THE INTERACTION BETWEEN LOCAL EDUCATIONAL EFFORTS
AND
STATE AND FEDERAL SUBSIDIES

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree of Doctor of Philosophy in the Graduate School
of The Ohio State University

by

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* * * * *

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PREFACE

The development of models explaining governmental expenditures by function has progressed from humble one equation models used by researchers only fifteen years ago to todays refined multi-equation models, linear and non-linear. Great progress has been made in evaluation of what should be explained and what kind of data best tests the developed hypotheses. A great deal of ambiguity still exists concerning what variables should be included in the model.

In this paper we will examine local government expenditure (or revenue) for noncolleges, regular educational purposes. The primary purpose of this paper is to demonstrate the methodology by which a comprehensive econometric model is derived from economic theory and the institutional structure. Institutional structure includes the laws under which state, local and federal decision makers operate. It also includes formulas or formalized processes through which subsidies are distributed to lower level governments. Only once these are well understood can a complete model explaining local revenues or expenditures and all relevant subsidies follow.

The unavailability of certain key data prevented the actual estimation of the model as a part of the text, but
with the use of certain approximations for the unavailable data, the developed model is estimated in an appendix. Where the data was known to be reliable the model performed well; where the approximations were used the model generally did not perform well. It cannot be determined a priori whether or not the model is deficient.

Several individuals merit particular recognition for their aid in this research. Dr. John C. Weicher, Associate Professor of Economics was very helpful from the formulation of this study until the end result. I am very grateful for his ideas, comments and criticisms.

Dr. John P. Mattila, Assistant Professor of Economics also provided many valuable insights during the compilation of this research, and these contributions are very much appreciated.

Particular thanks must go to Dr. Helen A. Cameron, Associate Professor of Economics, who served in the role of dissertation supervisor. The aid and encouragement during the past years was far beyond what any student has a right to expect. For this effort I can only say thank you very much.

The one individual who deserves the greatest thanks is my wonderful wife, Barbara. In addition to the routine duties of a wife and mother, she has spent hundreds of hours with me collecting, coding and proofreading data as well as editing the manuscript. She performed each of
these tasks with skill and devotion far above the call of duty.
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INTRODUCTION

This dissertation attempts to analyze expenditure on elementary and secondary education using Ohio data from 1967. We devote primary attention to the distribution of federal and state subsidies to local districts and to the investigation of ways in which they interact with local effort. Each subsidy is analyzed based upon the institutional framework under which funds are awarded to local school districts. A statistical analysis of patterns of funding districts is also performed. The study then attempts to build a model of the entire system of educational efforts and subsidies.

Previous studies have inadequately treated the interaction of subsidies and expenditures. Other studies of governmental expenditure (school expenditure as well as other categories) have centered either primarily upon theoretical analysis of effects of subsidy or they have related total subsidy to total expenditure by means of a variety of statistical techniques. These include one equation linear and nonlinear models, principal component analysis, and simultaneous systems.

A few studies have combined theoretical and empirical analysis, but none have looked at the institutional
framework governing the distribution of the subsidies and none have examined each subsidy program in detail. The consequence of these omissions will be brought out in this dissertation.

The primary question to be answered is "Do subsidies interact with local effort?". The problem of interaction is well documented in Economic Theory. In the particular case discussed in this paper, subsidies are said to interact with local efforts if the level of (or change in level of) subsidy changes local effort, or if the level of (or change in level of) local effort affects the level of subsidy, or both. An investigation of each relevant subsidy coupled with the econometric analysis should shed some light upon this question. Clearly we must know how state and federal subsidies are distributed before we can say much about interaction.

In the first chapter, the entire body of economic theory as it applies to this problem will be outlined. In Chapter Two, a survey of the literature will be summarized. As will be shown in this section, the primary emphasis of previous researchers has been toward the selection of variables in their models. Very little attention has been given toward the problem of selecting the best model based upon the institutional structure. In general, virtually all previous models have assumed interaction was non-existent in order to make their analysis and conclusions.
Indeed, if interaction does exist, many conclusions may not follow.

In the third chapter the institutional structure of the locality (the school district) will be outlined. In the fourth we will examine the state subsidy plan. In Chapter Five each federal subsidy which supports educational activities will be presented and outlined. In Chapter Six empirical analysis of each subsidy will be performed as an attempt to verify whether the subsidy distribution structure acts as demonstrated in the previous chapter. These measurements should guide us toward a partial answer toward confirming or denying the interaction effects previously mentioned. This chapter will also contain additional analysis of several subsidies in which the mathematical analysis is deficient.

The last chapter will summarize the accomplishments of the study as well as the failures and provide a guide to other researchers working in this area. It should be mentioned that the institutional structure is presented and subsidies are examined based upon the year 1967. Even where the study proves successful, care must be taken to be sure the institutional structure and subsidy allocation are unchanged before applying the analysis to other years. The hope is that this paper will show a method of organization of subsidy problems which leads to a reasonable model; this aspect of the paper is more important than the results themselves.
CHAPTER I

The purpose of this chapter is to outline the theory of Public Finance as applied to local governmental revenue or expenditure, and the effects of governmental grants upon local expenditure decisions. The institutional framework of local school revenues will be examined as it relates to economic theory and the linkage between theory and the methodology used in this paper will be exalted.

In recent literature the theoretical structure of individual choice has been applied to the case of collective choice. Two basic theoretical approaches have been developed in the past five years. One approach is to define community preferences in a specific form. Henderson defined an expodential orginal collective welfare function and mathematically maximized it subject to an income restraint. 1 Gramlich performed a similar analysis based upon a quadratic utility function. 2 Both utility functions are designed to produce a consistent indifference map (convex to the origin and non-intersecting), and both


have continuous first and second partial derivatives. The second theoretical approach simply postulates the existence of a consistent "preference" or indifference map or part of a social welfare function. One implicit assumption is that community decision making can be examined in the same framework as individual decisions. There is some evidence that under the assumption of simple majority rule with fixed tax shares and a single public good, the theory of individual choice as applied to the median voter would symbolize the position of the community.

**INDIVIDUAL CHOICE - DEMAND CURVES**

In basic microeconomic theory, the demand curve for good 1 of an individual is derived in the following setting: the quantity demanded of good 1 by the ith consumer per period of time is related to

1. the price of good 1
2. the price of other goods demanded by the consumer
3. the amount of money the consumer spends on all goods
4. the consumer's preferences (tastes)
5. the length of time period involved (usually treated as a parameter)

---

3James A. Wilde, "The Expenditure Effects of Grant-In-Aid Programs," *National Tax Journal*, XXI, No. 3 (September, 1968) 34-348.

6. other factors; all of which can be treated jointly as a random variable with the expected value assumed to be zero.

Thus we have a relationship expressed as

\[ q_{11} = q_{11}^R(p_1, p_2, \ldots, p_n, y_1, u_1, e_1) \]

where \( p_j \) is the price of the \( j \)th good; there are assumed to be \( n \) goods

\( y_1 \) is the income of consumer 1

\( u_1 \) is the utility curve of consumer 1.

In order to treat \( q_{11} \) as a function, it is necessary to quantify the tastes of the \( i \)th consumer by introducing a utility index function \( u_1 = u_1(q_{i1}, q_{i2}, \ldots, q_{in}) \) with first and second order continuous partial derivatives.\(^5\) In the above setting the utility function is assumed to have only arguments which are quantities of the \( n \) goods consumed.

In the simple case, the demand curve for good 1 for consumer 1 is derived by considering the changes in the price of good 1, \( p_1 \), with everything else remaining constant. The market demand curve for good 1 is considered to be the total quantity demanded at each level of \( p_1 \) in the range of \( q_{k1} \), where \( k \) is any consumer.

**COLLECTIVE CHOICE**

The primary distinction between collective and individual choice is that we are considering a family of community or group preference functions rather than an

individual utility curve, although they are analogous. The income restraint is considered to be the total or total disposable income of the community or group. One axis is generally expressed as either units of a social or public good X or in terms of dollar expenditure on X, and the other axis consists of community resources for all other social and private uses in dollar terms. While it may seem plausible to consider this community preference curve as some sort of aggregation of individual utility curves, the only workable approach is to consider the arguments of the preference function to be demographic or taste variables. For example, a community with a substantial proportion of connected dwellings may prefer to allocate a larger proportion of community resources for fire protection than would a community where the population resides in separate dwellings. For the purposes of this paper, it is not the preference function itself which is being estimated.

Other analogies between individual and collective choice would be the effect of exogenous subsidies upon the resource allocation of the community. It will be apparent that general and earmarked grants (earmarked toward X) are related to a change in income for the individual case, and a matching grant for X is related to a change in price of good 1.
NON-MATCHING GRANTS - GENERAL VS. EARMARKED

Known initial prices of all goods together with total disposable community income provide an initial budget line PP'. PP' and the preference curve tangent to PP' determine an initial equilibrium at AO in the absence of any subsidy. This is illustrated in figure 1. Now suppose the central government gives an earmarked non-matching grant of PT dollars which must be spent on X. PR represents the number of units of X that PT dollars will buy. Since the community is forced to consume PR units of X regardless of their desired level of consumption, the community budget line becomes the linked line PRT'. Equilibrium is at BO and the consumption of X has been increased by A'B' units. A general non-matching grant of PT dollars which can be spent on X or anything else confronts the community with budget line TT'. Equilibrium is again at BO; the stimulus toward the consumption of X is identical regardless whether the grant is general or earmarked. In this case only the fraction (1 - AB/PT) of the grant actually went toward that good; the rest leaked into nondesignated areas. The magnitude of the leak depends on the marginal propensity of the community to spend its resources on X. This can be measured by the slope of OO'.

Specific grants are unable to cause any greater expenditure on X that a general grant of the same amount until
the magnitude of the grant reaches PV dollars. Beyond that the specific grant has a "deflective effect" causing greater allocation of resources to X than if the grant
had not been earmarked. For instance, a specific grant of PW will produce a budget line PE_oW' with equilibrium at E_o while an equal general grant yields an equilibrium at D_o on budget line WW'. The defl ective effect has taken over when the locality's own funds are all devoted to other uses and only grant money is used for the aided function.

Figure 2 illustrates the relative effects of general and earmarked non-matching aid. OZ represents the expenditures on X in the absence of aid, equal to AP dollars in


Expenditures on X (in dollars)

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ZZ' applies to general non-matching aid
ZZ'' applies to specific non-matching aid
ZZ'''' applies to specific matching aid (open ended)

Figure 2
Figure 1. ZZ' indicates that only a fraction of the general grant would go toward expenditures on the social good X. ZZ'' indicates the analogous effects of earmarked grants, which would be identical to general aid up to ZY, which is equal to PV in Figure 1. At that point the leakage of grant money into other uses has reached the original expenditure on X. Further leakage is prevented as earmarked aid is wholly devoted to X at the margin and ZZ'' diverges from ZZ' and becomes the 45° line.

MATCHING GRANTS - OPEN AND CLOSED ENDED

In the case of a matching grant, the local government is simply faced with a lower effective price for social good X. In Figure 3, the grant shifts the budget line from PP' to PP''. In this case the central government has agreed to pay \( \frac{PP''}{OP''} \) of the cost of X. In the case presented in Figure 3, consumption of X and other things has increased; thus we have a leakage of amount AB.

In this case, we have a price inelastic demand for good X in the indicated region. It is theoretically possible to find the expenditure of X will increase faster than the change in the price of X. This would be detectable in Figure 2 at point Y' (where the slope of ZZ''' is 45°). The maximum possible leakage is the initial expenditure on X. In the limit, as the good becomes virtually free, the price consumption line II' will be asymptotic to PQ. In figure 1-2, ZZ''' will be-
Community Resources for all other uses (in $)
come asymptotic to the 45° line. Thus, for large aid programs there is little allocative difference between earmarked matching and non-matching grants. The situation in which the local government would not have purchased any X at the given price does not alter the basic conclusion.

In the situation where the central government agrees to pay \( \frac{P'P''}{OP''} \) of the cost of X, but will finance at this rate only for OE" units of X placing a ceiling of PT dollars on aid), then units beyond OE' would be available at full price. The community budget line would be PRT'. Equilibrium would occur at point H. The dashed budget lines indicate the amount of general grant or total community income necessary to allow the community to receive the same package of goods as would lowering the price of X, although, in general, the community will reallocate expenditure decisions due to the different relative price ratios. This can be noted by the divergence of the income consumption line CC" and the price consumption line II'.

For rather small amounts of aid (if the kink occurs before the income consumption line CC' intersects the budget line) then the result is the same as a general grant. If the kink occurs between CC' and II' then we will have a tangency at the kink. The latter is illustrated by the budget line PC V' in Figure 3. This result shows a level of matching grant which yields more spending on X than equal amount non-matching grant but less than an open-
ended grant with the same matching requirements. For rather massive amounts of grant, illustrated by the budget line PD W' (in fact, for any level of grant resulting in the kink occurring after passing II'), we would have an equilibrium at point J; the result would be the same as an open-ended matching grant.

In the sense that taxes can be considered negative grants, a general tax would be equivalent to a lowering of PP', the level of community income, and a specific tax on X would be equivalent to raising the price of X. It is obvious that a general tax and a general subsidy of the same amount would exactly cancel out; there will be no change in the consumption of X or other commodities. If a community pays less general tax than it receives in subsidy, then we need only consider the net effect, the difference would be reflected as a change in PP'. All other combinations can be considered in the sense of net position after tax-subsidy.

**GRANTS REQUIRING MAINTAINENCE OF EFFORT**

In the case of a grant toward a particular function with the stipulation that the locality spend at least as much as they would have in the absence of the grant (assuming that amount is known), then the relevant budget line becomes the kinked line PP'S'O shown in Figure 4 for non-matching grants. Assume an initial equilibrium at P'O, the tangency of U'O and PP'. In a "normal"
case (where the family of preference curves lie north-east of the region $Q_0R_0S_0$) then the equilibrium will occur at $S_0$.

In the case of a matching grant (not illustrated) we would find a similar situation. Thus, if maintainence of effort can be enforced, we often would find the effect of grants would be to enrich the community only with respect to the aided function by the amount of the subsidy, with no leakage into undesignated areas.

Community resources for all other uses (in dollars)

Figure 4
Some federal subsidies support local programs which the state would have, in part, undertaken without such subsidy. Other federal subsidies to local areas contain matching requirements which the state shares with the locality. A good place to begin examining any theoretical effects is to consider the case of a federal subsidy to a state government.

In a general equilibrium setting, the state receives subsidies for many kinds of public expenditure. The state must choose a method of taxing and/or selecting a tax rate given the existing taxation mechanism to produce the "desired" level of expenditure allocated over all public goods the state supports, or the state must allocate the expected revenue level (where there is no change in the tax structure) among the various subsidy programs.

A simpler partial equilibrium method of analysis is similar to the theory presented in the last section. That is, given the existing budget line (or, as will be shown, budget region), we can consider the theoretical effect of a single federal program to provide funds to the state on a matching basis.

Consider two extreme cases, presented in Figure 5. Point M represents total state resources available for public expenditure (including any non-matching federal subsidies) which can be allocated between educational
expenditure (good X) or alternative programs. Point N represents the total funds available to the state if they choose to spend all funds on the single federal program which has the highest ratio of federal funds to state funds, and that program is open ended, and is not for good X. These budget lines would be MM' and NM'' respectively. If the federal program is limited and sufficient funds are unavailable to match total state money, then the budget line becomes the kinked KRM', with KR parallel to MM'. If the state switches to another federal program with a lower ratio of federal money to state funds, then the budget line has a y intercept between K and N.
intercepts NM' at R, and coincides with RM'. If the state has some minimum level of expenditure it will allocate toward X despite any other federal program, then the budget line becomes LQ M' with an open ended federal program. In any case, or combination of programs, any feasible budget lines must lie in the indicated triangular region. However, the relevant budget line is not necessarily continuous (it may not be if there exists minimum levels of grant in the desired package of federal programs).

The introduction of a "new" matching subsidy for education effectively lowers the slope in absolute value as previously outlines. Lines LP and KT are analogous to LQ and KR respectively. What is actually observable are the dollar amounts labeled $S_2$ and $S'_2$. If the federal funds are considered part of state subsidy, then we would "observe" a shift as depicted from $S_1$ to $S_2$ and from $S'_1$ to $S'_2$, although the actual shift depends upon the relevant price elasticities. If the federal funds are considered to be a separate component, then the state portion could decline as federal matching programs become available, although in total the sum should increase.

Since the state decision makers must allocate total funds among alternative programs given relative prices, the decision rule must involve an optimization process. This implies the existence of a preference function since optimization is conditional upon tastes and prices.
The additional complication of a budget region rather than a budget line is relevant for the local area also, although the complication is of relatively small proportion compared to the state allocation problem. In the formulation presented, the relevant budget line may be presented as a series of kinked straight line segments which must lie within the indicated regions.

SUMMARY

In this chapter we have outlined economic theory as it relates to the problem of expenditure on a single public good and the effect of exogenous subsidies upon the allocative decisions by the community. Assumptions implied by the theory include the ability of school authorities to alter expenditure decisions based upon changes in revenues (income) and prices. In the latter case, it would not be surprising if we found that school authorities reacted simply by reallocation of funds within the education category in response to aid toward a particular educational category; thus the measured response of the good "education" could well be that it is completely price inelastic.
CHAPTER 2

The purpose of this chapter is to examine types of revenue or expenditure models used in public finance in the last twelve years. We are particularly interested in models which deal with local school expenditures or a similar category, the manner in which the models deal with exogenous taste variables and subsidy variables, and the implication of the model with respect to the impact of subsidies upon revenue-expenditure decisions by the local school authorities.

Most early researchers used interstate data and used total revenue as the dependent variable. The latter in particular leads to a statistical problem which will be examined in some detail. The models are worth examining nevertheless.

The theory would lead us to expect that some measure of per capita income would be one variable explaining the magnitude of own revenue or total revenue. In the setting given in chapter 1, the income and subsidy variables together determine the budget line; other significant variables determine or approximate impacts of the taste variables on the utility function. Given a reasonable stable preference function and exogenous subsidies, we should reasonably expect the aid variable (s) to have coefficients
between 0 and 1 in magnitude, and to be statistically significant.

**LINEAR ONE EQUATION MODELS**

Between 1960 and 1964 Sacks and Harris (72) developed a one equation model similar to a pioneer study by Solomon Fabricant. They regressed per capita state and local combined expenditures on population density, percentage urban, and per capita income for 1960 data. The results are summarized in Table 1. They also ran the regressions with standardized data. The resulting coefficients, called beta weights, implied that per capita income was the variable with the greatest explanatory power. By stating both the dependent and independent variables in standard units, that is, stating both sets of variables in terms of units of its own standard deviation, we derive "beta" coefficients which can be regarded as a measure of the relative importance of the independent variables. (The partial coefficient of correlation, which is the square root of the proportion of variation unexplained by the other variables which is explained when the given variable is added, can be used for the same purpose. Ranking the independent variable by the size of the coefficient of partial correlation often produces a somewhat different ranking than does ranking on the basis of beta coefficients.) One of the main aims of Sacks and Harris was to find a set of variables with a high coefficient of multiple determination.
(R²), and show that the addition of per capita state aid as an explanatory variable made it even higher. For every category of expenditure except education, they also introduced per capita federal aid as an explanatory variable in an effort to raise the R². It will turn out that it is not surprising that they did in fact get a higher R² after including aid as an independent variable.

Fisher (46 and 47) also used normalized data in order to use the regression coefficients in his study as a measure of association. Fisher expressly does not include the federal aid variable in his one equation model. His reasoning is better stated by Morss (57) and will be examined shortly.

Table 1

Sacks and Harris Table

Factors influencing per capita local school expenditures of state and local governments, 48 conterminous states, 1960

E = 10.27 - .05X₁ + .14X₂ + 3.45X₃  \( R^2 = .60 \)

E = 6.04 - .32X₁ - .32X₂ + 3.70X₃ + .52X₄  \( R^2 = .72 \)

* implies significant at the 5% level (standard errors not given)

E = Local school expenditures per capita

X₁ = Population density per square mile

X₂ = Per cent urban

X₃ = Per capita income (hundreds of dollars)

X₄ = Per capita state aid, 1960 (dollars)
Table 2
Fisher's Table

Regression coefficients: per capita state and local government expenditure, 50 states, 1960 fiscal year

\[ E = 60.42 - 1.155X_1 + 0.365X_2 - 0.021X_3 - 0.183X_4 \\
+ 263X_5 + 0.110X_6 + 0.771X_7 \]

\( (0.541) \quad (0.124) \quad (0.013) \quad (0.192) \)

\[ + 0.263X_5 + 0.110X_6 + 0.771X_7 \]

\( (0.106) \quad (0.112) \quad (0.744) \)

Beta coefficients: same data and variables

\[ E = -0.475X_1 + 0.411X_2 - 0.217X_3 - 0.148X_4 + 0.279X_5 \]

\( (0.214) \quad (0.140) \quad (0.128) \quad (0.156) \quad (0.113) \)

\[ + 0.172X_6 + 0.211X_7 \]

\( (0.174) \quad (0.204) \)

* indicates that the coefficient is at least 1.5 times its standard error, approximately 30% significance level

\[ E = \text{combined state-local per capita school expenditures} \]

\[ X_1 = \text{percentage of families with less than $2000 income} \]

\[ X_2 = \text{yield of representative tax system} \]

\[ X_3 = \text{population per square mile} \]

\[ X_4 = \text{percentage of population in urban places} \]

\[ X_5 = \text{increase in population 1950 to 1960} \]

\[ X_6 = \text{two party system index} \]

\[ X_7 = \text{percentage of population over 25 with less than 5 years schooling} \]
One of Fisher's conclusions is that the distribution of income is an important explanatory variable, possibly because political resistance to increased government expenditure and higher taxes may be greater among low income groups.

A somewhat later study along similar lines was done by Sharkansky (73). He was primarily interested in explaining per capita expenditures of the states, rather than combined state-local expenditures. This model eliminates one objection of previous studies, which will be examined shortly. Sharkansky's article introduced two alterations in the examination of government expenditures: "(1) the analysis of state expenditures apart from the combination of state and local government expenditures; and (2) the inclusion of previous expenditures within the correlation and regression analysis of current expenditures."7

One highly criticized but interesting and promising study, was done by Osman (69). Osman believes that federal aid stimulates not only the functions to which they are directed (unless they serve as a substitute for local revenue), but also aid functions unrelated to the one(s) directed (or reduce taxes and/or debt). His technique for measuring this impact, or dual effect of federal funds,

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Table 3
Sharkansky's Table

Regression coefficients for state expenditures per capita on several independent variables, 1963 data

\[
S = -0.02150a + 0.00001X_1 + 0.04238X_2 - 0.00046X_3 + 0.00309X_4 \\
\quad + 0.98040X_5 \\
\quad (0.00000) \quad (0.02807) \quad (0.00109) \quad (0.00166) \\
\quad (0.09824)
\]

* denotes coefficient is at least 1.5 times standard error

S = state educational expenditures per capita

X_1 = per capita personal income

X_2 = federal grants as a per cent of state government revenue

X_3 = state and local government taxes as a percentage of personal income, called tax effort

X_4 = state role; i.e., the percentage of state and local expenditures spent by state agencies

X_5 = previous expenditures; expenditures per capita in 1961

a the standard error of constant was not shown
Table 4

Osman's Table

Regression equations for per capita local school expenditures, 1960

\[ E = -54.41263 + 0.03682X_1 + 2.70713X_2 + 0.33439X_3 \]
\[ + 0.17965X_4 \]
\[ (.00389) \quad (.64289) \quad (.06985) \]
\[ (.06978) \]

(all variables are significant at the 5% level)

\[ R^2 = .809 \]

\( E \) = state and local combined outlay for local education, per capita

\( X_1 \) = per capita income

\( X_2 \) = per capita federal aid to education (including higher education)

\( X_3 \) = per capita federal aid to all categories except education

\( X_4 \) = state population

is to include in the regression equations the variable "total federal aid to all categories except the one under consideration."

Osman says a high degree of federal stimulation is implied by the large regression coefficient for aid to education. Each dollar of federal aid implies a $2.71 increase in state-local expenditures for education, or $1.71 increase from the state plus local government's own revenue sources. Also, each dollar of federal aid to functions other than education increase state-local
expenditures to education by 33 cents. The reasons he offers are: (1) financial resources are being released to education from other functions when some of the other functions receive federal aid, or (2) education is complementary to some other functions, or (3) both effects are operating.

Several authors take vehement exception to Osman's results. Cates (60) states that the purpose of his paper is to take issue both with Osman's procedures and with his interpretation of the results. Cates contends that: (1) serious econometric problems bias his coefficients severely, and (2) since Osman claims there is leakage of funds, a significant stimulative response should not be expected. There are compelling reasons for believing that Osman's coefficient for his specific aid variable is seriously biased.

Statistical analysis of state-local expenditures have been based largely on the statistical significance of the regression coefficients, which in turn have been used to rank the importance of the independent variables. The use of federal aid as a determinant of the level of state and local government expenditures may be questioned on two counts: (1) if the importance of the federal grants variable in the regression models is due solely to a strong correlation with (school) revenues, it contributes little to an understanding of the pattern of interstate
expenditure disparities, and (2) the direction of causality between expenditures and federal grants is extremely nebulous.8 Also, the statistical tests are based on the assumption that the explanatory variables are independent; where two independent variables are highly interrelated or correlated, their standard errors tend to be large, and a simple t-test may lead to the conclusion that one or the other of the regression coefficients is not significantly different from zero. Where there is substantial intercorrelation among independent variables, measures of separate effect such as partial correlation, elasticity, and beta coefficients have little meaning when interpreted out of context.

Since a relatively low percentage of federal grants to education are of a matching variety, and since a relatively high percentage of federal grants toward public goods other than education are of a matching variety, the resultant budget line after exogenous grants (open-ended) should have a greater slope than the community budget line prior to grants. We would expect a change in the price ratios unfavorable toward expenditure on education. If the preference curves follow the setting shown in figure 6, we would not expect Osman's coefficients for the two aid variables;

in fact, the reverse situation would be more "plausible."
Of course, there theoretically exists some set of preference curves which support Osman's conclusions, but no one else has yet noted results consistent with his.

Private Expenditure in dollars

\[ \text{Aid to Education in dollars} \]

Figure 6

Bahl and Saunders (33 and 34) attempt to extend the analysis by regressing changes in selected independent variables on changes in governmental expenditures. The primary conclusion of this analysis is that changes in the level of federal aid and income have had the most pronounced effect on changes in government expenditure.

Bahl and Saunders linear regressions are of the form:

\[ Y = a + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n. \]

A regression coefficient should be interpreted as the change in expenditures which is accompanied by a one unit change in the independent variable. A summary of their results for school expenditures is given in the following table.
Table 5

Bahl and Saunders

Coefficient of multiple determination for regressions of changes in per capita school expenditures on changes in several independent variables between 1957 and 1960

\[ E = F( X_1, X_2, X_3, X_4, X_5 ) \]
\[ \text{48 states } R^2 = .2261 \]
\[ E = F( X_1, X_2, X_4 ) \]
\[ \text{48 states } R^2 = .2100 \]
\[ E = F( X_4 ) \]
\[ \text{48 states } R^2 = .1377 \]

\( E \) = local public school expenditures
\( X_1 \) = changes in per capita income
\( X_2 \) = changes in population density
\( X_3 \) = changes in urban population
\( X_4 \) = changes in federal grants
\( X_5 \) = changes in public school enrollment

In view of the low \( R^2 \)'s shown above, it should be mentioned that in most cases much less of the variation in changes in expenditures can be explained for specific functions (local public school expenditures in this case) than they could for total spending (not shown).

**CRITICISM OF USING TOTAL EXPENDITURE AS EXPLAINED VARIABLE**

A general problem occurs with respect to the selection of the explained variable. Studies which show that changes in a particular variable are associated with changes in their components add little to our knowledge of the
expenditure process. Putting it differently, little is to be gained from simply regressing the dependent variable on parts of itself. Even if the relationships are not one to one, these cases generally prove to be uninformative. To see what is really going on in such cases, one needs more than a single equation model. The case of the early models can be symbolized as follows.

\[(1) \quad Y = b_0 + b_1X_1 + b_2X_2 + \ldots + b_kX_k\]

where \(Y = \) total expenditure

\(X_k = \) federal subsidy

\(X_i = \) other explanatory variables, with \(i = 1, 2, \ldots, k-1\)

Also we have

\[(2) \quad Y = X_k + S \text{ (identity)}\]

where \(S = \) state and local expenditures other than those financed by federal aid.

If \(X_k\) and \(S\) are both exogenous, and if the variables are defined as deviations from their mean, the \(R^2\) statistic for form \((1)\) can be defined as

\[(3a) \quad R^2 = \frac{B'X'y}{y'y}\]

where \(B\) is the vector of coefficients \(b_i\), \(i=1, 2, \ldots, k\)

\(x\) is the matrix of explanatory variables defined as deviations

\(y\) is the vector of the explained variable in terms of deviations

The numerator of \((3a)\) represents the sums of squares due to the linear influence of the explanatory variables, and it can be expanded into:
(3b) \[ B'x'y = b_1 \sum_{i=1}^{n} x_{1i}y_1 + b_2 \sum_{i=1}^{n} x_{2i}y_1 + \ldots + b_k \sum_{i=1}^{n} x_{ki}y_1 \]

Now if the identity (2) is combined with (1) and the common element \( x_k \) is removed from both sides, then:

(4) \[ S = b_0 + b_1x_1 + b_2x_2 + \ldots + b_kx_k \]

and \( b_k^* = b_k - 1 \); the other variables defined the same as before. With the form as (4) the \( R^2 \) becomes:

(5a) \[ R^2 = \frac{B'^*x'y}{y'y} \]

with \( B^* \) is the vector of regression coefficients of (4)

\( x \) is the matrix of explanatory variables defined as deviations

\( y \) is the vector of the explained variable in terms of deviations.

The corresponding sums of squares representing the linear influence of the explanatory variables can be expanded into:

(5b) \[ B'^*x'y = b_1 \sum_{i=1}^{n} x_{1i}y_1 + b_2 \sum_{i=1}^{n} x_{2i}y_1 + \ldots + b_k \sum_{i=1}^{n} x_{ki}y_1 \]

It is literally impossible to tell which \( R^2 \) (3a) or (5a) is higher in this general setting, but it is suspected that the element of spurious correlation introduced in the first form will generally tend to induce the former to appear greater despite the fact they essentially measure


\[ ^{10}\text{Ibid.} \]
the same phenomenon.

An experiment has been conducted with a similar case. In the above setting, assume the value of $S$ is given exogenously, $X_k$ is the only explanatory variable, and that $S$ depends at least in part on $X_k$. Also assume that the latter can be expressed as:

$$ (6) \quad S = a + bX_k $$

and that we retain identity (2). The proper way to get estimates of the parameters in the above case is to calculate the reduced form equations, which will be:

$$ (7) \quad Y = a + (1 + b) X_k $$

The regression coefficient of $X_k$, $1 + b$, gives an estimate of the effect an increase in $X_k$ will have on $Y$. It is superior to the estimate derived from regressing $Y$ on $S$ and $X_k$ in that it makes allowance for the interaction between $S$ and $X_k$. But (7) is not entirely satisfactory. Its $R^2$ will overstate the explanatory power of the behavioral relationship between $X_k$ and $Y$. When we remove the identity we are back to form (6). The following example was developed by Elliott Morss.\(^{11}\) Using 1960 data, he gets

$$ (7) \quad Y = 226.96 + 1.25X_k \quad R^2 = .30 $$

The results suggest that federal aid explains 30 per cent of the variation of $Y$, and that there is a significant,

---

positive relationship between \( Y \) and \( X_k \). However, if the identity portion is removed, we have

\[
(6) \quad s = 227.30 + 0.25X_k \quad R^2 = 0.02
\]

There is little in these results to suggest that any meaningful relationship exists between the dependent and independent variables. It appears that federal aid is significant in explaining variation in state-local expenditures only because these lower level governments are required to spend all the federal aid payments they receive. Thus, the dependent variables is best expressed as expenditure (or revenue) from their own resources, or total expenditure less federal subsidies.

