (having to do with generally accepted standards) and Question Number Two (having to do with proper use of cost factors) are addressed. An evaluation of the present pupil transportation funding formula is conducted utilizing generally accepted standards established through the literature review in Chapter 2, and research methods outlined in Chapter 1 are employed to examine the equalizing properties of the present pupil transportation funding formula.

In Chapter 4, Question Number Three (having to do with a better funding formula) is addressed. Three alternative pupil transportation funding formulae are constructed and their potential tested for equalizing the distribution of pupil transportation funds in Virginia.

Chapter 5 consists of a summary, conclusions, and recommendations.

Chapter 2

REVIEW OF RELATED LITERATURE

GENERALLY ACCEPTED STANDARDS FOR PUPIL TRANSPORTATION FUNDING FORMULAE

Several sources were examined to identify criteria commonly used in evaluating pupil transportation funding formulae. Terminology used by the several researchers in referring to evaluative criteria was quite consistent. In the case of a few exceptions, concepts being referenced appeared to be the same despite the use of differing terms. Among the sources examined, eleven evaluative criteria were referenced by at least one source, but only five criteria were consistently referenced. The five most commonly used evaluative criteria are defined and discussed below.

Criterion One: Equity--The equitable distribution of state funds is a concern in all states and with all funding sources. This is especially true in the case of pupil transportation funds, since school districts with the greatest need for transportation services are often those that can least afford excessive pupil transportation costs (Zeitlin, 1990). As discussed in Chapter 1, the equity criterion is addressed through consideration of two kinds of inequality that exist among school districts:

(A) The state must use a valid measure of local fiscal capacity in order to address the "revenue side" of fiscal equalization. The Commonwealth of Virginia currently employs an index of taxpaying capacity entitled the Local Composite Index as defined in Chapter 1. While better alternatives are available, the Local Composite Index is generally believed to be a valid measure of local fiscal capacity (JLARC, 1986).

(B) The state must consider varying pupil transportation cost factors in order to adequately address the "cost side" of fiscal equalization. As stated by Johns (1977), it is the state's responsibility to compensate local school districts for extraordinary circumstances that produce unavoidable variations in pupil transportation costs.

<u>Criterion Two: Efficiency</u>--The concept of efficiency in reference to state pupil transportation funding formulae has to do with the state exerting its interest in cost-efficient management. The manner of state funding (the formula), should have the effect of discouraging unnecessary expenditures at the local level (Featherson and Culp, 1965).

<u>Criterion Three: Objectivity</u>--A state pupil

transportation funding formula must be based upon objective information, i.e., information that does not require subjective interpretation by state officials. In the matter of cost identification, little or no discretionary power should be left in the hands of state officials (Stollar, 1971).

Criterion Four: Reliability--The reliability of a state pupil transportation funding formula has to do with treating equals as equals. That is, school districts with similar circumstances should be identified as possessing similar costs. Consequently, a pupil transportation funding formula should be designed and administered in a manner that prevents manipulation of the formula by local officials. Reliability is ensured through routine supervision, auditing, and cross-checking local transportation reports against other school district reports required by the State Department of Education (Stollar, 1971).

Criterion Five: Simplicity--The simplicity of a state pupil transportation funding formula relates to the ease with which state officials are able to administer the formula. A pupil transportation funding formula that meets the simplicity criterion is characterized by uncomplicated calculations using easily verified cost factors, and therefore requiring minimal record keeping, auditing, and clerical staff (Jordan and Hanes, 1978).

Obviously, there are conflicts inherent in attempting to satisfy all identified criteria. For example, the use of elaborate cost factors for the purpose of achieving equity in a pupil transportation funding formula will conflict with the need for simplicity. It is necessary, therefore, for builders of pupil transportation funding formulae to reach a balance that neither ignores nor gives excessive weight to any single criterion. According to Zeitlin (1990), no single funding method will ensure by itself that a state's pupil transportation goals are met, but success or failure depends upon the manner in which the funding formula is applied through appropriate reporting and auditing procedures.

COST FACTORS AFFECTING PUPIL TRANSPORTATION

In funding a state pupil transportation program, the state must be concerned with two kinds of cost factors that exert themselves at the local level. There are those cost factors which are universally consistent and those which vary among school districts. Consistent cost factors, an example of which would be the price of buses purchased via a statewide purchasing agreement, are factors that must be taken into consideration as a constant in determining the statewide level of funding. In contrast, variable cost factors are those that are unique to each school district and therefore must be taken into consideration in the manner of distributing available funds. Universally consistent cost factors are easily identified and can be efficiently accommodated by the state. Variable cost factors, however, often are more difficult to identify and measure, and therefore present methodological problems.

The variable factor that most profoundly affects the cost of providing pupil transportation services is the size of the required program. The size of a pupil transportation program is distinguishable through various quantities, none of which is totally definitive of program size by itself. Quantities that contribute to program size include: (1) the number of pupils requiring transportation services, (2) the number of square miles, (3) the number of linear miles school buses are required to travel, and (4) the total number of buses required. Each of these size quantities is at the "ratio" level of statistical measurement, and therefore each is commonly used as an independent variable in pupil transportation funding formulae (Burns, 1927).

Variable cost factors other than size are neither so easily identified nor so obvious in their effect upon pupil transportation costs. Furthermore, non-size cost factors generally are not subject to control by either the state or the local school district. The most frequently mentioned non-size cost factors are: (1) density or sparsity of pupils needing transportation, (2) economies of scale, (3) public and private wage levels, (4) availability and quality of roads, and (5) topographical features.

Density or sparsity of transported pupils, commonly referred to simply as "density," is the non-size factor with the most substantial effect upon transportation costs (Johns and Alexander, 1971). Although not a direct measurement of size, density is quantified as a ratio between two size factors, either the number of transported pupils per square mile, termed "area density," or the number of transported pupils per mile of bus route, termed "linear density" (Froelich, 1973).

Thus, the use of density as part a funding formula is only slightly more cumbersome than the use of size factors. Of the two density ratios, area and linear, linear density is thought to be more closely related to actual costs (Featherson and Culp, 1965).

Economy of scale is another cost factor closely linked to the size of a pupil transportation program. Indeed, it is a direct function of size. Pupil transportation programs within a certain range of sizes, for example, may be adequately served by the same number of buses and drivers, and the larger program is therefore more economical than the smaller program. The difficulty is in identifying the points of maximum cost economy. This task is usually accomplished by tracking historical cost patterns over a wide range of sizes and assuming that points of maximum cost efficiency have been naturally identified through past practice (Mort, 1924).

General wage levels within school districts would seem to have a substantial influence upon the required cost of providing pupil transportation services. School districts must compete with other public and private enterprises for their employees. When alternative employment opportunities are abundant, as is usually the case in urban and suburban areas, higher salaries are necessary to attract and retain quality employees in the school district, including bus drivers and other transportation personnel. Despite this apparent influence, and despite the fact that salary and benefit costs historically account for approximately 40 percent of national pupil transportation expenditures, few attempts have been made to include community wage levels as an independent variable in pupil transportation funding formulae (Roe, 1961). One reason for the reluctance by states to use variable wage scales as a distribution factor is that such measures tend to direct state aid to more affluent school districts and thus run counter to fiscal equalization.

Historically, both road availability and road quality have affected pupil transportation costs, but have decreased in significance through general improvement in quantity and quality of roads. Also, road availability, the more easily measurable of the two, is given proxy representation in formulae that use either miles of bus travel or linear density as cost factors (Johns, 1978).

Topographical features of certain school districts may increase pupil transportation costs either by increasing the number of bus miles required or by increasing per-mile costs. Increased bus mileage is necessary, for example, if a natural barrier such as a river traverses a school district. Per-mile costs increase if buses are required to travel over rugged rather than flat terrain. An increase in mileage is provided for by funding formulae based upon miles of bus travel, a past practice in Virginia as well as most other states. An increase in per-mile costs, however, would be of dramatic consequence in states that vary widely in topographical features, which is the case in Virginia (Jordan and Hanes, 1978).

HISTORY OF VIRGINIA'S PUPIL TRANSPORTATION FUNDING FORMULA

The Tenth Amendment to the Constitution of the United States holds, in part, that powers not delegated to the United States government are reserved to the respective state governments. Since responsibility for public education is not directly addressed by the Constitution, it becomes, by default, a responsibility of state government (Alexander and Alexander, 1985).

The Tenth Amendment has also been interpreted to mean that the power of local government is awarded or withheld at the discretion of its respective state government. Judicial precedent has established that such power may be awarded either explicitly or impliedly through the language of state law, but it may not be presumed to exist through the absence of restraining language. Without such explicit or implied granting of power, then, local governmental units are restrained from the exercise of power. More pointedly, a local governmental unit may neither raise nor expend funds in a manner not explicitly or impliedly sanctioned by its state government (Alexander and Alexander, 1985).

Authority to raise and expend public funds for the purpose of transporting pupils is given to local governmental units in Virginia, by implication, through the state's compulsory attendance statute. Enabling language provides that compulsory attendance shall not be required of children who live more than a given distance from a public school "unless public transportation is provided" within a given distance of the place where such children reside (Virginia School Laws, 1989 supplement, p. 147).

Therefore, Virginia's school districts have possessed the power to expend public funds for pupil transportation through application of compulsory attendance legislation that was originally enacted in 1908 (Alexander and Jordan, 1973). State funds were not specifically targeted for pupil transportation, however, until the 1942-43 school year (Virginia Department of Education, 1974).

It is evident from a review of Table 1 that, commencing in 1949-50, the number of pupils transported at public expense in Virginia, bus miles traveled to transport pupils, the number of buses used to transport pupils, and the cost of transporting pupils have increased steadily through each five-year period.

While categorical state funds for pupil transportation have increased substantially since 1949-50, an examination of Table 2 shows that the increase in funding has not kept pace with the increase in total pupil transportation costs. Indeed, the state appropriation as a percentage of total cost decreased from a high of 81 percent in 1949-50 to a low of 24 percent in 1987-88.

When categorical state funding for pupil transportation was first provided local school districts during the 1942-43 school year, funds were distributed on the basis of transportation figures from the 1941-42 school year (Burnett, 1981). This one-year gap between incurred costs and state funding continued through the 1987-88 school year, but ballooned to a three-year gap for 1988-89. As noted in

Table 1

Growth of Pupil Transportation in Virginia

Year	1,000s of Pupils Transported	1,000s of Miles Traveled	1,000s of Number of Buses	$1,000s of Cost of Operation
49-50	251	25,101	2.9	4,445
54-55	347	32,907	3.8	6,519
59-60	422	39,781	4.6	8,495
64-65	525	48,347	5.8	12,051
69-70	619	54,955	6.8	19,632
74-75	719	66,366	8.0	39,089
79-80	753	79,279	9.1	77,170
84-85	726	81,753	9.2	106,766
87-88	744	88,920	9.9	137,369

Sources: Burnett, Clyde, H. Jr., 1981
Virginia Department of Education

Table 2

Growth of Pupil Transportation Funding in Virginia

Year	$1,000s of Cost of Operation	$1,000s of Categorical Appropriation	Percent of State Reimbursement
49-50	4,445	3,600	81%
54-55	6,519	4,320	66%
59-60	8,495	5,367	63%
64-65	12,051	7,187	60%
69-70	19,632	9,140	47%
74-75	39,089	15,934	41%
79-80	77,170	21,778	28%
84-85	106,766	33,015	31%
87-88	137,369	32,988	24%

Sources: Burnett, Clyde, H. Jr., 1981
Virginia Department of Education

Chapter 1, each school district's 1988-89 entitlement was based upon data collected from the school district for the 1985-86 school year and adjusted for inflation. Projected pupil transportation costs for the 1989-90, 1990-91, and 1991-92 school years were also based upon 1985-86 data (JLARC, 1987).

Until implementation of the current Virginia pupil transportation funding formula, determination of funding entitlements had been easily understood by those receiving funds. Beginning with the 1949-50 school year and through the 1987-88 school year, 40 percent of state pupil transportation funds were distributed on the basis of pupils transported, 40 percent on the basis of bus miles traveled, and 20 percent based on the number of state-approved buses (Virginia Department of Education, 1974).[1]

For a typical school year in Virginia prior to 1988-89, the following scenario commonly unfolded and culminated in the allocation of categorical state pupil transportation aid to local school districts.

(1) The proportionment to be used (40-40-20) was in place, and after nominal or no debate went unaltered by the

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[1]Prior to the 1949-50 school year, the number of state-approved buses was not used as a basis of distribution. Beginning in 1942-43 and through 1948-49, 50 percent of state pupil transportation funds were distributed on the basis of pupils transported and 50 percent were distributed on the basis of bus miles traveled.

General Assembly from one funding period to the next.

(2) The General Assembly appropriated an aggregate dollar amount to be distributed for pupil transportation purposes during the upcoming funding period.

(3) The aggregate dollar amount was proportioned into three smaller dollar amounts according to the ratio stated in (1) above, resulting in a dollar amount (40 percent of the total appropriation) to be distributed to school districts on the basis of pupils transported, a dollar amount (40 percent of the total appropriation) to be distributed on the basis of bus miles traveled, and a dollar amount (20 percent of the total appropriation) to be distributed on the basis of state-approved buses.

(4) The dollar amount to be distributed on the basis of pupils transported was divided by the total number of pupils transported statewide during the previous school year, the dollar amount to be distributed on the basis of bus miles traveled was divided by the total number of bus miles traveled statewide during the previous school year, and the dollar amount to be distributed on the basis of state-approved buses was divided by the total number of state-approved buses during the previous school year. Thus, three statewide multipliers were created: (1) a per-pupil multiplier, (2) a per-mile multiplier, and (3) a per-bus multiplier.

(5) The three statewide multipliers were applied to the unique data for each school district. In brief, the number of pupils transported in each school district during the previous school year was multiplied by the statewide per-pupil multiplier to determine the allocation for each school district based upon pupils transported, and similar computations were made to determine each school district's allocation based upon bus miles traveled and state-approved buses. The three products were then summed to derive a total pupil transportation payment for each school district (Burnett, 1981).

