

DETERMINANTS OF MUNICIPAL
EXPENDITURES AND REVENUES
IN THE BOSTON SMSA

by

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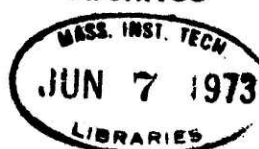
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ABSTRACT

Determinants of Municipal Expenditures and Revenues in the Boston SMSA

by

Daniel Edward Klein

Submitted to the Department of Urban Studies and Planning on May 11, 1973 in partial fulfillment of the requirements for the degree of Bachelor of Science in Urban Studies.

This thesis is an analysis of per capita variations in municipal finances. Forty-five cities and towns in the Boston SMSA were selected for an analysis of factors influencing expenditure and revenue behavior. Variances among municipalities are explained as functions of selected socio-economic and demographic variables.

As a first step, predictor variables were selected and municipal expenditures and revenues were aggregated into their major categories. Behavioral relationships were then hypothesized, linking the categories to the predictor variables. These hypotheses were tested using computer-based techniques of multiple regression and correlation. For most of the categories used in this study, the predictor variables were capable of explaining 40% to 70% of the variances. The implications of the findings and their applicability to planning decisions are discussed.

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I. INTRODUCTION

Municipal finance is big business. In the Boston SMSA, an average town of 10,000 will receive and spend over five million dollars annually.¹ Nationally, this totals to tens of billions of dollars spent each year on the local level. The quantity and quality of these services, as well as their respective costs, varies over a wide range.

With such vast sums of money being administered, there is a natural interest in understanding what factors affect municipal expenditures and revenues. As a community's characteristics change over time, both through continuation of present trends and explicit planning decisions, the demands and needs for municipal services will likewise show changes, as will the revenue sources available to meet these needs.

Planners are in large part guided by two goals. One is to improve the "quality of life" within the community, through the quality and quantity of services and improvements in the general social, economic, and physical environment. The other goal is to increase the value of the tax base, so that these services can be provided at a lower tax rate. Unfortunately, these two goals often work in opposition. For instance, setting aside land for a recreational area may improve the social environment of the community, but at a cost of decreasing the tax base. On the other hand, new industry may increase the value of the tax base, but at the expense of generating undesirable social and environmental side effects. Obviously, trade-offs are often involved, and decisions are based upon a complex set of factors.

Effective planning requires the ability to predict future as well as present impacts. These impacts include changes to the physical environment, socio-economic makeup of the population, and municipal finances. The results of these planning actions (or inactions) can affect the expenses incurred for the schools, fire protection, etc., and the sources of revenue available to fund these services. Of particular importance to planners is the property tax. When the changes in expenditures differ from the changes in revenues, the property tax rate must be adjusted to make up this difference.

In attempting to explain the differences among local expenditures and revenues, we are faced with the enormously complex and unquantifiable

processes which make up any city or town. Each municipality has numerous characteristics and peculiarities which render it unique. However, this complexity can be reduced, and a greatly simplified model created, by using certain descriptive statistics, such as average income or population density, as predictor variables. A town or city can be modeled with these statistics, and fiscal impacts of planning can be represented as the resulting changes in these statistics.

This study is an attempt to identify those factors which affect municipal finances. Whereas previous studies of this sort have analyzed variances among states and/or cities throughout the nation, this study will concentrate on those variances within a single metropolitan area, the cities and towns in the Boston SMSA. The theories and results obtained from previous efforts can be examined for their applicability to this area. A closer examination of behavioral relationships and variances can be made, since uniformities will exist regarding state-local interactions, regional standards of living and price fluctuations, climate considerations, etc.

II. FRAMEWORK FOR ANALYSIS

A. Procedural Method and Sample Selection.

This study was based upon the cities and towns in the Boston Standard Metropolitan Statistical Area (SMSA). The procedure which has been used was as follows: After a survey of the existing literature and interviews with relevant town officials, those variables thought to have a significant influence were identified. A system for classifying municipal expenditures and revenues was developed. Behavioral relationships were then formulated, relating the independent predictor variables to the revenue and expenditure categories. The validity and significance of these hypotheses were tested using computer-based techniques of multiple regression and correlation. Computation was performed on the IBM 370/165 at the MIT Computation Center, using the Statistical Package for the Social Sciences (SPSS).

Since much of the data is based on census returns, 1970 has been chosen as the base year. All other data has likewise come from various 1970 reports. Data for the independent variables could be found for all 78 cities and towns in the Boston SMSA. Data concerning the expenditures and revenues was not so readily available. In order to be consistent with the various accounting practices in effect among the cities and towns, it was necessary to use data in a standard form. This was found in the "Schedule A" Report of Financial Transactions that each city and town in Massachusetts files yearly with the Massachusetts Department of Corporations and Taxation.² In 1970, 47 of the 78 cities and towns filed this report.

Boston and Cambridge, the two largest cities in the SMSA, have been omitted from this study. Their large size and central city functions are sufficiently different from the other cities and towns to distort the overall averages. They have been omitted in the hope that more consistent results will be obtained, although a chance to study central city-suburb differences has been lost. Thus, the sample size in this study has been reduced to 45.

As a final note, all references to expenditures and revenues will be taken to mean per capita expenditures and revenues. Total expenditures and revenues tend to correlate most closely with population, thus obscuring the effect of other influences. The level of interest is the amount spent on and received from the individual taxpayer and consumer, and this can only be effectively examined when all values are expressed on a per capita basis.

B. Selection of Independent Variables.

A survey of the available literature showed a limited but useful number of studies relating to state and local finances. One of the earliest studies was done by Solomon Fabricant, using 1942 data.³ In this effort he examined state and local operating expenditures as functions of income, density, and level of urbanization. Several years later, Glenn W. Fisher used the same variables to study 1957 expenditures, including capital outlays.⁴ Although the results were generally similar, the percentage of variation explained was somewhat lower. In 1964, Seymour Sacks and Robert Harris were able to account for this shift in results by introducing state and federal aid payments as new variables.⁵ Also in 1964, Mordecai Feinberg reported on the effects of growth and decline on municipal functions.⁶ This study relied heavily upon a work by Amos H. Hawley which related core-city expenditures to the proportion of the SMSA's population in the suburban ring—the so-called "spillover" effects.⁷

Based upon these studies, interviews with local budget officials, and examination of selected town budgets, I selected a set of variables for an in-depth study. These variables, it was felt, were the ones most applicable to the cities and towns in the the Boston SMSA. The following is a brief description of these variables. A more thorough discussion will follow in the section on Behavioral Characteristics. An explanation of the measures used, as well as the sources for the data, can be found in Appendix A, Data Base Description.

INCOME and POVERTY: The amount of money available heavily influences the amount that people are willing to spend. Generally, as people's incomes rise, so do their "tastes" for municipal services. A tax on wealth or property raises more revenue in wealthier communities. These communities can either spend more than poorer communities at an equal tax rate, spend equally at a lower tax rate, or a combination of both.

While income refers to some measure of average wealth, poverty is used in a somewhat different sense. Poverty, as it is used in this study, is meant to refer to the fraction of families below a certain income level. Many services are set up to serve only this particular low-income segment of the population, instead of the community at large.

One way to contrast income and poverty would be to think of the distribution of income among the people in the community. Income refers

to some average or mean value of this distribution. Poverty, on the other hand, refers to the size of the low income end. In a sense, it reflects the variance of the income distribution. A community with a high average income can also have a high poverty level if the income distribution is quite spread out.

SCHOOL PERCENTAGE: This variable is used to indicate the fraction of the total population that is enrolled in the municipality's public school system. The major portion of a town's expenditures are school related, as is the state-aid revenue. In defining this variable as the fraction enrolled, the private and parochial school children have been excluded from the numerator. This is appropriate, since they are effectively removed from these services.

DENSITY: The density of a town influences the methods and expense of servicing it. Densely populated areas tend to have more structures as well as more people. Although this leads to a larger tax base, it also requires additional services per unit area than do sparsely populated areas. Some suburban practices, such as private septic tanks, become infeasible in space-intensive areas, and must be replaced by alternative, generally tax-supported, methods.

RATE OF GROWTH: A municipality which is exhibiting growth incurs additional expenses. There are several types of growth possible, such as growth in population, economic activity, tax base value, etc. In this study, growth will refer to the rate of population growth. Since year-to-year fluctuations would greatly distort the real growth trends, the population growth over a 10-year period has been used.