Studies have been done using both interstate and intrastate data. In the case of intrastate data, it has been noted that "the introduction of a state aid variable presents far greater problems (than federal aid) because of the variation in the types of programs among states..." Unfortunately, this specification of the state aid variable in the regression equation accounts for more than the variation in the provisions of the state aid programs; it also allows for interstate differences in the institutional structure and variations in marginal evaluations of communities of benefits of public consumption versus private actions."^{12}

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The general solution in the case of interstate data is to combine state and local expenditure (or revenue) into the explained variable, and, instead of both subsidy variables as explanatory variables, use only federal aid. If the effect of state aid is desired, then intrastate data has been used.\(^{13}\)

**NONLINEAR MODELS**

All known expenditure-revenue models developed to date are intrinsically linear (linear in the parameters). Several models have been developed which are nonlinear in the variables. A model in the form of (1) assumes the relationship among the variables is additive; that is, the impact of the predictor variables is found by adding the separate effects of individual factors. An additive model implies that the change in one of the predictor variables is the same, no matter what the level of the predictor variables might be. Two examples of popular nonlinear models are:

(8) \[ Y = b_0 X_1^{b_1} X_2^{b_2} X_3^{b_3} \ldots X_k^{b_k} \]

(9) \[ \log Y = \log b_0 + b_1 \log X_1 + b_2 \log X_2 + \ldots + b_k \log X_k \]

The above incorporate the "advantage" that the level of the variable is taken into account, and they are sometimes

\(^{13}\)George A. Bishop, "Stimulative Versus Substitutive Effects of State Aid in New England," *National Tax Journal*, XVII, No. 2 (June, 1964) 143.
called joint effects models. The exponents associated with the X terms are elasticity coefficients. That is, for a one per cent change in the level of the X variable, the corresponding b value indicates the corresponding percentage change in the dependent variable, and the sign of the b value indicates the direction of change. A variable is said to be elastic if the regression coefficient is greater than one and where it is statistically significant.

The models are generally evaluated in form (9). However, if the $R^2$s are to be compared with a linear model with the same variables, the model must be converted into form (8). (8) differs from (9) by a simple transformation. If the model is not converted into form (8) before comparisons are made, the $R^2$ statistic cannot be directly compared to the corresponding linear model. Because form (9) explains the log of the dependent variable.  

Any comments which apply to linear models also apply directly to all nonlinear types, and any error which could be made formerly could be made in this nonlinear setting. For example, if the explanatory variables are correlated

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altogether or in part, it is likely that the calculated elasticity coefficients measure the extent to which increases in the dependent variable follows from changes in any particular predictor variable because of influences of one "independent" variable upon another. In summary, all previous and future comments apply to these models.

Ernest Kurnow (55) was one of the first to develop a nonlinear one equation model. His model was of the form (8), and he first took the Fisher model's variables and estimated the elasticity coefficients. In terms of an $R^2$ measure with 1957 data, the $R^2$, are .72 and .88 for Fisher and Kurnow model respectively.

Also, population density and degree of urbanization are highly correlated, and there is no significant advantage in using both variables. Kurnow "improves" his model by deleting $X_2$, density and adding two different independent variables.

Table 6

Kurnow Model

\[ Y = X_1^{.56} X_2^{.22} X_3^{.26} X_4^{-.39} \]  
(All coefficients significant at 95\% level)

$Y =$ per capita expenditure  
$X_1 =$ per capita personal income  
$X_2 =$ degree of urbanization  
$X_3 =$ per capita federal aid  
$X_4 =$ student-teacher ratio
Using his model using 1942 data, Kurnow's model with the above four variables yields an $R^2$ of .81, the Kurnow model with Sacks and Harris' three variables (per capita income, density, degree of urbanization) yields an $R^2$ of .78 and for the linear model with the above three variables the $R^2$ is .53.

Kurnow does note that there are intercorrelations among the explanatory variables, which makes it difficult to state whether the calculated elasticity coefficients measure "precisely" the extent to which increases in the dependent variable follows from changes in any particular predictor variable because of influences of one independent variable upon another.

MODELS USING LOCAL REVENUE AS THE DEPENDENT VARIABLE

Following the suggestions of Morss, David Smith (74) estimated the expenditure response of state-local governments to federal grants by means of a linear multiple regression model. Smith used state-local expenditure from internal sources (total expenditure less federal aid) as the dependent variable in an effort to improve the regression estimates of the effects of federal subsidies on expenditures. Smith is concerned with the question of whether or not federal grants stimulate educational expenditures. Stimulation is shown if the coefficient of the federal subsidy variable is greater than zero and significant. Little or no response is indicated with respect to federal aid for education. In conclusion, the indications
Table 7

Smith Linear Model

Regression equations for per capita state and local government expenditures from internal sources for education, 50 states, fiscal year 1965.

\[ E = -214.05 + 0.6800X_1 + 0.0642X_2 - 0.0417X_3 + 0.8674X_4 \]

\[ (0.5961) (0.0077) (0.0100) \]

\[ (0.1788) \]

* denotes that the variable is significant at the 5% level

\[ E = \text{per capita education expenditures from internal sources of state and local governments} \]

\[ X_1 = \text{per capita federal aid to education} \]

\[ X_2 = \text{state per capita personal income} \]

\[ X_3 = \text{population density} \]

\[ X_4 = \text{public school enrollment per 1000 of state population} \]

Table 8

Smith Log Model

Elasticity coefficients of per capita state and local government expenditures for education from internal sources, 50 states, fiscal year 1965.

\[ E = -3.8709 - 0.0438 \log X_1 + 1.1387 \log X_2 - 0.0788 \log X_3 + 0.9828 \log X_4 \]

\[ (0.0391) (0.1095) (0.0196) (0.2552) \]

\[ R^2 = 0.74 \]

* denotes the variable is significant at the 9% level

\[ E = \text{the log of per capita state-local education expenditures} \]

\[ X_1 = \text{per capita federal aid to education} \]

\[ X_2 = \text{state per capita personal income} \]

\[ X_3 = \text{population density} \]

\[ X_4 = \text{public school enrollment per 1000 of state population} \]
of the Smith model is that federal grants tend to subsidize other state-local activities.

David Smith (74) also estimated the elasticity of state and local expenditures with respect to federal grants by means of a log-linear model of the form: \( \log E = \log a + c_1 \log X_1 + c_2 \log X_2 + \ldots + c_n \log X_n \). The dependent variable is per capita state and local government expenditures from internal sources. The results are summarized in Table 8.

A variable is said to be elastic (federal aid in particular) if the regression coefficient is greater than one and where it is statistically significant. Federal aid is said to be inelastic when its coefficient is greater than zero but less than one and where it is significant. A significant negative coefficient indicates a substitution of federal funds for local funds, suggesting that the function might be considered an "inferior" good.

Federal education grants should not lead to budget distortion since the coefficient, although negative, is not statistically different from zero. Smith takes the lack of association between federal aid to education and state-local expenditures for education from internal sources to imply that the demand for education is perfectly price inelastic. 16

PRINCIPAL COMPONENTS

As we have indicated, many previous results have been difficult to interpret due in part to multicollinearity which gives rise to misleading high correlations and poor parameter estimates. Principal components is one way to find a set of factors which are totally uncorrelated with each other. At the risk of oversimplifying the rather complex principal component analysis, the first step is to select from a large list of variables groups which are highly correlated among themselves and lowly correlated between groups. In essence, a single "proxy" from each group is selected, and these representative variables are subject to a mathematical rotation of axis to reduce the correlation to zero of any "representative" with another. In practice, intercorrelations are exceedingly complex and varied, and the final selection of variables rests with the statistician. The main problem occurs with variables which are in the "middle" correlation range (in absolute value between .3 and .7). There is no firm rule for dealing with such variables.

Pidot (70) tested by means of principal components a group of 30 variables, each with 81 observations taken from large, metropolitan core areas. Pidot found that six factors had sufficient explanatory power to be retained. His results are summarized in the following table. The label given to each of the six groups is the author's description of the types of variables which are in that
component or group.

Table 9

Pidot's Table

Regression coefficients from equations relating per capita revenues and expenditures to current education expenditures and principal components

\[ E = 56.35 + 0.323X_1 + 0.134X_2 - 4.910C_1 - 8.622C_2 + 0.247C_3 - 1.781C_4 - 2.349C_5 + 1.784C_6 \]

\[ (19.35) (6.75) (0.62) (-4.43) (-7.41) (0.22) (-1.68) (-2.21) (1.64) \]

\[ E = \text{current educational expenditure} \]

\[ X_1 = 1962 \text{ total state aid per capita} \]

\[ X_2 = 1962 \text{ direct federal aid per capita} \]

\[ C_1 = \text{metropolitanism (density, growth rate)} \]

\[ C_2 = \text{wealth} \]

\[ C_3 = \text{size index} \]

\[ C_4 = \text{absence of older or lower income people and presence of a manufacturing base} \]

\[ C_5 = \text{residential vs. commercial development including proportion of students in public school} \]

\[ C_6 = \text{crude measure of stagnation} \]

The metropolitan component is the most important single variable, being associated with greater outlays for social welfare programs, protection, renewal, sewage, and sanitation. While this sounds unrelated to school expenditure, the negative sign in front of this coefficient (although it is not significant) implies a source of competition for educational funds. These areas also are characterized by a somewhat
smaller relative number of children in public schools. The wealth component appears to have a mixed impact. The lower the wealth index, the greater the outlay for education.

STUDIES UTILIZING INTRASTATE DATA

To restate the problem detected by Adams (previously noted), when state aid is separated from local support for education, the regression coefficients appear to measure the institutional structure of state aid. One way to temporarily filter this factor out is to restrict our analysis to one state. This conclusion was also reached by Bishop.

Bishop (39) is the only author noted here whom is primarily concerned with school expenditures. In his study, "Stimulative Versus Substitutive Effects of State School Aid in New England," Bishop found it impossible to aggregate the states and still have any meaningful relationships. In effect, he concluded it was best to run regression for each state separately. The equation fitted to the data was:

\[ E = a + b_1X_1 + b_2X_2 + b_3X_3 \]

where \( E \) = current local expenditures for education per capita

\( X_1 \) = state aid for current expenditures per capita

\( X_2 \) = equalized valuation of property per capita

\( X_3 \) = number of pupils in average daily membership

His conclusions can be summarized as:

1. If each town has equal weight regardless of size, an additional dollar of state aid is associated
with an increase in expenditures from 40% to 80%.

2. For small towns state aid has a more important stimulative effect than in larger towns.

3. When city data is weighted by number of pupils or size of expenditures, state aid appears not to have a significant effect on expenditures. The primary effect of additional state aid then is to reduce the burden on the property tax.

4. The implication of the previous conclusion is that despite the stimulating effects of state aid in smaller towns, the primary effect of additional state aid on a state-wide basis is to reduce the property tax burden.

OTHER POSSIBLE STRUCTURES FOR MODELS

Pogue and Gontz (71) investigated four possible types of models (with respect to variable interaction and structure) which are theoretically possible in the setting presented. They can be summarized as follows:

1. Expenditures are determined, in part, by aid payments with expenditures having no effect on aid payments.

2. Aid payments are determined, in part, by expenditures, with aid payments having no effect on expenditures.

3. Aid payments and expenditures are jointly determined, i.e., a function of each other.
4. At least some of the factors determining expenditures also influence aid; and, the set of variables \( X_1, X_2, \ldots, X_{k-1} \) does not include all of these common determinants. Instead, some of the factors which influence both aid and expenditures are included in the error term.

Many of the early papers either did not recognize the possibility or implicitly assumed that 2, 3, and 4 are invalid. If the state of the world was such that 2, 3, or 4 were valid, then the calculated regression coefficient for \( X_k \) (assumed to be the only variable in question) would be biased.

Three of the above points can be expressed in an explicit form. If 1 is true, then the model in linear form will be:

\[
E_1 = b_{10} + b_{11}X_1 + b_{12}X_2 + \ldots + b_{1k-1}X_{k-1} + b_{1k}S + u_1
\]

where \( S \) is the aid variable

- \( E_1 \) is own revenue
- \( X_1 \) is the set of other independent explanatory variables,

with \( i=1,2,\ldots,k-1. \)
Theoretically, 2 would be a rather special case. Regardless of whether aid is determined by expenditures or is exogenous, if expenditures (or total units of education purchased) is invariant, we have preference curves as illustrated in Figure 7. For the "right" set of preference curves, several states of the world could produce the same result.

![Diagram: Private Expenditure in dollars vs Units of Education]

Figure 7

The lower budget line shows allocation of income prior to subsidy. The higher budget line shows the higher level of wealth after subsidies and the case where expenditure on (units of) education does not change. Unless subsidies are an argument of the community preference function, any increase in the level of wealth (within a range) would have the same effect.

If 3 holds, then the functional relationship in linear form can be expressed as:
\[ E_2 = b_{20} + b_{21}X_1 + \ldots + b_{2k-1}X_{k-1} + b_{2k}S + u_2 \]  
\[ S = a_{20} + a_{21}X_1 + \ldots + a_{2k-1}X_{k-1} + a_{2k}E_2 + u_2 \]

This model, if identified, can be evaluated by two stage least squares. Another possible interpretation of 3 would be the same as the above except the coefficient \( a_{2k} \) would equal zero.

The functional representation of 4 would also be similar to (11), although both \( a_{2k} \) and \( b_{2k} \) could equal zero. Case 4 is not mutually exclusive from any of the others, and as a practical matter one never captures all the variables which may influence a relationship. If the "omitted" variables are treated jointly and have expected value zero, we have no serious difficulty.

Fogge and Sgontz attempt to investigate the four possibilities via the ensuing analysis. The conclusions shown are their interpretation of the results. Table 10 gives the estimated regression equations relating school expenditures to a number of economic and demographic factors. Table 11 gives the explained variation resulting when federal aid payments for education is regressed on the variables used to explain school expenditures. For all categories of federal aid, these explanatory variables account for a statistically significant portion of the variation in per capita aid payments. Consequently, aid payments appear to be determined, at least in part, by expenditures and/or the same variables which determine expenditures. That is, it appears that statements 2, 3,
Table 10
Pogue and Sgontz Model

Regression statistics: equations for per capita expenditures of
state and local governments, pooled data, fiscal years 1958-64

\[ E = 114.6 + 0.142 X_1 - 3.54 X_2 + 00 X_4 + 00 X_5 - 1.43 X_6 + 1.496 X_7 + 00 X_{12} \]

\[ + 7.99X_{13} \]

\[ R^2 = 0.802 \]

All coefficients shown are significant at the 10% level.
00 coefficient indicates the variable was run but results were not
significant.

\[ E \] = state and local education expenditures, per capita

\[ X_1 \] = per capita personal income; average of current and previous years
income.

\[ X_2 \] = families with income under $2000 and unrelated individuals with
income under $1000 as a percent of total families and unrelated
individuals.

\[ X_4 \] = square miles per public school enrollee by state (fall enrollment)

\[ X_5 \] = percent of 1960 population living in urban areas over 500,000
population.

\[ X_6 \] = percent of 1960 population living in areas of 50,000-500,000
population.

\[ X_7 \] = percent of 1960 population living in urban areas over 2,500
population.

\[ X_{12} \] = percent change in state population: \( \frac{Population(t-1) - Population(t-3)}{Population(t-3)} \)

\[ X_{13} \] = time (1958 = 0, 1959 = 1, ..., 1964 = 6)
Table 11
Pogue and Sgontz table

Regression statistics; equations for per capita federal aid to state and local governments, pooled data, fiscal year 1958-1964

\[ F = 282.6 - .12 X_1 - 2.25 X_2 + 157.7 X_4 + .00X_5 + .96 X_6 + 1.76 X_7 + 2.36 X_{12} \]

\[ \begin{align*}
(59.3) \quad (0.02) & \\
(1.10) \quad (13.2) & \\
(54) \quad (0.63) \quad (0.89) & \\
\end{align*} \]

\[ + 20.8 X_{13} \]

(2.3)

All coefficients shown are significant at the 10% level

00 coefficient denotes that variable was run but the results were not significant

\[ F = \text{per capita federal aid to education} \]

All other variables defined in Table 10.
and 4 are valid. The chief implication is that the estimated regression coefficients of federal aid payments in such an equation cannot be correctly interpreted as an estimate of the change in per capita expenditures which would result from a change in per capita federal aid payments.

The hypothesis that federal aid stimulates state-local spending is tested by observing whether the coefficients in Table 12 are greater than one and statistically significant. For local educational expenditures, none of the six years (three shown) from 1958 to 1964 show significant coefficients. This result shows little support for the hypothesis that aid stimulates expenditures, even where it is assumed that there is no positive bias in the estimated coefficient, and if the probable positive bias is taken into account, support for the hypothesis is even weaker. In fact, for local educational expenditures, the hypothesis that the federal aid coefficients are greater than zero must be rejected.

In addition to concluding that federal aid has an effect on state and local expenditures, Sacks and Harris conclude that state aid to local governments is an important determinant of state-local spending. This conclusion is based on the positive partial correlation between state-local expenditures per capita and state aid per capita. Although Fisher disagrees with the Sacks-Harris conclusion that federal aid is an independent determinant of expenditures,
Table 12

Pogue and Sgontz

Regression coefficient for federal aid as an explanatory variable

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>1958</th>
<th>1960</th>
<th>1962</th>
<th>1964</th>
</tr>
</thead>
<tbody>
<tr>
<td>state-local education expenditure per capita</td>
<td>-2.461</td>
<td>1.231</td>
<td>.0998</td>
<td>1.722</td>
</tr>
<tr>
<td></td>
<td>(1.131)</td>
<td>(1.087)</td>
<td>(1.033)</td>
<td>(1.156)</td>
</tr>
</tbody>
</table>

He does agree that their empirical result supports the hypothesis that state aid is a determinant of state-local spending. However, the correlation between state aid and state-local spending need not indicate a cause-effect relationship if both aid and spending are determined by the same set of factors (condition 4). Pogue and Sgontz, using their data, regressed total state aid per capita on all the variables which had a significant effect on total expenditures. Most pairs yielded significant partial correlation coefficients. This suggests that state aid may be determined, at least in part, by the same set of factors which determine expenditures.

Given their conclusions, it is somewhat surprising that Pogue and Sgontz didn't attempt a direct attack upon the problem by investigating a simultaneous equation relationship. However, other recent investigators have moved in that direction.
SIMULTANEOUS-EQUATION METHODS

Another recent approach toward explaining differences in the level of state and local governmental expenditures is the use of simultaneous-equation techniques. Two recent papers have expounded the use of the simultaneous approach.

Wadycki and Gertz (48) use simultaneous equation methods to examine the case of police protection. The purpose of the paper is to estimate the parameters of a model which determines both level of expenditure and service for police protection (service measured by the prevailing crime rate). One advantage of this model is that it avoids an implicit assumption that the level of per capita expenditure equals the level of service; i.e., cost and efficiency differentials are not ignored. Another theoretical advantage over the one equation model is that the effect of certain key variables cannot be predicted a priori in a single equation model. For example, consider the effect of income on expenditure. It would be expected that as income in a community rises, people would desire a greater level of protection; yet it is also known that the crime rate and income are negatively correlated, indicating that the need for protection diminishes as income increases. In a single equation model the influence of income on the demand for service cannot be separated from its influence on cost. In this simultaneous system the direct effects of income are included in the expen-
diture equation while the effects of income on crime (which in turn influences expenditure) is taken into account in the crime equation.\textsuperscript{17}

An earlier study by Horowitz (54) uses a large simultaneous system to analyze interstate differences in state and local governmental expenditure, as well as some measure of service provided (as measured by the number of state and local governmental employees adjusted to a full-time basis per 10,000 population). Interdependence of variables implies that explanatory variables not only influence the level of public service but are influenced by it, either directly or indirectly.\textsuperscript{18}

Horowitz was primarily concerned with total governmental expenditures rather than any particular category. The variables which proved significant were fiscal capacity or per capita income, tax effort, percentage of workers employed in manufacturing, distribution of income, size and density of population, percentage of population


resident in urban areas, percentage nonwhite population, and level of per capita federal aid. Other variables considered which did not prove significant were the growth of the population, geographic size of the state, several measures of the age distribution of the population, average enrollment per public school, and debt of the state and local governments. In particular, federal aid was significant toward explaining both per capita expenditure and number of state and local governmental employees per 10,000 population.

**SUMMARY**

There is mounting evidence that the one equation model, linear and nonlinear, is inadequate to adequately explain the "state of the world" as applied to the interaction between federal and state subsidies and local revenues. It has also been demonstrated that local expenditure or revenue is a more reasonable dependent variable than total expenditure or revenue, despite the fact both are intended to explain the same phenomenon.

Every study in this area has found some measure of wealth, generally per capita income, to be a significant explanatory variable. Economic theory leads us to expect this. Demographic variables which seem to explain some of the statistical variation include population density, index of poverty or income distribution, rate of change of population, degree of urbanization, student-teacher
ratio, number of students in average daily attendance, and state and/or federal subsidies. Other studies have found that urbanization, population density, and rate of change of population to be insignificant toward explaining statistical variation in the level of local revenue. The variables selected for consideration in this study will be examined in chapter 3 through 6.
CHAPTER 3

The purpose of this chapter is to examine the institutional framework and political structure of local school agencies. The structure will be annotated by reviewing the voting process in Ohio and the laws under which school authorities operate. We will attempt to isolate forces which influence the direction and level of local school revenues, although many of these forces are in theory arguments of the corresponding community preference function.

THE SCHOOL DISTRICT

Educational services in Ohio are provided by an autonomous governmental body, the school district. The school district is governed by an elected board and generally administered by a superintendent responsible to the school board. The school board alone is responsible for raising revenue for the operation of public schools.

For purposes of this paper, school districts will be combined into "county units." The school district does not necessarily follow other governmental jurisdictional boundaries (including state lines), but the classification of school districts into counties has been satisfactorily accomplished. County totals have been reported by the Auditor of the State (of Ohio), and this source of data will be tapped in large part.
OWN REVENUE

Own revenue is defined as the total sum of money per year collected from local sources for public schools, or, alternatively, total school revenue collected in a school district or county less federal and state subsidies. Local sources of revenue open to boards of education are primarily taxes on tangible and intangible personal property. These general taxes comprise an average of 73 per cent of own revenue. Proceeds from bonds and notes total 14 per cent of own revenue; the balance is composed of gifts, sale of equipment, lunchroom sales, and other minor items.

Net indebtedness of a school district can never exceed 1/10 of 1 per cent of total value of assessible property without the vote of the people. With the vote, debt is allowable up to 9 per cent, but amounts over 4 per cent need expressed authorization by one or more levels of state government.¹⁹

The bulk of local revenues is raised by property taxation. "At any time the board of education of any school district by a vote of 2/3 of all its members may . . . submit to the electors of a school district at a special or primary election to be held at a time specified in the resolution."²⁰


However, only one special election may be held in any one calendar year. Also, a special levy can run for a maximum of two years. For any school revenue election, 50 per cent of the vote is needed for current expenditures, 55 per cent is necessary for other school purposes.\textsuperscript{21}

Since in every year in most school districts voters are called upon to renew old levies or confer new ones, the tax rate agreed upon by the school board must be a rate they feel has a reasonable probability of passage. This rate must produce enough revenue to operate the school system with respect to the known fixed obligations and the requests of the school administration. It is generally assumed that the board represents the electors and in any case they must estimate the desire of the population to support public education. In the event they overestimate or fix a higher rate than the public will support, they get only one additional chance (per year) to either publicize their position and/or offer a lower rate to the voters.

\textbf{EXPLANATION OF OWN REVENUE}

As depicted in Figure 8, the theoretical forces which determine the level of own revenue are determined by

\textsuperscript{21}Ibid., 50.
1. the location of the total income line (called effective income) which includes the total subsidies to education and,

2. the location of the preference curve which is tangent to the income line, which is determined by the "taste" variables which determine it's shape.

Thus, in addition to total wealth, including federal and state subsidies, whatever forces are arguments of the preference function also determine the level of own revenue. In the setting shown, we should expect both federal and state nonmatching subsidies to have the same statistical
impact if in fact they are exogenous. This impact is determined by the slope of the income-consumption line. The general shape expected would be as the 00' in Figure 8. We are in an income inelastic region of the "demand" curve for public education, thus the subsidy impacts would be between 0 and +1. An income-consumption curve such as QQ' indicates we are in an income-elastic region of the "demand" curve and the subsidy impacts would be greater than +1.

Finally, it should be noted that we are not attempting to derive a demand curve for public education. The variables which vary from locality to locality are the taste variables. We also are not attempting to derive "units" of public education." In the absence of these units a demand curve is an unrealistic goal. However, we do not have the implicit assumption that equal expenditure implies equal productivity. Productivity variables would be arguments of the preference curve. They probably are not measurable however.

ARGUMENTS OF THE PREFERENCE FUNCTION

Some of the demographic and taste variables in the preference function have economic explanations; others simply record the tastes of different groups of people and have no economic interpretation. If a variable has been used "successfully" in a previous study on school expenditures, then it is reasonable to assume that a
researcher has found a variable which is, or is a proxy for, an argument of the preference function. In general Economic theory does not purport to identify arguments of a community preference function. Some reasonable arguments include:

- Expected permanent income
- Changes in expectations about permanent income
- Distribution of income
- Age distribution of population
- Religious distribution of local population
- Rural-urban composition of local population
- Composition of tax base
- Rate of growth of the local population
- Educational level of the population

Some of the above are readily quantifiable; in other cases a specific proxy for the general effect must be found. The source or derivation of collected data which is used to represent or proxy the above are catalogued in Appendix A. The nature of the proxies and the expected direction of impacts will be discussed next.

**EXPECTED INCOME**

Economic theory hypothesizes that an individual's level of current expenditure is a function of permanent rather than current income. To the extent that this can be abstracted to groups, then the difference between current and expected permanent income could influence the
preference function. Since permanent income is generally not measurable, the level of unemployment and/or change in level of unemployment will be used to try to capture some of this effect. The rational is that people generally do not plan to be unemployed, and if unemployment occurs, revisions in permanent income would ensue. High levels of unemployment indicate depressed economic conditions, which often affect permanent income of groups other than the unemployed. A one or two year lead is reasonable since revenues for this year (for schools) are derived from levies voted or in effect from the previous year. That is, there is an average one year delay between the passage of a levy and its first collection (in Ohio). In the setting presented here, revenue to the schools is synonymous with expenditure for schools as far as the group is concerned, the group consisting of the voting taxpayers whose preference function is being expressed in this analysis.

The level of current income may be an important facet of permanent income expectations. In this study current income is estimated by the residence of the wage earner rather than the location at which the income was earned. This was done because a majority of the tax burden falls upon residential property for school operating purposes.
DISPERSION OF INCOME

There is some evidence that the level of per capita income may also be a measure of income distribution; that is, the percentage of families classified as poor may be highly negatively correlated with the average level of per capita income. Also, the percentage of families classified as "poverty level" by the United States Government standards (in 1967) will be used directly.

COMPOSITION OF THE TAX BASE

The composition of the tax base is relevant for several reasons. First, given the presence of a large industrial base, property taxes amount to partial tax shifting (to non-residents or to a small relatively wealthy group). Second, heavy property taxes hold little appeal for groups with large real estate holding, such as rural areas. It is also possible that attitudes toward public education differ between urban and rural groups. The variables selected will be percent of land classified as taxable and industrial and percent of land classified as agricultural and taxable. It would also be wise to include for each locality the percent of land classified as tax exempt. If pupils are relatively uniformly dispersed throughout a locality, then the presence of tax exempt land presents the local taxpayers with a somewhat larger burden if they wished the same level of expenditure per pupil than would a similar area with a lesser level of tax exempt land.

22 Nels W. Hanson, "Economy of Scale as a Cost Factor in Financing Public Schools," National Tax Journal, XVII, No. 1 (March, 1964), 92-95.
POPULATION VARIABLES

Many previous studies have found population density, population size, and/or number of students in average daily membership to be significant factors in explaining statistical variation in own revenue or total revenue for public education. The primary economic reasons for this potential link between revenues and size (density) is the possibility of economics of scale in public school systems.

No specific data has generally been collected concerning the actual size of school systems with respect to individual school plants, but it is generally true that school systems with large numbers of students tend to have large individual schools. Even a large system or district with many small schools could exhibit economics of scale in the sense that certain indivisible costs such as administration or special instruction may be lower on a per pupil basis. Also, if larger systems tended to need more levels of administration or institute programs a smaller district would not initiate, then per pupil costs could tend to be higher for the larger district.

It is also reasonable that areas with a large population have a corresponding large number of pupils. If that is the case, both population and student variables should not directly be used in the same regression due to multicollinearity. There is a reasonable way to isolate both effects. The ratio of pupils in average daily membership to population gives an indication of
the percentage of an area's population which need be supported in schools. Logically, the greater the ratio of students to population, the larger "effort" may be made by a community. Thus, within a population size or density class, we would expect higher per capita costs (or revenues) associated with the larger ratios.

As to the question of whether economies of scale are likely in public schools, the available evidence reports mixed results. One study of 577 school districts in nine states has shown some tendency for a U shaped distribution in six of the nine, and decreasing unit costs in the other three. This was established when an equation of the form:

\[ Y = a + bX + cX^2 \]

with \( Y \) = unit cost (per capita)

and \( X \) = size of district (average daily membership)

is regressed and \( b \) is found to be negative and significant, \( c \) is found to be positive. \( c \) was significant in the six states mentioned, not significant in the other three.\(^{23}\)

However, another empirical correlation and regression analysis did not reveal significant economies of scale in school districts of the St. Louis city-county area. This study involved 27 school districts ranging from 600 to

84,000 pupils. In this study no parabola effect whatsoever was found - in fact there was also no linear effect. This study found that there also was no significant effect for the variable "percent increase in average daily membership." Thus, while population size and/or density should influence per capita expenditure on schools if economies of scales exist or for other possible reasons, the expected effect on the preference function and own revenue has not been empirically established.

It also becomes evident that other variables will be highly correlated with population size or density (in this case perhaps positively to percent nonwhite or negatively to percent land zoned agricultural). Since evidence justifying the inclusion of this variable is rather mixed, and since the approach used here is to include variables only which can be justified, neither population variable will be used to explain the level of own revenue in the ensuing analysis.

However, rate of growth of the population may be a proxy for the need for educational services. Less population pressure would allow diversion of funds from additional physical facilities toward current operation expenditures or toward other public services. Here we

also assume a uniform distributional decline; we may find that the actual decline occurs mainly among the young educated members of the population, implying a deteriorating tax base and economic stagnation.

The composition of the population is also an area of interest. First, age composition of the population is considered since relatively old populations may have different attitudes toward education. Localities with a high percentage of voters with children in public school should react more favorably toward school taxes. Likewise, voters with children in nonpublic schools (mainly Catholic) may be less in favor of school taxes. Another premise is that the more highly educated the adult population, the more the adults value and will support education. To measure these, the variables percentage of population over age 65, percentage of school age population in nonpublic schools, and median educational level of the population have been selected.

Also included as a composition variable is the percentage of a locality which is nonwhite. Unfortunately, it is suspected that possible difference in attitudes between whites and nonwhites may not be measurable due to suspected high correlation between poverty and nonwhite (positive) and population size and nonwhite (positive). In Ohio in any case the majority of nonwhites reside in densely populated areas.
DESIRED LEVEL OF EXPENDITURE

The tangency of the community preference function and the income line indicate the level of local revenue earmarked for schools and for other consumption, which can be symbolized as the position of the median voter given that school authorities have correctly estimated this position in selection of the tax rate. We have examined what types of "within locality" forces tend to produce differentials from locality to locality. The actual level of local or own revenue per pupil should be reasonably close to the desired level of expenditure in the absence of outside forces. Since some demographic or taste variables are changing smoothly over time, it is not expected that lagging the variables (by a year or more in an effort to match current funds with the characteristics of the population which produced that level) is necessary with the exception of unemployment rate, which is expected to be more of a "shock" to the system than the other variables. It seems reasonable that we can assume that tax rates are smoothly adjusted to reflect the current (or current direction) of change desired by the locality.