In addition to categorical funds, state funding for pupil transportation has also been provided through State Basic Aid in Virginia (JLARC, 1987). This has been true beginning with the 1974-75 school year, when pupil transportation costs were included in computing "support" costs necessary to meet state-imposed Standards of Quality. Prior to 1988-89, however, no attempt was made to relate the pupil transportation component of Basic Aid to varying pupil transportation costs. Support costs were computed simply by applying a statewide per-pupil multiplier to the total enrollment in each school district, resulting in all school districts being compensated for pupil transportation costs whether or not such costs were actually incurred (JLARC, 1986).

CURRENT STATUS OF THE VIRGINIA PUPIL TRANSPORTATION FUNDING FORMULA

The funding procedure described in the previous section was the subject of Burnett's 1981 study. As noted in Chapter 1, however, significant changes have occurred since the time of the Burnett study. An alteration in the Virginia method of distributing pupil transportation funds was recommended by JLARC (1987), approved by the General Assembly (Baliles, 1988), and became applicable during the 1988-89 school year. The essence of the change was that all state aid for pupil transportation (both categorical aid and the transportation component of State Basic Aid) was to be computed according to a single cost-recognition formula.

In its 1987 report, JLARC attempted to identify cost factors related to varying pupil transportation costs at the local level. The two cost factors most closely related to variations in pupil transportation costs, according to JLARC, were the land area of a school district and the number of pupils transported. The JLARC report did not identify cost factors that might have been considered other than those recommended for use in the new funding formula (JLARC, 1987).

In terms of land area, JLARC divided the state's school districts into those containing less than and those containing equal to or more than eighty square miles. In terms of pupils transported, school districts were divided into three equal groups (the low third, the middle third, and the high third) for each category of pupils transported.

Grouping school districts on the basis of two levels of land area and three levels of pupils transported resulted in a cross-sectional matrix of six distinct cells. For each matrix cell, JLARC calculated a prevailing[2] per-pupil cost for "regular" pupils, for "exclusive schedule" pupils (handicapped pupils transported on school buses but not on the regular bus schedule), and for "special arrangement" pupils (handicapped pupils requiring transportation arrangements other than on school buses). The resultant per-pupil cost figures are listed in Table 3 for each of the six matrix cells (JLARC, 1987). Note that the cost for special arrangement pupils is the same in all matrix cells.

The per-pupil costs portrayed in Table 3, along with an allowance for bus replacement on a twelve-year schedule, served as the means of recognizing and funding pupil transportation costs during the 1988-89 school year (Virginia

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[2]The JLARC method of calculating prevailing costs has been the subject of a good deal of debate among students of school finance. It is not the intent of this study to enter the debate but JLARC's method will be tested, in effect, when Matrix System outcomes are compared to alternative formulae outcomes in Chapter 4 and Chapter 5. In brief, a measure of central tendency called the "linear weighted average with weight of 5" was used. This statistic is identical to the arithmetic mean or median on a normally distributed curve of values, but falls between the mean and median on a skewed distribution (Rolz, 1987).

Table 3

JLARC-Constructed Prevailing Per-Pupil Cost Matrix

ADA of Pupils Transported

	Low Third	Middle Third	High Third
Less than 80 Sq Mi	Reg= $74 ES = $1,591 SA = $1,399	Reg= $117 ES = $908 SA = $1,399	Reg= $117 ES = $908 SA = $1,399
More than 80 Sq Mi	Reg= $194 ES = $2,715 SA = $1,399	Reg= $157 ES = $1,978 SA = $1,399	Reg= $129 ES = $1,553 SA = $1,399

Reg: ADA of Pupils Transported on Regular Bus Routes
ES: ADA of Pupils Transported on Exclusive Schedule Routes
SA: ADA of Pupils Transported by Special Arrangement

Dollar amounts are per-pupil costs for school divisions assigned to each matrix cell.

Source: JLARC, 1987

Department of Education, Supt. Memo. No. 18, 1988). It does not appear that the method of cost recognition and fund distribution have been provided in either a comprehensive or comprehensible format for public perusal. The following outline was pieced together through several written sources and oral communications, both formal and informal, and finally reviewed and verified by John Rickman (personal communication, March 5, 1990) of the Virginia Department of Education.

(1) Each school district was assigned to matrix cells corresponding to its respective number of transported pupils and square miles of land area for the 1985-86 school year. The assignment of school districts to matrix cells is reflected in Appendix D. Note from Appendix D that a school district might be placed in two different matrix cells. The land area ranking would remain constant, of course, but one matrix placement was made according to the school district's rank order in terms of number of regular pupils transported and one placement made according to the school district's rank order in terms of number of exclusive schedule pupils transported. No particular cell assignment was necessary for special arrangement pupils, since the per-pupil cost for such pupils was identical in all cells.

(2) The number of each category of pupils transported on state-approved school buses during the 1985-86 school year

(regular and exclusive schedule pupils) in each school district were multiplied by the appropriate per-pupil costs determined by the school district's matrix cell assignments.

(3) The number of handicapped pupils transported in each school district through special arrangements during the 1985-86 school was multiplied by $1,399.

(4) The number of pupils that had used public transit systems at school district expense during the 1986-87[3] school year was multiplied by the regular per-pupil cost determined by the school district's matrix placement based upon its number of regular pupils.

(5) The number of state-approved buses in each school district during the 1985-86 school year (a number determined either by the prevailing per-pupil rate of buses used in school districts in the matrix position, or the actual number of buses used in the individual school district, whichever was less) was divided by twelve and multiplied by the 1988 state-bid cost for a 64-passenger bus with hydraulic brakes ($23,311).

(6) The products derived in steps (2) through (5) above were totaled, and the total for each school district was increased by an inflation figure of 16.3 percent to project pupil transportation costs for the 1988-89 school year.

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[3]For reasons that remain obscure, this is the only calculation using other than 1985-86 data.

Subsequently, these costs were used to distribute state funds as described in steps (7) through (10) below.

(7) The unique pupil transportation cost identified in step (6) above for each school district was divided into two parts. One part, an amount equal to categorical pupil transportation aid paid to the school district during the previous (1987-88) school year, would serve as the basis for the 1988-89 categorical aid payment. The remaining amount would serve as pupil transportation costs to be recognized through State Basic Aid.

(8) The amount designated for each school district to serve as the basis for categorical state aid was multiplied by one minus the school district's Local Composite Index. The result was the amount paid to the school district as 1988-89 categorical state support for pupil transportation.

(9) A portion of the amount designated as pupil transportation costs under State Basic Aid for each school district ultimately was paid to the school district as a part of State Basic Aid. The portion ultimately paid was in the same cost-to-payment ratio as for State Basic Aid in general.[4]

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[4]To calculate the amount of pupil transportation aid paid to a school district through State Basic Aid, divide the total State Basic Aid payment to the school district by the total of State Basic Aid recognized by costs, and then multiply the resultant ratio by the total of transportation costs credited to State Basic Aid. This computation reflects the amount of transportation aid ultimately paid to a school district through State Basic Aid after a proportioned share of other (continued...)

(10) The two amounts together, categorical funding for pupil transportation and the pupil transportation component contained within State Basic Aid, represent the 1988-89 total of state aid allocated for pupil transportation.

It bears reiteration that the purpose of this study has to do with the equitable recognition of variance in pupil transportation costs, which is not nearly so complex as the process outlined above. The study focuses largely upon step (2) of the funding procedure, since step (2) accounts for 97 percent of total pupil transportation operational costs as reported by local school districts. The state's method of separating costs between categorical and State Basic Aid funding mechanisms, adjusting for inflation, and applying Local Composite Indices, is not a focus of this study.

SUMMARY

The first section of this chapter was directed toward identifying and defining criteria that are generally accepted as indicative of quality in a pupil transportation funding formula. Criteria identified for later use in evaluating the Virginia pupil transportation funding formula were: (1) equity, (2) efficiency, (3) objectivity, (4) reliability, and (5) simplicity.

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[4](...continued)
revenue sources was subtracted and the Local Composite Index was applied.

identifying factors that are generally considered to cause variations in the costs of operating a school district pupil transportation program. Cost factors identified were: (1) size of the program in terms of the number of pupils transported, bus miles traveled, land area, and the number of buses, and non-size factors including (2) density of pupils, (3) economies of scale, (4) public and private wage levels, (5) availability and quality of roads, and (6) topographical features.

The third and fourth sections of this chapter were used to outline the history of pupil transportation funding in Virginia, from initial empowerment implied by language in the state's compulsory attendance law, to the establishment of categorical funding for pupil transportation in 1942-43, to the relatively simple pupil transportation funding formula used in Virginia from 1949-50 through 1987-88, to the current funding method designed by JLARC and used for the 1988-89 school year.

Chapter 3

THE FIRST QUESTION

When the method of distributing pupil transportation funds was altered in Virginia, were generally accepted standards of quality for such distribution methods given proper consideration?

Generally accepted standards of quality identified through the literature review of Chapter 2 were: (1) Equity, (2) Efficiency, (3) Objectivity, (4) Reliability, and (5) Simplicity. The equity standard will not be addressed in this section, for it is the standard upon which the answer to Question Number Two will rest in the following section.

Efficiency in regard to pupil transportation funding formulae has to do with cost-efficient management. The method of state funding should have the effect of discouraging unnecessary expenditures at the local level. Efficiency in pupil transportation programs is promoted, according to Featherson and Culp (1965), by utilizing some aspect of a state average cost in the mechanism used to distribute state funds. If averaging is used, districts with higher than average costs receive a lower proportion of their transportation funding from state sources, and therefore are required to fund a higher proportion of costs through local sources. It is the use of local funding sources for which local authorities are directly answerable to their local publics that provides the incentive for cost efficiency in pupil transportation programs (Alexander, 1977).

The current method used in Virginia to distribute state funds for pupil transportation utilizes a Matrix System as outlined in Chapter 2 and illustrated in Table 3. The Matrix System is used to determine per-pupil costs for the school districts assigned to each matrix cell, and these per-pupil costs are used to project total costs upon which funding will be based. The per-pupil costs are determined through a measure of the central tendency of the per-pupil costs for all school districts within the cell (Rotz, November 24, 1987). Furthermore, the respective LCI of each school district is applied to projected costs prior to allocation of state aid, resulting in state funding in an amount substantially less than projected costs (Baliles, 1988).

It must be concluded that the Virginia method of distributing state funds for pupil transportation requires the expenditure of local funds to offset transportation costs, and therefore contains an incentive for school districts to control costs. The criterion of efficiency is therefore satisfied.

Objectivity in a state pupil transportation funding formula has to do with the factors upon which funding is based. The factors must be measurable and quantifiable in a consistent manner that is not subject to individual manipulation and misinterpretation, thereby removing the ability of state and local authorities to exercise discretion in the distribution of funds (Stollar, 1971).

Virginia's pupil transportation funds are distributed, under the current plan, on the basis of the number of pupils transported through various modes of transportation, the land area of a school division, and the number of state approved buses in a school district's fleet, all of which are precisely measurable and easily verifiable. Therefore, it must be concluded that the present method of distributing state funds for pupil transportation in Virginia satisfies the objectivity criterion.

Reliability of a state pupil transportation funding method depends upon the ability of state officials to ascertain that data upon which funding is based are not being manipulated by local officials.

The Virginia Department of Education is very specific in defining data that must be submitted by local school districts (Virginia Department of Education, Regulations Governing Pupil Transportation, VR 270-03-0006). Furthermore, data upon which a major component of pupil transportation funding is based (number of pupils transported) is easily verifiable. On a yearly basis, the Transportation Division of the Department of Education compares data submitted on pupil transportation reports with data submitted on other school district reports for consistency and reliability (Buster Bynum, personal communication, March 1, 1990). The other factor upon which state funding is based, the number of state approved buses in a school district's fleet, is verified through annual bus inspections that are required and monitored by the state.

Although the state does not employ sufficient staff to perform frequent on-site audits of local transportation programs, one must conclude that Virginia's pupil transportation funding formula is reliable in its construction and intent, and that sufficient administrative attention is exerted to maintain reliability.

In order to meet the simplicity criterion, a state pupil transportation funding method must not require complex administrative procedures. Data upon which funding is based must be easily gathered and verified. Calculations required by the formula must be uncomplicated and widely understood.

Easiness of data gathering and verification activities required by the Virginia pupil transportation funding method has been established through previous evaluative standards. Calculations required after raw data is gathered and verified, however, are neither uncomplicated nor widely understood.

To suspect that a good deal of confusion exists regarding the manner in which pupil transportation fund entitlements are determined in Virginia, one has only to review the funding outline presented in Chapter 2. Several local school officials were contacted for background information prior to commencing this study. Without exception, local officials who were contacted, including officials responsible for fiscal management and officials responsible for supervising the pupil transportation program, were unable to describe the state's method of distributing pupil transportation aid in even the broadest terms.

Interestingly, personnel of the Pupil Transportation Division of the Virginia Department of Education are not involved in administering the state pupil transportation funding method in more than a peripheral capacity, mostly in gathering and compiling data upon which the funding formula is belatedly based (Buster Bynum, personal communication, March 1, 1990).

Neither, in fact, is the Virginia Department of Education itself involved in administering the pupil transportation funding formula in more than a peripheral capacity. Pupil transportation payments for 1988-89 were computed by JLARC in 1987 based upon 1985-86 data provided by the Virginia Department of Education. Amounts to be paid to individual school districts were simply forwarded by JLARC to the Virginia Department of Education to be enacted at the proper time (John Rickman, personal communication, March 5, 1990, and

JLARC, 1987).

It must be concluded that the simplicity standard is not satisfactorily met by Virginia's method of distributing state funds for pupil transportation. Data upon which the funding formula is based are easily obtained and verified, but the funding mechanism itself is neither simple nor widely understood.

It has been found that the Virginia method of distributing state funds for pupil transportation meets generally accepted standards for efficiency, objectivity, and reliability, but fails the generally accepted standard of simplicity. The generally accepted standard of equity required of state pupil transportation funding methods will be addressed in the following section.

THE SECOND QUESTION

Does the recently altered method of distributing pupil transportation funds serve, in fact, to enhance fiscal equalization in Virginia by properly considering cost factors that vary among the Commonwealth's school districts?

In order to address the proposed question, another question must first be answered: How does one determine whether or not cost factors are "properly" taken into consideration? In other words, a means must be established to determine the relative merit of any system's use of varying cost factors.