A growing municipality must eventually enlarge its facilities to meet the additional demands. This means building additional schools, roads, utilities, etc. Often this new construction is financed through long-term borrowing, other times on a pay-as-you-go basis.

It should be noted that communities which have experienced a decline in population, thus experiencing a negative growth rate, rarely save by selling or vacating facilities. More likely, they will operate below full capacity. For this reason, all towns which have had negative growth in the past decade will be considered as having zero growth. In the sample, only 7 of the 45 cities and towns had lost in population between 1960 and 1970, and in only one case (Chelsea) was the 1970 population less than 95%

of the 1960 population. Thus, treating negative growth as zero growth is apt to have a greater conceptual than statistical impact.

The other variables relate to a specific point in time; that is, they do not directly indicate past activities and trends. Growth, on the other hand, is a dynamic variable, and summarizes the change over time. In using a dynamic variable as an explainer of present revenue and expenditure variations, certain difficulties arise. One example would be a time lag between a period of growth and the response to this growth. The immediate response to growth is a more intensive use of facilities, and increasing the size of facilities is apt to follow at a later time.⁸ Thus, the effects of growth upon expenditures are likely to shift over time.

LEVEL OF ACTIVITY (SPILLOVERS): In the Boston SMSA, the distribution of economic and industrial activity is quite different from the distribution of population. Communities with low levels of activity have a net outflow of workers and shoppers during the day, while communities with high levels of activity have net inflows. This is also known as a spillover effect. The daytime population is not the same as the residential population. These additional workers, as well as the shoppers and suppliers they attract, place extra demands on certain services such as roads, traffic control, sewage, utilities, etc. These extra demands and expenditures are counteracted by the additional economic opportunity and the property tax revenues from the buildings which are devoted to this activity.

Spillovers are also indicative of density differences as well. A town with a net inflow of people is likely to have more buildings and property dedicated to this use than a town with a net outflow. To this extent, it is effectively more dense, even though the residential populations and total areas may be identical. The real density of a town is a combination of the residential and commercial densities.

C. Selection of Expenditure and Revenue Categories.

Municipal revenues are obtained from a large number of sources through a variety of collection formulas. These funds are spent on an even larger number of projects, services, etc. In order to limit this study to a workable size, and since accounting methods rarely allow finest-grained analysis, it was necessary to establish aggregate categories into which most revenues and expenditures were subsequently classified.

Most of the earlier studies used essentially the same set of expenditure categories. With some small exceptions, these categories were local schools, higher education, highways, public welfare, health and hospitals, police, fire, sewerage and sanitation, interest and miscellaneous, and general control. Not all of these categories are applicable to the cities and towns in the Boston SMSA. Some of the categories, such as welfare and higher education, are administered mostly or completely at the state level. Other modifications were made necessary by the budgeting and accounting practices found in the available data. For instance, many health expenditures were included in the totals for sewerage and sanitation.

The following discussion will briefly define the expenditure and revenue categories chosen for this study. In the section on Behavioral Characteristics, these will be related to the independent variables. The precise basis for measurement, as well as the sources of the data, can be found in Appendix A, Data Base Description.

Municipal expenditures were aggregated into six categories. These six categories accounted for 75% to 95% of the total municipal expenditures, averaging 86%. They are:

SCHOOL EXPENDITURES: This consists of the expenses incurred by the public school system, including administration, instruction, school buses, school lunches, etc. This is the major expenditure category in all of the cities and towns, usually accounting for slightly less than one-half of all local expenditures. This value does not include expenses for libraries other than school libraries.

POLICE EXPENDITURES: Police expenses are all of the law enforcement, patrol, traffic regulation, and other activities of the Police Department. This accounts for about 5% of total expenditures.

FIRE EXPENDITURES: Fire expenses are those incurred in all activities of the Fire Department. This category also accounts for about 5% of total expenditures.

PUBLIC WORKS EXPENDITURES: This category includes a large number of diverse, generally property-related services. Its major components are sewage, refuse collection, road services, and utilities. Some services are supplied directly by the municipality, others are supplied by private enterprise, and still others are "purchased" on a regional plan, such as MBTA or MDC services. As a result, per capita public works

expenses show a high degree of variance. In general, this category accounts for about 15%-25% of total expenditures.

PARKS and RECREATION EXPENDITURES: This category refers to the expense of maintaining recreational and park areas, and any recreational programs which may be involved. Also highly variable among the towns, this category accounts for roughly 2%-3% of total expenditures.

DEBT and INTEREST EXPENDITURES: This category includes the principal payment on all long-term loans, as well as the interest on all long- and short-term loans. This accounts for about 7%-8% of total expenditures. Temporary loans and loans in anticipation of revenue are not considered part of this category.

Municipal revenues were aggregated into five categories. Collectively, these categories account for an average of 85% of total local revenues. These categories are:

PROPERTY TAX REVENUE: By far the most important revenue source on the municipal level is the revenue from property taxes. It accounts for nearly 60% of total local revenue, and an even higher percentage of total local tax revenue.

AUTO EXCISE TAX REVENUE: The second major source of local tax revenue, ranking far behind property tax revenue, is the ad valorem tax revenue from motor vehicles. This revenue accounts for roughly 5% of total revenues.

PUBLIC WORKS REVENUE: User charges are usually associated with most utilities, primarily gas, water, and electricity. Since not all towns provide these services, wide variations exist, but this revenue usually accounts for about 5%-10% of all local revenues.

STATE-AID REVENUE: Some services formerly provided on the local level, such as welfare, have been assumed by the state and must be excluded from consideration. Other services, primarily education, are administered on the local level but receive substantial state aid. On the average, the total of all forms of state aid accounts for over 10% of local revenues.

FEDERAL-AID REVENUE: The Federal government also provides aid to municipalities under a large number of programs. Although most federal aid is distributed to the states, a significant amount goes directly to the local governments. These grants generally relate to health, schools, urban renewal, and construction. Although the per capita amounts vary

widely over the Boston SMSA, this revenue accounts for about 2%-5% of total revenues.

III. BEHAVIORAL CHARACTERISTICS

A. Relationships between Categories and Variables.

With the independent variables and the expenditure and revenue categories defined, it is now possible to examine the various relationships between them. In particular, we want to know how each of the independent variables influences each of the expenditure and revenue categories.

This section will be a discussion on a qualitative level. Tentative relationships will be postulated based on previous studies, interviews, and information from related literature. Once this has been done, computer-based techniques can be used to examine the validity and significance of these hypotheses, as they apply to the Boston SMSA.

SCHOOL EXPENDITURES: School expenditures are usually budgeted on a per-pupil basis. This suggests a linear relationship between school expenditures and school percentage. The other variable which is thought to influence spending is income. As income levels rise, one would expect expenditures to also rise, since wealthier families are willing and able to pay more for education. However, at least two factors tend to reduce the influence of income on school expenditures. Although wealthier families may be willing to pay a greater absolute amount, poorer families are probably willing to give up a larger fraction of their incomes, to provide additional opportunity for their children. The other reason is easier to document. Most school expenditures are reimbursed by the state under provisions of Chapter 70 of the Massachusetts General Laws Amended. The fraction of the expenses which are reimbursed ranges from a floor of 15% to a ceiling of 75%, with an average of 35%.⁹ The formula used is a version of percentage equalizing, based upon the NESDEC (New England School Development Council) formula.¹⁰ This formula operates in such a way that poorer communities receive a higher percentage of reimbursement. This school aid from the state serves to diminish per pupil expenditure variations resulting from income differences. As a result of these two forces, one might expect school expenditures to vary as some lesser power of income. That is,

$$\text{SCHOOL EXP.} = k(\text{INCOME})^n$$

where n is between 0 and 1.

POLICE EXPENDITURES: Police services are primarily population-based, in that they serve people more than property. The three major sub-divisions of this category are crime prevention and patrol, maintaining order, and regulating activity. (There is considerable overlap in these areas.) Since many police activities (especially traffic control) relate to daytime activities, it is likely that the additional population due to spillovers will increase police expenditures.

Density is another variable likely to be significant. Areas of high density usually need more regulatory services, such as traffic control and patrol, than do low density areas. Densities range from a high of over 14,000 people/sq. mi. in Chelsea to a low of 215 people/sq. mi. in Sherborn, a range of 65 to 1. Since expenditures are known to vary over a much smaller range, it is likely that expenditures vary with some low positive power of density.