ALTERNATIVE METHODS FOR MEASURE OF LOCAL SUPPORT FOR PUBLIC EDUCATION

Since property taxes are (in 1967) the only taxes in the direct control of the public, within a narrow range of alternatives the public can shift expenditure categories without changing the tax burden or incidence. It would
be meaningful to examine both the balance between school expenditure and total expenditure on public goods supported by property taxation for 1967 and the change from 1966 and 1967 in the allocation of property tax funds between school taxes and total property taxes. The former should be an indicator of the desired balance of public expenditure with respect to activities supported by property taxation; the latter should reflect the change in priorities due to changes in attitudes and socio-economic conditions. It is judged these variables are reasonable independent. The latter variable is over 100 per cent in 8 of the 28 cases indicating reductions are registered by other taxing units while school revenues increased in all 88 Ohio counties.

Let's consider what the first variable is exactly. In Figure 9 we have a graph similar to Figure 1. Let B represent the part of private expenditure which represents public goods supported by local property taxes. The horizontal axis will also be expressed in dollars of educational expenditure. The level of local or own revenue will be designated by the letters "OR".

The line segment OP represents total community expenditure except on education. OCR represents educational expenditure, and OB represents the public component of private expenditure. Total public expenditure is the segments OB + OCR. The ratio OCR to the sum is the first variable. Cp is completely determined by the same forces
which determine OR, however the location of B is not necessarily determined by this system. That is, the same level of OR could result no matter where B is located in the OP segment. Economic theory suggests the level of B (and OR and P) will rise as the budget line rises, but we have no clue as to what will happen to the ratio represented by the "desired level" variable. There is no priori reason to assume that this rate is related in any way to the level of OR.

The interpretation of the charge variable is essentially similar; it is the ratio of the line segments \((OR_2-OR_1)\) to the sum of \((OR_2-OR_1)\) and \((B_2-B_1)\) in Figure 10, where we are depicting the position of a community in the year 1966 (level 1) and again in 1967 (level 2).

Although other public expenditure is not under the direct control of the public, to the extent that elected or appointed decision makers at any governmental level
attempt to allocate public funds toward areas which the public most covets, these variables could well be indicators of the desires of the localities.

SURVEY OF INSTITUTIONAL FRAMEWORK ACROSS THE UNITED STATES

Many states have a somewhat different institutional framework than Ohio, but broad areas of the United States have strong similarities. "School districts have primary responsibility for providing local public schools throughout 25 states... In four states all public school systems are operated by the state or by other local governments as 'dependent' school systems. In the remaining 21 states, public schools in some areas are provided by school districts, while in others the state or other local governments operate 'dependent' school systems. However, in 5 of these 21 states, all school systems that provide education through grade 12 are independent districts, and
the additional 'dependent' school systems involve only institutions of higher education operated by city or county governments."^{25}

Whether school support comes chiefly from the state or from the local districts, revenue bases are the same in most states; property taxes for local support, and legislative appropriations from general state revenues raised by non-earmarked taxes for state support. In 27 states, local property taxes are the source of from 95 to 100% of all local funds.

**SUMMARY**

In this chapter the role and power of local school authorities in Ohio have been examined. In addition, several economic and taste variables which should influence local expenditure decisions have been examined and an economic interpretation, if any, given. No claim is made that every possible influence is accounted for, but it is hoped that a substantial proportion of the statistical variation in own revenue can be explained. Finally, it is shown that there exists other areas of the United States with similar institutional structures. It is hoped that results from this study may have broader applications than to the State of Ohio alone.

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^{25}Ohio Legislative Service Commission, *Ohio School Foundation Program* (Columbus, Ohio: Published by State of Ohio, Report No. 94, January, 1969).
CHAPTER 4

In this chapter we will investigate the mechanism through which state subsidies are distributed to localities in Ohio. The bulk of state support is derived by a rigid formula requiring a minimum of 40 separate mathematical computations; thus the formula itself should be the key toward delineating the arguments of a state subsidy function.

THE STATE FOUNDATION PROGRAM

The school foundation program is the basic instrument for the distribution of state funds to public elementary and secondary schools in Ohio. To be eligible for foundation support, a district must have a current school operating levy of 10 mills (effective January 1, 1969, this was increased to 17.5 mills) and have a minimum salary schedule in effect. The 1955 School Foundation Program Law is still used, although it has been amended. Under this program the basic payment to each school district was calculated according to a formula which may be simply expressed as:

\[ \text{Amount of State aid} = \text{operating expenditure allowance} + \text{salary and retirement allowance} - \text{local effort}. \]

The operating expenditure allowance, salary allowance and retirement allowance are primarily based on classroom or teacher units. The number of teacher units for a district is composed of basic units and administrative units. First the number of pupils in average daily membership (A.D.M.) is divided by 30 for grades 1-12, 60 for kindergarten. Other basic units include special classes for handicapped children and for vocational education.

For each 8 basic units, an additional unit is credited for administration and special instruction. One supervision unit is allowed for the first 50 basic units, and one per each 100 basic units after that.

The number of classroom or teacher units is used in two ways. First, the total number of approved units is multiplied by $2,425 and called a classroom or operating expenditure allowance. Second, the number of teaching units is used to determine the salary allowance.

Salary Allowance

The salary allowance is based upon the level of formal training by a district's teachers and the years of experience. Each teacher with a master's degree or higher is allotted a basic wage of $5,500 (for a nine month contract) plus $250 per year for each year of experience with a maximum allotment of $8,500. A teacher with five years of formal school but without a master's degree is allowed a base of $5,200 plus $215 per year with a maximum allowance of $7,675.
For teachers with a bachelor's degree and for teachers with less than a bachelor's degree the base salaries are $5,000 plus $200 per year with a maximum of $7,200 and $8,300 plus $180 per year with a maximum of $6,100 respectively.27

This minimum schedule must be in effect. However, school districts are not constrained from paying salaries at a higher rate than this minimum.

In addition, the state allows 13 per cent of the total minimum salary allowance as its contribution toward sick leave and retirement. Extended service, such as summer school, is also subsidized based upon the number of approved extended units and the training and experience of the teachers given these supplemental positions.

Flat Rate Districts

In no case can any qualifying district receive less than a minimum payment of $3,050 times the number of approved classroom units plus $1000 times the number of special units previously discussed. In all cases a district would make both sets of calculations and receive the larger of the two amounts.

Miscellaneous Categories Considered Foundation Fund

Additional foundation grants of $1000 times the number

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27 ibid., 59
of "special" units is granted in recognition of the higher cost of operating these units. A special unit subsidy is restricted to vocational units, deaf, blind, emotionally disturbed, and crippled children units, and slow learner units. Speech and hearing and child study approved units do not qualify for these additional grants.

Although categorized separately by the state, transportation or school bus grants are included with the foundation funds for purposes of this paper. The transportation allowance is based on the number of pupils transported. In addition, a grant is made for school bus depreciation, the rate of which is determined by the type of roads in the district and number of miles driven.\textsuperscript{28}

\textbf{Required Local Effort}

From the amounts granted to operate a school district, an amount equal to 12.5 mills times the assessed tax valuation of property in a district is subtracted from the sum of the subsidies previously discussed. Each district must have this minimum rate in effect to operate the school systems at the minimum standard suggested by the state. Theoretically, a district levying only 10 mills could operate by having class size greater than 30, since this is not expressly disallowed. All local funds in addition

\textsuperscript{28}Ibid., 3.
to 12.5 mills would be income to operate a school system above this minimum standard. It would be emphasized here that the state subsidies are for current operation allowance only; no allowance is made for capital improvements.

OBJECTIVES OF STATE FORMULA PROGRAM

The Ohio school foundation program is designed to accomplish several states objectives. These include:

1) to increase local support

2) to extend "equal education opportunity" to pupils throughout Ohio

3) "to eliminate disparities among school districts in terms of money 'available' to finance education."29

Only 2 of 685 school districts had a 1967 tax rate levied for collection of less than 10 mills. All districts must levy a minimum of 17.5 mills for school operation purposes after the 1968 calendar year to qualify for state aid. If a district has its total millage reduced below the requirement by action of the county budget commission, board of tax appeals, or the county auditor, the state superintendent of public instruction shall waive the minimum millate requirement for one year. The state board of education may authorize exceptions to school districts where topography, sparsity of population, and other factors

29Ibid., 25.
make compliance impracticable.\textsuperscript{30} As of April, 1968 only 42 districts were still levying less than the required 17.5 mills.\textsuperscript{31}

Gross state aid distributed through the school foundation program averages $98 per pupil in the 5 wealthiest districts (as measured by tax valuation per pupil), and $332 per pupil in the 5 poorest.\textsuperscript{32} The disparity between these rich and poor districts is about 25 to 1 in amount of local funds, and is reduced to about 4 to 1 when state aid is added. These 5 rich districts maintain an average of 16.5 pupils to certified employee, while the 5 poorest districts average 24.4 pupils to certified employee. Wealthier districts can lower the pupil-teacher ratio, but at their own expense.

**OTHER STATE SUBSIDIES**

State subsidies outside of the foundation program which apply to regular public education can be categorized as follows:

a. An amount to the approved cost of board and transportation required by physically and emotionally handicapped children attending regular school or special

\textsuperscript{30}Ohio Public Expenditure Council, Analysis of School Districts in Ohio Levying Less Than The Levy 17.5 Mill Minimum For Operating Purposes Required to Qualify For State Foundation Program in 1969, No. 68-7.

\textsuperscript{31}Ibid.

\textsuperscript{32}Ohio Legislative Service Commission, Op. Cit., 30.
education classes and home instruction.

b. An amount to each island school district and to each district with one and two teacher schools.

c. An amount to each school district for operation of classes for children of migrant workers who are unable to attend Ohio schools during the regular school year.

d. An amount to each school district which participates in approved educational television courses.

e. An amount to each school district with approved programs for guidance, counseling and testing.

Effective January 1, 1968, a special subsidy was granted for districts having disadvantaged children. To qualify a school district must have 100 or more or at least five per cent of average daily membership (A.D.M.) receiving A.D.C. payments. Table 13 shows the 20 districts, all city districts, which received this subsidy for the second half of school year 1967-68. This subsidy was not in effect for the time period used in this report.

The emergency board, upon declaration of an educational emergency by the governor, may upon application by the Superintendent of Public Instruction authorize payment pursuant to Sections 127.01 and 127.05 of the Revised Code to be made to any school district which has either an unexpected increase in enrollment resulting from the destruction of, or the necessary closing of a school because of flood, fire, or other calamity; or a severe loss of
local tax revenue for school purposes. In the latter case, the circumstances for which the aid is requested is an important criteria toward the determination of aid by the State.

In many aspects these funds appear to be formula in nature. However, in most cases these programs correspond to Federal programs and appear to be an attempt by the state to defray the cost of matching requirements where the federal program requires a matching amount to be paid by the locality or state in whatever proportion specified by the state, or an attempt by the state to supplement Federal programs which have no matching provisions.

In all cases, the State Department of Education must approve any request for additional subsidy; once approved the amount granted becomes formula in nature. For this reason this category of state subsidies together with non-formula Federal subsidies are considered one subsidy category. A more detailed explanation will follow in the next chapter in the section called "The Source of Matching Funds."

STATE SUPPORT PROGRAMS ACROSS THE UNITED STATES

All states contribute to the financial support of their public schools, but the extent of contributions vary from less than 10 per cent to approximately 90 per cent, excluding Hawaii, which contains only one school district.
The unweighted mean percentage of support is 46 per cent; Ohio contributed approximately 33 per cent during the 1966-67 school year to rank thirty-third among the states in the percentage of support it provides.

Whether school support comes mainly from the state or locality, revenue bases are the same in most states: property taxes for local support and legislative appropriations raised by non-earmarked taxes for state support.\(^{33}\)

In Ohio, one-tenth of one per cent of the state support money comes from a permanent school endowment fund and 99.9 per cent is provided through legislative appropriations. Legislative appropriations account for over 95 per cent of state support in 22 other states and furnish over 70 per cent in 7 others.

Ohio's method of determining the amount of state aid granted each district - subtracting a required local effort from calculated operating costs - is essentially the method used in 28 other states. Fifteen other states apportion the major part of their support through per-pupil payments, and 5 pay fixed amounts for each teacher or teacher unit.\(^{34}\)

\(^{33}\)Ibid., 43.

### Table 13

AID TO DISADVANTAGED CHILDREN PAYMENTS

TO 20 CITY SCHOOL DISTRICTS

January to June, 1968

<table>
<thead>
<tr>
<th>City</th>
<th>ADM&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Number of ADC Pupils</th>
<th>Per cent of ADM or ADC</th>
<th>Total Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleveland</td>
<td>153,253</td>
<td>29,289</td>
<td>19.11</td>
<td>$1,229,760</td>
</tr>
<tr>
<td>Columbus</td>
<td>106,230</td>
<td>12,409</td>
<td>11.68</td>
<td>521,682</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>89,155</td>
<td>12,829</td>
<td>14.39</td>
<td>538,818</td>
</tr>
<tr>
<td>Toledo</td>
<td>61,334</td>
<td>7,480</td>
<td>12.19</td>
<td>316,764</td>
</tr>
<tr>
<td>Dayton</td>
<td>59,932</td>
<td>5,911</td>
<td>9.86</td>
<td>248,240</td>
</tr>
<tr>
<td>Akron</td>
<td>58,637</td>
<td>4,988</td>
<td>8.51</td>
<td>209,496</td>
</tr>
<tr>
<td>Youngstown</td>
<td>25,831</td>
<td>2,656</td>
<td>10.28</td>
<td>111,552</td>
</tr>
<tr>
<td>Canton</td>
<td>22,162</td>
<td>1,375</td>
<td>6.20</td>
<td>57,750</td>
</tr>
<tr>
<td>Springfield</td>
<td>18,747</td>
<td>841</td>
<td>4.49</td>
<td>35,322</td>
</tr>
<tr>
<td>Lorain</td>
<td>17,145</td>
<td>1,359</td>
<td>7.93</td>
<td>57,078</td>
</tr>
<tr>
<td>Hamilton</td>
<td>15,801</td>
<td>825</td>
<td>5.22</td>
<td>34,440</td>
</tr>
<tr>
<td>Warren</td>
<td>14,476</td>
<td>1,234</td>
<td>8.52</td>
<td>51,912</td>
</tr>
<tr>
<td>Middletown</td>
<td>14,108</td>
<td>734</td>
<td>5.20</td>
<td>30,828</td>
</tr>
<tr>
<td>Mansfield</td>
<td>12,306</td>
<td>669</td>
<td>5.44</td>
<td>26,545</td>
</tr>
<tr>
<td>Lima</td>
<td>11,201</td>
<td>560</td>
<td>5.00</td>
<td>31,878</td>
</tr>
<tr>
<td>Zanesville</td>
<td>8,067</td>
<td>694</td>
<td>8.60</td>
<td>24,218</td>
</tr>
<tr>
<td>Massillon</td>
<td>7,327</td>
<td>234</td>
<td>3.19</td>
<td>9,828</td>
</tr>
<tr>
<td>Sandusky</td>
<td>6,559</td>
<td>139</td>
<td>2.12</td>
<td>5,586</td>
</tr>
<tr>
<td>Alliance</td>
<td>6,298</td>
<td>303</td>
<td>4.81</td>
<td>12,726</td>
</tr>
<tr>
<td>East Liverpool</td>
<td>5,662</td>
<td>113</td>
<td>1.99</td>
<td>4,746</td>
</tr>
</tbody>
</table>

Total 84,642 $3,559,169

State Total 104,428 $4,385,976

<sup>a</sup>January, 1968, calculation for ADM in grades K-12

Source: Ohio Legislative Service Commission, p. 38.
### Table 14

**STATE EDUCATIONAL APPROPRIATIONS.**

**FISCAL YEARS 1967-68 AND 1968-69**

(Including Educational Units Other Than Regular Public Schools)

<table>
<thead>
<tr>
<th>Appropriations within the Formula</th>
<th>Non-Formula Appropriations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Allowance $797,142,646</td>
<td>Non public auxiliary services $15,000,000</td>
</tr>
<tr>
<td>Transportation 56,005,000</td>
<td>Disadvantaged children 13,158,000</td>
</tr>
<tr>
<td>Vocational education 9,009,158</td>
<td>Driver education 10,450,000</td>
</tr>
<tr>
<td></td>
<td>Emergency bus purchase 9,330,000</td>
</tr>
<tr>
<td></td>
<td>County, island, joint state, and 1- and 2- teacher districts 6,724,000*</td>
</tr>
<tr>
<td></td>
<td>Services for handicapped 4,226,000*</td>
</tr>
<tr>
<td></td>
<td>Guidance 600,000</td>
</tr>
<tr>
<td></td>
<td>Adult literacy 230,000</td>
</tr>
<tr>
<td></td>
<td>Schools for retarded 142,500</td>
</tr>
<tr>
<td></td>
<td>Migrant workers 90,000</td>
</tr>
</tbody>
</table>

Total formula $862,156,804

Total non-formula $59,950,500

*No appropriation made; this figure was arrived at by doubling expenditures for fiscal 1968.

**Source:** Ohio Legislative Service Commission, pg. 15.

**STATE APPROPRIATIONS TO PUBLIC SCHOOLS FOR CALENDAR 1967**

(Vocational School Districts Excluded)

State Foundation program (including Transportation) 359,719,000
Other State Subsidies 11,223,000

### Table 15
**SF-12 FORM FOR DISTRICT X**

<table>
<thead>
<tr>
<th>ADM</th>
<th>LEGEND</th>
<th>DIVISOR</th>
<th>NUMBER OF UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 168</td>
<td>Kindergarten (excluding ADM in lines 4 &amp; 5)</td>
<td>60</td>
<td>2.80</td>
</tr>
<tr>
<td>2. 1,896</td>
<td>Grades 1-12 (excluding ADM in lines 3, 4, &amp; 5, but including 75% of pupils enrolled in vocational courses or joint vocational districts)</td>
<td></td>
<td>63.26</td>
</tr>
<tr>
<td>3. 160</td>
<td>Vocational Units (approved units, only; under ADM insert 25% of pupils enrolled in vocational school districts)</td>
<td>30</td>
<td>5.33</td>
</tr>
<tr>
<td>4. 37</td>
<td>Deaf, blind, emotionally disturbed, and crippled (approved units and actual ADM)</td>
<td>5</td>
<td>7.40</td>
</tr>
<tr>
<td>5. 21</td>
<td>Slow learning (approved units and actual ADM)</td>
<td>5</td>
<td>4.20</td>
</tr>
<tr>
<td>6. 18</td>
<td>Speech and hearing (approved units)</td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>7. 13</td>
<td>Child study (approved units)</td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>8. 2,315</td>
<td>Total Administration and special instruction (units line 8 divided by 8)</td>
<td></td>
<td>84.99</td>
</tr>
<tr>
<td>9. 2,315</td>
<td>Supervision (line 8 -- first 50 units divided by 50; units over 50 divided by 100)</td>
<td></td>
<td>10.62</td>
</tr>
<tr>
<td>10. 2,315</td>
<td>Total ADM and Approved Classroom Units</td>
<td></td>
<td>96.96</td>
</tr>
</tbody>
</table>
Table 15 Continued
State Support Calculations

<table>
<thead>
<tr>
<th>Number Employed</th>
<th>Calculation based on</th>
<th>TRAINING</th>
<th>MINIMUM SALARY</th>
<th>CUMULATIVE EXPERIENCE</th>
<th>CREDIT YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. 20</td>
<td>20</td>
<td>Master's Degree 5 years</td>
<td>$5,500 + 120 x $250</td>
<td>(12 yrs) = $140,000.00</td>
<td></td>
</tr>
<tr>
<td>13. 15</td>
<td>15</td>
<td>no Master's Degree</td>
<td>5,200 + 45 x $225</td>
<td>(11 yrs) = $88,125.00</td>
<td></td>
</tr>
<tr>
<td>14. 48</td>
<td>48</td>
<td>Bachelor's degree</td>
<td>5,000 + 240 x $200</td>
<td>(11 yrs) = $288,000.00</td>
<td></td>
</tr>
<tr>
<td>15. 13.06</td>
<td>Total allowance for certified salaries</td>
<td>4,300 + 27.32 x $180</td>
<td>(10 yrs) = $65,052.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. 87</td>
<td>93.96</td>
<td>Less than Bachelor's degree</td>
<td></td>
<td>$581,178.60</td>
<td></td>
</tr>
</tbody>
</table>

17. Total dollars line 16 X 13% for retirement and sick leave = $74,365.85
18. Approved extended service $22,116.00 + 13% of $22,116.00 = $24,991.08
19. Total units line 16B x $2,425 for classroom allowance = $235,128.00
20. Transportation = $13,037.00
21. Total (lines 16, 17, 18, 19 and 20) = $928,700.53
22. 17.5 mills x tax valuation of $25,982,467 = $454,693.17
23. Basic State Support (line 21 minus 22 plus $1,000 x units on lines 3, 4, and 5) = $490,937.36
24. Classroom units lines 16B x $3,050, plus $1,000 x units on lines 3, 4, and 5 = $312,658.00
Total State Support (largest of lines 23, 24) = $490,937.36
Example of State Formula

District X has 168 kindergarten and 2096 elementary and secondary school children including:

160 vocational education
37 in special education classes
21 slow learners
18 speech and hearing therapy
13 children study program
249 total

The employees include:
1 superintendent
1 assistant superintendent
3 elementary school principals
1 secondary school principal
1 guidance counselor
1 speech and hearing therapist
89 teachers
97 total

The training and education of the 97 employees is classified as follows:

20 with Masters degree, average 6 years experience
6 of these will teach summer school
15 no Masters, but 5 years or more education, average
3 years experience. 5 will teach summer school
48 with B.A. degree only, average 5 years experience
14 with no B.A., average 2 years experience
97

District X will receive a transportation or bus allowance of $13,037.00. The formula amount of aid for district X is shown in table 1.35

In the case of District X the subsidy amounted to $217 per pupil. With local tax rate for schools of 21 mills, the total local plus state support becomes $438 per pupil.

In the states which subtract local support (local tax base times required millage) prior to making foundation payments, the amount deducted is greatest in districts where wealth is greatest. Conversely, deductions are smaller and payments relatively larger to districts with less taxable wealth. Among the 21 states which used other methods of appropriation, all but 7 use an "equalizing" factor designed to reduce disparities in tax base from district to district.

CONCLUSIONS

The state subsidy formula dictates that the greater the A.D.M. in a locality, the higher the level of subsidy; on a per capita basis, the higher the ratio of pupils to population, the higher the per capita subsidy. The charge off for local effort implies that the level of subsidy should be negatively related to taxable wealth. Taxable income may be a reasonable measure of tax valuation, but whatever forces determine the level of tax valuation also affect the level of subsidy. A high percentage of tax exempt or impacted land would lower the charge-off factor independent of wealth measured by income. The presence of a large industrial base would tend to raise the charge-off factor, thus lower the level of state subsidy.
In the sense that virtually all districts met the minimum tax rate requirement (or were exempted from it), we would not expect that local effort as measured by tax rate to be a significant factor toward explaining state foundation subsidies despite the stated objective of increasing local support.

The nonfoundation category of state subsidy is in part discretionary in the sense that the requests for these funds must be approved by the State Board of Education. In large part this category ties in with corresponding Federal grants.
CHAPTER 5

In this chapter we will examine the various federal subsidy programs toward education that were used in 1967 and the institutional framework through which these funds were distributed to localities. Despite the fact that federal grants comprise a rather small percentage of the total revenue of Ohio school districts (about 5 per cent in 1967), the impact of federal grants is somewhat larger than it may appear. Some federal grants have matching requirements which may have price effects upon state-local educational expenditure decisions. Others are used as incentives to encourage localities to conform to certain behavioral patterns.

The term federal subsidies as used in this report refers to federal grants either allocated directly to school districts or allocated to states to be distributed to local schools by an approved federal formula. If a grant has matching requirements, the portion of the total grant originating with the federal government is considered federal subsidy. In terms of analysis each grant will be classified as pure matching, formula (matching and nonmatching), or nonformula.

All relevant federal programs will be individually categorized in the setting of the public law toward which
the federal funds were appropriated, and then in light of the state plan (where there was one) through which the funds were actually distributed. In all cases where there were state plans, they had been approved by the appropriate federal agency, although plans differed from state to state. Some grants had provisions for special or additional amounts of subsidy; these special grants were of the nonformula type even though the basic grant was categorized as formula.

After each presentation a brief statistical check of each formula subsidy will be shown. In most cases we would expect good fits using a regression equation.

_Federally Affected Areas_

Public Laws 81-874 and 81-815 together are known as The Federally Impacted Areas programs. Public Law 81-874, Title I (parts 1-6) (financial assistance for local school districts in areas affected by federal activities), was enacted to provide free public education to children who either lived on federal property or whose parents were employed on federal property where no state or local educational agency was able, because of state law or otherwise, to provide suitable free public education to children. In some cases this grant went to a federal agency having jurisdiction over the property rather than to the school district directly. The total 1967 appropriation to all states was 416.2 million dollars. Of the 4200 school districts in the United States eligible for this grant, the average
award was 5 to 6 per cent of their total current operating expenses. This grant was primarily based upon the number of federally affected children.

Public Law 81-815 provided for school construction in areas affected by federal activities. This grant provided for about 66 percent of the total funds expended by eligible school districts for construction. The total 1967 appropriation for all states was 22.3 million dollars, and was awarded by a formula utilizing the rate of increase in federally affected children and the cost of construction of a minimum school facility. These grants have no matching requirements.

In Ohio, to qualify for aid under the Federally Impacted Programs, a school district was required to have 3 percent or more of its A.D.M. as affected pupils (in 1969 qualifications were changed to 3 percent provided there were at least 10 such pupils or a minimum of 400 pupils). According to the Ohio plan there were two categories of affected pupils: (A) Those whose families both worked and lived on Federal Property and (B) those who lived in taxable residential property but had one or more parent working on a "reservation" or any federal property exempt from local taxation (excluding postal service).

The Ohio plan divided the state into three regions which will be called: (1) Southeast Ohio (2) Western Ohio (3) Industrial Ohio
Southeastern Ohio includes the mountainous region and as a group has the lowest average per capita income in the state. Western Ohio includes a strip about two counties wide including all of the agricultural western portion of Ohio except the southwestern corner around Hamilton County. The balance of Ohio is considered the Industrial sector.

In the first two regions an average level of own revenue per pupil is estimated. However, in the Industrial sector two subcategories were created, called high and low industrial. Any locality with a relatively high level of own revenue per pupil were considered in the high industrial subcategory, the balance of localities in the industrial region were placed in the low industrial grouping. The average level of own revenue per pupil for the four classes was calculated to be:

- Southeast Group $251
- Western Group $319
- High Industrial Group $457
- Low Industrial Group $245

For each pupil in category B, the federal government awarded a locality a payment equal to its region's average level of own revenue per pupil. For each pupil in category A, the award was equal to half the indicated amount.

A section of Public Law 81-874, Title I-7, contained a provision for providing relief to any school area which suffered a disaster such as earthquake or other catastrophe. During calendar 1967 Ohio schools suffered no disasters and
received no funds for disasters suffered in previous years.

Ohio has the authority to destroy all but the three most current years of data. Thus the number and classification of affected pupils in each Ohio district or county is not available for 1967. 1970 data will be used as a proxy in order to test the significance of the relationships to be indicated.

Rather than estimate each class given that class A is relatively sparse, a variable was created called "impacted units." An impacted unit equals the number of pupils in class B plus twice the number of impacted pupils in class A. This variable corresponds to the basis of the award.

The regression equation is:

Total impacted aid = $154.7 * Number of impacted units
Standard error (9.96)
t ratio (39.07)

\[ r^2 = .94 \]

As expected, the fit is reasonably good. A portion of the unexplained variation is due to the minor changes in requirements concerning eligibility, nonproportional changes in the number of affected pupils, and several payments for school construction under Public Law 81-815.

**E.S.E.A. Title I**

Public Law 89-10, The Elementary and Secondary Education Act of 1965, Title I, Educationally Deprived Children, designed to provide financial assistance to local educational agencies in areas with high concentrations of low-income families to enable them to expand and improve educational programs designed to meet the special needs of
educationally deprived children. In 1967, 1035.4 million dollars were appropriated to the states. This award was limited to 30 per cent of a local agency's budget. The basis for award was by formula based on the number of children 5-17 years of age from low-income families and the state average expenditure per pupil. There was also an additional award for assistance to handicapped children based upon the average daily membership of such children and the state average per pupil cost of education.

The title I grant was distributed to localities by the State of Ohio based on a formula incorporating the number of children, age five through seventeen, residing in the district who were:

a. From low income families
b. From families receiving ADC payments
c. Living in institutions for neglected or delinquent children and being educated by the district
d. Living in foster homes in the district

An index or formula was derived using the above four factors, and all school districts were informed as to the amount of Title I subsidy the state has encumbered for their use pending the presentation of an acceptable proposal delineating the explicit use for the said funds. State agents continually worked with the districts until a proposal was acceptable or the school district declined to submit one.

In 1967, 92% of all districts eligible for any funds participated; all of those who did not participate were eligible
only for very small allocations. Thus, for all practical purposes, this grant was formula with arguments as specified. No matching funds but local maintenance of effort was required.

Total E.S.E.A. I = 139.0* estimated number of Poor Children
Std. error   (5.20)  \( R^2 = .87 \)
t ratio       (26.73)  

E.S.E.A. Title II

Public Law 89-10, Title II, is intended to provide grants for the procurement of school library resources, textbooks, and other printed and published instructional material for use by students and teachers in public and private elementary and secondary schools. This award entails a one-to-one matching requirement by the state. In 1967, 102.0 million dollars was appropriated to the states. The grant to each state is based on the number of school age population.

In 1967, 691 local districts and 34 other educational institutions in Ohio received a total of $5,451,355; about $4.7 million was for the basic grant, the balance for special purpose grants. The basic grant was distributed to localities strictly on a per pupil basis. However, the special purpose grants were awarded on the basis of a specific proposal. All proposals conforming to the intended

36 State of Ohio Department of Education, Educational Opportunities Through Federal Assistance Programs, (Columbus: Published by the State of Ohio, 1970), 5.
purpose of the grant were ranked by a committee. The ranking procedure included relative need factors, although the school's library had to have met state standards in order to quality. In addition to relative need, another important factor was "the likelihood the project will be effective". That is, many of these special grants were for model projects. In addition, if the district did not have the specialized personnel or facilities to exemplify or complement the proposed project, then the official view was that the funds would be unlikely to have the full impact or success desired by the state authorities. This formula can be interpreted as: allocate funds toward less endowed areas provided they are well enough endowed to have a high likelihood of success. No matching funds were required but local maintenance of effort was necessary.

\[
\text{Total E.S.E.A. II} = 2.45 \times \text{Number of pupils} \\
\text{Std. error} = (0.07) \\
\text{t ratio} = (35.88)
\]

**E.S.E.A. Title III**

Public Law 89-10, Title III (Supplementary Centers and Services), was purported to provide grants for supplementary educational centers and services, to stimulate and assist in the development of exemplary elementary and secondary school programs to serve as models for regular programs. The total 1967 appropriation to the states was $135.0 million dollars. This grant was distributed to Ohio by a formula based on number of school age population.
Ohio awarded this grant to localities on a project basis only. The state plan was to allow programs which called for concentrated service to the youngest school age group and to approve none to older school age groups. Any project for any program was judged on the basis of whether the school had an innovative educational concept. Ideally, projects were ranked by merit; however, if a certain district already had several grants approved, another district with a lower ranked proposal was likely to get the funding. Thus some attempt was made to balance funds. An extremely important criterion was the estimated local support. If the school had a history of continuing programs after federal funding was complete, new projects for that district were viewed favorably. If they had a history of discontinuing projects once funding was complete, new requests were viewed less favorably. One example given was Toledo public schools. Toledo was given a three year grant to initiate Russian and German into the school program. After the three year grant expired, Toledo continued the language program with its own funds. Thus future Toledo programs were considered "good investments". In any case, the state program was designed to stimulate lasting change; thus some estimate of community support was a subtle part of the ranking procedure. An additional factor which was admitted to be a relevant factor was the beauty of the proposal itself. A well written request for funds including the right kinds of information and eloquence was viewed more favorably than a proposal
equal in merit but more crudely written.