Jordan and Alexander (1975) have stated that, "One may theorize as to what some elements of the transportation program should cost, but . . . use of data bearing on past performance is the most defensible method of computing costs" (p. 115).

The position stated by Johns and Alexander is given tacit support by the 1987 JLARC study, which established cost-projection multipliers by calculating "prevailing" costs. This means that per-pupil multipliers used to calculate 1988-89 costs, the indices reflected in JLARC's matrix cells, were approximations of past (1985-86) per-pupil costs for the school districts assigned to a particular cell.

It seems, then, that merit or lack of merit in any particular use of cost factors should be measured by success or failure in approximating costs in the base (1985-86) year, since that is what JLARC was purportedly attempting to accomplish with its Matrix System.

In order to measure the relative merit of the JLARC Matrix System, raw data were gathered for each school district providing pupil transportation services in Virginia during the 1985-86 school year. The data are arrayed in Appendix B as

Tables B-1 and B-2.[5]

There were 131 school districts that provided pupil transportation services in Virginia during the 1985-86 school year. As was explained in Chapter 1, 12 school districts were removed from consideration due to incomplete or conflicting data, leaving 119 school districts for which complete data sets were available.

The data in Tables B-1 and B-2 are directed, either individually or in arithmetic combinations, toward placing quantitative values upon each of the cost factors identified as worthy of consideration through the literature review in Chapter 2. Cost factors identified in Chapter 2 and their corresponding data positions from Tables B-1 and B-2 are presented in Table 4.

The 1987 JLARC report, the report within which the current pupil transportation funding formula was proposed, stated that only two factors exerted a significant influence upon the variance in 1985-86 pupil transportation costs among Virginia school districts. The two factors cited by JLARC were: (1) the land area of a school district, and (2) the number of pupils transported in a school district, both of

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[5]Due to the large number of school districts included in this study, tables requiring data entries for all school districts are inserted enmass in Appendix B. Also, columns are numbered consecutively from Table B-1 to Table B-2 and prefixed with a "B" so that only column designations need be referenced in text. The source or mathematical derivation of each column is presented in Appendix C.

Table 4

Representation of Cost Factors in Table B-1 and B-2

COST FACTOR/ SUB-FACTOR	REPRESENTATION IN TABLE B-1 AND B-2
(1) SIZE OF PROGRAM	
Pupils Transported	Column B-3
Bus Miles Traveled	Column B-4
State Approved Buses	Column B-5
Land Area	Column B-6
(2) PUPIL DENSITY	
Linear Density	Column B-11
Area Density	Column B-12
(3) ROAD AVAILABILITY AND QUALITY	
Road Availability	Column B-14
Road Quality	Column B-13
(4) COMMUNITY WAGE LEVELS	Column B-7
(5) TOPOGRAPHICAL FEATURES	
Natural Barriers	Proxy of Column B-4
Ruggedness of Terrain*	Column B-8
(6) ECONOMIES OF SCALE	Proxy of Column B-3 B-4 B-5 B-6

* The best index for this variable is called "Drainage Density," (Mike McNeil, Virginia Tech Geography Dept, personal communication, Feb. 28, 1990), which is a function of the number of linear miles of streams in a given land area and the square mileage of the area. This statistic has not been calculated for political subdivisions in Virginia, and therefore was unavailable for use in this study.

which are components of "program size" as defined in Chapter 2. It should be noted also that the arithmetic ratio between the two size factors cited by JLARC is commonly used as a non-size factor called area density.

The assignment of school districts into the JLARC Matrix System is reflected in Appendix D. The effect of these assignments, grouping school districts in a cross-sectional manner according to broad ranges of pupil numbers and broad ranges of land area, is that school districts are grouped in broad ranges of area density. In effect, then, the Matrix System is a means of using area density as an independent variable, but an independent variable with only six possible values rather than a continuous range of values.

Since the Matrix System has only six possible values, it cannot be used to predict total costs directly. Rather, the matrix cells are used to assign per-pupil cost figures which are then multiplied by the number of pupils in each classification (regular pupils, exclusive schedule pupils, and special arrangement pupils) to derive a total cost figure for each school district.

Thus, the JLARC method of cost projection depends upon the use of three increments of a single continuous variable (pupils transported) to provide a continuous range of outcomes. This contrasts with three distinctly different continuous variables (pupils transported, bus miles traveled, and state-approved buses) formerly used in Virginia to allocate state pupil transportation aid to school districts.

In addition to JLARC's contention that number of pupils transported and land area are the cost factors most closely related to total transportation costs, a relationship of even greater consequence is implied by the choice of number of pupils transported as the single continuous variable upon which total costs were finally based. This choice of continuous variable suggests that the number of pupils transported in a school district was the size factor most closely related to total costs in operating pupil transportation programs, a suggestion easily tested through correlation analysis.

Correlations between selected columns of Tables B-1 and B-2 are presented in Table B-3 of Appendix B. Attention is directed to the correlation between Actual Cost and Total Pupils Transported and the correlation between Actual Cost and Bus Miles Traveled.

The strength of relationship between Actual Cost and Total Pupils Transported (r = .94) is indeed quite strong. It is not so strong, however, as the relationship between Actual Cost and Bus Miles Traveled (r = .98). Therefore, the decision by JLARC to use numbers of pupils transported as the sole continuous variable in its method of recognizing pupil transportation costs, and the consequences to state pupil transportation fund distribution engendered by that decision, appear to be invalid.

The use of a matrix configuration between land area and numbers of pupils transported suggests that area density was the cost factor most closely related to variations in per-pupil costs among Virginia's local pupil transportation programs in 1985-86. As was determined in Chapter 2, linear density is generally considered more closely related to transportation costs than is area density. Whether or not this was true of per-pupil cost variations in Virginia in 1985-86 is easily tested through correlation analysis. Attention is directed to the correlation between Actual Per-Pupil Cost and Area Density and the correlation between Actual Per-Pupil Cost and Linear Density listed in Table B-3.

Obviously, Linear Density (r = -.67) was much more closely related than was Area Density (r = -.16) to the Actual Per-Pupil costs incurred by local school districts during the 1985-86 school year. The decision by JLARC to use a form of area density rather than linear density as a non-size cost factor in its method of recognizing pupil transportation costs, and the consequences to state pupil transportation fund distribution engendered by that decision, appear to be invalid.

Provided in Column B-18 are the cost-projection outcomes from the Matrix System for each school district in the study.

To achieve the values in Column B-18, the values of Regular Pupils Transported (Column B-1) and the values of Exclusive Schedule Pupils Transported (Column B-2) were multiplied by the appropriate per-pupil costs listed in the matrix cells (Table 3, Chapter 2) to which each school district was assigned (Appendix D), and the products were added to achieve a total cost projection for each school district. These projections were compared to 1988-89 cost projections provided by the Virginia Department of Education (Financial and Support Services, 1988, and VDE Supt. Memo No. 52, 1988) and found accurate for each school district retained in this study.

Note that the total of Matrix System Cost (at the bottom of Column B-18) matches almost exactly the total of Actual Cost (at the bottom of Column B-15). This would be expected, of course, of a cost-projection system that attempts to predict Actual Cost, but the similarity of totals provides evidence that deletion of twelve school districts from consideration did not alter the relationship between Matrix Projected Cost and Actual Cost.

Despite what appear to be invalid decisions made by JLARC in choosing the independent variables for its method of fund distribution, one cannot assume that Matrix System outcomes are flawed. Indeed, correlation analysis reveals a very close relationship between Matrix System Cost and Actual Cost, as reflected in Table 5.

Table 5

Correlation between Actual Cost and Matrix-Projected Cost

Correlations with Actual Cost (Col B-15)			
Column Label	N	Corr.	R-Squared
Matrix Proj. Cost (Col. B-18)	119	.95	.90

The JLARC method of applying prevailing cost indices to increments of a single continuous variable succeeds in generating values that are highly correlated with the actual costs incurred in the operation of local school district transportation programs during the 1985-86 school year. This, after all, was the purpose of the Matrix System, and the purpose was achieved to the extent of explaining 90 percent of cost variation. Funds were distributed accordingly to compensate for legitimate, uncontrollable variations in cost.

It should be remembered, however, that JLARC could have explained 88 percent (the square of the correlation between Actual Cost and Total Pupils Transported reflected in Table B-3) of cost variations simply by computing a single per-pupil cost multiplier and using the total number of pupils transported as a continuous variable, with no Matrix System necessary and no distinction between pupils transported on regular bus routes and those transported on exclusive schedule routes. The Matrix System, therefore, was responsible for less than 2 percent of the variance in Actual Cost accounted for by JLARC.

In order to assess the relative quality of the Matrix System as a cost projection system, the system must be compared to an alternative system. This was done with the understanding that "past performance," as cited by Jordan and Alexander (1975) and later employed by JLARC itself (1987), would serve as the final standard upon which relative merit would be determined. In other words, the system that produced outcomes more closely correlated with the actual costs incurred during the base year (1985-86) would be judged the more worthy system.

The alternative cost projection system constructed for comparative purposes was patterned after the 40-40-20 system that was used to distribute categorical pupil transportation funds in Virginia from 1949-50 through 1987-88. Use of the 40-40-20 System as a comparative device should not be construed as a proposal for its reenactment. It was used only as a familiar, widely understood system against which the Matrix System could be measured. The 40-40-20 System was also useful since JLARC must, it seems, have considered and rejected it as a prospective cost projection system prior to recommending the Matrix System.

The 40-40-20 System was readily adaptable to project pupil transportation costs in a manner similar to its former use in distributing pupil transportation funds:

(1) The total amount of Actual Cost (also, as noted above, the total amount of Matrix System Cost) was divided into three subtotals to be allocated on the basis of three size factors, 40 percent of the total to be allocated on the basis of pupils transported, 40 percent on the basis of bus miles traveled, and 20 percent on the basis of state approved buses.

(2) The three subtotals of Actual Cost were divided by their respective size factors; the subtotal to be allocated on the basis of pupils transported was divided by the number of pupils transported statewide, the subtotal to be allocated on the basis of bus miles traveled divided by the number of bus miles traveled statewide, and the subtotal to be allocated on the basis of state approved buses divided by the statewide number of state approved buses. This resulted in three statewide multipliers, one for pupils transported, one for bus miles traveled, and one for state approved buses.

(3) The three statewide multipliers were applied to appropriate size factors for each school district; the multiplier for pupils transported was multiplied by each school district's number of pupils transported, the multiplier for bus miles traveled multiplied by each school district's number of bus miles traveled, and the multiplier for state

approved buses multiplied by each school district's number of state approved buses. This resulted in three products for each school district.

(4) The three products for each school district were summed, producing a total pupil transportation cost projection for each school district.

The outcomes of the 40-40-20 System are presented in Column B-19. A comparison of the quality of 40-40-20 System projections and the quality of Matrix System projections was achieved by viewing their respective relationships with Actual Cost, as reflected in Table 6 below.

Table 6

Correlation Analysis Between
Cost Projections and Actual Cost

Correlations with Actual Cost (Col B-15)			
Column Labels	N	Corr.	R-Squared
Matrix Proj. Cost (Col B-18)	119	.95	.90
40-40-20 Proj. Cost (Col. B-19)	119	.97	.95

It should be remembered that the 40-40-20 System did not have the advantage of distinguishing between regular pupil costs and exclusive schedule pupil costs, as was the case with the Matrix System. Nor was such a distinction possible, since separate expenditure totals for regular pupils and exclusive schedule pupils could not be provided for the 1985-86 school year by the Virginia Department of Education. The 40-40-20 System simply used total pupils, total miles, and total buses to project total costs.

And yet, the 40-40-20 System, patterned in a matter of minutes after a discarded funding formula, a funding formula long presumed to owe its longevity to legislative complacency rather than any intrinsic merit, accounted for 95 percent of variance in Actual Cost. And the Matrix System, a system chronicled by JLARC as a means of bringing equity to the distribution of pupil transportation funds in Virginia, accounted for only 90 percent of the variance in Actual Cost.

Although a difference of 5 percentage points may appear nominal in terms of explaining variance, the monetary repercussions visited upon Virginia's school districts as a consequence of JLARC's choice of the Matrix System are anything but nominal. To begin with, one would immediately suspect from the respective correlation coefficients that gaps between Actual Cost and 40-40-20 System projections would be substantially smaller, on the average, than the gaps between Actual Cost and Matrix System projections. This was verified as follows.

Simple calculations revealed that the mean of absolute value differences between Matrix System projections and Actual Cost (Column B-18 minus Column B-15, and remove positive or negative value designations) was $228,188, while the mean of absolute value differences between 40-40-20 System projections and Actual Cost was found to be $192,073. In other words, 40-40-20 System projections were $26,115 closer to Actual Cost, on the average, than were Matrix System projections. The difference in projection accuracy became even more significant when individual school districts were considered.

The monetary effect of the Matrix System versus the 40-40-20 System is reflected for individual school districts in Column B-20. The values in Column B-20 were achieved simply by subtracting the values of 40-40-20 System projections (Column B-19) from the values of Matrix System projections (Column B-18) for each school district.

School districts with a negative value in Column B-20 are those school districts that lost state funding as a result of the implementation of the Matrix System (the less accurate system in approximating actual costs) over the 40-40-20 System, a system that was essentially in place at the time the Matrix System was proposed and implemented. School districts with a positive value in Column B-20 are those that gained state funding as a result of the Matrix System being implemented and the 40-40-20 System being discarded.

The values displayed in Column B-21 are the gain or loss to each school district <u>per pupil</u> as a result of the Matrix System being implemented. These values were derived simply by dividing the values in Column B-20 by the values in Column B-3, thereby expressing the Matrix System effect upon all school districts in standardized units.

For purposes of examining the effects of the Matrix System, the values in Column B-21 are treated hereafter as direct reflections of gain or loss to each school district, although it is understood that numerous arithmetic operations would be necessary to compute the net gain or loss to a school district. Application of an inflation factor would increase the values in both negative and positive directions, and use of Local Composite Indices would alter rank orders, but the designation of a school district as a gainer or a loser would remain consistent and the rank order effect of gain or loss would remain consistent in terms of fiscal capacity.