Lastly, the effects of income and poverty must be considered. Higher crime rates are often found in the lower income (high poverty) areas. If poverty is used as a measure, then we are thinking of a function where a high rate of crime is associated with poverty areas, and a lower rate elsewhere. If income is used as a measure, then we are thinking of an inverse relationship, downward sloping but continuous. It is important to note that expenditures do not always follow directly from need. Higher income communities would probably be willing to pay more for police protection, both in the form of more police and better paid police. The level of poverty may be more influential in determining the need, but the level of income will determine the response to that need. This difference will be further explored in the regression analysis. A positive correlation between income and police expenditures has been found in other studies.¹¹ In this study, no attempt will be made to determine causality in this relationship. That is, the lower crime rates found in the wealthier communities may be due to increased spending for police or to other factors, but the answer lies outside the scope of this study.

FIRE EXPENDITURES: Whereas police expenditures tend to be population-related, Fire Department activities tend to be property-related. Density is likely to be highly significant, since closely-packed structures present more fire hazards than low-level, low-density structures. The effect of spillovers must also be considered. The increase in density due

to additional commercial and industrial structures certainly should have an effect. This would mean positive correlations for both spillovers and density.

Income and poverty levels would seem to affect fire expenditures much in the same way they would affect police expenditures. As income rises, structures tend to become safer and more fire-resistant. Thus, the poverty areas would seem to have a disproportionately large need for fire protection. But to the extent that income indicates a willingness to pay, expenditures will rise with income. Thus there are two opposing forces—a high demand in low-income areas based on need and a high demand in high-income areas based on desire.

PUBLIC WORKS EXPENDITURES: These services are also property-related, but much of the demand is also due to population as well. Spillover effects are likely to show a positive correlation, since the additional people and activities would impose additional demands on roads, utilities, sewage, etc.

Density and income are also likely to exhibit positive correlations with these expenditures. Denser areas create demands for additional services which are not always necessary in sparsely populated areas. Higher income communities would probably be willing to spend more for quality services.

Lastly, rate of growth must be considered. Growing communities have to expand their capital facilities, by building new roads, sewer lines, etc. Some of this is financed through long-term borrowing, but a significant portion is constructed on a pay-as-you-go basis.

PARKS and RECREATION EXPENDITURES: Expenditures in this category are not essential in the same sense that the other categories are. Parks and recreational activities are more of a luxury expense. As a result, there is likely to be a positive correlation between expenditures and income. Density may have mixed effects. Low density communities are in a better position to set aside more land for these activities, whereas parks are more space intensive in high density areas. However, land costs more in high density areas. The additional activities imposed by spillovers may have an effect different from that of density. There may be a stronger feeling to "compensate" for the industrial and commercial activity by

offering more parks and recreational programs than in a primarily residential community.

The effect of the school percentage is difficult to predict. Generally speaking, many recreational programs are directed towards school-aged children. However, many of these programs come under the control of School Boards, and would therefore be accounted for as school expenses. It may be that the non-school recreational activities are primarily directed towards the elderly and others who are outside of the school system, but this is not clear. Also, since school expenses are free of the legal limits of bonded debt for the communities, a town may be tempted to "hide" this expense in the total school expenses.

DEBT and INTEREST EXPENDITURES: For a number of reasons, municipalities make use of long-term debt for financing capital projects. The most common reasons are (1) to finance projects which are too expensive to pay out of current tax levies, and (2) to shift the burden of payment onto those who will be receiving the future benefits. Since many large capital projects are funded in this way, this category serves to smooth out the "bumpiness" of capital outlays over time.

Growth is a key factor in capital outlays,¹² so we should expect a positive correlation between growth and such expenditures. Inasmuch as higher income levels indicate a desire for additional services, we might expect a positive correlation here as well. School construction is usually financed in this way, so debt would probably correlate with school percentages, too.

PROPERTY TAX REVENUE: Property tax revenue is by far the major revenue source for municipalities in the Boston SMSA as well as for cities and towns throughout the nation. This has come about as a result of a long, evolutionary process in our nation's tax history. Two major influences on this development have been that (1) property is the primary taxable item which has not largely been pre-empted by state and federal taxes, and (2) since many municipal services are in some way related to property, the property taxes resemble a crude form of user charges. The property tax has been under constant criticism on a number of grounds, among them its alleged regressivity (it takes a higher percentage of housing costs for low income families), distortion of land-use patterns, discouraging effect on housing investment, inequalities in administration, and inappropriateness

for funding many services. The legality of using property tax revenues as a means of financing many municipal services, particularly public schools, has recently been challenged in several court cases. Nevertheless, it is virtually certain that some form of property taxation will continue to play a major role in municipal financing.

The property tax revenue is equal to the property tax rate times the property tax base. By property tax rate, I am referring to the effective property tax rate, which is equal to the actual tax rate times the assessment ratio. That is,

$$\text{EFF. RATE} = \text{ACTUAL RATE}$$

$$* (\text{ASSESSED VALUE} / \text{ACTUAL VALUE})$$

In 1970, the effective tax rates in our sample ranged from a low of \$28.20 per \$1000 of property in Wenham, to \$106.30 in Chelsea, with most towns and cities in the \$40-\$55 range.¹³

The property tax rate is a crucial value for planners. To the extent that towns "compete" with each other for quality residential and commercial users, a high property tax rate serves as a discouragement to the individual choosing land sites. The rate is set so that revenues will approximate expenditures. That is, the property tax revenue must equal (over the long run) total expenditures minus all other revenues. Once this revenue need has been determined, it is divided by the tax base to yield the necessary property tax rate. Because of the effect of property taxes on the supply and demand processes in the real estate market, many planning decisions are influenced by their potential impact on property tax rates.

In examining the possible relationships between the independent variables and the size of the tax base, we are really looking at their effect on property consumption. Income is certainly an important factor. Several studies have shown positive relationships between income and the quantity and quality of housing consumed.¹⁴ One would also expect a positive relationship between the tax base size and density, since high density implies more structures. However, this absolute increase is countered by a corresponding increase in people, so that the per capita tax base might show mixed changes. Lastly, the level of spillovers, as an indicator of the amount of commercial and industrial property in use, would also increase the tax base size for higher levels of activity.

Even if these relationships are all valid, being able to explain variations in the per capita tax base does not allow us to directly predict property tax revenues. As mentioned before, property tax revenues are the product of the tax base and the tax rate, and the tax rate is set according to total expenditures, other revenues, and the size of the tax base. If expenditures and other revenues remain constant, an increase in the tax base would likely result in a decrease in the tax rate. Thus, even though we can look at the correlations between property tax revenue and the independent variables, this revenue is really dependent upon the other expenditure and revenue categories.

AUTO EXCISE REVENUE: Although tax revenues from motor vehicles amount to only about one-tenth that of property tax revenues, they constitute the second major source of municipal tax revenues. One would expect these revenues to correlate primarily with income, for at least two reasons: (1) Wealthier people and families tend to own more cars, and (2) they tend to own more valuable cars, both newer and larger. There may also exist a correlation between this revenue and the percentage of school children, since families with school-aged children probably depend more on cars. However, the number of autos/family is apt to rise more slowly than people/family, so that the number of autos/person may be smaller for families with school children.

PUBLIC WORKS REVENUE: This revenue is the primary source of user charges. Other user charges consist of licenses, sale of school lunches, health care fees, etc., and are scattered over a wide range of activities. Revenue from public works, as used here, is obtained from the sale of electricity, gas, and water. Since different communities provide different combinations of these services, this revenue is apt to be highly variable. (These differences are later taken into account by considering net public works expenditures.) One might expect to find a slight increase in consumption due to income, but if this is so, it is probably a weak relationship. The level of commercial and industrial activities, measured by the spillovers, would probably also show a positive correlation.

STATE-AID REVENUE: Massachusetts reimburses the towns and cities under a large number of different programs. Approximately 80% of these funds are educationally related, and over 50% is distributed under Chapter 70 provisions alone.¹⁵ Chapter 70, of the Massachusetts General

Laws Amended, is the major school aid reimbursement program, and pays for a percentage of school expenditures exclusive of construction, transportation, lunches, special educational programs, and handicapped students (many of these items are covered by other state-aid funds.). The state aid which is not school-related is primarily directed towards veteran's benefits and urban renewal projects.