Despite the fact that this is not a formula subsidy, the regression equation with number of pupils in average daily membership will be shown because the final results depend in part upon understanding the relationship between the total subsidy and number of pupils.

Total E.S.E.A. III = 2.47 * Number of pupils
std. error (0.12)
t ratio (20.34)

N.D.E.A. Title III

Public Law 85-864, The National Defense Education Act, Title III, was initiated as a program of federal financial assistance to state education agencies for staff development and strengthening instruction in the subjects of science, mathematics, and modern foreign language. It was later amended to include history, civics, geography, English, reading, economics, and industrial arts. The method of accomplishing this objective was to support the purchase of special equipment and materials and to subsidize the remodeling of facilities to accommodate this special equipment. The federal government contributed up to 50 per cent of the costs; state and local educational agencies provided the balance.

Under this act, 88.2 million dollars was allocated to the states in direct ratio to the state's proportion of the school age population in the Nation and in reverse ratio to the state's income. Each state determined local agency
eligibility and established a mechanism for the distribution of funds.

In Ohio, the state authorities earmarked the bulk of these funds by a simple formula. The number of approved teaching units used to calculate the state foundation payment times a fixed dollar amount ($40 in 1967) was allowed for each district subject to an equal local contribution toward each approved project. Each district could draw upon their allotment by receiving fifty per cent reimbursement for all approved projects or expenditures. In general districts drew upon the earmarked funds in a piecemeal manner, and often used less than the full amount available. Districts using their full allotment often could get supplemental funding given that surplus or unused funds were available. The supplemental funds were reallocated based upon three levels of priority. The first level was composed of school districts which had used less than the full allotment in either or both of the two preceding years. Districts virtually always received supplemental funds up to the amount foregone in the previous two years with first priority. The second level was composed of school districts with low tax duplicate. Districts with low tax valuation generally are areas with a high percentage of tax exempt land, rapid growth areas, or bedroom communities. The latter two often are characterized by low levels of industry. Districts of any of the above types were likely to receive additional levels of per pupil subsidy.
The last level of priority was composed of districts which had undergone forced consolidation by the state. In these cases a weak area was forced to combine with an adjacent district with a relatively sound financial situation. If any funds were still available, these areas were likely to receive additional per pupil subsidy. However, if the consolidation of districts was voluntary rather than at the mandate of the state authorities, voluntary merged districts did not qualify for additional levels of subsidy.

In calendar 1967, 97 of 718 Ohio school districts in fifty-four of the eighty-eight counties did not receive funds in this program. In large parts this is an accounting problem due to the difference between the calendar and fiscal year. This is discussed in detail later in the paper.

The subsidy equation, using only the number of pupils in average daily membership as the dependent variable, is:

\[
\text{Total N.D.E.A. III} = 3.71 \times \text{Number of Pupils} \quad R^2 = .95
\]

\[
\text{Std. Error} \quad (0.08)
\]

\[
\text{t ratio} \quad (45.57)
\]

**N.D.E.A. Title V**

Title V of this law allotted $24.5 million dollars to the states toward guidance, counseling and testing. This grant to the states was based on the number of school age population and had a 1-1 matching requirement.

In this case initially Ohio paid the matching amount, and imposed a less specific requirement on participating districts. With regard to testing, Ohio paid 50% of the cost of testing up to a maximum of $1 per test group.
(consisting of four tests). With regard to counselors, Ohio paid a fixed percentage (19 per cent in 1967) of the salary of the actual number of counselors employed, although subsidy was limited to one counselor per 400 pupils. That is, if a school district had more counselors than one per 400 pupils, these additional counselors were not subsidized by the state. State law requires at least one counselor per 500 students, and virtually every school district complied. The regression equation is:

$$ \text{Total N.D.E.A. } V = 3.06 * \text{Number of pupils} \quad R^2 = .78 $$

$$ \text{std. error} \quad ( .16 ) \quad t \text{ ratio} \quad (14.71) $$

The computed regression line is a fairly good fit, although not as good as some of the others. The reason for the unexplained variation is because of the somewhat random variation between the 1/500 to 1/400 counselor/student ratio and the actual number of tests given to the student body. The actual number of tests (which in many cases are less than four) seemed to be a matter of school policy and unrelated to any measured demographic characteristic.

**Federal Food Programs**

The Child Nutrition Act of 1966 (including Public Laws 83-690 and 89-642) consists of two principal parts. The Special Milk Program authorized an appropriation of 110.0 million dollars for fiscal 1967. Schools are the primary consumers of these funds, although child care centers, summer camps, and other organizational which are nonprofit in nature are eligible. The School Breakfast Program
utilized 715 million dollars for fiscal 1967, and was distributed primarily to public schools, directly or indirectly. This program stipulated that "in selecting schools, the State educational agency shall...give first consideration to those schools drawing attendance from areas in which poor economic conditions exist and to those schools to which a substantial proportion of the children enrolled must travel long distances daily." These programs were non-matching except that the Breakfast Program allowed subsidy only to 80 per cent of the cost of the program to the local agency.

The National School Lunch Act and Child Nutrition Act administered by the Department of Agriculture made awards both to local school agencies and to states. Poverty levels was defined as $3000 per year family income for the period July, 1967 to June, 1968.


The National School Lunch Act, Public Laws 79-396 and 89-642, consisted of several distinct parts. The principal sections pertaining to public education were the following:

Section 4 defined an index for allocation of the designated funds to the states. The formula allocated relatively greater funds to states with lower levels of per capita income. For states with the same level of per capita income, the award is proportional to the number of lunches served which meet minimum nutritional requirements prescribed by the Secretary of Agriculture.\(^3\)\(^9\) Section 5 indicated that nonfood assistance (kitchen equipment, etc.) was to be distributed by a similar formula. Section 11 formulated criteria toward special assistance to schools drawing attendance from areas in which poor economic conditions existed. Section 6 allows the Secretary to use all appropriated funds not allocated by sections 4, 5 and 11 for direct grants to participating school districts.\(^4\)\(^0\) The particular criterion for allocation of Section 6 funds is not specified in the act.

This program had a 3 for 1 matching requirement for the states, but in states with per capita income below average, the federal portion was relatively increased. In 1967, 448 million dollars was appropriated to the states.


\(^4\)\(^0\) *Ibid.*, 274.
The State of Ohio distributed all of these funds to localities without requiring matching funds. The formula used allotted each district 40% to serve a free meal which went to all pupils in A.D.M. from families considered at the poverty level. Twenty cents was paid toward a reduced price meal (for example, in 1971 all children from families of four earning between $3940 and $4530 qualified). All other students were subsidized at the rate of 6% per meal. In 1967, 3664 schools participated in the lunch program; 407 did not since they were without kitchen facilities. These latter schools qualified for the equipment assistance to needy schools program, and the number of schools without lunch facilities gradually dwindles.

The milk program paid each school 4% per day per A.D.M. if the school was in the lunch program; 3% per day per A.D.M. otherwise. Also, 211 schools applied for breakfast programs. The state allocated 15% per meal or cost, whichever was less.

In summary, while in general the lunch program transferred income to less wealthy areas, extremely poor areas were apt to be exempted because they lack kitchen facilities.

Unfortunately many school districts did not separately classify the levels of subsidy received for these two programs; thus they cannot be individually estimated. For the aggregate of the food programs we have:

\[
\text{Total food assistance subsidies} = 3.65 \times \text{Number of pupils, Std. error} \approx 0.08, R^2 = 0.94 \]

\text{t ratio} \approx 47.27
Total food asst. sub. = 12.16 * No. of Poor Children + 2.08 * No. of pupils

std. error (3.19) (.42)
t ratio (3.81) (4.95)

R^2 = .95

Adult Basic Education

Public Law 89-750, Title III, The Adult Education Act of 1966, provided funds for instructional programs for persons sixteen years of age and older who were not enrolled in school and who had less than a twelfth-grade education or its functional equivalency. The federal formula allocated funds on a per individual basis to the states. The federal program paid up to 90% of expenditure. In 1967 no state funds were allotted, although in subsequent years the state provided an amount approximately equal to the local share. The state required local main tenance of effort.

In 1967 there were 632 classes offered by Ohio schools to adults. In this year slightly more than half of them were funded under E.O.A. in 1964; in subsequent years they were all funded under the Adult Education act.

To clarify the funding procedure, 1960 census data was used to obtain for each school district the number of adults (sixteen years of age or older) who were not currently enrolled in school and did not have a secondary graduation certificate or its functional equivalency. The total funds allotted to the state are tenatively assigned by the state to each school district based upon the census data. Areas which actually recruited adult students
applied for reimbursement against this preliminary allotment. The state shifted funds from areas not participating in this program to areas participating heavily. The reimbursement was based upon actual number of qualifying persons enrolled in basic education courses. The Ohio primary allocation seemed pointless since the program was effectively 90% reimbursement of all accountable expenses for each locality.

No data by locality is available concerning the number of individuals enrolled in one or more adult basic education classes. For this program no equation will be developed.

**Vocational Education Acts**

Public Laws 79-586 and 64-247, the George-Barden Act and The Smith-Highes Act respectively, were somewhat similar in nature. (Public Laws 84-911 and 85-864 are also part of the George-Barden Act). They earmarked grants to states for vocational education in agriculture, home economics, trades and industry, fishery trades, health occupations and for highly skilled technicians. They appropriated total amounts of 50.0 and 7.2 million dollars respectively, contained a dollar for dollar matching requirement, and were awarded to a state based on the percentage of the population which was classified as farm, nonfarm, rural, fishery, etc., according to the particular program for both grants.

Public Law 88-210, The Vocational Education Act of 1963 (except Section D), appropriated 198.2 million dollars to the states for expanding vocational educational facilities.
This grant had a one-to-one matching requirement. The formula for the distribution of funds to states was based on the number of school-age population in attendance. Section D allotted to total of 10.0 million dollars for research and training grants available to any level of public education, including higher learning. The average federal share of total costs in this area was 80%.

Public Law 89-4, The Appalachian Regional Development Act of 1965, appropriated 8.0 million dollars toward vocational education in the Appalachia Region. Matching requirements ranged from 50 to 80 per cent. These grants were available for states within the Appalachian Region.

Public Law 87-415, The Manpower Development and Training Act (as amended) consisted of three parts pertaining to education. Title II-A allowed 4.0 million dollars on a non-matching basis for on job training with supplementary classroom instruction. The award was to the state and on a project basis. Title II-B assigned 123.7 million dollars to states on a project basis for institutional training to fill manpower shortages. The federal subsidy was 90 per cent of cost. Title II-C was a non-matching grant totaling 8.0 million dollars to provide supplemental training for unemployed and underemployed persons living in areas designated as redevelopment areas.

Under the Ohio State Plan for Vocational Education a plan was established such that the majority of the funds were distributed on a per pupil basis. However, construction
funds were not allocated this way; rather a set of socio-economic factors was used to derive an index. The state plan says:

"Whenever applicable, the State School Foundation formula, which is applied throughout the state on a socio-economic base, shall be used in reimbursing local educational agencies for vocational education programs, services, and activities.

However, when the State School Foundation formula does not apply, the method that will be employed by the Division of Vocational Education in weighing the criteria will be on an index scale.

Each school district will be ranked on each of the six criteria listed below and the composite of the six rankings will be the basis for rank for the school priority. Each of the six criteria items listed have equal weight in the final composite. Priority shall be given annually to local educational agencies with the highest composite rank order.

Criteria

1. Manpower Needs and Job Opportunities.
2. Rate of Unemployment Compared to State Average
3. Per cent of Unemployment that are Youth Compared to State Average.
4. Number of Children From Low Income Families Per Thousand Compared to State Average.
5. Local Agency's Wealth Per Student Compared to State Average.
6. Local Agency's Per Pupil Cost of Education Compared to State Average.

The ranking of all school districts is then divided into two or more groupings for the purpose of differentiaitory reimbursement. For the school year 1971-72, three groupings have been established; A, B, and C. Highest rank is A."[^41]

[^41]: State Department of Education, Relative Priority of Local Applications of Ohio Public School Districts for Vocational Education Programs, Services, Equipment, and Activities, Fiscal Year, 1972 (Columbus: Published by the State of Ohio, 1972), foreward.
Adequate data was not available for the year 1967 for either the total level of vocational educational subsidy or for any given program. Therefore, for these programs no equations will be developed.

**Miscellaneous Grants**

Public Law 88-452, The Equal Opportunity Act of 1964, amended by Public Law 89-329, The Higher Education Act of 1965, Title V-A, appropriated funds available to state and local educational agencies and other public or non-profit organizations to identify qualified youths of exceptional financial need and to encourage them to complete secondary school and undertake post-secondary training. This act was commonly called the Youth Corps. The grant was non-matching and awarded on a proposal basis.

Title V-B of the H.E.A., 1965, called the National Teachers Corps, allocated a total of 7.5 million dollars which was available to local educational agencies and to institutions of higher learning. The act was designed to improve educational opportunities for children in areas having concentrations of low-income families by providing funds for teaching teams to local educational agencies. The grant was based on proportion of need and the rational of request for assistance. It was primarily given as salary supplements or allowances, and was essentially a 100% or non-matching subsidy.
On a county basis, less than half of the counties received either of these subsidies. We would not expect a very good fit with so many zero level data points. The regression equations using number of pupils as the dependent variable is:

Total Youth Corps = 4.05 * Number of Pupils \( \mathbf{R^2 = .67} \)

std. error ( .29)
t ratio (13.78)

Total National Teacher Corps = .29 * No. of pupils

std. error ( .03) \( \mathbf{R^2 = .47} \)
t ratio (9.14)

The Educational Television Facilities Act, Public Law 87-467, allocated 3.0 million dollars for states, higher education, or nonprofit foundations to aid in the acquisition and installation of equipment necessary for broadcasting. The federal share was from 25 to 50 percent of the cost. The State of Ohio imposed a maximum of 60 cents per pupil participating in televised instruction. By 1967 only a few Ohio public schools had initiated televised coursework.

Public Law 88-352, The Civil Rights Act of 1964, Title IV, authorized specialized assistance to help public school systems and school personnel cope with problems relating to school desegregation through technical assistance. This grant was also available for schools of higher education. The entire 1967 appropriation was 8.0 million dollars, and was non-matching. There is no record of any Ohio school receiving this grant in 1967.
<table>
<thead>
<tr>
<th>Public Law</th>
<th>Total Amount Appropriated (Millions of Dollars)</th>
<th>Amount Appropriated to Ohio (Millions of Dollars)</th>
<th>Approx. Matching Requirements (State-Local to Federal)</th>
<th>Effective Matching Requirement Local to State-Federal</th>
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<tr>
<td>89-101e</td>
<td>1035.4</td>
<td>37.4</td>
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<tr>
<td>89-101IIe</td>
<td>102.0</td>
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<tr>
<td>89-101III</td>
<td>135.0</td>
<td>5.4</td>
<td>none</td>
<td>none</td>
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<tr>
<td>81-874I(1-6)e</td>
<td>416.2</td>
<td>8.6</td>
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<td>none</td>
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<tr>
<td>81-815</td>
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<td>85-864Ve</td>
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<td>6.3</td>
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<td>.4</td>
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<td>84-911a</td>
<td>30.5</td>
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<td>85-864a</td>
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<td>c</td>
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<td>87-415a</td>
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<td>88-452</td>
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<tr>
<td>87-477</td>
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<tr>
<td>88-352IV</td>
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Table 16 Continued

<table>
<thead>
<tr>
<th>Public Law</th>
<th>Total(^b)</th>
<th>Amount(^b)</th>
<th>Approx. Matching</th>
<th>Effective Matching</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount</td>
<td>Appropriated to Ohio</td>
<td>Requirements</td>
<td>Requirement</td>
</tr>
<tr>
<td></td>
<td>of Dollars</td>
<td>(State-Local to Federal)</td>
<td>State-Federal</td>
<td></td>
</tr>
<tr>
<td>89-329 V</td>
<td>10.0</td>
<td>.4</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>89-864 III(^e)</td>
<td>88.2</td>
<td>8.6</td>
<td>1-1</td>
<td>1-1</td>
</tr>
</tbody>
</table>

\(^a\) Much of these funds went to vocational school districts, which are excluded from this study.

\(^b\) The first data set is for fiscal 1967; the second data set (for Ohio) is for calendar 1967 and is tabulated from the financial statements of the school districts.

\(^c\) These funds were not separately classified by most districts.

\(^d\) This is the only federal program which matched total educational expenditure; all others with matching requirements stipulated only that a particular educational program be matched.

\(^e\) These subsidies are primarily formula grants according to the Federal or State policy for the primary distribution to localities.
The Subsidy Application Procedure and Classification of Grants

For the majority of the federal subsidy programs available to local school authorities, it was necessary to apply to The Division of Federal Assistance, Department of Education, State of Ohio, to secure these funds. Public Laws 89-10 (E.S.E.A.) Title I and most of Title II, 85-864 (N.D.E.A.) Title III and V, 81-874, 81-815, The Lunch and Nutrition Acts, the bulk of the vocational educational funds and the Adult Education Act were distributed as formula grants. N.D.E.A. Titles III and V, the Adult Education Act, and the Vocational Educational Acts had matching requirements imposed on the localities. Only E.S.E.A. Title III, E.O.A. and H.E.A. Title V could be classified as nonformula or proposal grants. Although parts of E.S.E.A. Title II and parts of vocational funds were non-formula, the amounts could not be separated. Only the Federally Affected Areas Acts was like a matching subsidy over total educational expenditures.

With a formula grant, an application was necessary, but the procedure was so simple that almost every school district applied for and received each of these grants. The only exceptions were those districts which would have received such trivial amounts of a particular grant that an application was not worth the effort. 42

Since each proposal for federal subsidies for non-formula grants needed to be evaluated, it would be interesting to note the characteristics of school districts which either failed to apply for or were denied a particular request. The State Department of Education generally either approved a request in total or denied the request. It was their opinion that there was no particular pattern with respect to applications or approvals. However, it seems reasonable that school districts would not apply for grants if they felt the probability of receiving any funds was extremely low. Also, the "beauty" of the proposal was undoubtedly a relevant factor. It seems logical that larger school districts were more likely to have the special personnel available to write "beautiful" proposals; thus, some measure of the size of a local area could be a relevant variable in the determination of per capita levels of federal subsidy actually received. No data is available to analyze characteristics of school districts which either rarely applied for or were denied funds based upon their proposal.

The Source of Matching Funds

Federal funds with matching requirements often left to the discretion of the state whether the funds obtained to match the federal grant came from the state or from the locality. In general, the state provided part of the necessary funds from the school districts. One exception in
1967 (school or fiscal year) was with respect to Public Law 89-750. Title III, Ohio received $773,000 from the federal government; the local governments in total provided $135,000 in matching funds. The state did not contribute. This grant went into effect for the second half of the fiscal year; in 1968, the first full year for this program, the state did allocate funds toward this program, almost half of the combined state-local total.

In Ohio, the state's share was highly variable. Toward Public Law 88-210 the state provided about 1/3 of the state-local total, but for laws 79-586 and 64-247 the state provided over 2/3 of the total. For Public Law 85-864, Title V-A, guidance, counseling, and testing, the state paid a percentage of salary allowances; the localities paid the balance of these costs. For Public Law 87-477, educational TV, the state allowed 40% to 60% per pupil in an approved program; additional expenditure, if any, was paid by the locality.

Summary

In fiscal 1967 Ohio received $101,514,038 in federal funds for support of 31 programs administered through the State Department of Education. Some of these funds were not intended for public (non-vocational) schools. Tables

Table 17

SOURCE OF SCHOOL REVENUES
School Year 1966-67

<table>
<thead>
<tr>
<th>School Revenues</th>
<th>Total</th>
<th>From Federal Government</th>
<th>From Federal Government</th>
<th>From Local Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.A. (Billions of Dollars)</td>
<td>26.8</td>
<td>2.15 (8%)</td>
<td>10.7 (39.9%)</td>
<td>14.0 (52.1%)</td>
</tr>
<tr>
<td>Ohio (Millions of Dollars)</td>
<td>1264</td>
<td>88 (7%)</td>
<td>318 (25.2%)</td>
<td>858 (67.9%)</td>
</tr>
</tbody>
</table>
16 and 17 show the comparative statistics.

The grants will be divided into three basic types: nonformula, pure matching, and formula (matching and non-matching. In a mathematical analysis, the theoretical arguments are defined by the formula equations for the formula grants. For non-formula grants, the selection criteria and knowledge of the state of the world is used to hypothesize an economic equation. These arguments will be identified in the next chapter.
CHAPTER 6

The purpose of this chapter is to build a model utilizing the information presented in the previous chapters. Each subsidy which can be investigated will be expressed quantitatively using variables dictated by the subsidy distribution structure. Where the institutional structure dictates that interaction between subsidy and local effort may occur, the own revenue variable will be included on the right hand side of the subsidy equation. Where the subsidy is non-formula in nature, variables hypothesized to be used by higher governmental decision makers will be used as regressors.

Adjustments necessary because of data problems will be made before each equation is estimated. In addition, the N.D.E.A. III program will be examined in great detail. This subsidy proves to be one of the hardest to explain statistically. Also, the sections of the Equal Opportunity Act and Higher Education Act dealing with public schools (named The Youth Corps and National Teacher Corps respectively), will be examined in somewhat greater depth due to the relatively small number of localities which
Table 18

$OR = \text{per capita own or local revenue for school operation}$

$S = \text{per capita state foundation subsidies to local school authorities}$

$Y_1 = \text{Federally Affected Areas Subsidy per capita}$

$Y_2 = \text{E.S.E.A. I per capita}$

$Y_3 = \text{E.S.E.A. II per capita}$

$Y_4 = \text{Lunch Act subsidy per capita}$

$Y_5 = \text{Milk Act subsidy per capita}$

$Y_6 = \text{Adult Education Act per capita}$

$Y_7 = \text{Vocational Education Acts per capita}$

$Y_8 = \text{N.D.E.A. III per capita}$

$Y_9 = \text{N.D.E.A. V per capita}$

$Y_{10} = \text{E.S.E.A. III per capita}$

$Y_{11} = \text{Higher Education Act per capita (Teacher Corps)}$

$Y_{12} = \text{Equal Opportunity per capita (Youth Corps)}$

$X_1 = \text{estimated per capita income}$

$X_2 = \text{ratio: population over 65 to total population in the locality}$

$X_3 = \text{ratio: pupils in A.D.M. to total population in the locality}$

$X_4 = \text{percentage of local population classified as poverty level}$

$X_5 = \text{percentage of local school population attending non-public schools}$
Table 18 Continued

$X_6 =$ percentage land classified as tax exempt
$X_7 =$ percentage land classified as agricultural and taxable
$X_8 =$ percentage land classified as industrial and taxable
$X_9 =$ percentage local population nonwhite
$X_{10} =$ locality's population size
$X_{11} =$ unemployment rate of locality in previous year
$X_{12} =$ rate of growth of local population
$X_{13} =$ median level of education attained by the male popula-
tion of locality
$X_{14} =$ average level of training of the teachers in a locality
$X_{15} =$ average number of years experience of the teachers in a locality
$X_{16} =$ percentage of local population classified as poor children
$X_{17} =$ average daily membership in local schools
$X_{18} =$ number of adults enrolled in basic education classes in a locality
$X_{19} =$ number of federally affected pupils (units) in a locality divided by population
received these funds in 1967.

**State Foundation Subsidies**

State formula subsidies per capita must be a function of the relative number of pupils, some measure of wealth, and years of education and training of the localities teachers. Also, due to a quirk in the foundation formula, a high level of impactedness implies a lower charge off factor (based upon tax valuation in the district). Thus, state subsidies per capita would be higher (everything else equal) in the areas with a high percentage of tax exempt land. Per cent of land zoned agricultural and taxable and per cent of land zoned industrial and taxable are indicators of relatively low and high charge off factors also. The State allocates relatively less subsidy per capita to areas with the tax base to support themselves.

The equation is:

2) \[ S = f(X_1, X_2, X_6, X_7, X_8, X_{14}, X_{15}) \]

This equation contains only exogenous variables. \( X_1 \), per capita income together with \( X_6, X_7, \) and \( X_8 \) composition of taxable land variables, are related to the charge off factor of the state formula. Percentage of population in A.D.M. and teacher quality variables are plus factors in the state formula.

In linear form, the regression equation was fitted as follows:
\[ S = -6.73 - 0.00824 X_1 + 231.3 X_3 + 0.106 X_6 \]
\[ \text{std. error} \begin{pmatrix} 25.85 & (0.0018) & (30.3) & (0.11) \\ \end{pmatrix} \]
\[ \text{t ratio} \begin{pmatrix} 0.26 & (4.70) & (7.64) & (0.98) \end{pmatrix} \]
\[ - 0.307 X_8 + 0.610 X_{14} + 0.624 X_{15} \]
\[ R^2 = 0.70 \]
\[ \text{std. error} \begin{pmatrix} 0.16 & (4.94) & (0.47) \\ 1.94 & (0.12) & (1.32) \end{pmatrix} \]

State subsidies per capita behave exactly as predicted. The larger the percentage of pupils to population, the greater the per capita subsidy. Subsidy is significantly negatively related to wealth measured by either income or tax base. The coefficients which are not significant are associated with the percentage of land which is tax exempt and the two teacher quality variables. Critical t values are approximately 1.99 for 95% confidence (two tailed), 1.649 for 90% confidence. All t values are given as the absolute value.

Neither teacher quality variable is significant in the regression equation. In particular, average number of years of training, performs very poorly, although the sign is correct. It was felt that this variable suffered from lack of spread, which may be a partial answer. However, it does somewhat better in other equations in which it appears. The best explanation is that this single equation fits both flat rate and formula subsidy districts. In Chapter 4 it was stated that no district can receive less than a certain per teacher unit amount. For these districts the teacher quality variables would not enter
into the subsidy formula. No dummy variable control was used since county data was used and since the equation performed very well without modification. If school district data had been used, dummy variable control would be mandatory. Since the majority of Ohio districts were not flat rate districts, certain intercorrelations may be partially responsible for the lack of significance of the teacher quality variables.

**Formula Pure Matching Subsidies**

The matching subsidies shown in Chapter 5 were of two distinct types. The categorical matching subsidy gave a subsidy dollar which must be matched by a certain local amount; the combined funds must be spent within some educational category. For any one particular subsidy, the matching requirement alone does not dictate that total local educational effort must necessarily increase. The pure matching subsidy provides the locality with a level of subsidy depending upon the level of the localities effort measured by total local expenditure per pupil. As demonstrated in Appendix D, subsidies of this type will interact with local effort; thus OR must be included on the right hand side of the subsidy equation. The only subsidy of the latter type is the Federally Impacted Areas Program.
The subsidy equation for this program is:

\[ Y_1 = f(X_{19}, OR) \]

We have this subsidy as a function of the number of the relative number of impacted units (approximately the relative number of impacted pupils), and local effort. Unfortunately, 1970 levels of impacted pupils had to be used to fit this equation. To estimate the equation, we will consider OR to be an independent variable for the present.

\[ Y = -0.059 + 135.5X_{19} + 0.00077 OR \quad R^2 = 0.96 \]

Std. error \( (.11) \quad (3.14) \quad (.0009) \)

\[ t \text{ ratio} \quad (.56) \quad (43.11) \quad (.84) \]

It is interesting to note that if OR is deleted the coefficient of \( X_{19} \) and the \( R^2 \) are virtually identical. The coefficient of OR is positive noting some tendency for higher local efforts to be associated with higher subsidies, but the blocklike manner of distributing the funds (explained in Chapter Five) does not allow the grant to behave as a pure matching subsidy. This is not entirely unexpected since a locality cannot make much of an impact upon the regional average if it alone makes a greater effort. It should also be noted that despite the apparent unusually good fit, several abnormalities appear in the data. Additional empirical work on this subsidy is presented in Appendix E.

**Formula Grants Without Maintenance of Effort Requirements**

As mentioned, categorical matching grants without
maintenance of effort requirements could derive funds to match the federal grant by shifting funds within educational categories. Thus, it may well be that no increase in total effort is necessary to receive a certain federal categorical matching subsidy. We would expect the level of the subsidy to be primarily determined by the variables in the formula itself to the extent that the subsidy is desirable and that virtually all localities participate.

In the case of nonmatching subsidies based upon some formula which does not include local performance or maintenance of effort requirements, the level of subsidy should be strictly determined by the variables in the formula.

The following federal programs are all formula type, either matching or nonmatching but contain no maintenance of effort requirement. It is still possible feedback effects local effort exists in the case that matching subsidies induce additional effort rather than funds diverted from other educational categories. This is judged unlikely in the cases shown and some additional support of that judgment is shown in this section. The equations
in functional form are:

\[ Y_4 = f(x_3, x_{16}) \]
\[ Y_5 = f(x_3, x_{16}) \]
\[ Y_7 = f(x_3, x_{11}) \]
\[ Y_8 = f(x_3, x_6, x_8, x_{12}) \]
\[ Y_9 = f(x_3, x_{16}) \]

In the case of matching programs, it is clear that state and federal matching subsidies are not independent. There is only one formula used to allocate funds to localities. It is devised by the state and approved by the relevant federal agency. Thus, matching state funds are some percentage of federal funds for each matching subsidy program. In the model state matching funds should be combined with the appropriate federal program. For,

This analysis incorporates the fact that the correlation between \( x_4 \) and \( x_{16} \) and the correlation between \( x_{10} \) and \( x_{17} \) are both approximately 1; thus only one of each pair can be used in the system. The variable \( x_{16} \) will replace \( x_4 \) and \( x_{17} \) will replace \( x_{10} \) in most equations where \( x_4 \) and/or \( x_{10} \) are desired. It also turns out that other independent variables which are highly correlated with others had to be deleted due to measurement problems they introduced. These variables were all wealth or size oriented. The intercorrelation is shown in Table 19 and additional details are given in Appendix C. It should be noted that one cannot tell by correlation alone whether to retain or delete a variable. In this case all variables were entered by stepwise regression. In this way the effects of a variable on others can be studied. After many combinations of trials, a usable subset remained.
Table 19

Subset of Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>-.45</td>
<td>.61</td>
<td>.33</td>
<td>-.54</td>
<td>.15</td>
<td>.58</td>
<td>.86</td>
<td>-.21</td>
</tr>
<tr>
<td>2</td>
<td>.45</td>
<td>2</td>
<td></td>
<td></td>
<td>.60</td>
<td>-.57</td>
<td>.62</td>
<td>-.45</td>
<td>.44</td>
</tr>
<tr>
<td>3</td>
<td>.61</td>
<td>-.63</td>
<td>3</td>
<td></td>
<td>.61</td>
<td>.30</td>
<td>.61</td>
<td>.57</td>
<td>-.56</td>
</tr>
<tr>
<td>4</td>
<td>.33</td>
<td>-.70</td>
<td>.57</td>
<td>4</td>
<td>.44</td>
<td>.69</td>
<td>.44</td>
<td>.25</td>
<td>.63</td>
</tr>
<tr>
<td>5</td>
<td>-.54</td>
<td>.60</td>
<td>-.45</td>
<td>-.29</td>
<td>.18</td>
<td>.69</td>
<td>.50</td>
<td>.09</td>
<td>.02</td>
</tr>
<tr>
<td>6</td>
<td>.15</td>
<td>-.57</td>
<td>.30</td>
<td>-.24</td>
<td>.18</td>
<td>.69</td>
<td>.50</td>
<td>.09</td>
<td>.35</td>
</tr>
<tr>
<td>7</td>
<td>.58</td>
<td>-.62</td>
<td>.61</td>
<td>.44</td>
<td>-.50</td>
<td>.69</td>
<td>.18</td>
<td>.60</td>
<td>-.32</td>
</tr>
<tr>
<td>8</td>
<td>.86</td>
<td>-.45</td>
<td>.57</td>
<td>.25</td>
<td>-.60</td>
<td>.69</td>
<td>.09</td>
<td>.60</td>
<td>-.22</td>
</tr>
<tr>
<td>9</td>
<td>-.21</td>
<td>.44</td>
<td>-.56</td>
<td>-.63</td>
<td>.02</td>
<td>.35</td>
<td>.32</td>
<td>.22</td>
<td></td>
</tr>
</tbody>
</table>

Subscripts of X variables defined in Table 18.
example, \( Y_4 \) should include the state matching component as well as the federal government grant. Unfortunately this cannot be done. Localities were not required to report the amount of state matching aid by category; only the total amount. Therefore, the best that can be done is to include state matching aid as an independent variable in the own revenue equation and to ignore it altogether in the subsidy equations.