In order to identify factor(s) that were either disregarded or given unjustifiable weight through JLARC's development and implementation of the Matrix System, the gain or loss values (Column B-21) were cross tabulated with all cost factors. Various trends were revealed, but only one trend was necessary to uncover the underlying effect or purpose of the JLARC Matrix System. That trend was between the values in Column B-21 and the values in Column B-11 (Linear Density) as portrayed in Table 7.

Table 7

Cross Tabulation Between
Cost Projections and Actual Cost

Column (B-11) LINEAR DENSITY	Column (B-21) Gain or Loss/Pupil Heavy* Loss	Light* Loss	Light* Gain	Heavy* Gain	Total
Least Dense 1/4	22(11)	7(9)	0(7)	0(2)	29
Second 1/4	12(11)	11(10)	8(8)	0(2)	31
Third 1/4	4(11)	15(10)	8(7)	3(2)	30
Most Dense 1/4	5(11)	5(9)	13(7)	6(2)	29
TOTAL	43	38	29	9	119

Values in parenthesis are expected frequencies.
Values not in parenthesis are actual frequencies.

* A "Light" gain or loss is 0 to 25 dollars/pupil, whereas a "heavy" gain or loss is 25 to 100 dollars/pupil.

It was shown through correlation analysis and an analysis of absolute value differences that a less accurate system (in terms of accomplishing the system's avowed purpose of approximating actual costs) was chosen for implementation over a more accurate system. The cross tabulation analysis presented in Table 7 then revealed that 81 (43 + 38) school districts in Virginia suffered a monetary loss as a consequence of JLARC's choice, while 38 school districts experienced a monetary gain. In other words, the difference in accuracy between the Matrix System and the 40-40-20 System had produced the effect of diverting funds from a large number of school districts and redistributing the funds to a few school districts.

Table 7 also identifies the kinds of school districts from which funds were diverted (losers) and the kinds of school districts to which the funds were redistributed (gainers).

Of the 38 school districts that gained funding through implementation of the Matrix System, 30 were above the median in linear density. Of the 29 least dense school districts in Virginia, all 29 suffered a monetary loss, and 22 of the 29 experienced a loss in excess of $25 per transported pupil. Of the 9 school districts that experienced gains in excess of $25 per transported pupil, all 9 were above the state median in linear density, and 6 of the 9 were in the upper quartile in terms of linear density.

The Chi-Square statistic generated by the cross tabulation presented in Table 7 is 49.12 with 9 degrees of freedom, which is significant at the 0.0000 level of probability.

Obviously, the JLARC Matrix System had the effect of diverting state pupil transportation funds from sparsely populated school districts and redistributing the funds to densely populated school districts. This was accomplished by disregarding a cost factor, linear density, widely recognized as the non-size cost factor more influential than any other in determining pupil transportation costs. It should be noted that the 40-40-20 System, by using both pupils transported and bus miles traveled as independent variables, had the effect of providing proxy representation to linear density as an independent variable.

It must be concluded that the final generally accepted criterion used to address Question Number One, having to do with equity, is not satisfactorily met by Virginia's present method of distributing state pupil transportation funds.

Question Number Two is also answered in the negative. The present method of distributing state pupil transportation funds has not served to enhance fiscal equalization in Virginia by properly taking into consideration cost factors that vary among the Commonwealth's local school districts. School districts disadvantaged by low pupil density (requiring more miles and therefore greater costs per pupil) have been required to expend a disproportionate share of local funds in order to provide adequate pupil transportation services.

SUMMARY

The first section of this chapter was devoted to answering Question Number One, having to do with whether or not Virginia's pupil transportation funding formula satisfies generally accepted standards for such funding formulae. It was shown that Virginia's formula meets the standards for efficiency, objectivity, and reliability, but fails to meet the standard for simplicity. The fifth standard, equity, was deferred for consideration through the statistical evaluation conducted in the following section.

The second section of this chapter was devoted to answering Question Number Two, having to do with whether or not Virginia's pupil transportation funding formula serves the purpose of fiscal equalization through proper consideration of varying cost factors. The existing Matrix System was measured against a 40-40-20 System for its ability to predict actual costs, and was shown inferior to the 40-40-20 System because of a failure to consider Linear Density as an influential determinant of costs. Question Number Two, and the equity component of Question Number One, were answered in the negative.

Chapter 4

THE THIRD QUESTION

What alternative method of distributing pupil transportation funds would serve to better meet generally accepted standards as well as enhance fiscal equalization in Virginia?

Proceeding with the understanding that the fiscal capacity side of equalization is not at issue as a focus of this study, there remains the cost side of equalization to be addressed by a pupil transportation funding formula. As was demonstrated in Chapter 3, a funding formula may be used to direct funds away from rather than toward areas of need. Conversely, when a pupil transportation funding formula is properly constructed, schools districts are compensated for unavoidable variations in cost. An effective funding formula reduces the need for disadvantaged school districts to divert excessive local effort away from instructional programming in order to provide an adequate program of pupil transportation.

In order to address the proposed question of this section, alternatives to the Matrix System funding formula were attempted in two formats: (1) through use of size and non-size factors to project total costs directly, and (2) through use of non-size factors to project varying multipliers that were then applied to a size factor to project total costs. Format number one is similar to the 40-40-20 System utilized in Chapter 3, but with the use of non-size as well as size factors. Format number two is similar to the Matrix System proposed by JLARC and adopted by the General Assembly, but with the use of continuous non-size variables rather than a constricted variable. Again, the relative effectiveness of each funding formula was tested by measuring the formula's ability to approximate actual 1985-86 pupil transportation costs.

Correlation analysis was used first to identify size and non-size factors most appropriate for use in predicting actual costs directly, and then to identify non-size factors most appropriate for use in predicting a varying multiplier to be applied to a selected size factor.

As noted previously, four size factors and several non-size factors were chosen for consideration through the literature review in Chapter 2. Economy of Scale was one non-size cost factor proposed for consideration, but is a direct function of size and therefore unneeded in a funding formula driven by size factors. No quantified index could be found to measure the effect of natural barriers in a school district. This factor could therefore not be considered, but will be given proxy representation by formulae that use miles traveled as an independent variable.

Examination of the correlation statistics listed in Table B-3 reveals that three of the four size factors, Total Pupils Transported, Bus Miles Traveled, and State Approved Buses, but not Land Area, are correlated to a high degree with Actual Cost. It is also true, however, that the three size factors are correlated to a high degree with each other. The effect is that regression analysis using combinations of any two of the three factors were found to contain a large, negative coefficient applied to at least one independent variable in the regression equation. When used as a funding formula, the negative coefficient results in funding being reduced by an increase in a size factor, which would be difficult if not impossible to justify to local authorities.

Therefore, regression analysis focused upon the single size factor, Bus Miles Traveled, most highly correlated with actual 1985-86 pupil transportation costs. The two non-size factors significantly correlated with Actual Cost (Area Density and Average Community Wage) were chosen as additional independent variables.

When regression analysis was attempted using Bus Miles Traveled, Area Density, and Average Community Wage as independent variables, and Actual Cost as the dependent variable, a large and negative constant term dominated the regression report. This would produce formula projections of negative costs for several smaller school districts, which again would be difficult for local authorities to understand. The constant term was therefore deleted through an option available in the Number Cruncher Statistical System (Hintze, 1986), which was the system used for statistical analysis throughout this study.

With the constant term optionally deleted, stepwise analysis revealed that all three independent variables (Bus Miles Traveled, Area Density, Average Community Wage) contributed significantly to explanation of variance in the independent variable (Actual Cost). The regression report is displayed as Table 8 below.

Table 8

Regression of Area Density and
Average Community Wage on Actual Cost

Regression on Actual Cost (Col B-15)

Column Label	N	Parameter Estimate	Standard Error	Prob. b=0	Seq. R^2
Constant		0			
Col B-4	119	1.625652	.0283632	.000	.9672
Col B-7	119	-699.8028	118.7816	.000	.9708
Col B-12	119	1299.365	291.8691	.000	.9751

The regression formula (Alternative #1) produced by the regression report is:

$$\underline{Cost' = 1.626(Mi) - 699.80(AW) + 1,299.37(AD)}$$

where Cost' is the predicted value of Actual Cost, Mi is Bus Miles Traveled, AW is Average Community Wage, and AD is Area

Density.

Alternate Formula #1 was used to generate cost projections for the 119 school districts, the results of which correlated with Actual Cost at .9842, with a commensurate R-squared statistic of .9687. Note that this R-squared statistic is not identical with the sequential R-squared statistic of the regression report, an aberration presumably caused by deletion of the constant term from the regression formula. The outcomes of Alternative Formula #1 do, however, show a higher correlation with Actual Cost than either the Matrix System outcomes ($r = .95$) or the 40-40-20 System outcomes ($r = .97$), as noted in Chapter 3.

Regression formulae were next attempted using non-size factors to predict a varying multiplier to be applied to a size factor. One formula was generated using Actual Per-Pupil Cost as the dependent variable, and one formula with Actual Per-Mile Cost as the independent variable. Table B-3 was first examined for non-size factors that correlate significantly with Actual Per-Pupil Cost.

Correlations between Actual Per-Pupil Cost and Linear Density ($r = .67$), Average Altitude ($r = .18$), and Percent Roads Paved ($r = .26$) were significant at 0.05. Linear Density, Average Altitude, and Percent Roads Paved were therefore chosen as independent variables to be tested through stepwise regression analysis.

Stepwise analysis revealed that Percent Roads Paved did not add significantly to the sequential R-Squared statistic of the regression formula. Percent Roads Paved was therefore removed from the mix of independent variables, and further analysis revealed that the two remaining independent variables (Linear Density and Average Altitude) showed significant contributions to the sequential R-squared statistic. The regression report is displayed as Table 9.

Table 9

Regression of Linear Density and Average Altitude on Actual Per-Pupil Cost

Regression on Actual Per-Pupil Cost (Col B-16)

Column Label	N	Parameter Estimate	Standard Error	Prob. b=0	Seq. R^2
Constant		238.0059			
Col B-11	119	-42.46027	4.404533	.000	.4437
Col B-8	119	-.0093968	.0045492	.041	.4634

The regression formula (Alternative #2) produced by the regression report was:

<u>PPC' = 238.01 - 42.46(LD) - .0094(AA)</u>

where PPC' is the predicted per-pupil cost, LD is Linear Density, and AA is Average Altitude.

Alternate Formula #2 was used to generate a per-pupil cost projection for each school district, and correlation analysis verified a .6807 correlation statistic and a .4634

R-squared statistic between Alternative Formula #2 outcomes and Actual Per-Pupil Cost, which was consistent with the sequential R-squared statistic of the regression report.

The per-pupil cost projections produced by Alternative Formula #2 were then multiplied by each school district's Total Pupils Transported (Column B-3) to produce a total cost projection for each school district. The results were found to correlate with Actual Cost at .9764, with a corresponding R-squared statistic of .9533.

Note from Table B-3 that the correlation between Total Pupils Transported and Actual Cost is .94, which is rounded up from .9399. The corresponding R-squared statistic is .8833, which means that 88.33 percent of variance in Actual Cost could have been accounted for simply by applying a statewide per-pupil cost multiplier to the number of pupils transported in each school district. Since the outcomes of Alternative Formula #2 produced an R-squared statistic of .9533 with Actual Cost, one may deduce that the formula itself added 7 percentage points (from 88.33 to 95.33) to the proportion of variance explained in Actual Cost. The same line of reasoning was applied to Matrix System outcomes in Chapter 3, and it was found that the Matrix System added less than 2 percentage points to the amount of variance in Actual Cost explained by Total Pupils Transported alone.

Correlations of non-size cost factors with Actual

Per-Mile Cost were then examined. Table B-3 shows that correlations between Actual Per-Mile Cost and all non-size factors except Average Altitude were significant at 0.05. Linear Density, Area Density, Average Community Wage, Roads/Sq. Mile, and Percent Roads Paved were therefore chosen as independent variables to predict Actual Per-Mile Cost. Stepwise regression analysis indicated contributions of Average Community Wage, Roads/Sq. Mile, and Percent Roads Paved were not significant at 0.05 with Linear Density and Area Density in the mix of independent variables. The independent variables used, then, were Linear Density and Area Density. The resulting regression report is displayed as Table 10.

Table 10

Regression of Linear Density and
Area Density on Actual Per-Mile Cost

Regression on Actual Per-Mile Cost (Col B-17)

Column Label	N	Parameter Estimate	Standard Error	Prob. b=0	Seq. R^2
Constant		.7739166			
Col B-11	119	.288376	4.975992	.000	.3756
Col B-12	119	.0012064	3.553419	.001	.4320

The regression formula (Alternative #3) produced by the regression report is:

$$\underline{PMC' = .7739 + .2884(LD) + .0012(AD)}$$

where PMC' is the predicted per-mile cost, LD is Linear Density, and AD is Area Density.

Alternative Formula #2 was used to generate a per-mile cost prediction for each school district. The predicted per-mile costs were found to correlate with Actual Per-Mile Cost at .6573, with a corresponding R-squared of .4320 as expected from the regression report. Predicted per-mile costs were then multiplied by Bus Miles Traveled (Column B-3) to generate a total cost projection for each school division. The results were found to correlate with Actual Cost at .9847, with a corresponding R-squared statistic of .9697.

It was found through univariate analysis that Alternative Formula #3 had allocated aggregate costs of $108,769,500 as compared to a statewide total Actual Cost of $113,782,200. A uniform multiplier (1.046) was therefore applied to increase each school district's allocation and retain the correlation with Total Cost.[6]

At this point, three alternative funding formulae had been prepared, and two formulae (the Matrix System and the 40-40-20 System) had been examined in Chapter 3. Each of the five formulae was used to predict total pupil transportation costs for each of the 119 school districts, and correlations between formulae outcomes and actual 1985-86 costs had been

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[6]The same result would have been achieved by applying the multiplier to the constant term and each coefficient of the regression formula.

noted in text. The correlations and their accompanying R-Squared statistics are presented from smallest to largest in Table 11. Although some correlations appear equal when expressed to only two decimal places, the rank order of correlations and differing R-squared statistics are determined by additional decimal places.