Since the funds for each program are distributed under different formulas, the total revenue is not likely to behave perfectly with any of the variables, although approximate correlations may be found. In general, one would expect that total state-aid funds would be strongly related to the percentage of school children, since so much is tied to education. Many of the programs, particularly the Chapter 70 funds, have a redistributive effect, returning proportionately more to the lower income communities. This would indicate a negative correlation between state aid and income.

FEDERAL-AID REVENUE: In addition to state-aid revenues, municipalities also receive grants from the Federal government. These grants total much less than the state aid, but are nonetheless quite significant in many municipalities. The grants cover a very wide range of activities and special programs. (The advent of Federal revenue-sharing will undoubtedly affect this.) The major categories of this aid are for construction, urban renewal, schools, and health.

Grants of this nature tend to vary greatly from year to year, and the 1970 figures may not accurately reflect the long-term averages. The growth rate would seem to be an important factor, since many of the grants are related to the construction of schools, sewers, etc. The grants relating to urban renewal and health care programs would likely be positively correlated with poverty (or negatively correlated with income) and density. The school aid programs would naturally relate to school percentage, but in particular to low income and disadvantaged school children.

B. Collinearity among Independent Variables.

So far we have developed tentative hypotheses concerning the relationships between the revenue and expenditure categories and the independent variables. By calling them "independent," there is an inference that their values do not relate to the values of the other predictor variables. That is, a change in one variable should not affect the values of the others.

Unfortunately, the real world does not operate in this way. Results and predictions can be seriously affected if two or more independent variables are significantly related. This condition is known as multicollinearity:

"...Multicollinearity arises whenever, either in the population or in the sample, various of the explanatory variables stand in an exact or almost-exact linear relation to each other.

When multicollinearity occurs, it is as if members of a subset of explanatory variables act always in unison. As a result, the data lack sufficient independent variation to allow us to sort out the separate effect of each X_i , $i=1, \dots, k$. The greater the degree of multicollinearity that obtains, the more arbitrary and unreliable does least squares allocate the sum of explained variation among the individual explanatory variables."¹⁶

In examining the choices of independent variables used in this study, a few potential cases of collinearity can be identified. The most obvious is a strong negative relationship between income and poverty. However, they are not used jointly in any of the revenue or expenditure categories, so this should not pose a serious problem. A more serious problem may exist between density and the other variables. The areas of highest densities are usually found in the central city, inner suburbs, and suburban centers. In these areas there is a disproportionately high percentage of the poor and the elderly.¹⁷ Young families with school-aged children tend to move out to the less dense suburbs. Thus there is strong reason to suspect a positive correlation between density and poverty, and a negative one between density and school percentage. Also, since dense areas have less room to expand, there should also be a negative correlation between density and growth.

Correlations were computed for each pair of independent variables. The results of this are summarized in Table 1. These were zero-order product-moment correlation coefficients, often called Pearson correlations. The four predicted correlations (income and poverty(-), density and poverty(+), density and growth(-), and density and school percentage(-)) were all strongly correlated, significant to the 0.001 level.

In addition, a few other significant correlations were observed. Poverty was negatively correlated with both school percentage and growth. One possible explanation of this can be derived from the originally predicted

correlations. Since poverty and density were strongly correlated in a positive manner, and density was negatively correlated with both growth and school percentage, it is not unlikely that poverty is also negatively correlated with these. This is essentially a transitive property, rather than evidence of new behavioral relationships.

Income was negatively correlated with spillovers, significant to the 0.05 level. Although this is a rather weak level of significance, it could be interpreted as evidence that higher income people prefer to live away from commercial and industrial areas. Additional evidence for this behavior can be seen in that there are very low levels of commercial and industrial activity within the wealthiest, outlying suburbs. This may be due either to zoning restrictions, impracticality of using outlying areas for non-residential activities, or a combination of these and other reasons.

A final significant correlation is a negative one between growth and spillovers; that is, the towns and cities with the highest rates of residential growth have the least non-residential activity. The exact reason for this relationship is unclear. The fact that growth is a dynamic variable, whereas spillovers are static in time, may provide one possible answer. The heaviest concentrations of jobs are in the older, denser cities. High growth rates are most frequent in the less dense suburbs. Although industry may be moving out to the suburbs, the majority of jobs are still in the densest areas. To put it another way, industrial growth may be highest in the suburbs, but industrial quantity is still highest in the non-growing dense areas.

Although these correlations may shed light on many interesting relationships, it tends to complicate the primary goals of this study. In attempting to determine the behavioral relationships between the independent variables and the revenue and expenditure categories, allowances must be made for the existing multicollinearity. In the case where two or more related variables are affecting the dependent category, the regression equations will not be able to accurately and reliably allocate the explained variation among them. Another potential problem is the inclusion of non-explanatory, but collinear, variables. For instance, if poverty has been postulated as the only explanatory variable, and poverty and density are collinear, then a regression equation would allocate some of the variance attributable to poverty to density instead, even though density may have no

logical relationship. These possibilities make it necessary to rely less heavily on the computer output and more heavily on our ability to interpret these results in terms of our real-world understanding and common sense.

C. Correlations among Categories.

The preceding section examined the problems of collinearity among the independent variables. A less serious problem, but still one worthy of note, are the correlations between the various expenditure and revenue categories. Although the categories were created in a way that seemed to lack interdependencies and overlap, there are at least three ways in which they can correlate.

If the categories are dependent upon the same independent variables, then correlation among categories is inevitable. For instance, if expenditures for parks and revenues from property taxes are both primarily related to income, then the two will correlate. There is no reason to suspect that the two are related behaviorally; they merely relate to a common set of predictor variables.

A somewhat more serious problem is that of causal relationships among the categories. This can be either positive or negative. A positive relationship might be observed if large school expenditures led to increased construction, which in turn would increase the debt expenses. A negative relationship would result if more parks and recreational programs somehow reduced the crime rate, which in turn reduced police expenditures.

A third source of correlation is readily understood if one realizes that revenue sources are not unlimited. With taxpayers showing unlimited demands but limited resources, funds must somehow be rationed among different services. Various programs are in competition for funds. The ability of one program to obtain additional funds must necessarily result in increasing revenue sources or decreasing other expenditures.

These three influences work in complex, interrelated, and conflicting ways. Fortunately, the affect of these interactions are minimal when small, incremental changes are being considered. For such small changes, we can safely overlook these influences, so long as we are aware that they do exist.

IV. RESULTS OF REGRESSION ANALYSIS

A. Methods of Regression.

The relationships between the independent variables and the expenditure and revenue categories were examined using two methods of regression analysis—linear (additive) and logarithmic (joint). Linear regression is the more familiar of the two. It takes the form

$$Y = a + b_1X_1 + b_2X_2 + \dots$$

where Y is the dependent variable, the X's are the independent variables, the b's are the coefficients of regression, and a is a constant term. This form treats the relationships between the dependent and independent variables as being linear; that is, the exponents of the variables are all 1. There is also an assumption that the independent variables separately affect the dependent variable in an additive way. The change in one variable will have the same impact regardless of the values of the other variables. The validity of this assumption is questionable. As an extreme example, if school expenditures are being explained by income and school percentage, and the school percentage were to drop to zero (no one in the school system), there would still be school expenditures predicted by the values of income and the constant term. Although the actual data does not show such drastic variations, this example does point out a major weakness in this method.

The logarithmic form of the regression takes a different approach, and avoids this weakness. It assumes that the independent variables operate in a multiplicative relationship to jointly determine the dependent variable. This takes the form

$$Y = 10^a X_1^{b_1} X_2^{b_2} \dots$$

where the X's, b's, Y and a have the same meaning as in the linear form. This equation predicts the value for any combination of independent variables, rather than their separate effects. This form of model is more appealing intuitively, and has been used successfully in obtaining improved results in previous studies.¹⁸

To reach a linear form of this equation which is suitable for computer techniques, logarithms of both sides are taken. This results in the form

$$\log Y = a + b_1 \log X_1 + b_2 \log X_2 + \dots$$

This form of the model yields two advantages. First, it permits us to express the dependent variable as being completely dependent upon the

independent variables; there is no constant term in the absence of other variables. Using our previous example, school expenditures would now drop to zero as the school percentage dropped to zero. The second advantage lies in the fact that the regression coefficients become the exponents of the variables, and some non-linear correlations can be better fitted. For instance, the highest town density is 65 times that of the lowest. Since expenditures are known to vary over a much smaller range, it seems probable that the relationship varies more closely with some power of density less than 1. If this is so, then we would expect to find the coefficient of regression for density to be less than 1. The difficulty with using this method is due to the collinearity among the independent variables. With their strong interactions, the sample space tends to "fold up," and it becomes even more difficult to allocate the explained variance among the variables.