In the case of the Vocational Educational Subsidy Programs, local authorities seemed confused as to the source of the funds. If a subsidy was labeled vocational at all, neither the source of the funds nor the program were identified in the majority of cases. In this case the data problems were too severe to attempt to estimate this equation. At this point it will be dropped from the analysis.

In the case of the Lunch and Milk Acts, many districts did not separately report the two levels of subsidy; rather they showed a combined total. Since the two equations contain identical arguments and expected signs (positive for both coefficients), it was felt that the aggregated variable Lunch and Milk subsidy could be retained in the analysis. The label \( Y_4 \) will be used for the combined Lunch-Milk program when this equation is estimated.

In the case of the N.D.E.A. III equation, the relative number of pupils reflects the basis for the award of this grant assuming all school districts apply for the funds despite the matching requirement. The tax exempt, indus-
trial and growth variables reflect the distribution of the supplemental funds.

In the N.D.E.A. V subsidy it is felt that the percentage of poor children is a policy variable with respect to the local authorities determination of the relative number of counselors and the actual number of tests per year. In large part the basis of the award is on the per pupil basis, but considerable additional variation remains to be explained.

In Chapter Five each subsidy equation was presented using raw data. The total level of subsidy was explained using arguments specified or suggested in the state plan. In each case the fit as measured by the $R^2$ was excellent. In the case of per capita levels of subsidy, the equations will be estimated with the constant term included. We get:

$$Y_4 = -0.515 + 5.312 X_3 + 0.103 X_{16} \quad R^2 = 0.57$$

\[ \begin{array}{ccc}
\text{Std. error} & (0.28) & (1.26) & (0.14) \\
\text{t ratio} & (1.83) & (4.21) & (7.24) \\
\end{array} \]

$$Y_8 = 0.082 + 2.451 X_3 + 0.010 X_6 + 0.0096 X_{12} \quad R^2 = 0.07$$

\[ \begin{array}{ccc}
\text{Std. error} & (0.40) & (1.58) & (0.06) & (0.077) \\
\text{t ratio} & (1.20) & (1.55) & (1.70) & (1.26) \\
\end{array} \]

$$Y_9 = 0.164 + 2.572 X_3 - 0.053 X_{16} \quad R^2 = 0.06$$

\[ \begin{array}{ccc}
\text{Std. error} & (0.48) & (2.14) & (0.2) \\
\text{t ratio} & (1.34) & (1.20) & (2.12) \\
\end{array} \]
Before interpretation of the results, an interesting question may be "Do any of the above subsidies interact with local effort?" The reason OR was not included on the right hand side have been previously explained. Nevertheless, we are concerned with how the subsidies behave given that we know something about how they should behave. In particular, $Y_8$ and $Y_9$ represent categorical matching subsidies. As mentioned, a locality could match one of the above by substituting funds from some other category. However, if a locality desired to participate in "many" matching programs, what is true for a single program (substitution of funds within educational categories), may not be true for the whole. Thus it is possible that communities participating in federal programs must increase local effort. The equations are as follows:

$$Y_4 = -0.47 + 5.57 X_3 + 0.096 X_6 - 0.0070 OR$$

| Std. error | (0.29) | (1.32) | (0.011) | (0.0010) |
| t ratio    | (1.61) | (5.94) | (4.42)  | (0.67)   |

$$R^2 = .58$$

$$Y_8 = 0.019 + 2.28 X_3 + 0.011 X_6 + 0.0056 X_8$$

| Std. error | (0.41) | (1.59) | (0.06)  | (0.009)  |
| t ratio    | (0.143)| (1.77) | (0.62)  |          |

$$-0.0041 X_{12} + 0.0013 OR$$

| Std. error | (0.005) | (0.0016) |
| t ratio    | (0.89)  | (0.86)   |

$$R^2 = .08$$
\[ Y_9 = 0.24 + 2.96 \, X_3 - 0.061 \, X_{16} - 0.0011 \quad \text{OR} \quad R^2 = 0.07 \]

\[
\text{std. err}\, (0.49) \quad (2.22) \quad (0.03) \quad (0.0017) \\
\text{t}\, \text{ratio} \quad (1.48) \quad (1.33) \quad (2.26) \quad (0.66)
\]

The OR variable shown above does not appear as significant in any of the three equations. However, this does not rule out the possibility of feedback since a more sophisticated model must be used which can account for feedbacks and interdependencies.

In general, the performance of the \( Y_4 \) equation is judged satisfactory. Both variables appear as significant and positive, which is reasonable in light of the program as specified. Both N.D.E.A. equations are extremely disappointing. In particular, it was expected a priori that our fit of N.D.E.A. III would be reasonably good. More details on this subsidy will be forthcoming.

Interpretation of the results show some surprises. Percentage poor children \( (X_{16}) \) appears with a significant negative sign in the \( Y_9 \) equation. If accurate, this implies that this subsidy is given in larger amounts (everything else held equal) to areas with a lesser percentage of poor children. This implies that the somewhat wealthier areas have more counselors per pupil than the areas with a higher percentage of poor children. This is likely to be true, and in this sense the subsidy is regressive.
It is also surprising that $X_3$, ratio of pupils to population does not appear as significant in either N.D.E.A. equation. This variable in effect converts from per capita to per pupil in that it captures the effect of the relative number of pupils in public school in a local population. $X_3$ appears as significant in virtually every other equation in which it appears. Additional comments will be deferred to a comprehensive summary.

Formula Grants with Maintenance of Effort Requirements

Formula grants, categorical matching or nonmatching, with maintenance of effort requirements include E.S.E.A Titles I and II and the Adult Education Act. The state criterion does not make clear whether maintenance of effort means total effort or simply effort within the aided category. If maintenance of total effort is a requirement given that it is enforced, the theoretical representation would be for the net budget line to be raised or lowered as the response of the higher level government to the level or change in level of own revenue.

Interviews with state officials indicate that maintenance of effort is limited to the aided category. In addition no enforcement mechanism is specified. A priori,

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46 State of Ohio Department of Education, Program Profiles. (Columbus, Ohio, Published by the State of Ohio, 1971), 611.
one could argue that OR should not appear on the right hand side of the above equations using logic similar to that presented when we excluded OR from $Y_4$, $Y_8$ and $Y_9$.

However, we are not certain that maintenance of effort requirements are restricted to the aided function; the interviews were merely one piece of evidence that this is the case. Because the maintenance of effort requirements exist, it was decided to include OR on the right hand side of the above equations. If the coefficient of OR is positive and significant, this is a piece of evidence that localities make a greater effort in response to a subsidy or that the subsidy rewards greater local efforts. If the coefficient of OR is not significantly different from zero, then the level or OR does not effect the level of subsidy. There are several hypotheses compatible with the insignificant coefficient case. One might use this as a piece of evidence that maintenance of effort is effective over the total educational program. It also could be argued that matching funds are derived from other educational programs. If state and/or federal officials enforce category maintenance of effort, then as long as the category is maintained, the level of subsidy would not fall. It is assumed subsidy would fall if the local officials tried to cut back on expenditure on the aided category.

One thing we would not expect is to find the coefficient of OR to be negative and significant. If this was
the case, higher local efforts imply lesser amount of subsidy. None of the programs described in the previous chapter are designed to perform in that way. From the subsidy distribution structures specified in Chapter Five, we derive the following functional forms for these equations.

\[
Y_2 = f(X_{16}, OR)
\]

\[
Y_3 = f(X_3, X_{16}, X_{17}, OR)
\]

\[
Y_6 = f(X_{18}, OR)
\]

In the case of the Adult Education Program, the number of adults enrolled in basic education classes in a locality in 1967 was not available. It is felt that the data for 1970 is not a good proxy for 1967 since the program expanded rapidly in this era and it is felt that the expansion was not proportional. The program began in 1966 and was expanding in 1967. In the next few years many districts initiated the program which had not participated in the earlier years. Thus this program will not be estimated, the variable will be considered entirely exogenous.

E.S.E.A. Title I per capita subsidy is expressed as a function of the percentage of poor children and maintenance of effort. The basic E.S.E.A Title II per capita grant is a function of the relative number of pupils in A.D.M. in the locality and maintenance of effort. In addition, there is a supplemental or discretionary portion of the E.S.E.A. II grant for which we must hypothesize determinants of the distribution mechanism.
Because E.S.E.A II is in part nonformula, and because there is another class of grants in which OR is included on the right hand side of the equations, the subsidy equations for E.S.E.A. Titles I and II will be presented with the next section. In this way all grants which contain OR on the right hand side will be presented as a group.

Nonformula Subsidies

A nonformula subsidy is any subsidy which is allocated to a locality based upon a specific proposal. In these cases the proposals are ranked and the funds awarded to the highest ranks. Thus nonformula subsidies are generally allocated by a mechanism which could allow a secondary reaction, i.e., these funds could be rationed on a reward system. For example, a poor local effort could cause the higher level government to view requests for subsidy less favorably than if the locality had made a better effort.

Nonformula subsidies include E.S.E.A. Title III, The Youth Corps section of the Higher Education Act, and the National Teacher Corps section of the Equal Opportunity Act. As mentioned, part of E.S.E.A. II is nonformula or discretionary. All subsidies which are discretionary will contain OR on the right hand side of the equation to measure the "reward" effect, if any, previously explained.

In addition, state authorities claim that the past history of the locality is an important determinant of future support. Using cross sectional data, use of OR in
these equations may in part reflect this history.

The nonformula programs all purport to serve areas with high concentrations of poor children. Also, state authorities admit than an explicit, well written, detailed proposal is somewhat more likely to gain official approval than one less well written or documented. It seems reasonable that the size of a school system is a measure of its human resources regarding the process of application for federal programs which require proposals. That is, large school systems are more likely to have the specialized personnel to write superior proposals. Thus, variables reflecting concentration of poor children and size of the system will be included with all nonformula subsidies including E.S.E.A. II.

With respect to the National Teacher Corps subsidy, it is believed that one purpose of the act is to provide an incentive for quality teachers in areas with economic problems. If this is true, the two teacher quality variables, average years of training and average years of experience, should in part reflect the allocation of these funds. It is expected both coefficients will be negative; that is, more funds per capita are destined for areas with low teacher quality. It is also believed that percentage of nonwhite local population may be a key governmental decision variable. In part this may
represent simple income redistribution effects, but we may also have a lobby effect. It is possible that other equally peer groups may do less well subsidywise. These three variables will be included in the National Teacher Corps equation to measure these expected effects.

Perhaps to a lesser degree, the Youth Corps subsidy seems to follow the same format as the National Teacher Corps. The program is a basic income redistribution plan aimed at areas where youth are believed to need incentive. It has been noted that rural peer seem somewhat less likely to participate (or the state is less likely to offer them the opportunity to participate) than urban peer.

In functional form these equations appear as:

\[ Y_{10} = f(X_{16}, X_{17}, OR) \]
\[ Y_{11} = f(X_9, X_{14}, X_{15}, X_{16}, X_{17}, OR) \]
\[ Y_{12} = f(X_9, X_{14}, S_{15}, X_{16}, X_{17}, OR) \]

In linear form, the estimation of each of the equations in the last two sections appear as follows. Again the estimates are made using OR as a regressor.

\[ Y_2 = -1.58 + 1.10 X_{16} + 0.0030 OR \quad R^2 = .62 \]

\[
\begin{array}{ccc}
\text{std. error} & (1.11) & (.10) \\
\text{t ratio} & (1.42) & (10.84) \\
\end{array}
\]

\[ Y_3 = .013 + 2.23 X_3 - .0016 X_{16} - .00000013 X_{17} \]
\[
\begin{array}{ccc}
(1.28) & (1.24) & (.015) \\
(.36) & (1.79) & (.11) \\
\end{array}
\]

\[ - .003 OR \quad R^2 = .05 \]

\[
\begin{array}{ccc}
(1.00095) & (.32) \\
\end{array}
\]
\[ Y_{10} = 0.307 - 0.0038 \times 16 + 0.0000098 \times 17 + 0.00012 \text{ OR} \\
\quad (0.38) (0.04) (0.000017) (0.00023) \\
R^2 = 0.01 \\
\]

\[ Y_{11} = -0.98 - 0.0086 \times 9 + 0.27 \times 14 - 0.0083 \times 15 \\
\quad (0.88) (0.014) (0.20) (0.018) \\
\quad (1.11) (0.61) (1.35) (0.46) \\
+ 0.021 \times 16 + 0.000039 \times 17 - 0.0012 \text{ OR} R^2 = 0.31 \\
\quad (0.017) (0.000012) (0.0009) \\
\quad (1.27) (3.31) (1.35) \\
\]

\[ Y_{12} = 1.06 + 0.0060 \times 9 - 0.201 \times 14 - 0.016 \times 15 \\
\quad (0.39) (0.0062) (0.09) (0.008) \\
\quad (2.72) (0.96) (2.26) (1.99) \\
+ 0.0022 \times 16 - 0.00000047 \times 17 - 0.00032 \text{ OR} \\
\quad (0.007) (0.0000052) (0.0004) \\
\quad (0.29) (0.09) (0.79) \\
R^2 = 0.13 \\
\]

In particular it was expected a priori that we would do reasonably well with the formula grants and somewhat poorer with the nonformula subsidies. The equation for E.S.E.A. I proves reasonably successful. The equation for E.S.E.A. II is essentially a total failure. Obviously much more needs to be known about this program and the subsidy allocation procedure. It is not as disappointing that the nonformula grants were rather poor fits. Even E.S.E.A. III, the largest of the three by dollar amount to Ohio and in number of projects funded, was awarded to only 86 localities in 1971. Thus our data contains many points with zero levels and a few with high levels while our explanatory variables are continuous. The equations
provide only rudimentary information concerning the dispersion of the non-formula subsidies.

In every case presented OR was insignificant. With respect to the nonformula subsidies, it is speculated that school districts do not view these programs as stable, dependable sources of funds. That is, they treat the funds as windfall and do not change local effort. With respect to the formula subsidies, if we accept the null hypothesis that the coefficient of OR is zero, then it may be that matching funds are derived from other educational categories. Among other possibilities, it also may be that funds are released to other categories if the availability of outside funds permits expenditure in the aided area to be maintained or increased with less local money than formerly was necessary. In part this depends upon the desired level of expenditure by category of the locality and the effectiveness of maintenance of effort requirements.

The variable $X_3$, ratio of pupils to population, should appear in any equation in which the funds are in part distributed on a per pupil basis. With respect to the last set of equations, only E.S.E.A. II, $Y_8$ is specified to be a per pupil subsidy. The coefficient is positive and of borderline significance in that equation.

The variable $X_{16}$ is used in all equations which are in part "poverty programs". These include all the above, this variable is significant in only the $Y_2$, E.S.E.A. I equation, and in that case it is highly significant.
The sign is correct in the other cases except for $Y_3$ and $X_{10}$, but based upon the description of the program for $Y_3$ provided in the last chapter, this is no real surprise. Recall that this program is a model library program first and supposedly a poverty program second. The specialized personnel indicator, $X_{17}$, number of pupils, appears in each subsidy in this section except $Y_2$. It is significant only in the case of $Y_{11}$ and with the correct sign. Otherwise, the significance is very low and the signs vary.

The teacher quality variables $X_{14}$ and $X_{15}$ are significant in the $Y_{12}$ equation with the correct negative sign. In the $Y_{11}$ equation one sign is wrong and neither is significant. No explanation is offered toward the positive coefficient in the $Y_{11}$ equation, although more detail is given in a later section of this chapter for these two subsidies in view of the extremely few nonzero observations available to estimate these equations.

In each case in this section, the equation was also estimated excluding OR. This was to check the effects of interaction of the OR variable on other coefficients. The results are given as follows:

$$Y_2 = -1.48 + 1.07 X_{16}$$

\[ R^2 = .60 \]

\[ \text{std. error} \ (\ .55 \) (\ .095 \]

\[ \text{t ratio} \ (2.68) (11.28) \]

$$Y_3 = .13 + 2.25 X_3 - .0018 X_{16} - .00000013 X_{17}$$

\[ (.29) \ (1.26) \ (\ .014 \) (\ .0000069 \]

\[ (.44) \ (1.78) \ (.13 \) \ (\ .18 \]

\[ R^2 = .04 \]
\[
Y_{10} = 0.32 - 0.0047 X_{16} + 0.0000099 X_{17} \quad R^2 = 0.01
\]
\[
(\begin{array}{c}
0.22 \\
1.50
\end{array})
(\begin{array}{c}
0.034 \\
0.14
\end{array})
(\begin{array}{c}
0.000016 \\
0.60
\end{array})
\]
\[
Y_{11} = -1.12 + 0.0069 X_9 + 0.26 X_{14} - 0.0072 X_{15} \quad R^2 = 0.30
\]
\[
(\begin{array}{c}
0.87 \\
1.50
\end{array})
(\begin{array}{c}
0.014 \\
0.49
\end{array})
(\begin{array}{c}
0.20 \\
1.31
\end{array})
(\begin{array}{c}
0.018 \\
0.39
\end{array})
\]
\[
+ 0.027 X_{16} + 0.0000040 X_{17}
\]
\[
(\begin{array}{c}
0.016 \\
1.68
\end{array})
(\begin{array}{c}
0.000012 \\
0.49
\end{array})
\]
\[
Y_{12} = 1.20 + 0.0065 X_9 - 0.020 X_{14} - 0.016 X_{15} \quad R^2 = 0.12
\]
\[
(\begin{array}{c}
0.38 \\
2.67
\end{array})
(\begin{array}{c}
0.0061 \\
1.06
\end{array})
(\begin{array}{c}
0.009 \\
2.30
\end{array})
(\begin{array}{c}
0.008 \\
1.98
\end{array})
\]
\[
+ 0.0037 X_{16} - 0.00000093 X_{17}
\]
\[
(\begin{array}{c}
0.0070 \\
0.52
\end{array})
(\begin{array}{c}
0.0000051 \\
0.52
\end{array})
\]

In this subset the effect of the OR variable on the others is negligible. Thus OR as an independent variable neither affects the magnitude nor significance of the other variables. The signs are unchanged and the \( R^2 \) is practically unchanged.

**Own Revenue**

Own revenue, as defined in Chapter 3, is found theoretically by noting the ordinate on the educational axis of the point representing the tangency of the preference curve and the income constraint (including educational subsidies); then subtracting the level of subsidies. Empirically it is found by aggregation of the component parts. For any locality the own revenue equation should include income and hypothetical arguments of the community preference function. The equation is:

\[
OR = f(X_j, S, Y_i) \quad j = 1,13 \quad i = 1,12
\]
Table 20
Variables Used in the Adjusted Model

<table>
<thead>
<tr>
<th>VARIABLE (NAME)</th>
<th>MEAN</th>
<th>STANDARD DEVIATION</th>
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</thead>
<tbody>
<tr>
<td>Own Revenue Per Capita</td>
<td>107.24</td>
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</tr>
<tr>
<td>State Foundation Subsidy Per Capita</td>
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<td>Elementary and Secondary Education Act Title II</td>
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</tr>
<tr>
<td>National Teacher Corps (H.E.A.)</td>
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<tr>
<td>Per Capita Income</td>
<td>1857.20</td>
<td>586.63</td>
</tr>
<tr>
<td>Approx. Per Cent of Population Over Age 65</td>
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</tr>
<tr>
<td>Average Daily Membership/Population</td>
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<td>.026</td>
</tr>
<tr>
<td>Per Cent of Tax Exempt Land</td>
<td>14.11</td>
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<tr>
<td>Per Cent Land Classified As Industrial</td>
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Table 20 Continued

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<td>122356.00</td>
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<td>Unemployment Rate in 1966</td>
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<td>Population Growth Rate</td>
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<td>Years of Experience of Teachers</td>
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<td>X₁₆</td>
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<td>Percentage of Children in ADM from Poor Families</td>
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<td>X₁₇</td>
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<td>Average Daily Membership</td>
</tr>
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<td>X₁₉</td>
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<td>.0097</td>
<td>Relative Number of Impacted Units in a Locality</td>
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* These values were calculated including localities with zero levels. In particular this affects the subsidies.
<table>
<thead>
<tr>
<th>Algebraic</th>
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<th>OWN Rev.</th>
<th>Found</th>
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Critical Limits for Significance of Correlation Coefficients:

95% Level: .2099
99% Level: .2736
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</tbody>
</table>

Critical limits for significance of correlation coefficients:

95% Level: .2099
99% Level: .2736
Table 23

Correlation Matrix

Independent Variables

| Symbolic Names | Inobs | % Old | ratio | % Poor | % Cath | % Imp | % Agr | % Ind | % Non W | pop | % Unp66 | Growth | Ed Lev | TQ Exp | TQ Yrs | A.D.M. | % Fr Ch | Imp Pup |
|----------------|-------|-------|-------|--------|--------|-------|-------|-------|---------|-----|---------|--------|--------|--------|--------|--------|--------|--------|---------|
|                |       | X1    | X2    | X3     | X4     | X5    | X6    | X7    | X8      | X9  | X10     | X11    | X12    | X13    | X14    | X15    | X16    | X17    | X18    |
| % Old          | - .24 |       |       |        |        |       |       |       |          |     |         |        |        |        |        |        |        |        |        |
| ratio          | - .23 | - .08 |       |        |        |       |       |       |          |     |         |        |        |        |        |        |        |        |        |
| % Poor         | - .65 | .47   | .16   |        |        |       |       |       |          |     |         |        |        |        |        |        |        |        |        |
| % Cath         | .61   | - .17 | - .39 | - .60  |        |       |       |       |          |     |         |        |        |        |        |        |        |        |        |
| % Imp          | - .21 | .07   | .02   | .19    | - .13  | X6    |       |       |          |     |         |        |        |        |        |        |        |        |        |
| % Agr          | - .44 | .23   | .45   | .54    | .50    | - .15 | X7    |       |          |     |         |        |        |        |        |        |        |        |        |
| % Ind          | .44   | - .13 | - .18 | - .19  | .29    | - .13 | - .50 | X8    |          |     |         |        |        |        |        |        |        |        |        |
| % Non W        | .57   | - .12 | - .42 | - .91  | .60    | .03   | - .60 | X9    |          |     |         |        |        |        |        |        |        |        |        |
| pop            | .59   | - .08 | - .40 | - .39  | .58    | - .01 | - .51 | .85   | X10     |     |         |        |        |        |        |        |        |        |        |
| % Unp66        | - .55 | .37   | - .05 | .49    | - .32  | - .01 | .02   | - .18  | - .22   | .20 | X11     |        |        |        |        |        |        |        |        |        |
| Growth         | .30   | - .28 | .14   | - .64  | .18    | - .03 | - .24  | - .01  | .08    | - .12 | - .35  | X12    |        |        |        |        |        |        |        |        |
| Ed Lev         | .57   | - .28 | - .02 | - .75  | .44    | - .01 | - .29  | .03    | .25    | - .30 | - .63  | .69    | X13    |        |        |        |        |        |        |        |        |
| TQ Exp         | - .49 | .19   | - .09 | .66    | - .44  | .11   | - .27  | .04    | - .38  | - .39 | .41    | - .60  | - .56  | X14    |        |        |        |        |        |        |        |        |
| TQ Yrs         | .32   | - .20 | - .29 | - .39  | .44    | 0     | .33    | .28    | .45    | .47   | - .27  | .29    | .39    | - .26  | X15    |        |        |        |        |        |        |        |        |
| A.D.M.         | .61   | - .09 | - .38 | - .42  | .58    | 0     | - .54  | .16    | .86    | 1.00  | - .21  | .15    | .33    | .48    | .47    | X17    |        |        |        |        |        |        |        |        |
| % Fr Ch        | - .64 | .49   | .40   | .97    | - .03  | .18   | .60    | - .21  | - .45  | - .42 | .44    | .57    | - .70  | .59    | - .42  | - .45  | X16    |        |        |        |        |        |        |        |        |
| Imp Pup        | .33   | - .08 | - .11 | - .25  | .20    | .22   | - .35  | - .02  | .60    | .57   | - .17  | .28    | .34    | .25    | - .27  | .62    | - .25  | X19    |        |        |        |        |        |        |        |        |

95% Level: .2099
99% Level: .2736
$X_i$, $S$ and $Y_i$, $i = 1,12$ represent the income components. $X_i$ also may be an argument of the preference function. Unemployment rate in the previous year is used as another component of permanent income.

Percentage of population age 65 and over, percentage of population attending public schools, percentage of pupils attending nonpublic schools, and percentage of population classified as nonwhite are demographic characteristics of the locality which are believed to influence the shape and location of the community preference curve. With respect to the own revenue function, the greater the relative number of young people in school, the greater will be the community support for public education in this area. Also, median education level and growth rate of the population could be classified as demographic characteristics. With respect to the latter, if the locality has a high growth rate which is uniform across age groups or biased toward the school age group, then the necessity for capital facilities should raise the per capita level of expenditure for education. Likewise, a low or negative growth rate may imply a lesser need for capital expenditure toward public schools. Population size may detect economies of scale, if any.

Three variables reflect the composition of the tax base. It is believed that areas with a high percentage of industrial property will be more likely to have high levels of per capita revenue since taxing industry
amounts to partial tax shifting. Coefficient implies that localities do not change local effort for any level of subsidy. In effect this demonstrates overall maintenance of effort, although we can say nothing about substitution if any within categories. If a subsidy coefficient is positive and significant, then total local effort rises as the level of subsidy rises. This seems most likely to occur in cases where total effort is being matched. None of the described educational subsidies are of that type, although $Y_1$ would seem to be the closest. If the coefficient is negative and significant, this implies that higher subsidies lead to lower local efforts. This is most likely to occur with grants without maintenance of effort requirements; if they occur with grants with maintenance of effort requirements then it appears that localities get around them somehow.

For this equation of the model, it was necessary to impose the additional zero restrictions upon the $OR$ equation. The restrictions were imposed on $X_6$, $X_9$, $X_{16}$ and $X_{17}$. The rational for this choice is given in Appendix C. The adjustments previously mentioned are also included in the following equation. Each subsidy is evaluated as if it were an independent variable.

$$OR = -33.94 + 0.019 X + 0.162 X_2 + 525.3 X_3$$

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<th>t ratio</th>
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<td>(.007)</td>
<td>(2.80)</td>
</tr>
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<td>(.26)</td>
<td>(.63)</td>
</tr>
<tr>
<td>(127.5)</td>
<td>(4.12)</td>
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</table>
\[ + 1.63 X_8 + 1.29 X_{11} + 1.007 X_{12} - 1.098 S \\
\begin{array}{c|c|c|c}
X_8 & X_{11} & X_{12} & S \\
\hline
(2.72) & (.49) & (2.87) & (2.09)
\end{array} \\
- 2.06 M - 2.78 Y_1 + 1.47 Y_2 + 10.51 Y_3 \\
\begin{array}{c|c|c|c}
M & Y_1 & Y_2 & Y_3 \\
\hline
(3.82) & (2.24) & (1.39) & (11.59)
\end{array} \\
- 8.09 Y_4 - 5.41 Y_6 + 4.89 Y_8 - 3.75 Y_9 \\
\begin{array}{c|c|c|c}
Y_4 & Y_6 & Y_8 & Y_9 \\
\hline
(8.92) & (43.75) & (7.82) & (5.83)
\end{array} \\
+ 4.35 Y_{10} - 11.33 Y_{11} - 16.23 Y_{12} \\
\begin{array}{c|c|c|c}
Y_{10} & Y_{11} & Y_{12} \\
\hline
(4.50) & (11.01) & (26.21)
\end{array} \\
R^2 = .66

In appendix C the entire model including the interaction effects will be presented. The model does not incorporate the additional adjustments with respect to the N.D.E.A. III equation shown in the next section. The demonstration that the system is identified and the evaluation of the model is also relegated to Appendix C. The reason this seemingly important analysis is not in the main body of the paper is due to certain data problems affecting some of the subsidy equations and the lack of proper specification with respect to several of the subsidies. An interdependent model would utilize each specification and the results affect other equations in the system. Thus the overall results in Appendix C are tentative and should be used with extreme caution.

Upon face value, the taste variables perform rather well and all signs are correct except \( X_{11} \), unemployment rate. In this case the coefficient is insignificant, but we had expected a negative sign. In the case of \( S \),
state subsidies, we get a negative coefficient of approximately -1.0, implying total substitution of state money for local money. All other subsidy coefficients are insignificant. The signs vary and the coefficients are too large. The magnitude of the coefficients may be due to estimation problems. In particular the sign of $Y_1$ is wrong. On the surface $Y_1$ seems closest to a overall matching program, and if a plus sign was expected anywhere, it would be for this subsidy.

**Detailed Analysis of N.D.E.A. Title III**

N.D.E.A. Title III is one of several federal programs shown in this paper for which the econometric method developed in this paper was of virtually no use. This result is very surprising since it was expected that this equation should have been one of our best fits. Therefore, additional analysis was judged necessary in an effort to aid future researchers develop improved predictive mechanisms.

A residual analysis showed that a portion of the problem is due to the large number of apparent nonapplicants. Tabulation of the data showed that 97 of 718 districts reported no subsidy in calendar 1967. In addition, the Appalachian Program which went into effect with respect to Ohio schools late in 1967 was originally assumed to have had no impact in that year. At this time dummy variable will be added to control for both these
problems.

Alternate sources of data verified that the discrepancy between the fiscal and calendar years was a large source of unexplained variation. Subsidies are allocated or earmarked to Ohio schools by the fiscal year, but the school district financial reports used as primary data are based on the calendar year. Many districts received fiscal 1967 funds in early 1968. Thus the source data would underestimate the actual level of subsidy utilized. Other districts reported fiscal 1966 appropriations in calendar 1967. In many cases the data overestimates the actual level of subsidy utilized. In many cases averaging out occurred, but this was not true in other cases. An effort was made to smooth the data to correct for the fiscal year-calendar year problem. Calendar 1967, 1968 and 1969 N.D.E.A. III subsidy was averaged, and this new variable called smoothed N.D.E.A. III replaced the 1967 N.D.E.A. III in the regression equation. The revised results with both smoothed and unsmoothed per capita subsidy levels are shown below. Many different combinations of proxy variables were utilized. The two shown are representative.

\[ Y_8 = 0.12 + 2.80 X_3 + 0.079 X_6 + 0.0026 X_{12} - 0.0042 X_8 \]

\[ t \text{ ratio} \quad (0.32) \quad (1.39) \quad (1.40) \quad (1.36) \]

\[ - 0.45 E_2 \]

\[ (0.92) \quad (1.05) \quad (3.68) \]
\[ V = 0.007 + 2.11X_3 + 0.0028X_6 + 0.0015X_8 - 0.0013X_{12} \\
\frac{(.04)}{(2.64)} \frac{(.93)}{(3.37)} \frac{(.54)}{(2.13)} + 0.22E_1 - 0.14E_2 \]

\[ R^2 = .28 \]

where \( E_1 = \) dummy variables for Appalachian Counties in Ohio

\( E_2 = \) dummy variable for counties in which 30 percent or more of school districts did not report 1967 N.D.E.A. III subsidy

\( V = \) smoothed N.D.E.A. III per capita subsidy

The other variables have been previously defined.