Table 11

Correlations between Formulae Projections and Actual Cost

Correlations with Actual Cost (Col B-15)			
Column Label	N	Corr.	R^2
Matrix Projections (Col B-18)	119	.95	.90
40-40-20 Projections (Col B-19)	119	.97	.95
Alt. #2 Projections (No Col)	119	.98	.95
Alt. #1 Projections (No Col)	119	.98	.97
Alt. #3 Projections (Col B-22)	119	.98	.97

It appears from examination of the R-squared statistics in Table 11 that the outcomes of Alternative Formula #3 and Alternative Formula #1 stand slightly apart in terms of explaining variance in Actual Cost, and that the Matrix System stands out as markedly less accurate in predicting Actual Cost than the other formulae.

As was done in the previous section, Actual Cost was subtracted from the projections of each formula for each school district. The absolute values of these differences were analyzed with the expectation that formulae with outcomes more closely related to Actual Cost would show smaller differences from Actual Cost, and that a "perfect" formula would have a zero value in each statistical category. The analysis is presented as Table 12 with the five formulae listed in the same rank order established through correlation analysis.

Table 12

Absolute Value Differences
Between Formulae Projections and Actual Cost

Formula	Corr. Rank	Absolute Value Diff. from Actual Cost: Mean	Median	S.D.	Range
Matrix System	1	228,188	76,642	52,358	4,644,763
40-40-20 System	2	202,073	76,596	48,988	4,887,468
Alt. #2	3	184,955	55,852	39,627	3,401,655
Alt. #1	4	194,466	112,356	24,684	2,085,582
Alt. #3	5	158,115	52,280	29,947	1,870,755

As expected, the rank order of absolute value difference statistics were in inverse order to the strength of relationship between each formula's outcomes and Actual Cost, but with one notable exception. The outcomes of Alternative Formula #1 held rank in the Range column, but jumped sharply out of rank order in the Mean, Median, and Standard Deviation columns. The outcomes of all other formulae consistently held rank, with a nominal exception between the Matrix System and the 40-40-20 System in the Range column.

It should be recalled that Alternative Formula #1 had been constructed differently from Alternative Formula #2 and Alternative Formula #3 in one important respect: Actual Cost was predicted directly by Alternative Formula #1 through the use of size and non-size factors, whereas a cost-per-size-factor was predicted by the other two formulae. It was found, upon belatedly examining the residuals from Alternative Formula #1, that the practice of predicting costs directly had resulted in negative costs being predicted for several of the smaller school districts. This eventuality might have been anticipated, since the constant term (Y intercept) removed through manipulation of the statistical system had been large and negative. Alternative Formula #1 was therefore eliminated from further consideration.

Absolute value differences between the outcomes of each formula and Actual Cost were then standardized by program size. This was done by dividing total differences by a size factor. The size factor chosen was Total Pupils Transported (Column B-3), not because use of another size factor would have been less valid but because per-pupil units are the most frequent standardized units used in school finance circles. It was anticipated that the resultant values would serve as a relative measure of the degree to which each formula "missed" in its attempt to predict the cost of each school district's program. Again, it was expected that statistics generated by these values would be smaller for more accurate formulae, and the statistics would all be zero for the "perfect" formula. The statistical comparisons are presented in Table 13.

Table 13

Absolute Value Per-Pupil Differences
Between Formulae Projections and Actual Cost

Formula	Corr. Rank	Absolute Value Diff. from Actual Cost: Mean	Median	S.D.	Range
Matrix System	1	31	24	26	123
40-40-20 System	2	29	26	23	130
Alt. #2	3	27	23	25	127
Alt. #3	5	26	19	25	122

As displayed in Table 13, the outcomes of Alternative Formula #3 generally provided the statistics expected of a formula more accurate than the other formulae in predicting Actual Cost.

One more test was conducted. Since Alternative Formula #2 and Alternative Formula #3 were designed to take all significant cost factors into account in predicting Actual Cost, one would expect the "failures" of each formula to be caused by something other than cost factors. In other words, if a formula made expeditious use of cost factors, the gaps between formula outcomes and Actual Cost would <u>not</u> be related to cost factors. This thesis was tested by examining correlations between each cost factor and the standardized measures of failure for each formula (differences between predicted per-pupil costs and Actual Per-Pupil Costs, but vectored differences now rather than absolute value differences). Only non-size cost factors were tested, however, since the formulae failures had been standardized according to program size. The results are presented in Table 14.

Table 14

Correlations Between Standardized Formula Failures and Cost Factors

	Per Pupil Difference from Actual Cost			
	Matrix	O.F.	Alt #2	Alt #3
Average Community Wage	-.02	-.26*	-.05	-.19*
Linear Density	.27*	-.10	.00	-.01
Average Altitude	.13	.10	.00	-.01
Percent Roads Paved	.03	-.18*	.00	-.02
Roads/Sq. Mile	-.18*	-.13	-.07	-.02
Area Density	-.08	-.33*	-.19*	-.02

*Significant at 0.05

The failures of Alternative Formula #3 exhibited a significant inverse relationship with Average Community Wage, which would indicate Alternative Formula #3 was likely to under predict the costs of school districts with a high Average Community Wage. The failures of Alternative Formula

#2 showed a significant inverse relationship with Area Density, which meant that Alternative Formula #2 would be likely to under predict the costs of school districts with higher than average area density. It bears mentioning that Area Density had not been used as an independent variable in Alternative Formula #2 because Area Density did not show a significant relationship with Actual Cost (Table B-3), and that Average Community Wage had been considered but rejected for use as an independent variable in Alternative Formula #3.

The failures of the 40-40-20 System were significantly related to three cost factors, as reflected in Table 14, while the failures of the Matrix System were significantly related to only two cost factors. And yet, the 40-40-20 System had proven substantially more accurate in predicting Actual Cost. This was true because, as reflected in Table B-3, the Matrix System disregarded the non-size cost factor (Linear Density) bearing most heavily upon the Matrix System's dependent variable (Per-Pupil Cost). Matrix System failures correlated at .27 with Linear Density, as one would expect from the cross tabulation matrix presented in Table 7 of Chapter 2.

It appeared that Alternative Formula #3 was markedly superior to the Matrix System and the 40-40-20 System as a cost-projection method, and somewhat superior to Alternative Formula #2 on the basis of explaining 97 percent versus 95 percent (R-squared statistics from Table 11) of the variance in Actual Cost.

The cost projections of Alternative Formula #3 for each school district are presented in Column B-22. Column B-23 presents the differences between Alternative Formula #3 projections and Actual Cost, and the differences are standardized on a per-pupil basis in Column B-24. Again, pupil numbers were used as a standardizing factor only because students of school finance are more familiar with per-pupil comparisons.

The more extreme "failures" (more than $50/pupil in Column B-24) of Alternative Formula #3 are presented in Table 15, sorted in ascending order of difference between Actual Per-Pupil cost and Alternative Formula #3's cost projection. Of the 15 school districts represented in Table 15, eight were over predicted and seven were under predicted by $50 or more per pupil.

Linear Density is included as a column in Table 15 by virtue of being the most influential non-size cost factor used as an independent variable in Alternative Formula #3, and in most cases explains why the formula would over or under predict the cost of a particular school district.

In order to assess the values presented in Table 15, one must bear in mind that a high linear density portends a low transportation cost per pupil, since large numbers of pupils are served through a minimum expenditure of bus travel and

Table 15

Alternative Formula #3
Failures of More Than $50/Pupil

School District	Actual Cost /Pupil	Alt. #3 Cost /Pupil	Failure	Linear Density
Alexandria Ci.	269	151	-118	2.26
Norfolk Ci.	249	154	-95	2.14
New Kent Co.	296	210	-86	0.95
Richmond Ci.	269	189	-80	1.53
Bath Co.	311	238	-73	0.79
Falls Church Ci.	175	116	-59	3.19
Hopewell Ci.	166	110	-55	3.37
Prince William Co.	216	162	-54	1.52
Lousia Co.	152	203	51	0.99
Buckingham Co.	179	230	51	0.83
Roanoke Ci.	135	187	52	1.43
Lunenberg Co.	168	225	57	0.86
Danville Ci.	166	252	86	1.50
King & Queen Co.	213	317	104	0.56
Williamsburg Ci.	193	316	123	1.00

employee time. The average linear density in Virginia school districts during the 1985-86 school year (statewide pupils transported multiplied by 180 and divided by statewide bus miles traveled) was 1.57. The average per-pupil transportation cost in Virginia during the 1985-86 school year was $159. Therefore, in most cases one would expect a school district of greater than 1.57 linear density to incur costs of less than $159 per pupil. In most cases this was true, since the relationship was discerned through regression analysis and described by Alternative Formula #3. If the opposite were true in a particular school district, however, then the costs of that school district would be under predicted by Alternative Formula #3.

With the above in mind, one is able to explain the differences in actual per-pupil cost and Alternative Formula #3 cost predictions. The city of Alexandria, for example, is expected by Alternative Formula #3 to incur somewhat lower than average per-pupil costs, since Alexandria's linear density of 2.26 is substantially above the state average. Therefore, the formula predicts a cost of $151 per pupil, $8 per pupil below the state average, but Alexandria incurs a per-pupil cost $110 <u>above</u> the state average per-pupil cost in spite of its advantageous linear density.

On the basis of tests performed, Alternative Formula #3 appeared to provide a viable answer to Question Number Three.

Alternative Formula #3 would serve the purpose of equalizing the distribution of state pupil transportation funds by properly considering variable and uncontrollable cost factors that exist among the local school districts of Virginia. Alternative Formula #3 also uses uncomplicated calculations and easily verified cost factors, and therefore would bring simplicity to the distribution of state pupil transportation funds in Virginia.

SUMMARY

This chapter was devoted to answering Question Number Three, having to do with the development of a funding formula to better meet generally accepted standards and also better meet the need for fiscal equalization in Virginia.

Three alternative pupil transportation funding formulae were developed, all three of which were proven superior to the 40-40-20 System and the JLARC Matrix System in terms of approximating actual costs. The alternative formula with outcomes most highly correlated with 1985-86 actual pupil transportation costs incurred by Virginia's local school districts (Alternative Formula #3) was tested through several statistical devices to ascertain its suitability as a simple and equitable means of allocating state pupil transportation aid in Virginia.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

Horace Mann's vision of education as the great equalizer has been given a good deal of attention in Virginia in recent years. In particular, a measure of local fiscal capacity has been developed to ensure that school divisions with lesser ability to raise revenue locally are given greater state aid. Very little attention, however, has been paid to the cost side of fiscal equalization, the idea that school divisions of equal fiscal capacity may nevertheless be unequal because of varying and uncontrollable cost factors. This study has focused upon the cost side of equalization as it pertains to the recently revised pupil transportation funding formula in Virginia. Three questions have been proposed and addressed:

(1) How well does Virginia's new pupil transportation funding formula meet generally accepted standards for such funding formulae? This question was addressed by identifying generally accepted standards through a review of pertinent literature and evaluating Virginia's method of distributing pupil transportation funds according to each of the identified standards.

(2) How well does Virginia's new pupil transportation

funding formula serve the purpose of statewide equalization through proper consideration of divergent cost factors? This question was addressed by identifying cost factors that are generally accepted as influencing pupil transportation costs, gathering data pertaining to each identified cost factor, and assessing the manner in which Virginia's distribution formula either considers or fails to consider quantified measures of each cost factor. A general standard was established to assess the merit or lack of merit in pupil transportation funding formulae in regard to "proper" consideration of cost factors, and the current formula was tested for merit against the formula that was used in Virginia from 1949-50 through 1987-88.

(3) How might Virginia's pupil transportation funding formula be altered to better meet generally accepted standards and at the same time better serve the goal of fiscal equalization? Several alternative formulae were developed, and a single formula was tested for its capacity to correct the deficiencies identified in the current formula.

CONCLUSIONS

Five criteria were found to be generally accepted as standards of quality for state pupil transportation funding formulae. Virginia's current pupil transportation funding formula was found to meet standards for efficiency, objectivity, and reliability. Virginia's current formula failed to meet the standard for simplicity because the method of distribution is needlessly complex, because there appears to be wide-spread confusion regarding the formula and no apparent attempt to provide a comprehensive explanation of the formula's application, and because the Transportation Division of the Virginia Department of Education was apparently directly involved neither in constructing the formula nor in evaluating the formula prior to its adoption, nor in administering the formula after its adoption.

Virginia's current pupil transportation funding formula failed also to meet the generally accepted standard for equity. For the same reasons, it was concluded that Virginia's current pupil transportation funding formula fails to equalize educational opportunities by properly taking into account varying and uncontrollable cost factors. These conclusions were drawn subsequent to finding that the current formula is inferior to the past formula in terms of accounting for variability in actual costs among Virginia's local pupil transportation programs, and subsequent to finding that the choice of a less accurate formula had the practical effect of diverting funds from sparsely populated to densely populated school divisions.

It was concluded through regression and correlation analysis, and through various tests of formulae outcomes, that the formula

$$PMC' = .514 + .2716979(LD) + .0008516849(AW) + .001106375(AD)$$

where PMC' is the predicted per-mile cost to be applied to a school division's number of Bus Miles Traveled, LD is the Linear Density of the school division, AW is the Average Community Wage in the school division, and AD is the Area Density of the school division, is a viable alternative formula that would overcome the deficiencies of Virginia's current pupil transportation funding formula.

RECOMMENDATIONS

First, the current Matrix System method of recognizing costs for purposes of pupil transportation funding should be discontinued. The formula labeled Alternative Formula #3 that was developed in the body of this study and cited above should be used to recognize costs upon which pupil transportation funding is based. In the alternative, the current method should be replaced by Alternative Formula #2 or by the 40-40-20 System used for cost recognition in the body of this study.

Second, a concerted effort should be made to provide, to local school authorities, a comprehensive but understandable description of the method of distributing pupil transportation funds in Virginia.

Third, the methods used in Chapter 4 and Chapter 5 of this study should be duplicated by a state agency with ready access to accurate and current data pertaining to pupil transportation costs and cost factors in Virginia, preferably the Pupil Transportation Division of the Virginia Department of Education. The study should be directed toward bringing simplicity, equity, and fiscal equalization to Virginia's method of distributing state pupil transportation aid.

Fourth, the Pupil Transportation Division of the Virginia Department of Education should be more directly involved in the administration of state pupil transportation funds.