B. Modifications to Procedural Framework.

As a first step, correlation coefficients were computed between the independent variables and the revenue and expenditure categories. This was done with the actual values as well as their logarithms. These coefficients are summarized in Tables 2-5. The collinearity among the independent variables restricts us from inferring too much from these values. Because of this condition, some behavioral relationships have had their simple correlations negated, while other spurious correlations have shown up among behaviorally unrelated pairs.

Once the correlation coefficients were computed, regression equations were run, regressing the different categories against the variables. This was done in both the linear and logarithmic forms. The technique used was stepwise regression, which brings variables into the equation one at a time in order of importance until either all variables are in the equation or until the outstanding variables will not contribute significantly to the explained variance. The early results suggested two alterations which were made to the procedural framework.

The first change was the elimination of poverty as an independent variable. Its explanatory value in all cases was less than the explanatory value of income. This finding could be taken as supporting the argument that even if poverty determines the need, it is primarily income which determines the response to that need.

Before deciding to remove this variable from consideration, a graph was constructed, plotting income against poverty levels. This is shown in Figure 1. The graph illustrates the general inverse relationship between income and poverty. The points corresponding to high incomes and relatively high poverty were found to belong to the large communities and inner suburbs, usually with high densities. After considering these factors, it was felt that the inclusion of poverty as an independent variable would not provide an explanation of the variance that could not be provided by income and density.

The second modification in the procedure concerned the treatment of public works expenditures and revenues. As pointed out before, the wide range of services provided, particularly regarding utilities, made these values highly variable. To reduce some of this variance, a new category was added, in which the user-financed utilities were subtracted out. This category, called NET PUBLIC WORKS EXPENDITURES, is computed as

PUBLIC WORKS EXPENDITURES - PUBLIC WORKS REVENUE.

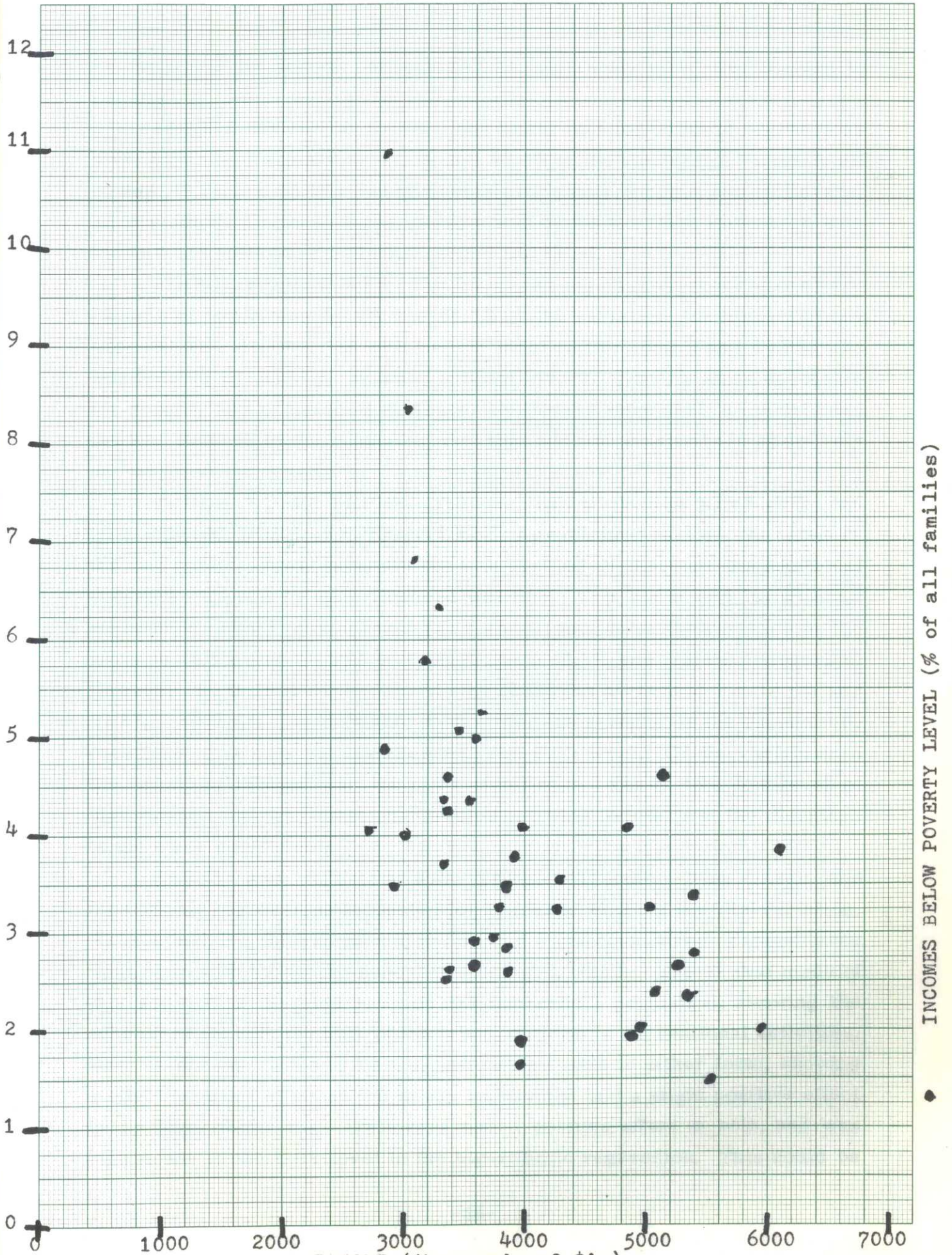
This value reflects the municipal expenditures above and beyond the user-financed services.

C. Explanation of Findings.

Using this now-modified framework of categories and variables, regressions were run in which all categories were regressed against all variables. Regressions were made both linearly and logarithmically. Following this, a separate set of regressions was computed in which only those variables predicted to have an influence were included. A summary of all regression runs is contained in Tables 6-9. The following discussion relates to and explains these results.

SCHOOL EXPENDITURES: The linear and logarithmic regressions were capable of explaining 51.9% and 56.6% of the total variation. Using only income and school percentage as variables, only 41.4% and 47.1% was explained. In both cases, density was the first variable brought into the stepwise regression. Its importance and significance dropped sharply as other variables were brought into the equation. This indicates the collinearity existing among the variables. Since school percentage and density were strongly correlated negatively, some of the variance that was expected to

FIGURE 1: GRAPH OF INCOME VS. POVERTY LEVELS



be explained by school percentage was apparently attributed instead to density.

POLICE EXPENDITURES: The linear and logarithmic regressions were capable of explaining 47.0% and 43.8% of the variation. Virtually all of this (46.9% and 43.2%) was attributable to density, income, and spillovers, as predicted. Of these three, density was by far the most important, with income and spillovers a distant second and third.

FIRE EXPENDITURES: The linear and logarithmic regressions were capable of explaining 64.2% and 66.3% of the variation, the highest of any expenditure category. As with police, most of this (63.2% and 64.9%) was attributable to density, income, and spillovers. Density alone accounted for roughly 50% of the total variance. Spillovers were next in importance, lending support to the reasoning that this additional activity is effectively an "addition" to density.

PUBLIC WORKS EXPENDITURES, PUBLIC WORKS REVENUES, and NET PUBLIC WORKS EXPENDITURES: As explained earlier, the category for net public works expenditures was created to discount the additional variance imposed by user-financed utilities. The linear and logarithmic regressions could only account for a small portion of the variance in the revenue (6.3% and 10.3%) and expenditure (8.1% and 23.4%) categories. However, in the net expenditures, the equations accounted for 14.4% and 27.8%. Although this is higher than either the revenue or the expenditure equations, it is still not significant at the 0.05 level. Of the variables in the equation, income was the most significant. Yet at this low level of significance, there is questionable value in trying to interpret the meanings of the other coefficients.