The impact of the Appalachian Program is readily noticed using the smoothed data. This program was effective in 1968 and 1969. It affected only a few Ohio districts in 1967. As measured by the \( R^2 \), the statistical explanation is somewhat improved with the smoothed data.

An interpretation of the above results and mention of other combinations is in order. First, if \( X_3 \), \( E_1 \) and \( E_2 \) alone were used in the \( Y_8 \) equation, we would have:

\[ Y_8 = 0.22 + 2.69X_3 + 0.18E_1 - 0.46E_2 \quad R^2 = .19 \]

\[ t \text{ ratio} \quad (.62) \quad (1.85) \quad (2.09) \quad (3.96) \]

In particular, rate of growth seems to affect the coefficient of the dummy Appalachian variable \( E_1 \). Thus the program is in part an income redistribution program. The same three variables are also the most important in the \( V \) (smoothed data) equation, but the introduction of the others does not affect the net result.
If $X_{16}$, percentage poor children, is introduced into the $Y_8$ equation, the $R^2$ is unchanged. However, it is one of the first variables to enter the stepwise regression and is significant with a t value of 2.38. The sign of the coefficient is positive. After additional variables are introduced, particularly the dummy Appalachia variable, neither appears as significant. The conclusion seems to be that both variables are measuring the same aspect of poverty. If smoothed data is used, either $X_{16}$ or $E_1$ measure poverty to some extent; $E_1$ seems to do it better. Even when both are used together $E_1$ is still highly significant although the introduction of $X_{16}$ will reduce its significance.

The introduction of $X_1$, per capita income, into the $Y_8$ equation neither changes the $R^2$ nor the level and standard errors of the other coefficients. It has a negative coefficient with a t value of .17. However, if smoothed data is used, the $R^2$ goes up a bit to .30 and the t ratio is over 1.5 while the other coefficients and standard errors are virtually unchanged. The coefficient of $X_1$ in the $V$ equation is negative.

The introduction of OR in the $Y_8$ equation neither changes the $R^2$ nor the magnitudes and significance of the other variables. It is insignificant in this equation and is one of the last variables to enter the stepwise regression. Using the $V$ equation, it enters the regression
toward the middle of the list and raises the $R^2$ to .29. However, it is not significant having a t value of .89. The sign of the coefficient is positive, and the introduction of this variables does not disturb the others.

The N.D.E.A. III subsidy is or seems to be in small part an income redistribution or poverty program, and became much more so in 1968 and 1969 when the impact of the Appalachian Program was introduced. We do improve our mathematical explanation a great deal with the inclusion of the dummy variables, and improve it additionally by smoothing the data. The results are still below what we had expected to achieve. In order to gain more insight about this program, the analysis will shift to a more basic unit, the school district.

At this point a sample of 162 districts was drawn including all eight large metropolitan areas, all nine medium sized cities not associated with a metropolitan area, every school district in the ten poorest per capita income counties by either the census county estimate for median family income or by the Battelle estimate of per capita income, and a sample of suburban and less poor rural areas. There were 47 districts in the very poor group, 40 in the suburban group, and 58 in the less poor rural class. The census median family income data for 1969 was available only for places 2000 or greater population. In the case of poorer, smaller counties weighted averages utilizing the known county average and the known
Table 24

Definition of Variables Used in Auxiliary Regressions

$D_1 = \text{Dummy variable for metropolitan areas}$

$D_2 = \text{Dummy variable for suburban areas}$

$D_3 = \text{Dummy variable for isolated, medium sized cities}$

$D_4 = \text{Dummy variable for rural, not so poor areas}$

$D_5 = \text{Dummy variable for very poor areas, all rural}$

$D_6 = \text{Dummy variable for localities with no reported N.D.E.A. Title III for two or more of the years used to smooth the data.}$

$D_7 = \text{Dummy variable for localities with no reported N.D.E.A. Title III for one of the three years used to smooth the data.}$

$D_8 = \text{Dummy variable for areas classified in the Appalachian Region in Ohio}$

$D_9 = \text{Dummy variable for localities which had a consolidation in any of the years used to smooth the data}$

$W_1 = \text{Median Family income}$

$W_2 = \text{Rate of population growth}$

$W_3 = \text{Percentage classified as poor in the locality}$

$W_4 = \text{Percentage industrial tax valuation}$

$W_5 = \text{Capital expenditure per pupil fiscal 1966}$

$W_6 = \text{Tax valuation per pupil}$

$W_7 = \text{Local dollars for schools per pupil}$

$V = \text{N.D.E.A. III subsidy per pupil (smoothed)}$

$V' = \text{N.D.E.A. III subsidy per pupil (Calendar 1967)}$
<table>
<thead>
<tr>
<th></th>
<th>Income</th>
<th>A.D.M.</th>
<th>T.V.P.P.</th>
<th>Local Dollars Per Pupil</th>
<th>Smoothed NDEA III Per Pupil</th>
<th>1967 NDEA III Per Pupil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mean</td>
<td>9535</td>
<td>68847</td>
<td>18771</td>
<td>429</td>
<td>2.38</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>538</td>
<td>41251</td>
<td>2318</td>
<td>53</td>
<td>.51</td>
</tr>
<tr>
<td>Mean</td>
<td>13957</td>
<td>7359</td>
<td>18247</td>
<td>574</td>
<td>1.92</td>
<td>3.93</td>
</tr>
<tr>
<td>2.</td>
<td>Std. Dev.</td>
<td>4259</td>
<td>5427</td>
<td>7412</td>
<td>214</td>
<td>.62</td>
</tr>
<tr>
<td>Mean</td>
<td>9826</td>
<td>12932</td>
<td>17194</td>
<td>489</td>
<td>1.84</td>
<td>3.07</td>
</tr>
<tr>
<td>3.</td>
<td>Std. Dev.</td>
<td>588</td>
<td>3813</td>
<td>4140</td>
<td>86</td>
<td>.70</td>
</tr>
<tr>
<td>Mean</td>
<td>9610</td>
<td>3948</td>
<td>14242</td>
<td>408</td>
<td>2.64</td>
<td>4.40</td>
</tr>
<tr>
<td>4.</td>
<td>Std. Dev.</td>
<td>1877</td>
<td>2303</td>
<td>2584</td>
<td>84</td>
<td>1.33</td>
</tr>
<tr>
<td>Mean</td>
<td>7076</td>
<td>904</td>
<td>11016</td>
<td>233</td>
<td>2.95</td>
<td>3.15</td>
</tr>
<tr>
<td>5.</td>
<td>Std. Dev.</td>
<td>1337</td>
<td>1041</td>
<td>11421</td>
<td>128</td>
<td>1.91</td>
</tr>
</tbody>
</table>

Codes

1 = Metropolitan areas
2 = Suburban Areas
3 = Isolated medium sized cities
4 = rural, not so poor areas
5 = very poor areas, all rural

a Average Daily Membership
b Tax Valuation Per pupil
Table 26

Levels of Variables Used in Auxiliary Regressions by Category

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Code 1</th>
<th>Code 2</th>
<th>Code 3</th>
<th>Code 4</th>
<th>Code 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>D6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.03</td>
<td>.04</td>
</tr>
<tr>
<td>D7</td>
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<td>.12</td>
<td>.11</td>
<td>.08</td>
<td>.23</td>
</tr>
<tr>
<td>D8</td>
<td>0</td>
<td>0</td>
<td>.11</td>
<td>.20</td>
<td>.94</td>
</tr>
<tr>
<td>D9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.10</td>
<td>.11</td>
</tr>
<tr>
<td>W2</td>
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<td>.97</td>
<td>.63</td>
<td>1.30</td>
<td>.49</td>
</tr>
<tr>
<td>W3</td>
<td>10.4</td>
<td>3.5</td>
<td>8.6</td>
<td>7.8</td>
<td>14.8</td>
</tr>
<tr>
<td>W4</td>
<td>8.39</td>
<td>8.36</td>
<td>11.48</td>
<td>6.80</td>
<td>3.62</td>
</tr>
<tr>
<td>W5</td>
<td>77.9</td>
<td>125.3</td>
<td>50.6</td>
<td>48.4</td>
<td>55.4</td>
</tr>
</tbody>
</table>

Codes

1 = Metropolitan Areas
2 = Suburban Areas
3 = Isolated medium sized cities
4 = Rural, not so poor areas
5 = Very poor areas, all rural

\(a\) Definition of each variable is given in table 24
<table>
<thead>
<tr>
<th>Adams</th>
<th>Jackson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athens</td>
<td>Lawrence</td>
</tr>
<tr>
<td>Belmont</td>
<td>Meigs</td>
</tr>
<tr>
<td>Brown</td>
<td>Monroe</td>
</tr>
<tr>
<td>Carroll</td>
<td>Morgan</td>
</tr>
<tr>
<td>Clermont</td>
<td>Muskingum</td>
</tr>
<tr>
<td>Coshocton</td>
<td>Noble</td>
</tr>
<tr>
<td>Gallia</td>
<td>Perry</td>
</tr>
<tr>
<td>Guernsey</td>
<td>Pike</td>
</tr>
<tr>
<td>Harrison</td>
<td>Ross</td>
</tr>
<tr>
<td>Highland</td>
<td>Scioto</td>
</tr>
<tr>
<td>Hocking</td>
<td>Tuscarawas</td>
</tr>
<tr>
<td>Holmes</td>
<td>Vinton</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Washington</td>
</tr>
</tbody>
</table>
Table 28

NUMBER OF SCHOOL DISTRICTS RECEIVING NO N.D.E.A. III SUBSIDY IN 1967 BY COUNTY

<table>
<thead>
<tr>
<th>County</th>
<th>Number of Districts (of Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams</td>
<td>3 (of 7)</td>
</tr>
<tr>
<td>Allen</td>
<td>1</td>
</tr>
<tr>
<td>Auglaize</td>
<td>3 (of 8)</td>
</tr>
<tr>
<td>Belmont</td>
<td>2</td>
</tr>
<tr>
<td>Brown</td>
<td>2</td>
</tr>
<tr>
<td>Carroll</td>
<td>2 (of 3)</td>
</tr>
<tr>
<td>Clermont</td>
<td>2</td>
</tr>
<tr>
<td>Columbiana</td>
<td>2</td>
</tr>
<tr>
<td>Darke</td>
<td>2</td>
</tr>
<tr>
<td>Defiance</td>
<td>1</td>
</tr>
<tr>
<td>Erie</td>
<td>2</td>
</tr>
<tr>
<td>Fairfield</td>
<td>1</td>
</tr>
<tr>
<td>Fulton</td>
<td>4 (of 10)</td>
</tr>
<tr>
<td>Gallia</td>
<td>3 (of 6)</td>
</tr>
<tr>
<td>Guerney</td>
<td>2 (of 5)</td>
</tr>
<tr>
<td>Hamilton</td>
<td>3</td>
</tr>
<tr>
<td>Hancock</td>
<td>2</td>
</tr>
<tr>
<td>Hardin</td>
<td>1</td>
</tr>
<tr>
<td>Harrison</td>
<td>1</td>
</tr>
<tr>
<td>Highland</td>
<td>1</td>
</tr>
<tr>
<td>Hocking</td>
<td>1</td>
</tr>
<tr>
<td>Holmes</td>
<td>3 (of 4)</td>
</tr>
<tr>
<td>Huron</td>
<td>1</td>
</tr>
<tr>
<td>Jackson</td>
<td>3 (of 9)</td>
</tr>
<tr>
<td>Jefferson</td>
<td>2</td>
</tr>
<tr>
<td>Licking</td>
<td>1</td>
</tr>
<tr>
<td>Lorain</td>
<td>2</td>
</tr>
<tr>
<td>Lucas</td>
<td>1</td>
</tr>
<tr>
<td>Madison</td>
<td>3 (of 5)</td>
</tr>
<tr>
<td>Mahoning</td>
<td>2</td>
</tr>
<tr>
<td>Medina</td>
<td>2 (of 7)</td>
</tr>
<tr>
<td>Miami</td>
<td>1</td>
</tr>
<tr>
<td>Muskingum</td>
<td>3 (of 9)</td>
</tr>
<tr>
<td>Noble</td>
<td>2 (of 3)</td>
</tr>
<tr>
<td>Ottowa</td>
<td>3</td>
</tr>
<tr>
<td>Perry</td>
<td>1</td>
</tr>
<tr>
<td>Pike</td>
<td>4 (of 4)</td>
</tr>
<tr>
<td>Portage</td>
<td>1</td>
</tr>
<tr>
<td>Preble</td>
<td>1</td>
</tr>
<tr>
<td>Putnum</td>
<td>1</td>
</tr>
<tr>
<td>Richland</td>
<td>1</td>
</tr>
<tr>
<td>Sandusky</td>
<td>1</td>
</tr>
<tr>
<td>Scioto</td>
<td>2</td>
</tr>
<tr>
<td>Seneca</td>
<td>1</td>
</tr>
<tr>
<td>Stark</td>
<td>1</td>
</tr>
<tr>
<td>Trumble</td>
<td>3</td>
</tr>
<tr>
<td>Tuskarawas</td>
<td>1</td>
</tr>
<tr>
<td>Van Wert</td>
<td>1</td>
</tr>
<tr>
<td>Warren</td>
<td>1</td>
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<tr>
<td>Washington</td>
<td>1</td>
</tr>
<tr>
<td>Wayne</td>
<td>1</td>
</tr>
<tr>
<td>Williams</td>
<td>2</td>
</tr>
<tr>
<td>Wood</td>
<td>2</td>
</tr>
<tr>
<td>Wyandot</td>
<td>1</td>
</tr>
</tbody>
</table>

54 Counties
97 districts with $0 N.D.E.A. III
718 districts in population

aMansfield City School District
## Table 29
Comparison of Calendar 1967 and Smoothed N.D.E.A. III Per Capita Subsidy

<table>
<thead>
<tr>
<th>County</th>
<th>1967</th>
<th>1968</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stark</td>
<td>0.84</td>
<td>0.58</td>
</tr>
<tr>
<td>Lucus</td>
<td>0.83</td>
<td>0.57</td>
</tr>
<tr>
<td>Hamilton</td>
<td>0.60</td>
<td>0.36</td>
</tr>
<tr>
<td>Cuyahoga</td>
<td>0.65</td>
<td>0.40</td>
</tr>
<tr>
<td>Massingum</td>
<td>0.40</td>
<td>0.56</td>
</tr>
<tr>
<td>Adams</td>
<td>0.46</td>
<td>0.63</td>
</tr>
<tr>
<td>Brown</td>
<td>0.68</td>
<td>0.51</td>
</tr>
<tr>
<td>Belmont</td>
<td>0.53</td>
<td>0.53</td>
</tr>
<tr>
<td>Warren</td>
<td>0.57</td>
<td>0.60</td>
</tr>
<tr>
<td>Madison</td>
<td>0.30</td>
<td>0.26</td>
</tr>
<tr>
<td>Jefferson</td>
<td>1.56</td>
<td>0.89</td>
</tr>
<tr>
<td>Darke</td>
<td>0.95</td>
<td>0.50</td>
</tr>
<tr>
<td>Hocking</td>
<td>0.47</td>
<td>0.38</td>
</tr>
<tr>
<td>Hardin</td>
<td>0.90</td>
<td>0.50</td>
</tr>
<tr>
<td>Ottawa</td>
<td>1.20</td>
<td>0.57</td>
</tr>
<tr>
<td>Putnam</td>
<td>1.33</td>
<td>0.80</td>
</tr>
<tr>
<td>Sandusky</td>
<td>0.50</td>
<td>0.56</td>
</tr>
<tr>
<td>Ashland</td>
<td>0.79</td>
<td>0.70</td>
</tr>
<tr>
<td>Tuscarawas</td>
<td>1.14</td>
<td>0.82</td>
</tr>
<tr>
<td>Lorain</td>
<td>0.71</td>
<td>0.47</td>
</tr>
<tr>
<td>Erie</td>
<td>1.39</td>
<td>0.82</td>
</tr>
<tr>
<td>Clark</td>
<td>1.31</td>
<td>0.83</td>
</tr>
<tr>
<td>Mahoning</td>
<td>0.69</td>
<td>0.40</td>
</tr>
<tr>
<td>Miami</td>
<td>0.74</td>
<td>0.42</td>
</tr>
<tr>
<td>Trumbull</td>
<td>0.72</td>
<td>0.48</td>
</tr>
<tr>
<td>Franklin</td>
<td>1.20</td>
<td>0.55</td>
</tr>
<tr>
<td>Summit</td>
<td>0.77</td>
<td>0.42</td>
</tr>
<tr>
<td>Montgomery</td>
<td>0.76</td>
<td>0.51</td>
</tr>
<tr>
<td>Lawrence</td>
<td>0.32</td>
<td>0.36</td>
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<td>1.70</td>
<td>1.15</td>
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<tr>
<td>Greene</td>
<td>1.01</td>
<td>0.60</td>
</tr>
<tr>
<td>Paulding</td>
<td>0.93</td>
<td>0.55</td>
</tr>
<tr>
<td>Vinton</td>
<td>0.78</td>
<td>0.73</td>
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<td>0.80</td>
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</tr>
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<tr>
<td>Logan</td>
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<td>1.14</td>
</tr>
<tr>
<td>Scioto</td>
<td>0.63</td>
<td>0.84</td>
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Mean: 0.86 0.60
town estimates were used to calculate a balance of county estimate, and this estimate was assigned to each district located in the outlying areas. In the case where it was found that the town and the school district were not a good match, the observation was discarded. We were left with 129 usable observations. The attrition came solely from the suburban and less poor rural area groups. The resultant sample sizes are 25 and 40 for the suburban and less poor rural groups respectively.

In the sample of 129, each of the five classes is dummy variable when the entire group is used. Since smoothed data was used, two classes of nonapplicants was used; those who reported no subsidy in one of the three years, and those that reported no subsidy in two or more of the three years. We have also included a dummy variable to represent the districts which were involved in a merger or consolidation in any of the three years. One final addition is the level of capital expenditure per pupil in fiscal 1966. The reason for this will be explained after the presentation of the auxiliary equations. The variables are defined in Table 24.

**Metropolitan Areas (sample size of 8)**

\[ V = 3.89 + 0.000058 W_1 - 0.15 W_2 - 0.29 W_3 + 0.11 W_4 \]

\[ R^2 = 0.67 \]
\[ V = 0.67 + 0.000031 W_1 - 0.16 W_2 - 0.16 W_3 + 0.087 W_4 - 0.0042 W_5 \]
\[ R^2 = 0.77 \]

In the above subset, the percentage poor \( W_3 \) is highly correlated with income \( W_1 \). The result was an enlargement of the standard errors of each variable. In this particular subset if \( W_3 \) was used without \( W_1 \), the results would appear as follows:

\[ V = 4.60 - 0.15 W_2 - 0.31 W_3 + 0.11 W_4 \]
\[ t \text{ ratio} \quad (5.81) \quad (1.26) \quad (2.60) \quad (1.28) \]
\[ R^2 = 0.66 \]

\[ V = 4.40 - 0.18 W_2 - 0.25 W_3 + 0.099 W_4 - 0.0035 W_5 \]
\[ (5.25) \quad (1.49) \quad 2 \quad (1.99) \quad 3 \quad (1.03) \quad (1.03) \]
\[ R^2 = 0.75 \]

The exclusion of median family income does not materially effect the \( R^2 \) nor the magnitude of the coefficients still included in the equation. However \( W_3 \) now appears as significant. Capital expenditure per pupil seems to materially effect the coefficients as well as improve the \( R^2 \).

In this subset the exclusion of percentage poor does materially effect the \( R^2 \). Despite the high correlation between the two wealth variables, percentage poor is the best performer with respect to explaining the variation. The regression equations excluding \( W_3 \) appear as follows:

\[ V = 0.77 + 0.000070 W_1 - 0.17 W_2 + 0.13 W_4 \]
\[ t \text{ ratio} \quad (0.88) \quad (0.65) \quad 1 \quad (1.10) \quad 2 \quad (0.68) \]
\[ R^2 = 0.48 \]
\[ V = 0.95 + 0.000044 W_1 - 0.20 W_2 + 0.11 W_4 - 0.0052 W_5 \]
\[ (2.55) (0.92) (1.30) (0.92) (0.96) \]
\[ R^2 = 0.57 \]

In addition, several of the signs of all the above regressions are wrong. For example, it was expected that \( W_1 \) would have a coefficient with a minus sign and that the coefficient of \( W_5 \) would be positive. Comments upon the results will be deferred until each subset is examined.

Suburban Areas (sample size of 25)

\[ V = 2.65 - 0.39 D_7 + 0.000017 W_1 - 0.12 W_2 - 0.035 W_3 \]
\[ (3.48) (0.90) (0.48) (1.21) (0.37) \]
\[ - 0.082 W_4 \]
\[ (1.65) \]
\[ R^2 = 0.17 \]

\[ V = 2.71 - 0.49 D_7 + 0.000035 W_1 - 0.15 W_2 \]
\[ (3.79) (1.25) (0.48) (1.03) \]
\[ + 0.057 W_3 - 0.085 W_4 - 0.0014 W_5 \]
\[ (0.65) (1.79) (1.92) \]
\[ R^2 = 0.31 \]

In this particular case the exclusion of \( W_1 \) or \( W_3 \) does not affect the significance of the remaining variables. Actually the influence of capital expenditure is the most important determinant in the above list toward increasing the explained variation and effecting other coefficients. However the sign of the \( W_5 \) coefficient is wrong. In order to have symmetrical results, the following equations will be shown for this subset.
\[ V = 2.87 - .35 D_7 - .13 W_2 - .049 W_3 - .074 W_4 \]
\[ t \text{ ratio (4.81) (1.31) (5.6) (1.60)} \]
\[ R^2 = .16 \]

\[ V = 3.12 - .44 D_7 - .16 W_2 - .081 W_3 - .069 W_4 \]
\[ (5.29) (1.12) (1.69) (1.96) (1.54) \]
\[ - .0012 W_5 \quad R^2 = .27 \]
\[ (1.70) \]

\[ V = 2.45 - .34 D_7 + .000021 W_1 - .11 W_2 - .08 W_4 \]
\[ (4.68) (.86) (.64) (1.20) (1.64) \]
\[ R^2 = .17 \]

\[ V = 2.38 - .43 D_7 + .000041 W_1 - .14 W_3 \]
\[ (4.80) (1.15) (1.26) \]
\[ - .081 W_4 - .0013 W_5 \quad R^2 = .30 \]
\[ (1.76) (1.88) \]

In this subset income outperforms percentage poor with respect to explaining the variation. Again the explanation is deferred.

**Isolated Cities** (sample size of 9)

\[ V = -21.31 + .40 D_7 + .21 D_8 + .0019 W_1 \]
\[ t \text{ ratio (0.39) (2.71) (0.06) (0.44)} \]
\[ - .17 W_2 + .68 W_3 + .12 W_2 \quad R^2 = .87 \]
\[ (0.24) (0.24) (.51) \]

\[ V = 11.25 + .49 D_7 + 1.85 D_8 + .00077 W_1 \]
\[ (.12) (2.66) (0.36) (0.10) \]
\[ - .11 W_2 - .25 W_3 - .02 W_4 + .0075 W_5 \quad R^2 = .88 \]
\[ (.13) (.09) (.06) (.47) \]

In this sample \( W_1 \) and \( W_3 \) have a correlation coefficient of -.88. If both are used, the t ratios are very low. This masks the results somewhat. A better picture emerges if either one of the two variables is used without
the other. In addition, the Appalachian dummy variable and growth are intercorrelated enough to additionally mask the results.

\[ V = 0.49 - 2.11 D_7 - 0.35 D_8 - 0.054 W_2 + 0.18 W_3 \]

\[ t \text{ ratio} \quad (0.35) \quad (3.59) \quad (1.45) \quad (0.26) \quad (1.21) \]

\[ + 0.096 W_4 \quad R^2 = 0.87 \]

\[ (1.95) \]

\[ V = -0.49 - 2.06 D_7 - 0.33 D_8 - 0.086 W_2 + 0.19 W_3 \]

\[ t \text{ ratio} \quad (0.30) \quad (2.70) \quad (0.33) \quad (1.27) \quad (1.16) \]

\[ + 0.092 W_4 + 0.00091 W_5 \quad R^2 = 0.87 \]

\[ (1.40) \quad (0.16) \]

\[ V = 5.35 - 2.07 D_7 + 0.034 D_8 - 0.00045 W_1 \]

\[ (1.63) \quad (3.41) \quad (0.05) \quad (1.25) \]

\[ + 0.0051 W_2 + 0.11 W_4 \quad R^2 = 0.86 \]

\[ (0.02) \quad (1.90) \]

\[ V = 5.71 - 2.00 D_7 + 0.071 D_8 - 0.00049 W_1 \]

\[ (1.39) \quad (2.61) \quad (0.88) \quad (1.09) \]

\[ - 0.049 W_2 + 0.10 W_4 + 0.0017 W_5 \quad R^2 = 0.87 \]

\[ (1.15) \quad (1.41) \quad (0.30) \]

In the equations excluding \( W_3 \), percentage poor, using \( W_1, W_4 \) and \( D_7 \) alone give an equation with an \( R^2 \) of 0.86 and all three variables are significant with the same signs as the equations as shown. The introduction of \( D_8 \) and \( W_2 \) contribute little toward the explained variation but each sharply reduces the significance of the three mentioned variables.

In the equations excluding \( W_1 \), median family income, using \( W_3, W_4 \) and \( D_7 \) alone give an equation with an \( R^2 \) of 0.85 and all three variables are significant. Thus either wealth variable performs approximately equally well in this subset.
The inclusion of $W_5$, capital expenditure, results in little change. The standard errors of $D_7$ and $W_4$ enlarge slightly, but all coefficients remain virtually unchanged, the signs are unchanged, and the $R^2$'s are approximately the same. In this subset the sign of the coefficient of $W_5$ is correct.

_Rural, not so poor areas (sample size of 40)_

\[
V = 5.37 - 1.56 D_6 - 0.69 D_7 + 0.66 D_8 - 0.92 D_9
\]
\[
t \text{ratio} \quad (1.76) \quad (1.01) \quad (0.82) \quad (0.93) \quad (0.130)
\]
\[
- 0.0031 W_1 + 0.060 W_2 + 0.0071 W_3 + 0.032 W_4 \quad R^2 = 0.28
\]
\[
(1.20) \quad (0.57) \quad (0.01) \quad (0.48)
\]

\[
V = 5.32 - 1.57 D_6 - 0.70 D_7 + 0.67 D_8 - 0.91 D_9
\]
\[
(0.167) \quad (1.02) \quad (0.81) \quad (0.91) \quad (0.126)
\]
\[
- 0.0031 W_1 + 0.059 W_2 + 0.0026 W_3 + 0.031 W_4
\]
\[
(1.19) \quad (0.55) \quad (0.02) \quad (0.46)
\]
\[
+ 0.00019 W_5 \quad R^2 = 0.28
\]
\[
(0.07)
\]

In this sample we have severe intercorrelation among the wealth variables. In a stepwise regression, the $D_8$ dummy Appalachia variable enters first with any combination in which it is included and $W_1$, income, enters second. $D_8$ is always significant and positive at this state. $W_1$ is of borderline significance and negative only if $D_8$ is not included. The inclusion of other variables tends to raise the standard error of $D_8$. In particular $W_4$, percentage industrial land, seems to heavily interact with $D_8$. They are positively correlated.
$W_3$, percentage poor, is the poorest performing wealth indicator. If $W_1$ and $D_8$ are excluded, this variable enters the regression fairly late, implying others contribute more toward explaining the variation. In addition it is not significant whether used alone or with other wealth variables.

$W_5$, capital expenditure, always enters the regression last with any other combination of variables. It is insignificant and has little effect on any of the others.

$$V = 1.87 - 1.55 D_6 - .89 D_7 + .80 D_8$$

$t$ ratio $(2.10)$ $(1.02)$ $(1.08)$ $(1.13)$

$$- .89 D_9 + .064 W_2 + .069 W_3 + .027 W_4$$

$(1.24)$ $(.61)$ $(.76)$ $(.40)$

$R^2 = .25$

$$V = 1.82 - 1.56 D_6 - .93 D_7 + .81 D_8 - .87 D_9$$

$(1.97)$ $(1.02)$ $(1.09)$ $(1.13)$ $(1.19)$

$$+ .061 W_2 + .074 W_3 + .024 W_4 + .00074 W_5$$

$R^2 = .25$

$(.57)$ $(.78)$ $(.35)$ $(.28)$

$$V = 5.38 - 1.56 D_6 - .69 D_7 + .66 D_8 - .92 D_9$$

$(2.57)$ $(1.17)$ $(.84)$ $(.98)$ $(1.33)$

$$- .00031 W_1 + .059 W_2 + .032 W_4$$

$(1.44)$ $(.59)$ $(.50)$

$R^2 = .28$

$$V = 5.37 - 1.56 D_6 - .70 D_7 + .67 D_8 - .91 D_9$$

$(2.52)$ $(1.14)$ $(.82)$ $(.96)$ $(1.29)$

$$- .00031 W_1 + .058 W_2 + .031 W_4 + .00017 W_5$$

$(1.41)$ $(.57)$ $(.47)$ $(.06)$

$R^2 = .28$
Rural, very poor (sample size of 47)

\[ V = 1.81 - 2.85 D_6 - .74 D_7 + .54 D_8 + .34 D_9 \\
\text{t ratio} = (1.21) (1.07) (43) (37) \\
- .000089 W_1 + .25 W_2 + .11 W_3 - .054 W_4 \\
(35) (1.10) (1.68) (77) \\
R^2 = .24 \\
\]

\[ V = 1.54 - 2.83 D_6 - .82 D_7 + .079 D_8 + .16 D_9 \\
(65) (2.14) (1.20) (06) (17) \\
- .000033 W_1 - .020 W_2 + .12 W_3 - .042 W_4 \\
(.13) (.07) (1.93) (63) \\
+ .0043 W \\
(1.64) \\
R^2 = .29 \\
\]

In this group, percentage poor, performs much better than \( W_1 \), income. The regressions excluding each of the two variables in turn appear as follows.

\[ V = 1.07 - 2.88 D_6 - .69 D_7 + .47 D_8 + .39 D_9 \\
\text{t ratio} = (1.16) (1.03) (39) (43) \\
+ .25 W_2 + .12 W_3 - .058 W_4 \\
(1.10) (2.24) (57) \\
R^2 = .24 \\
\]

\[ V = 1.26 - 2.84 D_6 - .80 D_7 + .049 D_8 + .17 D_9 \\
(1.11) (1.21) (04) (20) \\
- .024 W_2 + .13 W_3 - .044 W_4 + .0043 W \\
(.09) (2.41) (67) (1.69) \\
R^2 = .29 \\
\]

\[ V = 4.22 - 2.65 D_6 + .75 D_7 + 1.35 D_8 + .10 D_9 \\
(2.13) (1.93) (1.05) (1.16) (11) \\
- .00031 W_1 + .20 W_2 - .037 W_4 \\
(1.44) (86) (52) \\
R^2 = .19 \\
\]

\[ V = 4.26 - 2.61 D_6 - .82 D_7 + 1.06 D_8 - .077 D_9 \\
(2.17) (1.92) (1.16) (90) (08) \\
- .00029 W_1 - .031 W_2 - .026 W + .0036 W \\
(1.35) (11) (37) (1.34) \\
R^2 = .22 \\
\]
If $W_4$ is excluded entirely, the resultant equation is similar to the equation with the $W_4$ variable. However, when $W_3$ is excluded the $D_8$ variable seems to attain more significance, although only with a $t$ value of about 1.0. Capital expenditure is extremely important in this subset. It always enters first over any other variable when it is included. When it is excluded the $R^2$ drops to .24 or less with any other combination of variables. In fact, it would have a higher $t$ value if growth rate, $W_2$ is excluded. The effect of $W_5$ on the other variables is negligible, although it seems to affect $W_4$ a bit more than the others.