Fifth, the practice of basing current pupil transportation funding on data more than one year old should be discontinued.

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APPENDIX A

Composite Index and Basic School Aid Formula

COMPOSITE INDEX

- **ADM Component =**

$$.5\left[\frac{\dfrac{\text{Local True Values}}{\text{Local ADM}}}{\dfrac{\text{State True Values}}{\text{State ADM}}}\right] + .4\left[\frac{\dfrac{\text{Local Personal Income}}{\text{Local ADM}}}{\dfrac{\text{State Personal Income}}{\text{State ADM}}}\right] + .1\left[\frac{\dfrac{\text{Local Taxable Retail Sales}}{\text{Local ADM}}}{\dfrac{\text{State Taxable Retail Sales}}{\text{State ADM}}}\right]$$

- **Population Component =**

$$.5\left[\frac{\dfrac{\text{Local True Values}}{\text{Local Population}}}{\dfrac{\text{State True Values}}{\text{State Population}}}\right] + .4\left[\frac{\dfrac{\text{Local Personal Income}}{\text{Local Population}}}{\dfrac{\text{State Personal Income}}{\text{State Population}}}\right] + .1\left[\frac{\dfrac{\text{Local Taxable Retail Sales}}{\text{Local Population}}}{\dfrac{\text{State Taxable Retail Sales}}{\text{State Population}}}\right]$$

- **Local Composite Index =**

$$\frac{.6667 \times \text{ADM Component} + .3333 \times \text{Population Component}}{2}$$

BASIC AID FORMULA

- **Local Share (Required Local Expenditure) =**

$$\left[\left[\text{Basic Operating Cost Per Pupil} \times \text{Local ADM}\right] - \text{State Sales Tax}\right] \times \text{Local Composite Index}$$

- **State Share =**

$$\left[\text{Basic Operating Cost Per Pupil} \times \text{Local ADM}\right] - \text{State Sales Tax} - \text{Local Share}$$

APPENDIX B

Table B-1

Raw Data and Computed Indices from Virginia's 1985-86 Transportation Programs

School Division	Reg Pup Tran B-1	E S Pup Tran B-2	Tot Pup Tran B-3	Bus Miles Tran B-4	Buses B-5	Land Area B-6	Ave Comm Wage B-7	Ave Alt B-8	Tot Roads B-9	Paved Roads B-10	Lin Den B-11	Ar Den B-12	% Pvd Rds B-13	Rd/ Sq Mi B-14	Actual Cost B-15
ACCOMACK CO	4315	28	4343	835,380	81	602	283	100	678	665	0.94	7	98	1	877,149
ALBEMARLE CO	8146	107	8253	1,164,420	129	741	407	500	906	670	1.28	11	74	1	1,781,563
ALLEGHANY CO	3086	44	3130	391,709	44	444	322	2,000	340	286	1.44	7	84	1	473,968
AMELIA CO	1446	1	1447	222,660	23	366	288	100	393	314	1.17	4	80	1	215,213
AMHERST CO	4106	56	4162	615,780	62	470	332	900	631	417	1.22	9	66	1	699,276
APPOMATTOX CO	2152	11	2163	329,184	42	345	292	500	476	400	1.18	6	84	1	322,271
ARLINGTON CO	6543	274	6817	512,290	56	24	602	100	37	37	2.40	284	100	2	209,211
AUGUSTA CO	9012	109	9121	1,027,692	141	986	517	1,500	1,123	804	1.60	9	72	1	1,226,037
BATH CO	853	0	853	193,392	20	540	336	2,000	317	257	0.79	2	81	1	264,947
BEDFORD CO	7081	65	7146	1,015,812	112	764	296	900	1,056	754	1.27	9	71	1	1,206,785
BLAND CO	972	5	977	152,491	21	369	316	2,000	285	208	1.16	3	73	1	204,513
BOTETOURT CO	3856	24	3880	509,940	58	549	318	1,500	599	419	1.37	7	70	1	598,160
BRUNSWICK CO	2488	14	2502	645,444	61	579	284	100	673	550	0.70	4	82	1	637,053
BUCHANAN CO	7031	16	7047	617,878	110	508	480	2,000	525	374	2.05	14	71	1	1,112,162
BUCKINGHAM CO	1943	17	1960	423,234	42	582	332	250	660	437	0.83	3	66	1	349,930
CAMPBELL CO	7948	106	8054	846,139	114	511	390	500	779	748	1.71	16	96	2	997,598
CAROLINE CO	3180	15	3195	682,326	61	549	348	100	559	518	0.84	6	93	1	742,371
CARROLL CO	3994	8	4002	584,100	70	494	292	2,000	916	559	1.23	8	61	2	634,917
CHARLES CITY CO	1112	0	1112	181,692	23	204	301	100	179	168	1.10	5	94	1	213,005
CHARLOTTE CO	2113	0	2113	348,048	43	471	294	250	589	459	1.09	4	78	1	359,186
CHESTERFIELD CO	33556	596	34152	2,870,190	292	446	425	100	1,231	1,210	2.14	77	98	3	3,748,468
CLARKE CO	1401	10	1411	179,964	18	174	325	750	257	212	1.41	8	82	1	202,100
CRAIG CO	693	0	693	109,728	10	336	258	2,000	240	195	1.14	2	81	1	117,299
CULPEPER CO	3607	42	3649	567,468	69	389	339	100	546	373	1.16	9	68	1	590,734
CUMBERLAND CO	1264	5	1269	255,240	25	292	249	100	350	231	0.89	4	66	1	281,785
DICKINSON CO	3721	24	3745	384,212	61	335	321	2,000	473	344	1.75	11	73	1	692,357
DINWIDDIE CO	3462	9	3471	669,960	74	501	329	100	618	534	0.93	7	86	1	743,656
ESSEX CO	1267	9	1276	277,884	26	264	276	100	304	262	0.83	5	86	1	318,763
FAIRFAX CO	82245	2181	84426	11,408,760	809	409	509	100	2,419	2,396	1.33	206	99	6	18,641,914
FAUQUIER CO	6574	21	6595	870,408	105	660	366	250	884	639	1.36	10	72	1	1,131,617
FLOYD CO	1816	9	1825	379,278	41	383	286	2,000	674	340	0.87	5	50	2	406,965
FLUVANNA CO	1872	0	1872	261,864	33	288	324	100	339	277	1.29	7	82	1	265,268
FRANKLIN CO	5526	3	5529	846,486	99	721	293	1,000	1,126	949	1.18	8	84	2	758,451
FREDERICK CO	6175	11	6186	949,140	77	427	365	750	629	474	1.17	14	75	1	951,023
GILES CO	2722	18	2740	276,558	38	363	357	2,000	427	292	1.78	8	68	1	349,884

Table B-1 (Continued)

Raw Data and Computed Indices from Virginia's 1985-86 Transportation Programs

School Division	Reg Pup Tran B-1	E S Pup Tran B-2	Tot Pup Tran B-3	Bus Miles Tran B-4	Buses B-5	Land Area B-6	Ave Comm Wage B-7	Ave Alt B-8	Tot Roads B-9	Paved Roads B-10	Lin Den B-11	Ar Den B-12	% Pvd Rds B-13	Rd/ Sq Mi B-14	Actual Cost B-15
GOOCHLAND CO	1647	7	1654	355,932	36	295	347	100	354	317	0.84	6	90	1	346,678
GRAYSON CO	2307	0	2307	357,696	47	451	294	2,000	764	382	1.16	5	50	2	380,231
GREENSVILLE CO	2620	29	2649	502,920	36	300	335	100	305	285	0.95	9	93	1	438,747
HALIFAX CO	5771	10	5781	898,704	107	803	335	250	994	856	1.16	7	86	1	1,066,762
HANOVER CO	8032	30	8062	891,684	132	471	347	100	797	731	1.63	17	92	2	1,301,859
HENRICO CO	23234	975	24209	1,888,944	231	234	408	100	101	101	2.31	103	100	0	2,682,300
HENRY CO	8363	79	8442	920,862	142	384	352	900	755	740	1.65	22	98	2	1,278,156
HIGHLAND CO	346	0	346	91,260	8	416	224	2,000	286	177	0.68	1	62	1	81,769
ISLE OF WIGHT CO	3506	17	3523	471,960	73	360	458	100	501	439	1.34	10	88	1	642,338
KING GEORGE CO	2058	0	2058	301,806	36	183	493	100	234	201	1.23	11	86	1	357,942
KING & QUEEN CO	892	10	902	291,060	22	327	261	100	344	262	0.56	3	76	1	191,809
KING WILLIAM CO	1296	5	1301	268,020	26	280	422	100	313	271	0.87	5	87	1	296,331
LANCASTER CO	1408	0	1408	281,890	26	153	291	100	260	242	0.90	9	93	2	242,684
LEE CO	4129	27	4156	473,580	66	438	277	2,000	656	401	1.58	9	61	1	672,484
LOUDOUN CO	8506	185	8691	1,173,852	146	517	468	250	909	556	1.33	17	61	2	1,612,873
LOUISA CO	3073	16	3089	560,520	55	517	495	100	601	485	0.99	6	81	1	469,155
LUNENBERG CO	2054	5	2059	431,280	41	443	260	100	566	374	0.86	5	66	1	346,318
MADISON CO	1669	0	1669	217,314	30	327	252	750	366	241	1.38	5	66	1	280,552
MATHEWS CO	1053	5	1058	171,000	19	105	246	100	173	155	1.11	10	90	2	190,100
MECKLENBERG CO	4863	33	4896	867,330	97	675	291	100	913	707	1.02	7	77	1	812,688
MIDDLESEX CO	1112	0	1112	169,200	20	138	255	100	199	186	1.18	8	93	1	212,095
MONTGOMERY CO	6789	72	6861	790,176	85	392	356	2,000	648	504	1.56	18	78	2	871,564
NELSON CO	1970	0	1970	466,542	45	471	299	900	574	336	0.76	4	59	1	439,016
NEW KENT CO	1605	6	1611	305,820	38	221	343	100	257	211	0.95	7	82	1	477,079
NORTHAMPTON CO	2246	0	2246	298,472	37	357	244	100	278	278	1.35	6	100	1	313,396
NORTHUMBERLAND CO	1300	6	1306	301,446	31	223	304	100	351	336	0.78	6	96	2	289,991
NOTTOWAY CO	2280	27	2307	305,244	36	308	327	100	416	371	1.36	7	89	1	311,345
ORANGE CO	2963	27	2990	523,530	55	355	314	100	436	333	1.03	8	76	1	535,571
PAGE CO	2699	34	2733	350,064	38	316	290	750	386	297	1.41	9	77	1	398,344
PATRICK CO	2521	0	2521	415,764	46	469	281	100	723	545	1.09	5	75	2	428,237
PITTSYLVANIA CO	10188	49	10237	1,618,380	189	1012	401	500	578	1,261	1.14	10	80	2	1,687,970
PRINCE EDWARD CO	2145	15	2160	318,240	37	357	285	250	504	375	1.22	6	74	1	381,888
PRINCE GEORGE CO	4663	46	4709	756,720	66	281	371	100	343	332	1.12	17	97	1	935,306
PRINCE WILLIAM CO	25527	914	26441	3,123,630	326	335	382	100	784	713	1.52	79	91	2	5,707,586
PULASKI CO	5088	57	5145	552,991	68	340	368	2,000	456	365	1.67	15	80	1	713,358

Table B-1 (Continued)

Raw Data and Computed Indices from Virginia's 1985-86 Transportation Programs

School Division	Reg Pup Tran B-1	E S Pup Tran B-2	Tot Pup Tran B-3	Bus Miles Tran B-4	Buses B-5	Land Area B-6	Ave Comm Wage B-7	Ave Alt B-8	Tot Roads B-9	Paved Roads B-10	Lin Den B-11	Ar Den B-12	% Pvd Rds B-13	Rd/ Sq Mi B-14	Actual Cost B-15
RAPPAHANNOCK CO	849	4	853	186,228	19	267	265	750	275	164	0.82	3	60	1	188,090
RICHMOND CO	1052	0	1052	193,572	21	203	350	100	239	223	0.98	5	93	1	176,344
ROANOKE CO	11712	67	11779	1,032,840	137	246	361	1,500	612	584	2.05	48	95	2	1,362,316
ROCKBRIDGE CO	2557	16	2573	428,922	44	598	317	1,500	721	498	1.08	4	69	1	460,662
ROCKINGHAM CO	8133	90	8223	979,452	128	853	362	1,500	052	798	1.51	10	76	1	1,303,651
RUSSELL CO	5354	42	5396	614,880	74	483	312	2,000	678	388	1.58	11	57	1	806,108
SCOTT CO	3910	80	3990	653,400	67	539	290	2,000	796	405	1.10	7	51	1	693,911
SHENANDOAH CO	4340	70	4410	598,680	78	507	316	1,000	755	483	1.33	9	64	1	668,127
SMYTH CO	5408	62	5470	413,382	49	435	326	2,000	572	462	2.38	13	81	1	541,811
SOUTHAMPTON CO	2332	11	2343	579,780	63	603	319	100	762	660	0.73	4	87	1	654,722
SPOTSYLVANIA CO	8242	63	8305	856,332	103	407	377	100	569	503	1.75	20	88	1	926,051
STAFFORD CO	8971	64	9035	906,498	102	277	346	100	421	396	1.79	33	94	2	1,267,284
SUSSEX CO	1497	10	1507	394,740	35	496	306	100	543	468	0.69	3	86	1	375,398
TAZEWELL CO	8424	49	8473	703,962	90	522	317	2,000	650	509	2.17	16	78	1	1,006,666
WARREN CO	2888	40	2928	254,286	36	219	325	750	289	207	2.07	13	72	1	337,183
WASHINGTON CO	6926	47	6973	746,712	83	571	347	2,000	898	705	1.68	12	79	2	827,357
WESTMORELAND CO	1853	7	1860	351,864	36	248	280	100	399	358	0.95	8	90	2	349,049
WISE CO	7489	38	7527	576,180	96	408	389	2,000	513	480	2.35	18	94	1	887,893
WYTHE CO	3887	38	3925	373,878	54	460	298	2,000	593	376	1.89	9	63	1	496,884
YORK CO	7776	71	7847	820,440	89	129	357	100	255	253	1.72	61	99	2	1,111,696
ALEXANDRIA CI	4597	176	4773	380,286	58	15	496	100	207	207	2.26	318	100	14	1,285,367
CHARLOTTESVILLE CI	2924	112	3036	218,770	29	10	338	500	134	134	2.50	304	100	13	559,872
CHESAPEAKE CI	19067	344	19411	1,340,712	194	353	342	100	736	736	2.61	55	100	2	2,051,490
COVINGTON CI	701	15	716	49,860	5	16	443	2,000	37	37	2.58	45	100	2	58,685
DANVILLE CI	1274	50	1324	159,300	24	2	318	500	278	278	1.50	662	100	139	220,153
FALLS CHURCH CI	449	0	449	25,298	6	2	462	100	32	32	3.19	225	100	16	78,744
FRANKLIN CI	1109	15	1124	61,308	13	4	295	100	42	42	3.30	281	100	11	83,011
FREDERICKSBURG CI	1820	46	1866	77,940	16	10	323	100	70	70	4.31	187	100	7	178,483
GALAX CI	686	0	686	30,847	6	8	267	2,000	59	59	4.00	86	100	7	50,311
HAMPTON CI	5518	562	6080	705,600	86	72	380	100	391	391	1.55	84	100	5	1,016,064
HARRISONBURG CI	1124	48	1172	112,680	10	18	323	1,000	110	110	1.87	65	100	6	138,087
HOPEWELL CI	2104	14	2118	113,040	30	11	434	100	117	117	3.37	193	100	11	350,943
LYNCHBURG CI	7254	186	7440	500,940	69	50	368	250	338	338	2.67	149	100	7	832,562
MANASSAS CI	2980	159	3139	175,751	26	17	494	100	78	78	3.21	185	100	5	263,627
MARTINSVILLE CI	2008	35	2043	109,620	18	10	324	500	97	97	3.35	204	100	10	193,614