PARKS and RECREATION EXPENDITURES: The linear and logarithmic regressions accounted for 39.5% and 41.3% of the total variation. As expected, income was the major factor of those considered. Expenditures went down with increased school percentages, which suggests that much of this activity is directed towards the non-school population, allowing the schools to provide the bulk of the school children's recreational activities. Density did not prove to be a significant variable in either form, showing a slight negative effect in the linear regression and a slight positive effect in the logarithmic one. Spillovers had a positive effect in both, and was significant to the 0.05 level in the logarithmic regression. This could be

interpreted as supporting the reasoning that towns with more industry "compensate" for the side-effects by providing more parks and recreational activities.

DEBT and INTEREST EXPENDITURES: The linear and logarithmic regressions accounted for 55.4% and 53.8% of the total variation. Income, school percentage, and growth were, as expected, major influences, but could only account for 37.3% and 39.6% of the variation. An unexpectedly strong relationship was shown between spillovers and debt expenditures. This relationship, significant to the 0.05 level, cannot readily be explained by the known collinearity among the independent variables.

PROPERTY TAX REVENUE: The linear and logarithmic regressions were quite effective in explaining variations in this revenue source, accounting for 71.0% and 70.7% of the variance. By far the most important variable in this regression was income, accounting for over one-half of the total variance. Density and spillovers also had significant impacts, as predicted.

As discussed before, property tax revenue is really dependent upon total expenditures and other revenue, and is used to make up this difference. Separate correlations were run in which the tax base and tax rate were compared to the independent variables. The property tax base correlated very strongly with income (0.789), with no other variables showing significant correlations. As expected, the tax rate correlated negatively with income and positively with density. Tax base and tax rate correlated negatively with each other; that is, the towns with the higher per capita tax base paid a lower tax rate.

AUTO EXCISE REVENUE: The linear and logarithmic regressions were able to account for 68.9% and 71.6% of the total variance. As expected, most of this was attributable to income. School percentage, which was projected as possibly having a negative effect, showed a surprisingly strong positive effect. This cannot readily be explained by the known collinearities, and may be due to behavior and/or tax laws not considered.

STATE-AID REVENUE: The linear and logarithmic equations were able to account for 52.5% and 59.4% of the total variance. The positive effect of school percentage and the negative effect of income were the major determinants. Growth was significant in the linear equation, and density

in the logarithmic equation, but this could have been due to the collinearity among the independent variables.

FEDERAL-AID REVENUE: The linear and logarithmic regressions were not very successful in explaining variances in Federal-aid revenues, accounting for only 18.7% and 13.5% of the variance. Neither of these values are significant to the 0.05 level, and attempting to explain the coefficients could therefore be misleading. An explanation of this relatively poor performance may be found in the nature of the Federal grants. A large portion of these funds are directed towards new construction and urban renewal. The new construction is found mainly in growing communities, and urban renewal is found mainly in the older, dense communities. Since growth and density have a strong negative correlation, a problem arises. The highest funding levels are apt to occur at the most-growing and least-growing communities, with lower funding levels in-between. This U-shaped distribution is particularly ill-suited for regression analysis, which attempts to construct a straight line through the distribution.

V. SUMMARY

A. General Conclusions and Applicability to Planning.

As can be seen from the previous pages, the independent variables seem to work in both linear and logarithmic combinations in explaining the variances in the different categories. The R^2 value, which indicates the percentage of variance explained, is generally about the same, regardless of which regression form is used. In most cases, the logarithmic form performed slightly better. Some variables have been used in a linear sense; e.g., spillovers have been used as an "addition" to density, and a joint function between the two is not as meaningful. The strengths and weaknesses of either approach tend to balance out the other.

An attempt was made to combine the two approaches into one. In this attempt, the dependent category was expressed as a linear combination of the independent variables, with each variable raised to the power obtained in the logarithmic regressions. This was not too successful. The R^2 values obtained in this way were lower than those obtained in the original regressions, although the differences were small. However, the significance of density and its contribution to the R^2 value was slightly higher than before. Since density had the highest standard deviation of any of the variables, the very low exponents assigned to it (generally under 0.25) served to compress its range into a form which more closely fits the revenue and expenditure variations.

Understanding the significance and shortcomings of these results, it is now possible to examine them in light of planning decisions. The first thing that can be observed is the dominating effect of income. Income had a positive effect on all expenditures and revenues except for state-aid revenues. (Those categories which were not significantly explained are omitted from consideration here.) By examining the exponents determined in the logarithmic regressions, it can be seen that income exponents for expenditures are generally lower than for revenues. This would mean that as incomes rise, so will expenditures and revenues, but revenues and tax base will rise at a faster rate. As a result, the property tax would probably be lower. This supports the numerous observations that wealthier communities are able to spend more per capita and still maintain lower tax rates.

Another point worthy of note is the low exponents which were computed for density in the logarithmic regressions. This seems to indicate that the effect of density reaches a "saturation point" beyond which further increases have little effect. A 10% increase in population would have a greater fiscal impact in a sparsely populated town than in an already dense one.

To describe the applicability of these results to planning decisions, an example may best serve to explain. Let us consider the case of a small town that is trying to increase its tax base by attracting new industry. In the early stages, this would bring in more workers and non-residential structures, and effectively increase the level of spillovers. These spillovers will force up costs for police, fire, and public works. This will be offset by a large increase in the tax base. Very likely, the tax base will increase proportionately more than expenditures, thus exerting downward pressure on the property tax rate.

But this is only the short-term effect. In succeeding years, this new activity is likely to attract new housing developments into the town. The increase in residential population will mean an increase in density and growth rate. A large portion of this new population will be young, mobile families with school children, thus raising the school percentage. The additional density will raise police and fire expenses. The growth and school percentage increases will raise several expenses, particularly those for schools, public works, and debt. Revenues will also rise during this period, but it does not seem to be enough to cover these additional expenses without raising the property tax rate. If we are to believe this sequence of events, then we would see a short-term decrease in the tax rate, which would climb upward in succeeding years. Our data and results lack the precision necessary to determine whether or not this future tax rate will be either higher or lower than the present one (not taking into account the effects of inflation).

The change in income levels has not yet been considered in this example. The changes will be due primarily to the differences in income of the new population, and the additional employment opportunities extended to the old. This in turn will depend on the types of commercial and industrial activity which have been developed. It has been pointed out that higher income levels tend to exert upward pressure on expenditures but downward

pressure on property tax rates. Thus, the town that can attract high value/acre industry without driving away the high income residents will likely fare better than towns which do the opposite.

Several points of caution are in order in this type of predicting. The first is to remember that impacts on municipal finances are not the only considerations. Impacts on the people and the environment must also be considered. Secondly, since many of the coefficients are not statistically significant, there is no guarantee that the effects described here will necessarily apply in all cases. Thirdly, it is somewhat dangerous to use data based on a single time period to predict changes over time, since many other factors can change. Still, it is certainly better to have some information than none at all.

B. Critique of Methods and Findings.

The methods and computer techniques used in this study can be extremely useful in increasing our understanding of municipal finances. However, it would be foolish to accept these results as absolute truths. In order to better understand what has been found, it may be useful to discuss what was not found. By examining the weaknesses involved, the strengths can be seen in a truer perspective.

1. BEING ABLE TO EXPLAIN VARIANCES DOES NOT INDICATE CAUSALITY. The variables were effective in explaining much of the variation in the categories, often as much as 50%, and in some cases up to 70% of the total variance. However, this does not mean that the variables were the cause of these differences. We have merely shown relationships, not causality.

2. OTHER FACTORS ENTER INTO THE PROCESSES OF MUNICIPAL FINANCES WHICH INCREASE THE EXPENDITURE AND REVENUE VARIATIONS. Distribution of political power, the age of the town or city, the nature of the decision-making process, and numerous other factors have influences upon the amounts spent and collected. The predictor variables used here cannot possibly take everything into account.

3. THE UNEXPLAINED VARIANCES RESTRICT THE USE OF THE REGRESSION RESULTS IN A PREDICTIVE WAY. Although being able to explain 60% of the variance may be statistically highly significant, there is still 40% which is unexplained. If these results are to be used for

predictive purposes, then this possibility of fluctuations must be taken into account.