The variable capital outlay per pupil was introduced for a specific reason. Analysis of specific localities receiving more subsidy than their per pupil share was conducted by interview with state officials responsible for the dispersion of the subsidy. Other than the Appalachian characteristic, the only common characteristic appearing time and time again was that the locality had recently completed a new high school. These districts desired to equip the new buildings with new equipment. During this period sufficient funds were available to honor most of the requests for supplemental funding.
The variable capital outlay per pupil is the sum of purchase of lands, improvement of sites, new buildings, additions, remodeling, landscaping, playgrounds, equipping school rooms and administrative offices, audio-visual equipment, motor vehicles, and miscellaneous expenditures for durable goods. N.D.E.A. III does not support all of the items listed above, but it was felt that we had a reasonably good measure which would pick up some effect of the subsidy allocation procedure.

From the description of the N.D.E.A. III subsidy program, we would expect nonapplicants to get less money, consolidated areas to get more money, Appalachian areas to get more, high income areas to get less, localities with high percentages of poor to get more, growing areas to get more, areas with high levels of industry to get less money, and areas with high capital expenditures to get more money. Thus the variables $D_6$, $D_7$, $W_1$ and $W_4$ should have negative coefficients; the other variables should have positive coefficients.

In the aggregate we get the correct signs. However, the five subsets individually have tremendous variation. The $D_6$, $D_7$ and $D_8$ variables generally have the correct sign in each subset. $W_1$, income enters with the correct sign for the very poor and not so poor rural areas. In
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<td>(1.95)</td>
<td>(2.26)</td>
<td>(.44)</td>
<td>(1.01)</td>
<td>(1.21)</td>
<td>(.17)</td>
<td>(.65)</td>
<td>(.41)</td>
<td>(1.01)</td>
<td></td>
</tr>
<tr>
<td>.27</td>
<td>1.84</td>
<td>-.000015</td>
<td>.088</td>
<td>-2.55</td>
<td>-.73</td>
<td>1.03</td>
<td>-.24</td>
<td>.06</td>
<td>-.039</td>
<td>.16</td>
<td>-.38</td>
<td>.32</td>
<td>-.69</td>
<td>.0014</td>
</tr>
<tr>
<td></td>
<td>(2.03)</td>
<td>(.24)</td>
<td>(2.52)</td>
<td>(3.19)</td>
<td>(1.95)</td>
<td>(2.19)</td>
<td>(.52)</td>
<td>(.75)</td>
<td>(.11)</td>
<td>(.26)</td>
<td>(.57)</td>
<td>(.58)</td>
<td>(.96)</td>
<td>(1.91)</td>
</tr>
</tbody>
</table>
the isolated cities group, income has the correct sign only if percentage poor is excluded. In the Metro and suburban areas it enters with the incorrect plus sign. Similarly, percentage poor has the correct sign for the very poor and not so poor rural areas and at least once in the isolated cities and suburban cases depending upon intercorrelations. Otherwise this variable has a coefficient with an incorrect minus sign. Generally, the poor and not so poor rural areas have the correct signs everywhere with one major exception. The industry variable enters the not so poor areas with an incorrect plus sign.

The capital expenditure variable is particularly unusual. The sign is wrong (negative) for the metropolitan and suburban subgroups and in the latter case is significant. In fact, these two groups exhibit incorrect signs virtually everywhere. The isolated cities group has signs that vary depending upon the included variables. In the case of the metropolitan group, the extremely small size of the sample may be partly to blame, but the strange behavior of the suburbs may warrent additional analysis which will not be done in this paper.

When the subgroups are combined into a single sample, the intercorrelations mentioned still occur. The regression results are summarized in Table 30. When income is
the only variable in the regression it is significant, but income and percentage poor interact so much that $W_1$ loses significance although $W_3$ remains significant. As additional variables are introduced, a constant pattern emerges. Percentage poor, dummy Appalachia, and the two non-applicant variables remain significant. Capital expenditure per pupil is not significant, but nearly so. In all cases the signs are correct.

The sign of $W_3$ is positive, indicating that the greater the percentage of poor people, the greater the subsidy everything else held constant. If income is used instead, the sign is negative indicating the lower the income, the greater the subsidy. The dummy Appalachia variable has a plus sign, indicating that Appalachian areas receive greater subsidy per pupil than non-Appalachian areas.

$D_6$, the dummy variable for areas receiving no subsidy in two or more of the three years used to smooth the data, represents beyond doubt non-applicants. Obviously areas which do not apply for the subsidy will appear as outliers in a residual analysis. $D_7$, the dummy variable for areas receiving no subsidy in exactly one of the three years used to smooth the data, may reflect non-applicants or simply be an aspect of the fiscal-calendar data problem previously discussed. In the aggregate the effect of capital expenditure was of borderline significance. Some interaction between growth and capital expenditure per pupil could be detected from the correlation matrix
and from the stepwise inclusion of variables in the regression equations.

Another interesting observation is that proxies used to evaluate the stated criterion for distributing supplemental funds, growth rate, impacted areas, and percentage valuation industry, do not perform well at all. It may well be that the stated criterion is not used as state policy determinants as much as we had been lead to believe. That is, either we have bad proxies, or there is much more discretion with respect to supplemental funding than is generally known.

It should be noted that the poorest districts tend to receive the highest level of per pupil subsidy, but with this group also having the largest variance. A reasonable interpretation of this is that poorer areas are favored if they apply, but this group tends to have larger numbers of districts which are nonapplicants or apply for less than the amount they could get. In this respect the problem may in part be a function of the particular administration of a school system. That is, with no particular pattern, certain administrators may be more efficient at obtaining subsidies than others. The last comment is simply an untested hypothesis; statistically this equation developed in the model is of little value as a predictive mechanism.
To recap the patterns mentioned with respect to supplemental funding, no detectable pattern emerged other than a tendency to favor poorer localities and areas completing a major addition qualifying for subsidy. The smoothed data indicates that the mentioned accounting problem (fiscal vs. calendar year) is not the main problem. Controlling for nonapplicants helped the results a bit.

One suggestion is given for future researchers. The control variables for nonapplicants perform reasonably well. But these variables control only for localities which receive virtually no subsidy at all. A great number of localities do participate in this and other programs, but do not participate fully. That is, they request less money than they are entitled to receive.

Additional, refined analysis or techniques may be useful toward the overall performance of a model and toward understanding the effective subsidy program. The greatest effort in this section was toward attempting to explain why some localities receive more than their per pupil share of subsidy. In addition, it is suggested that an alternate data source be utilized. The State Department of Education, Division of Federal Assistance, N.D.E.A. Title III Section, recently made available data previously kept in their personal files. This data shows allocation and
usage of funds by fiscal year; the use of this data would eliminate at least one source of error present in the analysis. Other sections of the above division may also be willing to make fiscal year data available. It is judged that this data is more useful than the school district financial reports.

Analysis of NTC and NYC Subsidies

The National Teacher Corps and National Youth Corps warrant special attention since these subsidies were not awarded to most areas. On a county basis, only 29 of the 88 counties received any N.Y.C. subsidy, sometimes in small amounts. In most cases only a single district in the county received the subsidy. In the case of the National Teacher Corps Subsidy, only five of the 88 counties received a portion of this grant. The unusual nature of these variables would tend to bias the fitted line. Fortunately the effects are small and no abnormal residual plot is evident due to the relatively small magnitudes involved.

The method of analysis employed is to estimate auxiliary equations and mean levels of selected variables for the N.Y.C subsidy and mean levels of selected variables for the N.T.C. subsidy. These summary statistics are shown in Table 31. What was done was to estimate several of the equations using only the 29 counties receiving the N.Y.C. subsidy. The most meaningful are given below.
### Table 31

Summary Statistics for Counties Receiving NYC-NTC Subsidies

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean NYC Subsidies</th>
<th>Std. Dev. NYC Subsidies</th>
<th>Mean NTC Subsidies</th>
<th>Std. Dev. NTC Subsidies</th>
<th>Mean All Counties</th>
<th>Std. Dev. All Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own Revenue</td>
<td>$103.9</td>
<td>23.5</td>
<td>$119.1</td>
<td>29.32</td>
<td>$107.2</td>
<td>32.97</td>
</tr>
<tr>
<td>Population</td>
<td>256311</td>
<td></td>
<td>732963</td>
<td></td>
<td>122356</td>
<td></td>
</tr>
<tr>
<td>ratio</td>
<td>.23</td>
<td>.024</td>
<td>.21</td>
<td>.025</td>
<td>.24</td>
<td>.026</td>
</tr>
<tr>
<td>% nonwhite</td>
<td>5.66</td>
<td>5.42</td>
<td>11.56</td>
<td>6.47</td>
<td>3.17</td>
<td>3.82</td>
</tr>
<tr>
<td>Growth rate</td>
<td>7.67</td>
<td>8.17</td>
<td>5.02</td>
<td>4.16</td>
<td>8.01</td>
<td>9.83</td>
</tr>
<tr>
<td>% poor children</td>
<td>4.86</td>
<td>2.72</td>
<td>3.17</td>
<td>1.16</td>
<td>5.34</td>
<td>2.30</td>
</tr>
<tr>
<td>Income</td>
<td>$2024</td>
<td>750</td>
<td>$2722</td>
<td>658</td>
<td>$1857</td>
<td>587</td>
</tr>
<tr>
<td>NYC subsidy (per capita)</td>
<td>.38</td>
<td></td>
<td>.57</td>
<td></td>
<td>.13</td>
<td></td>
</tr>
<tr>
<td>NTC subsidy (per capita)</td>
<td>.09</td>
<td></td>
<td>.27</td>
<td></td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>Years of training of teachers</td>
<td>4.3</td>
<td>.15</td>
<td>4.4</td>
<td>.28</td>
<td>4.2</td>
<td>.16</td>
</tr>
<tr>
<td>Years of experience of teachers</td>
<td>11.1</td>
<td>1.79</td>
<td>9.1</td>
<td>.68</td>
<td>11.7</td>
<td>1.89</td>
</tr>
</tbody>
</table>
Page 178 does not exist
CHAPTER 7

In this chapter we will summarize what has been accomplished by this study, what has not been accomplished by this study, and other facets of the problem which may aid future researchers. A great deal about the distribution of subsidies has been learned and compiled in this paper. Additional information is derived from the model used to test the equations developed from the subsidy distribution structure. A number of results we had expected to materialize and relationships we anticipated did not develop. Additional analysis was shown with some of the subsidies which performed poorly in the econometric model.

The primary purpose of this study was to examine the relationship between educational subsidies and local effort. The major question to be answered is "Do subsidies change local effort?". In order to attempt to answer this question, we must have complete knowledge about the distribution of the subsidy to the locality. The result of this portion of the study lead us to believe we knew the major policy variables through which the subsidies were distributed. We also determined that the model which best expressed the indicated relationships was in part recursive; the balance interdependent. At this point the arguments or variables in the model were developed from the subsidy
distribution structures. Proxy variables represented arguments of formula subsidies and hypothesized policy variables were used for nonformula subsidies. Certain data limitations prevented several of the subsidy equations from being estimated.

In the case of the own revenue function, our predictive equation worked rather well. Our algebraic representation of the state foundation program, the Impacted Areas Program, the Lunch and Milk Acts, and E.S.E.A. Title I performed satisfactory. In these cases our proxy variables seem to adequately represent the subsidy distribution mechanism. In Appendix C we show that state foundation subsidies have a measured impact of complete substitution; for each additional state foundation dollar, local effort is reduced by approximately the same amount. In the case of every federal subsidy, including these stated as performing satisfactory and those which did not, we measure virtually no interaction between subsidy and local efforts.

Formula grants which should have performed well in the econometric model include N.D.E.A. Titles III and V and E.S.E.A. Title II. Nonformula subsidies, all of which proved difficult, are E.S.E.A. Title III, The Youth Corps, and The National Teacher Corps. Now we will examine each program as it was perceived to be.

Subsidies which are distributed in part on a per pupil basis include the state foundation program, E.S.E.A. II,
The Lunch and Milk Acts, and N.D.E.A. III and V. The evidence presented in the last two chapters tends to support this claim, but in the case of N.D.E.A. III and V the per pupil element was much less than anticipated. The other subsidies do not purport to be distributed on a per pupil basis.

Several subsidies claim to be poverty or income redistribution programs. In this case percentage poor children in the locality was generally used to measure this effect. E.S.E.A. I is designed for no other purpose. Percentage poor children performs well in the E.S.E.A. II equation. The lunch and milk program is a dual purpose plan; a minimum amount is distributed on a per pupil basis and supplemental funding is awarded to "needy" areas. In this case the algebraic representation of the plan seems satisfactory and both variables are significant. N.D.E.A. III was also conjectured to be a dual purpose per pupil and poverty program (actually the plan made no claim to be a poverty program in 1967, but after that year income redistribution policy was built in via the Appalachian Program). The data and the analysis indicate that in 1967 there is a small tendency to distribute funds on a per pupil basis, but the program did not seem to perform as a poverty program. However, if we use the smoothed data utilizing 1968 and 1969, the program does appear to redistribute funds toward poorer areas. In the 1967 case we never did discover much
else about how the funds were dispensed. E.S.E.A. II pur-
ports to be in part a poverty program, but measurements do
not bear this claim out. Again we learned very little about
how the program actually operates.

In the case of the nonformula subsidies E.S.E.A. III,
The Youth Corps, and National Teacher Corps, we postulate
that these programs are in part poverty programs. E.S.E.A.
III was particularly disappointing. The Program does not
perform as a poverty program and we were statistically
unable to explain the subsidy in any manner. No positive
statement as to what type of program it is can be made.
The other two programs are somewhat specialized poverty
programs. In the case of the National Teacher Corps we
do make some progress toward confirming the claim and iden-
tifying policy variables.

The state foundation program is also a dual purpose
per pupil and poverty program, but its purpose is also
specialized. In this case the object of the poverty por-
tion is to support areas considered poor because of low
tax duplicate. Our proxy variables indicate that the pro-
gram does work as explained. There is also an additional
component of the act which grants additional subsidy to
areas with higher quality teachers. Our measurement of
this feature was less satisfactory.

In the case of all nonformula subsidies, it was
hypothesized that specialized personnel implied greater
per capita level of subsidy. The proxy variable chosen was number of pupils in the locality. The linkage is that larger systems tend to be those with specialized personnel. The variable is significant only in the case of the National Teacher Corps. Perhaps some better proxy or direct measurement would be useful for this aspect of nonformula subsidies.

Two special cases remain. The impacted pupils program allocated funds on a per impacted pupil basis modified by a rather unusual "regional" matching criteria previously explained. Measurement indicates that the per capita level of funds received by localities is well explained by the relative number of impacted pupils.

The last case developed in the paper concerns the distribution of supplemental N.D.E.A. III funds. The criterion stated by governmental officials does not seem to coincide with the actual level of funds received by localities. Some progress has been made toward determination of the effective program, but the journey is not complete.

The equations developed for N.D.E.A. V and E.S.E.A. II subsidies indicate that additional research is necessary into these programs before econometric analysis is again attempted. Refinements could also be made in most of the other equations. For example, better proxy variables may be able to detect hypothesized relationships. Other organizations of the problem may be fruitful. Many
subsidies contain a capital expenditure component and a current operation component. For example, the Impacted Areas grant was estimated ignoring the capital component. This did not seem to impair the fit for 1967 because only six Ohio districts received building funds in that year. In other years it could be a more important portion of the subsidy.

If the data is available, separate analysis of formula vs. discretionary funds would be useful. In several subsidies both methods of funding were employed, but no separation of the data was found. Separate analysis of nonapplicants may give additional information. In addition, if available, data from the governmental agency dispensing the subsidy is judged superior to school district financial reports. The data will be fiscal year and separation into formula-discretionary components may be possible.

The results presented in the previous chapter give insight into the question of interaction. The analysis of the programs and formulas as well as interviews with state officials in charge of the subsidy programs gives some evidence that interaction should be present. In large part the measurements do not bear this out. It should be again noted that the single equation models presented in the last chapter gives us only a guide; to test for interaction a multi-stage model must be used in order that all interaction and feedbacks can be accounted for. If our tentative conclusion is correct, then it is possible that
localities shift funds within categories. Given that the maintenance of effort requirements are rather vague and probably restricted to the aided category, then such requirements are of little value toward guaranteeing maintained overall effort.
APPENDIX A

Description of Collected Data

The following data was collected for the purposes of this study. The sources are indicated in the footnotes.

- Own revenue or revenue collected from local sources\(^{49}\)
- State formula (foundation) subsidies\(^{50}\)
- Federal formula subsidies\(^{51}\)
- Total (State plus Federal) nonformula subsidies
- Income
- Population\(^{52}\)
- Proportion of school age population in public schools approximated by the ratio: Average daily membership to population\(^{53}\)

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\(^{50}\) Ibid., 6-45


\(^{52}\) Development Department of the State of Ohio--Economic Research Division, Population Estimates for Ohio--January 1, 1968:

\(^{53}\) State Department of Education, Costs Per Pupil--1967 (Columbus, Ohio: Published by the State of Ohio, 1968), Section 2, p. 7-37.
Proportion of pupils in nonpublic schools

Per cent of an area considered tax exempt or impacted

Per cent of nonwhite population in the county

Per cent of labor force age 65 or older

Per cent of families with incomes below $3000 per year

Unemployment rate for 1966 and 1965 (and actual and percentage change in unemployment rate between 1965 and 1966)

Per cent of land classified as industrial

Per cent of land classified as agricultural

Median level of education attained by the male population age 65 or older

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54 State of Ohio, Ohio Board of Regents, 1969-70 Nonpublic Average Daily Membership by County (Columbus, Ohio: Unpublished Report, 1970)

55 Ohio Public Expenditure Council, Real Property Tax Exemptions In Ohio, No. 68-19.


58 Ibid.

59 State of Ohio, Bureau of Employment Services, Division of Research and Statistics (Columbus, Ohio) Tables RS 219-65 and RS 219-66.

60 Ohio Public Expenditure Council, Analysis of Taxable Property in Ohio's 88 Counties, No. 68-21.

61 Ibid.

Level of school and total property taxes for 1966 and 1967.\textsuperscript{63}

Average level of training of teachers in the locality.\textsuperscript{64}

Average number of years experience of teachers in the locality.\textsuperscript{65}

In the cases where the data has been manipulated a detailed explanation of this manipulation will be included in this section.

\textbf{CONSOLIDATED VARIABLES}

Public school revenues, enrollment data, all subsidy variables, and the teacher quality variables were collected on the school district level and aggregated into county totals using the same classification scheme devised by the auditor of the state in cases where a school district overlapped county (or state) lines. The enrollment data is a simple sum of each school district's average daily membership, the sum being taken over each school district reputed to be in a particular county. The other consolidated variables were a bit more complicated.

\textsuperscript{63}Ohio Public Expenditure Council, \textit{A Comparison of Total and School Taxes Levied in Ohio's 88 Counties}, No. 68-69.


\textsuperscript{65}Ibid.
Own or local revenue is the sum of eight categories as collected by the Auditor of the State. The principal amounts are under the categories of general property tax and tangible personal property tax; the other variables are lunch room sales, other revenue (tuition, rental fees, gifts, and sales) nonrevenue (refunds and interest on inactive funds), sale of bonds, sale of notes, and net transfers. The latter may be negative. Transfers refer to funds paid to a district by another district for some service one district performed for the other. The service is usually educating a student under the jurisdiction of the other district. To avoid double counting, only the net of transfer revenues minus transfer expenditure is included. It is fairly common for a school district to have some incidence of each due to reallocation of students to areas better able to serve special needs. For example, if School District X transferred n students to other districts and accepted n from other districts due to programs with different relative strengths, the net funds transferred would be near zero (depending upon the prices charged by district X and the other districts for their services). No other revenue category involved double counting. The level of these variables is shown in Table A-1.
Subsidies

Fourteen categories of federal subsidy (including unclassified) were extracted from form 59(10-68), Financial Report of the Board of Education. Each school district is required to file this form within a short time following the end of the fiscal year, which in all cases ends on December 31. Separate pages are allowed for tabulation of N.D.E.A. Title III, N.D.E.S. Title V, E.S.E.A. Title I, E.S.E.A. Title II, E.S.E.A. Title III, Public Law 874, and for Lunch and Milk funds. All other subsidies from federal sources are to be identified and filled out on a blank page. In some cases the identification was nonexistent or so incomplete as to defy classification. However, it is virtually certain that such funds were of the nonformula category since all of the formula types are included in the above list. Excluded were amounts designated for activities which did not pertain to students of school age, primarily preschool, except adult education, which was included and examined separately.

The fourteen categories were aggregated into two variables; formula and nonformula subsidies using the classification presented in Chapter 5. The sum of the two could be balanced with totals presented by the Auditor of the State for each school district to determine whether any serious omissions occurred.
State subsidies which were part of matching nonformula grants were available from the auditor of the State and these amounts were added to the Federal nonformula category.

**Years of Experience and Years of Training**

This data was extracted from a research report by the Ohio Education Association for the 1966-67 school year. A survey questionnaire was sent to each of 708 school districts and 538 usable responses were tabulated. The usable responses included 95.8% of city school districts, 89.9% of exempted village school districts, and 68.3% of local school districts.

By September, 1967 some of the above school districts had consolidated. In many cases the data could be used, but 13 school district reports had to be discarded since the names given in the survey could not be matched with any other source to determine the county in which the school district was located. The data was presented by school district name in size order.

Exact data for years of experience was not collected. Instead each supervisor was asked to classify each teacher into one of the following classes.

- First year teacher
- Second to and including fifth year teacher
- Sixth to and including tenth year teacher
- ....
- Thirty-first to and including thirty-fifth year teacher
- Teachers with more than 35 years experience.
Grouped data methods were used to calculate the average year of training for each school district.

For years of experience, the following schema was used. For teachers with less than a B.A., the weight of 3 was assigned. Teachers with only a B.A. were assigned a weight of 4. Teachers with a B.A. plus 30 (semester) hours but without an M.A. were assigned a weight of 5. Teachers with only an M.A. were assigned a weight of 6. Teachers with an M.A. plus 30 (semester) hours were assigned a weight of 7. Teachers with a Ph.D. were assigned a weight of 8.

The weights are some approximation to the years of education attained. Thus the calculated average does not exactly represent years of training, but does accurately represent a level of a subsidy classification for the State Foundation Program. The higher the calculated average for any school district, the higher the level of state subsidy, everything else equal.

All school district data was tabulated into county groupings for the purposes of this study, and consolidated into county averages by weighing each school district by the level of A.D.M. Since most of the school districts which failed to respond were relatively small, the calculated county averages should be an adequate approximation.
NON-CONSOLIDATED VARIABLES

The balance of the enumerated data is available only on the county level. The majority was not manipulated, but the derivation of the variables per cent of land classified as industrial and taxable, per cent of land classified as agricultural and taxable, and per capita income should be further explained.

Percentage Composition of Tax Base

Per cent of land classified as agricultural, residential, industrial, and commercial are readily obtainable for each Ohio county. The sum of the four categories was 100% in each case. Also available is the per cent of land classified as tax exempt. The percentage figure for industrial land was multiplied by (100 - per cent of land classified as tax exempt). The same was done for per cent of land classified as agricultural. The resultant was converted into percentages. For example, if a county had 80% of its taxable classified as agricultural, and had 10% classified as tax exempt, then the percentage of land classified as agricultural and taxable was considered to be 80(1-.10)% = 72%, or 8% was considered nontaxable agricultural land. The above assumes that tax exempt status is independent of the other classification; while unrealistic, it is the only quantitative approach which could be used.
Per Capita Income

For income it was possible to estimate county levels at the residence of the wage earner rather than the county (or state) where the wage was earned based on a lengthy study on this subject. The income figure used in this study is called by Economists 'adjusted gross income.'

Adjusted gross income is the closest approach in tax law to what an economist might call "total income." But it departs from an economic definition of income in some important respects. It represents the total income from all taxable sources, less certain expenses incurred in earning that income. In general, only money income is treated as taxable, but many items are excluded. Such exclusion includes one-half of realized capital gains on assets held six months or more, interest on state and local government bonds, all transfer payments, fringe benefits received by employees from their employers, and income on savings through life insurance. The emphasis on money automatically excludes unrealized capital gains and such imputed income as the rental value of owner occupied homes.66

Adjusted gross income earned by residents of Ohio has been estimated by Bowman, Brown, Goodman and Hovey for 1969.67 The estimation technique for the Ohio share of adjusted gross income is projected as 5.57% of $560 billion. The figure of $560 billion was projected from 1966 using a growth rate of 6.8% per year.

The state total income was distributed to the counties based on their relative shares in 1966 of three income components: wages and salaries, farm proprietors' income, and other income subject to Ohio intangible property tax. The county income calculations represent income based upon place of employment rather than income of county residents.

The Battelle income figures are particularly useful because an attempt has been made to attribute income to the resident county of the income earner, rather than the county (or state) where the income was earned. Intercounty and interstate commuting patterns developed from unpublished tabulations from the Bureau of the Census. 1960 commuting patterns were not revised to 1969. The census data on commuting purchased by Battelle permit less insight into interstate commuting patterns than into intercounty patterns within Ohio. This is so because only the unpublished tabu-

67Harland Hovey et al., Research Report--Local Government Tax Revision in Ohio to the State of Ohio (Columbus, Ohio: Battelle Memorial Institute, 1968), 24-45.
lations for Ohio were purchased. These gave only the outflows of commuters from their home counties to various places of employment; from these the inflows had to be constructed. Moreover, the published commuting data -- which gives commuter flows in both directions -- pertain only to the twelve Ohio counties which comprise the state's eight largest SMSA'S.

It was assumed that each interstate commuter will earn, on the average $7,500 (this is the weekly earnings in 1966 multiplied by 52 weeks and inflated 15%). In other words, from the estimates of commuter patterns given as total number of people inflowing and outflowing each Ohio county, it is assumed each person takes to his residence a uniform income.

The Battelle Adjusted Gross Income figures are adjusted by Battelle to become, in effect, taxable income. In this study only one adjustment is used, net changes in Ohio personal income due to interstate commuting. This represents a loss of $100 million. The Battelle study estimates GPE by county, and then separately gives the adjustment for commuting patterns. This study condenses the data into

68 State of Ohio, Bureau of Unemployment Compensation, Division of Research and Statistics, Table RS 203 2.
69 Harland Hovey et al., op. cit. 31.
a single income figure per county. If the sum of income does not equal the assumed Ohio total, each county is changed by the same percentage in order that the total balances.

Finally, the 1969 Ohio total income figure is reduced by 6.8% annually to obtain an estimate of total income for 1967. This income is distributed among Ohio counties in the same ratio as the final 1969 income estimates.
Appendix B

IDENTIFICATION

A common problem in econometrics is that two or more theories may have exactly the same implications about observable phenomena under all circumstances. If so, then no possible set of observations would enable us to choose among these theories. This problem is of concern to econometricians attempting to estimate the parameters of a relationship, and with respect to systems of simultaneous equations has become known as the problem of identification.

Identification is logically prior to estimation. Without sufficient restrictions the structural parameters of our simultaneous system are not identified. Fortunately for econometric model construction, economic theory generally provides a priori information beyond that incorporated into our simultaneous linear structural model. The simplest set of restrictions can be represented by the following theorem, called the order condition of identifiability.

Theorem 1: In the simultaneous linear structural equation model, a necessary condition for a structural equation to be identified is that the number of predetermined or exogenous variables excluded from the equation must be greater than or equal to the number of endogenous or dependent variables.

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included on the right hand side.\textsuperscript{71}

Generally Theorem 1 is easy to use in practical situations; however, it is only necessary, it is not sufficient. A theorem which is structured in terms of necessary and sufficient conditions cannot be stated in a simple way; that is, without several pages of developing the notation and theory of identification. However, for the uses needed with respect to the particular models in this paper, the application is simple. For those familiar with the notation, the rank condition of identifiability states:

Theorem 2: In the simultaneous linear structural equation model, a structural equation is identified if and only if $r(\pi^{**}, \bullet) = $ the number of dependent variables included on the right hand side of the equation.\textsuperscript{72}

The matrix $\pi^{**}, \bullet$ will be isolated in the following models. In the cases used in this paper, any structural equation has either zero or one dependent variable on the right hand side. In either case, it will be evident that the rank and order conditions will be equivalent, since a singularity which would reduce the rank of the $\pi^{**}, \bullet$ matrix cannot occur unless a key coefficient is zero.

Consider the following systems or models:

\begin{align*}
Y_1 &= a_0 + a_1 X_1 + a_3 X_3 + a_4 X_4 + a_5 Y_2 + u_1 \text{ Equat.} a \\
Y_2 &= b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + u_2 \text{ Equat.} b
\end{align*}

\textsuperscript{71}Ibid., 316

\textsuperscript{72}Ibid.
\[ Y_1 = a_0 + a_1 X_1 + a_2 X_2 + a_3 X_3 + a_4 X_4 + a_5 Y_2 + u_1 \]  \text{Eqn. a}

\[ Y_2 = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 \]  \text{Eqn. b}

\[ Y_1 = a_0 + a_1 X_1 + a_3 X_3 + a_4 X_4 + a_5 Y_2 + u_1 \]  \text{Eqn. a}

\[ Y_2 = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_5 Y_1 + u_2 \]  \text{Eqn. b}

In the above setting, the Y variables are considered dependent, the X variables independent. In B-1 and B-2, equation b has only exogenous variables on the right hand side. B-1 and B-2 are categorized as recursive; B-3 would be called interdependent.

B-1 can be written as:

\[
\begin{bmatrix}
Y_1 \\
Y_2
\end{bmatrix}
= 
\begin{bmatrix}
-1 & 0 \\
0 & 1
\end{bmatrix}
+ 
\begin{bmatrix}
X_1 X_2 X_3 X_4
\end{bmatrix}
\begin{bmatrix}
a_0 \\
b_1 \\
a_3 \\
a_4
\end{bmatrix}
+ 
\begin{bmatrix}
0 \\
0 \\
b_2 \\
a_4 + u_2
\end{bmatrix}
\]

or

\[ Y \cdot C + X \cdot D + U = 0 \]

Any of the above models could be compacted into similar form.

The solution matrix, or reduced form matrix is of the form:

\[ Y = X \Pi + v \] where \( \Pi = -D C^{-1} \), C and D are defined in B-1'.

The matrix is partitioned; \( \Pi^{**.*} \) refers to the submatrix of coefficients of variables secluded from the original structural equation. Since B-1 and B-2 Equation b have no dependent variables on the right hand side, the rank of \( \Pi^{**.*} \) for
those equations need only be zero; a trivial case. Thus these equations will present no identification problem. For B-1(a) the excluded variable is $X_2$; the submatrix called $\Pi^{**,*}$ is $(b_2 a_5)$, the coefficient of $X_2$ when the reduced form of B-1 is computed. As long as $b_2 \neq 0$ and $a_5 \neq 0$ the rank of this submatrix is one, which equals the number of dependent variables on the right hand side. For B-2 (a) the order conditions are not met; thus this equation is not identified.

In a somewhat similar manner, the $\Pi^{**,*}$ matrices for B-3 each contain one element, the reduced form coefficient of the excluded variable. The magnitude of these coefficients will be illustrated shortly.