Table B-1 (Continued)

Raw Data and Computed Indices from Virginia's 1985-86 Transportation Programs

School Division	Reg Pup Tran B-1	E S Pup Tran B-2	Tot Pup Tran B-3	Bus Miles Tran B-4	Buses B-5	Land Area B-6	Ave Comm Wage B-7	Ave Alt B-8	Tot Roads B-9	Paved Roads B-10	Lin Den B-11	Ar Den B-12	% Pvd Rds B-13	Rd/ Sq Mi B-14	Actual Cost B-15
NEWPORT NEWS CI	19851	770	20621	1,288,440	231	118	404	100	438	438	2.88	175	100	4	2,521,477
NORFOLK CI	18716	932	19648	1,649,340	268	66	400	100	682	682	2.14	298	100	10	4,893,268
NORTON CI	521	6	527	30,258	5	7	381	2,000	27	27	3.14	75	100	4	38,186
PETERSBURG CI	5379	144	5523	328,860	50	23	320	100	174	174	3.02	240	100	8	850,407
POQUOSON CI	1984	10	1994	109,620	2	10	302	100	48	48	3.27	199	100	5	159,278
PORTSMOUTH CI	13356	372	13728	689,562	112	46	424	100	385	385	3.58	298	100	8	1,366,890
RICHMOND CI	13824	2727	16551	1,947,780	201	63	453	100	810	810	1.53	263	100	13	4,448,730
ROANOKE CI	8056	454	8510	1,067,605	100	43	353	1,000	441	441	1.43	198	100	10	1,150,878
SALEM CI	3077	26	3103	226,612	24	14	442	1,500	126	126	2.46	222	100	9	285,078
SUFFOLK CI	7333	160	7493	1,175,040	96	430	335	100	643	623	1.15	17	97	1	1,155,064
VIRGINIA BEACH CI	44973	954	45927	3,144,332	377	310	310	100	1,186	1,186	2.63	148	100	4	4,314,024
WILLIAMSBURG CI	4543	80	4623	829,080	65	9	303	100	42	42	1.00	514	100	5	893,748
WINCHESTER CI	1394	74	1468	111,780	14	9	382	1,000	83	83	2.36	163	100	9	153,586
COLONIAL BEACH CI	293	0	293	24,588	3	4	263	100	76	76	2.14	73	100	19	29,128
MEAN OF COLUMN	5863	133	5996	686,307	77	332	344	684	503	411	1.61	63	85	4	956,153
TOTAL OF COLUMN IN 1000s	698	13	714	8,167	9	40			60	49					113,780

Table B-2

Comparative Cost Projections

School Division	Act Cost Pup B-16	Act Cost Mile B-17	Matrix Proj Cost B-18	40-40-20 Proj Cost B-19	Gain or Loss B-20	G-L Per Pup B-21	Alt #3 Proj Cost B-22	Alt #3 Failures B-23	Alt #3 Fail/ Pupil B-24
ACCOMACK CO	202	1.05	732,839	944,191	-211,352	-49	919,739	42,590	9
ALBEMARLE CO	216	1.53	1,217,005	1,496,311	-279,306	-34	1,407,198	-374,365	-45
ALLEGHANY CO	151	1.21	571,534	527,394	44,140	14	490,564	16,596	5
AMELIA CO	149	0.97	283,239	273,615	9,624	7	259,945	44,633	31
AMHERST CO	168	1.14	731,610	762,897	-31,287	-8	731,403	32,127	8
APPOMATTOX CO	149	0.98	367,729	425,960	-58,231	-27	386,557	64,286	30
ARLINGTON CO	31	0.41	1,014,323	859,380	154,943	23	968,540	759,329	111
AUGUSTA CO	134	1.19	1,331,825	1,505,301	-173,476	-19	1,339,269	113,232	12
BATH CO	311	1.37	165,482	211,985	-46,503	-55	203,270	-61,677	-72
BEDFORD CO	169	1.19	1,014,394	1,300,586	-286,192	-40	1,222,402	15,616	2
BLAND CO	209	1.35	202,143	199,021	3,122	3	176,202	-28,311	-29
BOTETOURT CO	154	1.17	652,864	675,968	-23,104	-6	628,070	29,910	8
BRUNSWICK CO	255	0.99	428,626	671,197	-242,571	-97	661,919	24,866	10
BUCHANAN CO	158	1.80	938,647	1,067,486	-128,839	-18	893,692	-218,470	-31
BUCKINGHAM CO	179	0.83	410,568	465,452	-54,884	-28	450,870	100,940	51
CAMPBELL CO	124	1.18	1,189,910	1,268,835	-78,925	-10	1,139,181	141,583	18
CAROLINE CO	232	1.09	539,985	735,899	-195,914	-61	730,899	-11,472	-4
CARROLL CO	159	1.09	648,778	754,987	-106,209	-27	696,157	61,240	15
CHARLES CITY CO	192	1.17	215,728	229,440	-13,712	-12	208,726	-4,279	-4
CHARLOTTE CO	170	1.03	331,741	435,782	-104,041	-49	398,480	39,294	19
CHESTERFIELD CO	110	1.31	5,254,312	4,503,169	751,144	22	4,455,472	707,004	21
CLARKE CO	143	1.12	298,944	235,060	63,884	45	224,155	22,055	16
CRAIG CO	169	1.07	134,442	130,233	4,209	6	126,749	9,450	14
CULPEPER CO	162	1.04	649,375	720,738	-71,363	-20	664,270	73,536	20
CUMBERLAND CO	222	1.10	258,791	285,421	-26,630	-21	276,944	-4,841	-4
DICKINSON CO	185	1.80	631,669	604,766	26,904	7	519,825	-172,532	-46
DINWIDDIE CO	214	1.11	567,969	778,992	-211,023	-61	736,721	-6,935	-2
ESSEX CO	250	1.15	270,233	300,982	-30,749	-24	295,952	-22,811	-18
FAIRFAX CO	221	1.63	13,996,700	13,753,700	242,997	3	1,679,268	-1,849,232	-22
FAUQUIER CO	172	1.30	889,584	1,166,991	-277,407	-42	1,073,751	-57,866	-9
FLOYD CO	223	1.07	376,739	429,859	-53,120	-29	408,435	1,470	1
FLUVANNA CO	142	1.01	363,168	347,466	15,703	8	315,798	50,530	27
FRANKLIN CO	137	0.90	720,999	1,070,797	-349,798	-63	993,717	235,266	43
FREDERICK CO	154	1.00	826,440	1,115,030	-288,590	-47	1,121,660	170,637	27
GILES CO	128	1.27	462,958	423,427	39,531	14	375,337	25,453	9

Table B-2

Comparative Cost Projections

School Division	Act Cost Pup B-16	Act Cost Mile B-17	Matrix Proj Cost B-18	40-40-20 Proj Cost B-19	Gain or Loss B-20	G-L Per Pup B-21	Alt #3 Proj Cost B-22	Alt #3 Failures B-23	Alt #3 Fail/ Pupil B-24
GOOCHLAND CO	210	0.97	338,523	393,490	-54,967	-33	380,487	33,809	20
GRAYSON CO	165	1.06	362,199	463,488	-101,289	-44	417,164	36,933	16
GREENSVILLE CO	166	0.87	468,702	538,803	-70,101	-26	556,600	117,853	44
HALIFAX CO	185	1.19	771,609	1,135,897	-364,288	-63	1,049,648	-17,114	-3
HANOVER CO	161	1.46	1,095,468	1,339,599	-244,131	-30	1,178,919	-122,940	-15
HENRICO CO	111	1.42	4,511,361	3,170,804	1,340,557	55	3,090,430	408,130	17
HENRY CO	151	1.39	1,201,514	1,404,995	-203,481	-24	1,229,463	-48,694	-6
HIGHLAND CO	236	0.90	67,124	92,849	-25,725	-74	92,766	10,997	32
ISLE OF WIGHT CO	182	1.36	584,068	669,446	-85,378	-24	579,218	-63,120	-18
KING GEORGE CO	174	1.19	323,106	389,055	-65,949	-32	360,369	2,427	1
KING & QUEEN CO	213	0.66	200,198	274,532	-74,334	-82	285,629	93,820	104
KING WILLIAM CO	228	1.11	264,999	297,076	-32,077	-25	289,200	-7,131	-5
LANCASTER CO	172	0.86	273,152	311,623	-38,471	-27	307,941	65,257	46
LEE CO	162	1.42	701,659	693,223	8,436	2	614,744	-57,741	-14
LOUDOUN CO	186	1.37	1,384,579	1,571,843	-187,264	-22	1,447,154	-165,719	-19
LOUISA CO	152	0.84	514,109	646,297	-132,188	-43	625,746	156,591	51
LUNENBERG CO	168	0.80	332,368	473,751	-141,383	-69	463,490	117,172	57
MADISON CO	168	1.29	323,786	302,224	21,562	13	267,960	-12,592	-8
MATHEWS CO	180	1.11	217,857	210,070	7,787	7	198,062	7,962	8
MECKLENBERG CO	166	0.94	692,601	1,037,108	-344,507	-70	975,967	163,279	33
MIDDLESEX CO	191	1.25	215,728	214,999	729	1	199,084	-13,012	-12
MONTGOMERY CO	127	1.10	987,597	1,089,362	-101,765	-15	1,029,718	158,154	23
NELSON CO	223	0.94	382,180	497,707	-115,527	-59	487,138	48,122	24
NEW KENT CO	296	1.56	327,660	367,804	-40,144	-25	337,877	-139,202	-86
NORTHAMPTON CO	140	1.05	352,622	401,665	-49,043	-22	365,965	52,569	23
NORTHUMBERLAND CO	222	0.96	268,490	328,489	-59,999	-46	317,189	27,198	21
NOTTOWAY CO	135	1.02	411,366	406,833	4,533	2	375,276	63,931	28
ORANGE CO	179	1.02	518,597	619,372	-100,775	-34	591,762	56,191	19
PAGE CO	146	1.14	490,995	463,937	27,058	10	435,628	37,284	14
PATRICK CO	170	1.03	395,797	506,995	-111,198	-44	476,306	48,069	19
PITTSYLVANIA CO	165	1.04	1,411,174	2,025,285	-614,111	-60	1,886,741	198,771	19
PRINCE EDWARD CO	177	1.20	377,490	407,206	-29,716	-14	377,359	-4,529	-2
PRINCE GEORGE CO	199	1.24	823,079	886,271	-63,192	-13	884,329	-50,977	-11
PRINCE WILLIAM CO	216	1.83	4,712,425	4,237,994	474,431	18	4,275,719	-1,431,867	-54
PULASKI CO	139	1.29	744,873	805,471	-60,598	-12	737,625	24,267	5