4. THE PROCESSES OF A TOWN OR CITY ARE VARIABLE OVER TIME. This study was done on data at a single point in time, the year 1970. Since that time, there have been changes in political processes, priorities, state-local-federal interactions, and funding methods. As these change, so may the explanatory power of the variables. This was experienced by Glenn Fisher when he tried to repeat Solomon Fabricant's 1942 study using 1957 data.¹⁹

5. SOME REVENUE AND EXPENDITURE CATEGORIES ARE HIGHLY VARIABLE FROM YEAR TO YEAR, AND SHOULD BE CONSIDERED ON A LONGER TIME INTERVAL. Many programs, such as road-building projects or certain Federal grants-in-aid are "one-time only" programs. As such, they are apt to show large yearly fluctuations which would be minimized if long-term averages were used instead.

6. SOME REVENUE AND EXPENDITURE CATEGORIES ARE TOO BROAD TO REACT IN A UNIFORM FASHION, AND SHOULD BE STUDIED ON A FINER-GRAINED LEVEL. In order to limit the scope of this study, it was necessary to aggregate many items into a small number of categories. It is probable that the many items that make up Federal-aid revenue or public works expenditures react in slightly different ways to each of the variables. Such breakdowns of categories are not always possible. For example, it would have been useful to study police expenditures as they were allocated among crime prevention, maintaining order, traffic control, and other functions, but data was not available in this finely-detailed form.

7. DIFFERENCES IN ACCOUNTING METHODS AND BUDGET PRACTICES CAN FURTHER DISTORT ANALYSIS. Although efforts were made to obtain data in a standardized format, these efforts were not completely successful. In some towns, ambulance service came under the control of the Police Department, whereas in others it was administered by the Fire or Health Departments. Maintenance for parks and school playgrounds was sometimes the responsibility of the Public Works Department. Further distortion occurred when some capital projects were funded by long-term borrowing, and others on a pay-as-you-go basis.

8. DATA FOR THE INDEPENDENT VARIABLES IS SUBJECT TO DISTORTED INTERPRETATION. In addition to the problems of collinearity,

a major flaw in defining the independent variables has been the interaction between density and spillovers. Density, as it is used here, refers to the people/sq. mi. over the entire municipality. A better value might have been people/residential sq. mi. This data could have been found for 1963,²⁰ but this was outdated by 1970. Spillovers imply some form of commercial and industrial density. The interactions between these two measures must be carefully watched.

FOOTNOTES

1. "1970 Schedule A Reports of Financial Transactions," Bureau of Accounts, Massachusetts Dept. of Corporations and Taxation.
2. Ibid.
3. Solomon Fabricant, The Trend of Governmental Activity in the United States since 1900 (New York, 1952).
4. Glenn W. Fisher, "Determinants of State and Local Government Expenditures: A Preliminary Analysis," National Tax Journal, Dec. 1961.
5. Seymour Sacks and Robert Harris, "The Determinants of State and Local Government Expenditures and Intergovernmental Flows of Funds," National Tax Journal, March 1964.
6. Mordecai S. Feinberg, "Implications of Core-City Decline for the Fiscal Structure of the Core-City," National Tax Journal, Sept. 1964.
7. Amos H. Hawley, "Metropolitan Population and Municipal Government Expenditures in Core-Cities," Journal of Social Issues, Nos. 1 and 2, 1951.
8. Feinberg, op. cit., p. 225.
9. "School Aid to Massachusetts Cities and Towns: Chapter 70 Amended, 1970," Dept. of Education, Commonwealth of Massachusetts.
10. David Stuart Stern, The Effects of Alternative State Aid Formulas on the Distribution of Public School Expenditures in Massachusetts (MIT PhD Thesis, Jan. 1972), p. 80.
11. Feinberg, op. cit., p. 228.
12. Werner Z. Hirsch, The Economics of State and Local Governments (New York, 1970), p. 173.
13. Source: Massachusetts Federation of Taxpayers.
14. Dick Netzer, Economics of the Property Tax (Washington, 1966), p. 63.
15. "Comparison of Cherry Sheet Expenditures: 1970 and 1971," Massachusetts Department of Corporations and Taxation.
16. Edward J. Kane, Economic Statistics and Econometrics (New York, 1968), pp. 277-278.
17. Netzer, op. cit., p. 116.

18. Ernest Kurnow, "Determinants of State and Local Expenditures Reexamined," National Tax Journal, Sept. 1963, p. 253.

19. Fisher, op. cit., p. 253.

20. Source: MIT Metropolitan Development Project.

APPENDIX A: DATA BASE DESCRIPTION

1. Definitions and Data Sources.

This Appendix is intended to more fully explain the meaning, derivation, and source of the data used in this study. Unless otherwise stated, all data relates to 1970 values. All per capita expenditures and revenues have been computed by dividing the category total by the municipality's population as given in the 1970 census. Any references to "Schedule A Reports" will refer specifically to the "1970 Schedule A Report of Financial Transactions," filed each year by the cities and towns with the Bureau of Accounts of the Massachusetts Department of Corporations and Taxation.

1960 POPULATION: Residential population during the 1960 Census. Source: 1970 Census of Population, Number of Inhabitants, Massachusetts, Table 13.

1970 POPULATION: Residential population during the 1970 Census. Source: 1970 Census of Population, Number of Inhabitants, Massachusetts, Table 13.

AREA: Area of the town or city, measured in square miles. Source: MIT Metropolitan Development Project.

AUTO EXCISE REVENUE: Total of all motor vehicle excise tax revenue. Source: "Schedule A Reports," p. 4.

DEBT and INTEREST EXPENDITURES: This includes repayment of principal on long-term, non-temporary loans and bonds, and interest on all long- and short-term loans and bonds. Source: "Schedule A Reports," p. 18.

DENSITY: Number of inhabitants per total square mile, computed as $1970 \text{ POPULATION} / \text{AREA}$.

EMPLOYMENT: The number of people employed within the boundaries of a town or city, that are covered by unemployment protection. Source: Massachusetts Division of Employment Security, "Covered Employment."

FEDERAL-AID REVENUE: Total of all grants and gifts from the Federal government. Source: "Schedule A Reports," p. 2.

FIRE EXPENDITURES: Total of Fire Department expenses and outlays. Source: "Schedule A Reports," p. 14.

GROWTH: The rate of population growth/decade between 1960 and 1970, computed as $1970 \text{ POPULATION} / 1960 \text{ POPULATION}$. In the case

where there has been an absolute decline in population (i.e., GROWTH less than 1.0), GROWTH is set equal to 1.0.

INCOME: Per capita income. Source: 1970 Census of Population, General Social and Economic Characteristics, Massachusetts, Tables 89, 107, 118.

NET PUBLIC WORKS EXPENDITURES: This category makes allowances for the differences offered in user-financed utilities. It is computed as PUBLIC WORKS EXPENDITURES - PUBLIC WORKS REVENUE, and reflects the non-user-financed public works expenses and outlays.

PARKS and RECREATION EXPENDITURES: Total of all expenses relating to maintenance of parks and recreational programs. Source: "Schedule A Reports," p. 16.

POLICE EXPENDITURES: Total of Police Department expenses and outlays. Source: "Schedule A Reports," p. 14.

POVERTY: The percentage of all families (exclusive of prison inmates, armed forces in barracks, college students in dormitories, and unrelated individuals under 14) with income less than the established poverty level. Source: 1970 Census of Population, General Social and Economic Characteristics, Massachusetts, Tables 90, 107, 118.

PROPERTY TAX REVENUE: The total of all revenues collected from taxes on property. This revenue does not include payments in lieu of taxes. Source: "Schedule A Reports," p. 1.

PUBLIC WORKS EXPENDITURES: This value is the total of four broad categories: (1) Health, Sanitation, and Hospital (consisting mainly of sewers and refuse collection), (2) Highway Expenses and Outlays, (3) Public Service Enterprises (gas, water, electricity, etc.), and (4) State and County Assessments (primarily MBTA and MDC functions). Source: "Schedule A Reports," pp. 14, 15, 17, 18.

PUBLIC WORKS REVENUE: Total revenue from Public Service Enterprises, primarily electricity, gas, and water. Source: "Schedule A Reports," p. 8.

SCHOOL EXPENDITURES: Total of all school expenses and outlays. This does not include non-school libraries. Source: "Schedule A Reports," p. 16.

SCHOOL POPULATION: The number of School Attending Children (SAC), exclusive of private and parochial school students. Source: Dept. of Education, Commonwealth of Massachusetts, "School Aid to Massachusetts Cities and Towns: Chapter 70 Amended, 1970."