**Recursive vs. Interdependent**

The objectives of this paper do not include entering the debate between recursive and interdependent formulations of the model. Bentzel and Hansen conclude that *a priori* reasoning does not lead to priority for one of these types, but the issue must be decided case to case, depending on the particular economic problem being considered.\(^7\) One problem illustrated here falls under the category of "observational equivalence."

Consider the following three systems, one independent, one recursive, and one interdependent.

---

\[ Y_1 = a_1 X_1 + a_2 X_2 + a_3 X_3 + a_4 X_4 \]

\[ Y_1 = a_1 X_1 + a_3 X_3 + a_4 X_4 + a_5 Y_2 \quad \text{Equation a} \]

\[ Y_2 = b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 \quad \text{Equation b} \]

The reduced form of Equation a will appear in the form

\[ Y_1 = (a_1 + a_5 b_1) X_1 + (a_5 b_2) X_2 + (a_3 + a_5 b_3) X_3 + (a_4 + a_5 b_4) X_4 \]

or

\[ Y_1 = c_1 X_1 + c_2 X_2 + c_3 X_3 + c_4 X_4 \]

\[ Y_1 = a_1 X_1 + a_3 X_3 + a_4 X_4 + a_5 Y_2 \quad \text{Equation a} \]

\[ Y_2 = b_1 X_1 + b_2 X_2 + b_3 X_3 + b_5 Y_1 \quad \text{Equation b} \]

The reduced form of the two equations will be:

\[ Y_1 = \frac{1}{1-a_5 b_5} (a_1 + a_5 b_1) X_1 + (a_5 b_2) X_2 + (a_3 + a_5 b_3) X_3 + a_4 X_4 \]

\[ Y_2 = \frac{1}{1-a_5 b_5} (b_1 + b_5 a_1) X_1 + (b_2) X_2 + (b_3 + b_5 a_3) X_3 + (b_5 a_4) X_4 \]

or

\[ Y_1 = c_1 X_1 + c_2 X_2 + c_3 X_3 + c_4 X_4 \]

\[ Y_2 = d_1 X_1 + d_2 X_2 + d_3 X_3 + d_4 X_4 \]

In the above cases, the constant and error terms have been removed for simplicity. B-5 is already in its reduced form. We cannot distinguish between the first equations of each
model based on the results alone. Likewise, the second equations of B-6' and B-7' are observationally equivalent. The coefficients may differ however. One basis for specifying one model instead of another would be based upon their performance or predicting ability. This was the criterion used by L'Esperance involving a comparison between an interdependent and a recursive specification for the watermelon market. 74 Another approach would be to examine the relationship between the models and the input (data) used to calculate the coefficients.

APPENDIX C

The purpose of this section is to demonstrate the need for the additional zero restrictions imposed upon the OR equation, demonstrate that the additional restrictions we have a system of equations each of which is identified, and to estimate the interdependent system in linear form. We will also discuss the interpretation of the final system and comment upon the results.

The Zero Restrictions

In the model indicated in Chapter Six, the OR equation is not identified without the additional zero restrictions imposed; i.e., no parameter estimates in this equation can be derived. This is evident since even the rank conditions for identification, which are necessary but not sufficient are not met (see Appendix B for the statement of the theorems called the rank and order conditions for identification). A search for the independent variables in the OR function yields four candidates for removal. What we are seeking is a variable judged to be relatively unimportant in the OR equation but more important in the particular subsidy function. It is judged that loss of information is minimized by imposing zero restrictions on the variable average daily membership (used to detect economies of scale given that they are linear), the variable percentage land which is
Page 205 does not exist
tax exempt (a measure of attitudes of people living in such areas), and the variable percentage of A.D.N. classified as poverty level, and percentage nonwhite population. The latter two are believed to be much more important as higher governmental decision variables than as attitude variables. A preliminary analysis shows, as expected, that their contribution was marginal at best.

Let us examine the system prior to additional restrictions. Identification means that there should be enough prior restrictions to leave no ambiguity in the structural form, that is, to ensure that $C$ and $B$ are uniquely determined and can be recovered once $\pi$ is known or estimated. Without loss of generality, suppose that it is the first equation we wish to identify. Order the variables so that the zero coefficients in the first column of $C$ and $B$ appear first; thus, the structure is: $YC + XB = e$.

\[
\begin{array}{c}
Q \\
Y \\
q \\
\end{array} \begin{bmatrix} 0 & C_0 \end{bmatrix} + 
\begin{array}{c}
M \\
X \\
q \\
\end{array} \begin{bmatrix} C & B_0 \\ b & m \end{bmatrix} m_o = 
\begin{array}{c}
Q \\
e \\
\end{array}
\]

A theorem equivalent to the rank condition for identification, a necessary and sufficient condition for identifying the first equation, says:

\[
\text{rank} \begin{bmatrix} C_0 \\ B_0 \end{bmatrix} = Q - 1 \text{ is necessary and sufficient for identifying the first equation.}
\]
In the original structure we have $Q = 7$.

$C_0$ is null (there are not excluded dependent variables in the first equation) and $B_0$ is the following set, using $\ast$ to show the location of hypothesized nonzero coefficients.\(^{75}\)

$$
B_0 = \begin{bmatrix}
0 & 0 & 0 & 0 & \ast & \ast & x_{14} \\
0 & 0 & 0 & 0 & \ast & \ast & x_{15} \\
\ast & 0 & 0 & 0 & 0 & 0 & x_{19}
\end{bmatrix}
\begin{bmatrix}
y_1 \\ y_2 \\ y_3 \\ y_{10} \\ y_{11} \\ y_{12}
\end{bmatrix}
$$

The subscripted letter simply identifies rows and columns.

Thus $\text{rank } B_0 \leq 3$, as there are only three rows. Since we have $Q-1 = 6$ columns in this case, it is necessary for the matrix to be of that rank.

We are left with three choices if we wish to estimate the system. We can:

1) aggregate subsidy functions containing OR as an explanatory variable, or

2) remove OR as an explanatory variable in one or more subsidy equations, or

3) include one or more subsidy equations additional explanatory variables not included in the OR function.

In the first two cases we are reducing the system to fewer equations including OR; in the last case we are increasing


Table 32
The Adjusted Model

A. **Structural Equations**

\[ OR = f(x_1, x_2, x_3, x_8, x_{11}, x_{12}, s, m, y_1, y_2, y_3, y_4, y_6, y_8, y_9, y_{10}, y_{11}, y_{12}) \]

\[ y_1 = f(x_{19}, OR) \]

\[ y_2 = f(x_{16}, OR) \]

\[ y_3 = f(x_3, x_{16}, x_{17}, OR) \]

\[ y_{10} = f(x_{16}, x_{17}, OR) \]

\[ y_{11} = f(x_9, x_{14}, x_{15}, x_{16}, x_{17}, OR) \]

\[ y_{12} = f(x_9, x_{14}, x_{15}, x_{16}, x_{17}, OR) \]

B. **Equations Containing Only Exogenous Arguments**

\[ s = f(x_1, x_3, x_6, x_8, x_{14}, x_{15}) \]

\[ y_4 = f(x_3, x_{16}) \]

\[ y_8 = f(x_3, x_6, x_8, x_{12}) \]

\[ y_9 = f(x_3, x_{16}) \]

C. **Subsidies Considered Exogenous**

\[ m = m_0 \]

\[ y_6 = y_{60} \]

All variables are defined in Table 20
the capacity of the system.

With the imposition of the indicated zero restrictions, \( C_o \) is still null, but the \( B_o \) matrix expands into the following:

\[
\begin{bmatrix}
0 & 0 & 0 & 0 & * & * & \cdots & x_9 \\
0 & 0 & 0 & 0 & * & * & \cdots & x_{14} \\
0 & 0 & 0 & 0 & * & * & \cdots & x_{15} \\
0 & * & * & * & * & * & \cdots & x_{16} \\
0 & 0 & * & * & * & * & \cdots & x_{17} \\
* & 0 & 0 & 0 & 0 & 0 & \cdots & x_{19} \\
\end{bmatrix}
\]

\( Y_1 \ Y_2 \ Y_3 \ Y_{10} \ Y_{11} \ Y_{12} \)

The rank of \( B_o \) will be exactly 6 unless the * coefficients in any column prove to be zero, or in the unlikely case that the pair \( Y_3, Y_{10} \) or \( Y_{11}, Y_{12} \) have coefficients which are linearly dependent, or several additional highly unlikely combination of coefficients which could produce a singularity in \( B_o \). However, we have every reason to expect \( B_o \) is of full rank.

**Estimation of the Interdependent System**

Once all the interdependent equations are put together the system can be evaluated by two or three stage least squares. Three stage least squares encorporates the full information in the estimation of the coefficients, and it was choosen to make the estimates. The results follow.\(^{76}\)

\(^{76}\)While the noninterdependent \( X \) variables are exogenous in the QR equation, some are determined by a set of exogenous variables. Many of these exogenous variables are in the QR structural equation, and all are in the reduced form. This will lead to minor interpretation difficulties which will be examined in this section.
\[
\hat{\Omega} = -1.36 + 0.0176 \, X_1 + 0.144 \, X_2 + 532.2 \, X_3 \\
\text{std. error} \quad (47.07) \quad (0.0079) \quad (0.28) \quad (193.8) \\
t \text{ ratio} \quad (0.03) \quad (2.22) \quad (0.52) \quad (2.75) \\
\]
\[
+ 0.932 \, X_8 + 0.354 \, X_11 + 1.079 \, X_{12} - 1.228 \, S \\
(0.71) \quad (3.52) \quad (0.62) \quad (0.76) \\
(1.31) \quad (1.76) \quad (1.62) \\
- 1.871 \, M - 5.69 \, \hat{Y}_1 + 1.81 \, \hat{Y}_2 - 1.99 \, \hat{Y}_3 - 8.44 \, Y_4 \\
(3.62) \quad (4.03) \quad (3.15) \quad (7.57) \quad (10.09) \\
(0.52) \quad (1.41) \quad (0.58) \quad (0.20) \quad (0.84) \\
- 21.60 \, Y_6 + 3.37 \, Y_8 + 3.37 \, Y_9 + 1.43 \, \hat{Y}_10 - 2.67 \, \hat{Y}_11 \\
(41.70) \quad (8.51) \quad (5.58) \quad (1.40) \quad (27.56) \quad (1.03) \quad (0.10) \\
- 128.4 \, \hat{Y}_{12} \\
(88.73) \quad (1.45) \\
\]
\[
\hat{Y}_1 = 1.015 + 0.00037 \, X_{19} - 0.0667 \hat{\Omega} \\
(0.75) \quad (0.0005) \quad (0.044) \\
(2.11) \quad (7.92) \quad (1.55) \\
\hat{Y}_2 = 1.145 + 1.078 \, X_{16} - 0.00287 \hat{\Omega} \\
(1.44) \quad (0.11) \quad (0.0097) \\
(0.80) \quad (0.98) \quad (0.30) \\
\hat{Y}_3 = 0.159 + 3.15 \, X_3 - 0.015 \, X_{16} + 0.00000034 \, X_{17} \\
(0.28) \quad (1.22) \quad (0.016) \quad (0.0000069) \\
(0.57) \quad (2.57) \quad (0.93) \quad (0.05) \\
- 0.0022 \hat{\Omega} \\
(0.0014) \quad (1.63) \\
\hat{Y}_{10} = 0.180 + 0.010 \, X_{16} + 0.0000030 \, X_{17} + 0.00010 \hat{\Omega} \\
(0.46) \quad (0.035) \quad (0.000016) \quad (0.0032) \\
(0.38) \quad (0.29) \quad (1.86) \quad (0.03) \\
\hat{Y}_{11} = -0.734 + 0.011 \, X_9 + 0.218 \, X_{14} - 0.009 \, X_{15} + 0.018 \, X_{16} \\
(0.86) \quad (0.014) \quad (1.19) \quad (0.02) \quad (0.017) \\
(0.86) \quad (0.80) \quad (1.12) \quad (0.05) \quad (1.04) \\
+ 0.0000038 \, X_{17} - 0.0011 \hat{\Omega} \\
(0.000011) \quad (0.0013) \\
(3.32) \quad (0.84) \quad
\[ \hat{Y}_{12} = 0.846 + 0.008 X_9 - 0.016 X_{14} - 0.0007 X_{15} + 0.002 X_{16} - 0.00000021 X_{17} - 0.00073 \text{ OR} \]

\[
\begin{array}{cccc}
0.005 & (0.34) & 0.007 & (0.006) \\
1.45 & (2.51) & 2.24 & (1.30) \\
0.0056 & (0.25) & 0.46 & (1.30)
\end{array}
\]

The reduced form of the own revenue equation contains every independent variable in the interdependent system. It can be interpreted as the equilibrium equation rather than the initial impact equation. That is, the reduced form indicates the resulting positions after all feedbacks are accounted for. The reduced form of the subsidy equations is of no interest here.

\[ \text{OR} = -156.7 + 0.0210 X_1 + 0.304 X_2 + 525.2 X_3 \]

\[
\begin{array}{cccc}
(0.086) & (0.27) & (176.6) \\
(1.52) & (2.44) & (1.11) & (2.98)
\end{array}
\]

\[ \begin{array}{cccc}
0.317 & X_6 + 1.459 X_8 - 0.917 X_9 + 0.00041 X_{11} \\
(0.44) & (0.61) & (1.46) & (2.62) \\
(0.73) & (1.41) & (1.63) & (0.00)
\end{array} \]

\[ \begin{array}{cccc}
1.393 X_{12} + 1.60 X_{19} + 4.06 X_{15} + 0.636 X_{16} \\
(0.44) & (2.03) & (2.23) & (2.84) \\
(3.10) & (0.79) & (1.82) & (0.22)
\end{array} \]

\[ \begin{array}{cccc}
0.000133 X_{17} - 0.0025 X_{19} - 0.924 S \\
(0.00012) & (0.0017) & (0.497) \\
(1.10) & (1.50) & (1.86)
\end{array} \]

\[ \begin{array}{cccc}
-1.299 M - 8.55 Y_4 - 7.04 Y_6 + 8.52 Y_8 \\
(3.85) & (10.43) & (43.31) & (7.46) \\
(0.34) & (0.82) & (0.16) & (1.14)
\end{array} \]

\[ \begin{array}{cccc}
-4.72 Y_9 \quad R^2 = 0.61 \\
(5.79) & (0.81)
\end{array} \]

With respect to the exogenous subsidies, only S is significant at the 90% level in the reduced form equation. Although S is not significant in the structural equation, its
t value is over 1.5 and higher than any other exogenous subsidy.

To this point we have three structures, the structural equation and reduced form shown in this section, and the all independent structure given in Chapter Six. Only a few differences emerge. In the interdependent system, state subsidies and percentage of land zoned as industrial are not significant, and growth rate is of borderline significance. These are all significant in the one equation model. Thus, excluding state subsidies, none of the subsidy variables individually have a significant impact on local revenue. If the latter is true, maintenance of effort criterions as specified by government agencies is judged successful.

In both the reduced form of the OR equation and in the one equation model $S$ has a significant coefficient of approximately -1.0. This signifies total substitution of state funds for local funds. Since the state program is a consistent, year after year, dependable source of funds, it is reasonable to expect that for this subsidy localities react by reducing local effort by about the full amount of the anticipated subsidy. It is also possible that the other, mostly federal, programs are viewed as too instable to anticipate the likely level of funding. In view of the fact that even programs which do not specify maintenance of effort have insignificant coefficients, this instability hypothesis may be more plausible than the other mentioned.
With respect to the non-subsidy independent variables, the one equation models and the reduced form equation show per capita income, ratio of pupils to population, percentage land zoned industrial and taxable, and rate of growth of population to be significant at the 90% or higher level. While the structural equation does not show all these variables to be significant, the coefficients in all three equations are reasonably consistent. Unfortunately, it is viewed that the standard errors in the structural equations are likely to be too large. It is possible that initial impacts are not significant, but in the aggregate, after all secondary effects are accounted for we attain significance.

It must be kept in mind that some subsidy variables appear as exogenous in the OR equation but determined completely by a set of independent variables, all of which are also in the OR reduced form equation. For example, a one per cent change in $X_3$, ratio pupils to population, will not only have the (direct) effect of raising OR by about $525, but will raise $S$ by about $230$, which lowers OR by about that amount. $X_3$ also has some effect on equations $Y_4$, $Y_8$ and $Y_9$ which complicate the interpretation of this coefficient somewhat.

Some approximation of the effect of the taste variables alone can be determined by examining the OR equation containing only the taste or $X$ variables. This equation
gives us:

\[
\text{OR} = -95.53 + 0.0226X_1 + 0.268X_2 + 316.5X_3
\]
\[
\text{std. error} \quad (100.3) \quad (.0083) \quad (.268) \quad (145.7)
\]
\[
\text{t ratio} \quad (.95) \quad (2.71) \quad (1.00) \quad (2.17)
\]
\[
+ 0.217X_6 + 1.839X_8 - 0.501X_9 - 2.632X_{11}
\]
\[
(3.43) \quad (5.58) \quad (1.44) \quad (2.31)
\]
\[
+ 1.114X_{12} + 6.777X_{14} + 4.031X_{15} - 1.513X_{16}
\]
\[
(2.63) \quad (20.01) \quad (2.24) \quad (2.44)
\]
\[
+ 0.000122X_{17} - 0.00247X_{19}
\]
\[
(0.00012) \quad (0.0010)
\]
\[
(1.02) \quad (1.51)
\]

For the most part the signs and magnitudes of the coefficients make sense. \(X_3\), the ratio of pupils to population has a net impact on OR of about + $316, which approximates the positive and negative effects previously mentioned.

Three of the X variables are linearly correlated with OR with a sign different from the regression coefficient. \(X_6\), percentage of land tax exempt, is negatively correlated with OR; \(X_2\) percentage old, is negatively correlated with OR, and \(X_{15}\), teacher experience, is negatively correlated with OR. In each case the regression coefficient is positive and in the case of \(X_{15}\), it is of borderline significance.

Intercorrelation among the X variables account for the "wrong" sign on these three coefficients, but pose no major problem in terms of the analysis presented.

\[77\] If the two exogenous subsidies \(M\) and \(Y_6\) are included in this equation, the resultant set of coefficients, and the t ratios are virtually identical with respect to all the included exogenous variables.
Summary

The summary presented will evaluate the model presented upon face value. The results shown, even where discounting is necessary, will be interpreted here.

The results of the presented and estimated econometric model confirm what previous researchers have assumed; at least with respect to school financing there is no apparent interaction between subsidies and own revenue. While results may have been more interesting if this had not been the case, we have clearly exhibited a new piece of evidence which is believed to be of interest to researchers in public finance.

Reporting negative findings does not make it possible to comment on the interdependent system as had been originally hoped. We cannot establish that it is a superior tool, since in this case we have no interaction to report. It is clearly a methodology which forces the researcher to have a rather complete grasp upon the entire system, and was very useful with respect to the development of the subsidy equations; a piece of evidence often overlooked.
APPENDIX D

Interaction Between Own Revenue and Pure Matching Subsidies.

The case of the pure matching subsidy to a single community is shown in Figure 11. The initial position before the subsidy is represented by the intersection of the community preference curve $U_0$ and the income possibilities curve $PP'$. Consider an array of possible and positions after the implementation of the subsidy. $U_1$ represents a completely inelastic response; the coefficient of the subsidy variable in the OR equation should be $-1$. OR is the local level of revenue after subsidy. Thus we have a case of 100% leakage.

Figure 11

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$U_2$ represents a somewhat elastic response to the subsidy. $TR_2$ represents total expenditure for good $X$, the line segment $bb'$ represents the level of subsidy, and $OR_2 = TR_2 - \text{subsidy}$. Thus $OR_2$ shows the level of own revenue after subsidy. $U_3$ represents the no leakage case. $cc'$ is the level of subsidy; $OR_3$ is the level of local revenue. In this illustration we will ignore the theoretically possible cases of preference curves outside the northeast quadrant since experience tells us that this would be a highly unusual result. If considered, the analysis is similar.

Careful construction of the curve shows us that for this community high levels of $OR$ are associated with larger subsidies and larger subsidies are associated with larger levels of $OR$. If a subsidy is a pure matching subsidy, $OR$ must be an explanatory variable in the subsidy equation. In fact, if we assume the matching rate or price is exogenous (not determined by the system), it would be the only explanatory variable.

To extend this analysis to the cross section, envision communities 1 and 2 in Figure 12. In this case both have the same income constraint but different preference curves. $OR_1$ represents community 1 after the absorption of the subsidy and the level of subsidy to community 1 is represented by the line segment $cc'$. $OR_2$ represents the end position of community 2 after adjusting to the subsidy. Clearly
the previous results extend to the cross section in the case of equal income possibilities; higher levels of own revenue are associated with higher levels of subsidy.

We also quickly see that two communities with different income possibility curves but with the same initial level or own revenue and preference curves shifting in the same manner would receive equal levels of subsidy. This is also sketched in Figure 12 as communities 1 and 3.

The distinction between the pure matching and formula matching grant is that the pure matching grant matches the total educational revenue at some rate, where the formula matching grant matches revenue (or expenditure) of some category within the educational context. In the latter case, where maintenance of effort is required, it is not
clear if the higher governmental authorities are influenced by the total educational effort or by the effort within the particular category being subsidized. Since data is not available for expenditure by educational categories, what will be examined is the reaction by higher governmental authorities as if own revenue is the key policy variable.

To restate the above, OR will be included in each formula subsidy equation which specified maintenance of effort even though it is possible for localities to shift funds within categories without necessarily changing total effort at all; indeed, it is possible for total effort to change in the opposite direction to the particular subsidized category.
APPENDIX E

The regression equations given in Chapters Five and Six for the Impacted Aid Subsidy were given as follows:

Total Impacted Aid = 154.7 * Number of impacted units
\[ \text{t ratio } = 39.07 \]
\[ R^2 = .94 \]

\[ Y_1 = .024 + 135.4 X_1 \]
\[ \text{t ratio } = .76 \]
\[ R^2 = .96 \]

The first equation shows that aid increases about $155 for each additional impacted unit. Recall from Chapter Five that an impacted unit would correspond to a student qualifying for half the level of subsidy shown in Chapter Five. Also recall that we have four "regional" levels of subsidy; thus the coefficient is an average of the four values. The $Y_1$ equation is a version excluding the OR variable on the right hand side. This equation shows the per capita level of subsidy as a function of the relative number of impacted pupils. In both cases the excellent fit masks certain extreme variation which would be discussed.

In several cases we have areas which received subsidy in 1967 but reported no impacted pupils in 1970. The data indicates that several of these had fewer than ten such pupils in 1967; a few had as few as one or two impacted pupils. According to the specifications of the program, it would appear that some of these areas did
not qualify for the subsidy they received. The primary qualification was that at least 3% of A.D.M. must be impacted to be eligible. However, they did receive the money.

In 1969 the eligibility requirements were changed in favor of larger districts. The new rules said that a district qualified for subsidy if 3% or more of A.D.M. are impacted provided there are at least 10 such pupils or if there were 400 pupils or more, disregarding the 3% criteria. Thus areas with less than 10 impacted pupils which somehow qualified in 1967 no longer reported impacted pupils in 1970. However, several districts reporting no 1970 impacted pupils seemingly had quite a few in 1967. Geauga and Fulton Counties may have had between 20 and 40 such pupils and Medina could have had between 100 and 200 based upon the amount of money they received.

There are several explanations. It is always possible that there is a data error in one or both years. It is also possible that construction funds were given to those areas in 1967. Originally the data had been reported separately but were merged for the original purposes of this paper. Unfortunately the original data is no longer available and only a portion of the research notes could be recovered. Another possibility is that a major federal complex closed, but that is judged un-
likely in these three cases. The magnitudes seem too large to be explained by normal random variation which occurs from year to year.

In general we overestimate the level of subsidy received by larger counties. This is probably due to the change in eligibility mentioned earlier. With Summit County the variation was much larger than most of the other large counties. This county received virtually no subsidy in 1967. Our estimate was about 25 times what they actually received. The only unusual case is Montgomery County. This county is actually underestimated. However, Mad River School District in that county is one which we can identify as having received over $200,000 of construction funds. Eliminating that portion from the Montgomery total still puts them high, but somewhat closer to the estimate. In this case it is believed that the population fluctuations of Wright Patterson Air Force Base could be the explanation.

Several additional counties which did report 1970 impacted pupils are predicted badly. In the case of Eric, Meigs, Pickaway and Portage Counties we underestimate the actual level of subsidy. In these cases the error is substantial. In the case of Portage it is known that the Ravenna Arsenal in that county was being fazed downward.
### Table 33

**Counties with 1970 Impacted Pupils and Receiving 1967 Impacted Subsidy**

<table>
<thead>
<tr>
<th>County</th>
<th>Dollars</th>
<th>Per Capita Subsidy</th>
<th>Estimated Subsidy</th>
<th>Number of 1970 Impacted Units</th>
<th>Ratios: Impacted Units to Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butler</td>
<td>14532</td>
<td>.06</td>
<td>.19</td>
<td>284</td>
<td>.00124</td>
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<tr>
<td>Champaign</td>
<td>4049</td>
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<td>.55</td>
<td>124</td>
<td>.00396</td>
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<td>Clark</td>
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<td>3.78</td>
<td>3.85</td>
<td>4137</td>
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<tr>
<td>Clermont</td>
<td>4413</td>
<td>.04</td>
<td>.07</td>
<td>33</td>
<td>.000313</td>
</tr>
<tr>
<td>Clinton</td>
<td>137385</td>
<td>4.13</td>
<td>3.94</td>
<td>963</td>
<td>.0290</td>
</tr>
<tr>
<td>Cuyahoga</td>
<td>523968</td>
<td>.30</td>
<td>.45</td>
<td>5529</td>
<td>.00312</td>
</tr>
<tr>
<td>Delaware</td>
<td>27281</td>
<td>.68</td>
<td>.60</td>
<td>172</td>
<td>.00428</td>
</tr>
<tr>
<td>Erie</td>
<td>108364</td>
<td>1.38</td>
<td>.20</td>
<td>107</td>
<td>.00137</td>
</tr>
<tr>
<td>Fairfield</td>
<td>107932</td>
<td>1.48</td>
<td>1.36</td>
<td>290</td>
<td>.00256</td>
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<tr>
<td>Fayette</td>
<td>17607</td>
<td>.67</td>
<td>.97</td>
<td>171</td>
<td>.00654</td>
</tr>
<tr>
<td>Franklin</td>
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<td>2.73</td>
<td>2.59</td>
<td>15352</td>
<td>.0189</td>
</tr>
<tr>
<td>Greene</td>
<td>1065441</td>
<td>8.96</td>
<td>9.02</td>
<td>7904</td>
<td>.0665</td>
</tr>
<tr>
<td>Hamilton</td>
<td>95198</td>
<td>.10</td>
<td>.37</td>
<td>2431</td>
<td>.00260</td>
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<tr>
<td>Hocking</td>
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<td>.18</td>
<td>.18</td>
<td>23</td>
<td>.00111</td>
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<td>Jackson</td>
<td>17864</td>
<td>.61</td>
<td>1.05</td>
<td>224</td>
<td>.00759</td>
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<td>.11</td>
<td>.18</td>
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<td>Licking</td>
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<td>3.86</td>
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<tr>
<td>Logan</td>
<td>14441</td>
<td>.40</td>
<td>.26</td>
<td>62</td>
<td>.00170</td>
</tr>
<tr>
<td>Lorain</td>
<td>59312</td>
<td>.22</td>
<td>.66</td>
<td>1251</td>
<td>.00470</td>
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<tr>
<td>Lucas</td>
<td>25625</td>
<td>.05</td>
<td>.16</td>
<td>483</td>
<td>.00099</td>
</tr>
<tr>
<td>Meigs</td>
<td>22272</td>
<td>1.05</td>
<td>.35</td>
<td>51</td>
<td>.00240</td>
</tr>
<tr>
<td>Miami</td>
<td>774</td>
<td>.01</td>
<td>.53</td>
<td>308</td>
<td>.00377</td>
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<tr>
<td>Montgomery</td>
<td>2460977</td>
<td>4.10</td>
<td>2.71</td>
<td>11952</td>
<td>.0209</td>
</tr>
<tr>
<td>Ottawa</td>
<td>30590</td>
<td>.80</td>
<td>.49</td>
<td>133</td>
<td>.00346</td>
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<tr>
<td>Perry</td>
<td>9741</td>
<td>.28</td>
<td>.41</td>
<td>78</td>
<td>.00286</td>
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<tr>
<td>Pickaway</td>
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<td>1.51</td>
<td>487</td>
<td>.0117</td>
</tr>
<tr>
<td>Pike</td>
<td>77227</td>
<td>3.55</td>
<td>3.71</td>
<td>592</td>
<td>.0272</td>
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<tr>
<td>Portage</td>
<td>132861</td>
<td>1.17</td>
<td>.37</td>
<td>290</td>
<td>.00256</td>
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<tr>
<td>Ross</td>
<td>154889</td>
<td>2.36</td>
<td>2.99</td>
<td>1436</td>
<td>.0219</td>
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<tr>
<td>Scioto</td>
<td>65627</td>
<td>.79</td>
<td>1.03</td>
<td>621</td>
<td>.00247</td>
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<td>955</td>
<td>.00170</td>
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<td>Trumbull</td>
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<td>.12</td>
<td>171</td>
<td>.000720</td>
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<tr>
<td>Warren</td>
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<td>.82</td>
<td>506</td>
<td>.00591</td>
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<td>Washington</td>
<td>12148</td>
<td>.21</td>
<td>.36</td>
<td>224</td>
<td>.00395</td>
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</tbody>
</table>

---

*a Estimated subsidy derived from the equation: \( X_1 = 0.024 + 135.4 X_1 \) where \( X_1 \) is number of impacted units for county 1.
### Table 34

Counties With No 1970 Impacted Pupils Receiving 1967 Impacted Subsidy

<table>
<thead>
<tr>
<th>County</th>
<th>Dollars</th>
<th>Per Capita Subsidy</th>
<th>Estimated Subsidy</th>
<th>Number of 1970 Impacted Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashland</td>
<td>250</td>
<td>.01</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Carroll</td>
<td>256</td>
<td>.01</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Defiance</td>
<td>650</td>
<td>.02</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Fulton</td>
<td>5257</td>
<td>.17</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Geauga</td>
<td>5181</td>
<td>.08</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Hancock</td>
<td>450</td>
<td>.01</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Highland</td>
<td>2858</td>
<td>.09</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Huron</td>
<td>1349</td>
<td>.03</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Jefferson</td>
<td>9954</td>
<td>.05</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Lawrence</td>
<td>605</td>
<td>.01</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Medina</td>
<td>23705</td>
<td>.29</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Noble</td>
<td>650</td>
<td>.06</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Seneca</td>
<td>2429</td>
<td>.04</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Shelby</td>
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<td>0</td>
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<tr>
<td>Stark</td>
<td>1950</td>
<td>.01</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Tuscarawas</td>
<td>1252</td>
<td>.02</td>
<td>.024</td>
<td>0</td>
</tr>
<tr>
<td>Wayne</td>
<td>2753</td>
<td>.03</td>
<td>.024</td>
<td>0</td>
</tr>
</tbody>
</table>

a Estimated subsidy is the constant term from the equation shown in Table 33.
In this case it is likely that there were fewer 1970 impacted pupils than 1967 impacted pupils. No information is available about the others.

In the case of Butler, Champaign, Fayette, Jackson, Lorain, Miami, Ross, Scioto and Washington Counties we overestimate the actual level of subsidy. Miami is particularly strange; they received practically no subsidy in 1967 yet report over 300 eligible pupils in 1970. In this case and the others no major federal installation opened as far as can be determined.

The solution or answers to the questions raised may be answered by either the local school officials in the unusual areas or by the state officials in charge of this program. This was not done as a part of this study. One point of this appendix was to demonstrate that even the equation with the best predictive ability in the group based upon the $R^2$ and $t$ values still has cases unusual enough to warrant special attention. Comparative data is shown in Tables 33 and 34.
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