Table B-2

Comparative Cost Projections

School Division	Act Cost Pup B-16	Act Cost Mile B-17	Matrix Proj Cost B-18	40-40-20 Proj Cost B-19	Gain or Loss B-20	G-L Per Pup B-21	Alt #3 Proj Cost B-22	Alt #3 Failures B-23	Alt #3 Fail/ Pupil B-24
RAPPAHANNOCK CO	221	1.01	175,566	205,499	-29,933	-35	197,836	9,746	11
RICHMOND CO	168	0.91	204,088	227,254	-23,166	-22	215,102	38,758	37
ROANOKE CO	116	1.32	1,614,899	1,667,515	-52,616	-4	1,538,180	175,864	15
ROCKBRIDGE CO	179	1.07	433,097	512,656	-79,559	-31	489,291	28,629	11
ROCKINGHAM CO	159	1.33	1,188,927	1,388,806	-199,879	-24	1,251,371	-52,280	-6
RUSSELL CO	149	1.31	773,742	870,912	-97,170	-18	799,468	-6,640	-1
SCOTT CO	174	1.06	738,110	785,373	-47,263	-12	751,742	57,831	14
SHENANDOAH CO	152	1.12	790,090	809,045	-18,955	-4	730,715	62,588	14
SMYTH CO	99	1.31	793,918	700,996	92,922	17	638,247	96,436	18
SOUTHAMPTON CO	279	1.13	395,989	629,453	-233,464	-100	599,448	-55,274	-24
SPOTSYLVANIA CO	112	1.08	1,161,057	1,263,087	-102,030	-12	1,166,284	240,233	29
STAFFORD CO	140	1.40	1,256,651	1,335,058	-78,407	-9	1,261,799	-5,485	-1
SUSSEX CO	249	0.95	317,568	403,265	-85,697	-57	402,918	27,520	18
TAZEWELL CO	119	1.43	1,183,618	1,156,453	27,165	3	1,044,419	37,753	4
WARREN CO	115	1.33	532,536	417,987	114,549	39	369,146	31,963	11
WASHINGTON CO	119	1.11	986,420	1,067,284	-80,864	-12	994,666	167,309	24
WESTMORELAND CO	188	0.99	378,487	404,345	-25,858	-14	389,191	40,142	22
WISE CO	118	1.54	1,041,245	1,039,923	1,322	0	888,595	702	0
WYTHE CO	127	1.33	685,423	593,023	92,400	24	519,838	22,954	6
YORK CO	142	1.36	1,113,367	1,179,009	-656,428	-8	1,153,288	41,592	5
ALEXANDRIA CI	269	3.38	697,657	660,583	37,074	8	719,758	-565,609	-119
CHARLOTTESVILLE CO	184	2.56	443,804	387,621	56,183	19	425,787	-134,085	-44
CHESAPEAKE CI	106	1.53	2,993,875	2,467,360	526,515	27	2,232,473	180,983	9
COVINGTON CI	82	1.18	75,739	85,864	-10,125	-14	82,060	23,375	33
DANVILLE CI	166	1.38	139,676	232,955	-93,279	-70	333,946	113,793	86
FALLS CHURCH CI	175	3.11	33,226	57,658	-24,432	-54	52,029	-26,715	-59
FRANKLIN CI	74	1.35	105,931	138,176	-32,245	-29	132,408	49,397	44
FREDERICKSBURG CI	96	2.29	176,448	202,190	-25,742	-14	182,777	4,294	2
GALAX CI	73	1.63	50,764	75,848	-25,084	-37	65,561	15,250	22
HAMPTON CI	167	1.44	1,155,902	994,962	160,940	26	976,580	-39,484	-6
HARRISONBURG CI	118	1.23	126,760	162,390	-35,630	-30	164,122	26,035	22
HOPEWELL CI	166	3.10	268,442	272,703	-4,261	-2	233,990	-116,953	-55
LYNCHBURG CI	112	1.66	1,017,606	925,142	92,464	12	903,613	71,051	10
MANASSAS CI	84	1.50	364,892	362,726	2,166	1	353,687	90,060	29
MARTINSVILLE CI	95	1.77	266,716	236,108	30,608	15	227,944	34,330	17

Table B-2

Comparative Cost Projections

School Division	Act Cost Pup B-16	Act Cost Mile B-17	Matrix Proj Cost B-18	40-40-20 Proj Cost B-19	Gain or Loss B-20	G-L Per Pup B-21	Alt #3 Proj Cost B-22	Alt #3 Failures B-23	Alt #3 Fail/ Pupil B-24
NEWPORT NEWS CI	122	1.96	3,021,727	2,607,527	414,200	20	2,446,970	-74,507	-4
NORFOLK CI	249	2.97	3,036,028	2,838,939	197,089	10	3,021,811	-1,871,458	-95
NORTON CI	72	1.26	48,100	62,899	-14,799	-28	55,987	17,801	34
PETERSBURG CI	154	2.59	760,095	659,752	100,343	18	665,797	-184,610	-33
POQUOSON CI	80	1.45	248,038	193,105	54,933	28	224,606	65,328	33
PORTSMOUTH CI	100	1.98	1,900,428	1,538,008	362,420	26	1,563,393	196,503	14
RICHMOND CI	269	2.28	4,093,524	2,641,006	1,452,518	88	3,121,387	-1,327,344	-80
ROANOKE CI	135	1.08	1,354,784	1,386,431	-31,647	-4	1,593,051	442,173	52
SALEM CI	92	1.26	383,617	383,797	-180	0	415,340	130,262	42
SUFFOLK CI	154	0.98	1,194,437	1,371,562	-177,125	-24	1,384,002	228,938	31
VIRGINIA BEACH CI	94	1.37	7,283,079	5,617,915	1,665,165	36	5,627,317	1,313,293	29
WILLIAMSBURG CI	193	1.08	837,491	918,634	-81,143	-18	1,459,688	565,940	122
WINCHESTER CI	105	1.37	170,348	190,714	-20,366	-14	193,217	39,631	27
COLONIAL BEACH CI	99	1.18	21,682	39,847	-18,165	-62	38,089	8,961	31
MEAN OF COLUMN	159	1.39	956,101	956,153	443	-16	956,153		
TOTAL OF COLUMN IN 1000s			113,782	113,776			113,782		

Table B-3

Correlations Between Cost Factors

	B-3	B-4	B-5	B-7	B-8	B-11	B-12	B-13	B-14	B-15	B-16	B-17
Tot Pub (3)	--											
Miles Trans (4)	.95*	--										
Buses (5)	.98*	.95*	--									
Ave Wage (7)	.35*	.32*	.37*	--								
Ave A/T (8)	.15	-.15	-.15	-.11	--							
Lin Den (11)	.14	-.03	.04	.32*	.06	--						
Area Den (12)	.20*	.13	.14	.30*	-.22*	.51*	--					
% Paved (13)	.23*	.14	.16	.32*	-.46*	.50*	.54*	--				
Rds/Mi^2 (14)	.02	-.03	-.04	.03	-.07	.15	.66*	.23*	--			
Act Cost (15)	.94*	.98*	.95*	.34*	-.15	.03	.20*	.18	.00	--		
Cost/Pup (16)	.04	.09	.05	-.16	-.18*	-.67*	-.16	-.26*	.03	.14	--	
Cost/Mi (17)	.19*	.10	.19*	.34*	-.08	.61*	.52*	.36*	.20*	.23*	.07	--

APPENDIX C

COLUMN HEADINGS, SOURCES, AND COMPUTATIONAL DERIVATIONS FOR TABLE B-1 AND TABLE B-2

B-1 Regular Pupils Transported -- The ADA of pupils transported on regular bus routes in each school district during the 1985-86 school year (Virginia Department of Education)

B-2 Exclusive Schedule Pupils Transported -- The ADA of pupils transported on exclusive schedule bus routes in each school district during the 1985-86 school year (Virginia Department of Education)

B-3 Total Pupils Transported -- (Col B-1 + Col B-2)

B-4 Bus Miles Traveled -- The total miles traveled by state approved buses on regular and exclusive schedule bus routes in each school district during the 1985-86 school year (Virginia Department of Education)

B-5 State Approved Buses -- The number of state approved buses used to transport pupils on regular and exclusive schedule routes in each school district during the 1985-86 school year (Virginia Department of Education)

B-6 Land Area -- The land area in square miles in each school district (Virginia Department of Transportation)

B-7 Average Community Wage -- The average, all-Industry wage in each school district for the quarter ending June 30, 1989 (Virginia Employment Commission)

B-8 Average Altitude -- The estimated average altitude above sea level of each school district (Estimated from topographical maps in the 1967 World Book Encyclopedia Atlas)

B-9 Total Roads -- The sum of primary system, secondary system, and urban system roads in each school district (Virginia Department of Transportation)

B-10 Paved Roads -- The sum of untreated primary system, secondary system, and urban system roads in each school division (Virginia Department of Transportation)

B-11 Linear Density -- (Column B-3 X 180)/Column B-4

B-12 Area Density -- Column B-3/Column B-6

B-13 Percent Roads Paved -- (Column B-10/Column B-9) X 100

B-14 Roads/Square Mile -- Column B-9/Column B-6

B-15 Actual Cost -- The total operating cost incurred by each school division for the operation of regular and exclusive schedule bus routes during the 1985-86 school year (Virginia Department of Education)

B-16 Actual Per-Pupil Cost -- Column B-15/Column B-3

B-17 Actual Per-Mile Cost -- Column B-15/Column B-4

B-18 Matrix Projected Cost -- Column B-1 and Column B-2 multiplied by indices found in Table 3, and the two products summed (These totals were verified as correct by the Virginia Department of Education.)

B-19 40-40-20 Projected Cost -- Computations for this column are detailed in the text of Chapter 3.

B-20 Total Gain or Loss -- Column B-18 minus Column B-19

B-21 Gain or Loss/Pupil -- Column B-20/Column B-3

B-22 Alt. #3 Projected Cost -- The per-mile outcomes from Alternative Formula #3 for each school division multiplied by Column B-4 for each school division

B-23 Alt. #3 Failures -- Column B-22 minus Column B-15

B-24 Alt. #3 Failures/Pupil -- Column 21/Column 3

APPENDIX D

CLUSTERS USED IN ANALYSIS OF
"REGULAR" PUPIL TRANSPORTATION DATA

LARGE LAND AREAS

Low Number of Pupils

Amelia
Bath
Bland
Buckingham
Charles City
Clarke
Craig
Cumberland
Essex
Floyd
Fluvanna
Goochland
Greene
Highland
King & Queen
King William
Lancaster
Madison
Mathews
Middlesex
Nelson
New Kent
Northumberland
Powhatan
Rappahannock
Richmond County
Surry
Sussex
Westmoreland

Medium Number of Pupils

Accomack
Alleghany Highlands
Amherst
Appomattox
Botetourt
Brunswick
Caroline
Carroll
Charlotte
Culpeper
Dickenson
Dinwiddie
Giles
Gloucester
Grayson
Greensville
Isle of Wight
King George
Lee
Louisa
Lunenburg
Northampton
Nottoway
Orange
Page
Patrick
Prince Edward
Prince George
Rockbridge
Scott
Shenandoah
Southampton
Warren
Williamsburg/James City
Wythe

High Number of Pupils

Albemarle
Augusta
Bedford County
Buchanan
Campbell
Chesapeake
Chesterfield
Fairfax County
Fauquier
Franklin County
Frederick
Halifax
Hanover
Henrico
Henry
Loudoun
Mecklenburg
Montgomery
Pittsylvania
Prince William
Pulaski
Roanoke County
Rockingham
Russell
Smyth
Spotsylvania
Stafford
Suffolk
Tazewell
Virginia Beach
Washington
Wise
York

CLUSTERS USED IN ANALYSIS OF "REGULAR" PUPIL TRANSPORTATION DATA

SMALL LAND AREAS

Low Number of Pupils

Bristol	Falls Church	Norton
Buena Vista	Franklin City	Radford
Colonial Beach	Fredericksburg	Staunton
Colonial Heights	Galax	Waynesboro
Covington	Harrisonburg	West Point
Danville	Manassas Park	Winchester

Medium and High Number of Pupils

Alexandria	Manassas	Portsmouth
Arlington	Martinsville	Richmond City
Charlottesville	Newport News	Roanoke City
Hampton	Norfolk	Salem
Hopewell	Petersburg	
Lynchburg	Poquoson	

CLUSTERS USED IN ANALYSIS OF EXCLUSIVE SCHEDULE PUPIL TRANSPORTATION DATA

LARGE LAND AREAS

Low Number of Pupils

Amelia
Appomattox
Bath
Bland
Brunswick
Carolina
Carroll
Charles City
Clarke
Craig
Cumberland
Dinwiddie
Essex
Floyd
Fluvanna
Franklin County
Frederick
Goochland
Greene
Halifax
Highland
King & Queen
King William
Lancaster
Madison
Mathews
Middlesex
Nelson
New Kent
Northumberland
Powhatan
Prince Edward
Rappahannock
Richmond County
Southampton
Surry
Sussex
Westmoreland

Medium Number of Pupils

Accomack
Alleghany Highlands
Botetourt
Buchanan
Buckingham
Charlotte
Culpeper
Dickenson
Fauquier
Giles
Gloucester
Grayson
Greensville
Hanover
Isle of Wight
King George
Lee
Louisa
Lunenburg
Mecklenburg
Northampton
Nottoway
Orange
Page
Patrick
Pittsylvania
Prince George
Rockbridge
Russell
Tazewell
Warren
Washington
Wise
Wythe

High Number of Pupils

Albemarle
Amherst
Augusta
Bedford County
Campbell
Chesapeake
Chesterfield
Fairfax County
Henry
Loudoun
Montgomery
Prince William
Pulaski
Roanoke County
Rockingham
Scott
Shenandoah
Smyth
Spotsylvania
Stafford
Suffolk
Virginia Beach
Williamsburg/James City
York

CLUSTERS USED IN ANALYSIS OF EXCLUSIVE SCHEDULE PUPIL TRANSPORTATION DATA

SMALL LAND AREAS

Low Number of Pupils

Buena Vista	Franklin City	Poquoson
Colonial Beach	Galax	Radford
Covington	Hopewell	West Point
Falls Church	Norton	

Medium and High Number of Pupils

Alexandria	Harrisonburg	Portsmouth
Arlington	Lynchburg	Richmond City
Bristol	Manassas	Roanoke City
Charlottesville	Manassas Park	Salem
Colonial Heights	Martinsville	Staunton
Danville	Newport News	Waynesboro
Fredericksburg	Norfolk	Winchester
Hampton	Petersburg	
Henrico		

VITA

Ross Julson

Ross Julson, son of W.C. and Alice Julson, was born on February 26, 1940, in Leeds, North Dakota. He graduated from Leeds High School in 1958 and received a Bachelor of Science degree in mathematics and physical science from Mayville State College in 1963. In 1967 he was awarded a Master of Science degree in Educational Administration by North Dakota State University. In 1990 he was awarded the degree of Doctorate of Education by Virginia Polytechnic Institute and State University.

Mr. Julson taught for five years at the secondary level for the Wolford Public School System in Wolford, North Dakota, and was appointed Superintendent of Schools in Wolford in 1968. In 1969, Mr Julson accepted the position of High School Principal for the Dickinson Public School System in Dickinson, North Dakota, and served in that position for eleven years. In 1980, Mr. Julson became the Assistant Superintendent for Fiscal Affairs in the Dickinson School System, and in 1984 he was appointed Superintendent of Schools in Dickinson.

While serving as a school administrator, Mr. Julson has been active in the American and North Dakota Associations of School Administrators, the National and North Dakota Associations of Secondary School Principals, the National and North Dakota Associations of School Business Officials, the

National Association of Educational Negotiators, and the North Dakota School Study Council.

Mr. Julson is married to the former Darlene Moen. Their family consists of a daughter, Dacota, and a son, Jackson.

Ross Julson