SPILOVERS: This variable reflects the ratio of "daytime population" to resident population, and is used as an indicator of commercial and industrial activity. In the Boston SMSA, the ratio of all employed people to all people is 0.347 (34.7% of the population is covered by unemployment insurance). Thus, if this activity were equally distributed according to population, the expected number of people working within a town's boundary would be equal to 1970 POPULATION * 0.347. The difference between this value and the actual number employed within the town's boundaries can be considered the EMPLOYMENT SURPLUS. The DAYTIME POPULATION is equal to the residential population plus or minus the EMPLOYMENT SURPLUS. SPILLOVER is the ratio of DAYTIME POPULATION divided by the RESIDENTIAL POPULATION. For a town where there exists no employment surplus, this value is 1.0. Values higher than this indicate relatively higher levels of commercial and industrial activity, and lower values indicate relative inactivity.

STATE-AID REVENUE: Total of all grants, gifts, and reimbursements from the Commonwealth. Source: Massachusetts Department of Corporations and Taxation, Cherry Sheet Summary.

TAX BASE: The total of all taxable real property in the city or town. Source: Department of Education, Commonwealth of Massachusetts, "School Aid to Massachusetts Cities and Towns: Chapter 70 Amended, 1970."

TAX RATE: The 1970 effective property tax rate, equal to the actual property tax rate multiplied by the assessment ratio. Source: Massachusetts Federation of Taxpayers.

TOTAL EXPENDITURES: Total expenditures have been adjusted to disallow for temporary, pass-through funds. This is computed as

TOTAL PAYMENTS & CASH ON HAND

- BALANCE AT END OF YEAR
- AGENCY, TRUST, AND DEVELOPMENT
- ANTICIPATION OF REVENUE LOANS

Source: "Schedule A Reports."

TOTAL REVENUE: Total revenues have been adjusted to disallow temporary, pass-through funds. This is computed as

TOTAL RECEIPTS & CASH ON HAND

- BALANCE AT BEGINNING OF YEAR
- AGENCY, TRUST AND DEVELOPMENT
- ANTICIPATION OF REVENUE LOANS

Source: "Schedule A Reports."

2. Cities and Towns in Sample.

The 45 cities and towns in the Boston SMSA which were used in this study are:

ARLINGTON
BEDFORD
BELMONT
BEVERLY
BRAINTREE
BROOKLINE
CHELSEA
CONCORD
DOVER
EVERETT
FRAMINGHAM
HINGHAM
HOLBROOK
LEXINGTON
LINCOLN
LYNN
LYNNFIELD
MALDEN
MARBLEHEAD
MARSHFIELD
MEDFIELD
MEDFORD
MILLIS
NATICK
NEEDHAM
NEWTON
NORFOLK
NORWOOD
PEMBROKE
QUINCY
READING
ROCKLAND
SALEM
SAUGUS
SHARON
STONEHAM
SWAMPSCOTT
WAKEFIELD
WALPOLE
WALTHAM
WATERTOWN
WAYLAND
WELLESLEY
WENHAM
WEYMOUTH

APPENDIX B: SUMMARY OF COMPUTER OUTPUT

The following pages summarize the results of the correlations and regressions computed during this study. Table 1 lists the correlations between pairs of independent variables, and was used in locating cases of collinearity. Tables 2, 3, 4, and 5 contain the correlation coefficients that were computed between the independent variables and the expenditure and revenue categories, for each pair of values as well as for the logarithms of each pair. Tables 6, 7, 8, and 9 summarize the regression computations, using the modified framework described in Section IV-B. These were also computed linearly and logarithmically for the expenditure and revenue categories.

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER	POVERTY
DENSITY	—	-0.199 (0.095)	-0.535 <u>(0.001)</u>	-0.675 <u>(0.001)</u>	0.143 (0.175)	0.706 <u>(0.001)</u>
INCOME	-0.199 (0.095)	—	0.008 (0.478)	0.013 (0.466)	-0.252 <u>(0.048)</u>	-0.552 <u>(0.001)</u>
GROWTH	-0.535 <u>(0.001)</u>	0.008 (0.478)	—	0.184 (0.113)	-0.356 <u>(0.008)</u>	-0.290 <u>(0.026)</u>
SCHOOL%	-0.675 <u>(0.001)</u>	0.013 (0.466)	0.184 (0.113)	—	0.035 (0.410)	-0.418 <u>(0.002)</u>
SPILLOVER	0.143 (0.175)	-0.252 <u>(0.048)</u>	-0.356 <u>(0.008)</u>	0.035 (0.410)	—	0.195 (0.100)
POVERTY	0.706 <u>(0.001)</u>	-0.552 <u>(0.001)</u>	-0.290 <u>(0.026)</u>	-0.418 <u>(0.002)</u>	0.195 (0.100)	—

Value in parentheses is level of significance.
Underlined values are significant to the 0.05 level.

TABLE 1: CORRELATIONS AMONG INDEPENDENT VARIABLES.

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER	POVERTY
SCHOOL EXP.	<u>-0.620</u>	<u>0.441</u>	<u>0.342</u>	<u>0.474</u>	-0.112	<u>-0.637</u>
POLICE EXP.	<u>0.617</u>	0.113	<u>-0.393</u>	<u>-0.416</u>	0.202	<u>0.452</u>
FIRE EXP.	<u>0.702</u>	-0.003	<u>-0.577</u>	<u>-0.437</u>	<u>0.402</u>	<u>0.508</u>
PUB. WORKS EXP.	0.042	0.157	-0.225	0.020	0.080	<u>-0.259</u>
PARKS EXP.	0.055	<u>0.441</u>	-0.103	<u>-0.364</u>	0.021	-0.143
DEBT EXP.	<u>-0.532</u>	0.149	<u>0.356</u>	<u>0.534</u>	<u>0.266</u>	<u>-0.425</u>

Underlined values are significant to the 0.05 level.

TABLE 2: CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND EXPENDITURE CATEGORIES—LINEAR RELATIONSHIPS.

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER	POVERTY
PROP. TAX REV.	0.000	<u>0.736</u>	-0.151	0.101	0.115	<u>-0.257</u>
AUTO EXCISE REV.	<u>-0.469</u>	<u>0.697</u>	0.183	<u>0.431</u>	-0.089	<u>-0.611</u>
PUB. WORKS REV.	-0.080	0.087	-0.147	0.138	0.063	<u>-0.269</u>
STATE-AID REV.	<u>-0.475</u>	<u>-0.271</u>	<u>0.383</u>	<u>0.608</u>	0.014	-0.139
FED.-AID REV.	-0.084	0.186	0.055	-0.238	-0.107	-0.147

Underlined values are significant to the 0.05 level.

TABLE 3: CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND
REVENUE CATEGORIES—LINEAR RELATIONSHIPS.

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER	POVERTY
SCHOOL EXP.	<u>-0.585</u>	<u>0.484</u>	<u>0.409</u>	<u>0.485</u>	-0.151	<u>-0.686</u>
POLICE EXP.	<u>0.596</u>	0.141	<u>-0.491</u>	<u>-0.394</u>	<u>0.266</u>	<u>0.438</u>
FIRE EXP.	<u>0.745</u>	0.002	<u>-0.589</u>	<u>-0.307</u>	<u>0.482</u>	<u>0.434</u>
PUB. WORKS EXP.	<u>0.321</u>	0.233	<u>-0.324</u>	-0.081	0.216	-0.235
PARKS EXP.	<u>0.243</u>	<u>0.418</u>	-0.220	<u>-0.334</u>	0.234	-0.128
DEBT EXP.	<u>-0.428</u>	0.222	<u>0.358</u>	<u>0.546</u>	0.197	<u>-0.471</u>

Underlined values are significant to the 0.05 level.

TABLE 4: CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND
EXPENDITURE CATEGORIES—LOGARITHMIC RELATIONSHIPS.

	DENSITY	INCOME	SCHOOL%	SPILLOVERS	GROWTH	POVERTY
PROP. TAX REV.	0.107	<u>0.729</u>	-0.183	0.048	0.165	<u>-0.257</u>
AUTO EXCISE REV.	<u>-0.368</u>	<u>0.707</u>	0.239	<u>0.416</u>	-0.087	<u>-0.625</u>
PUB. WORKS REV.	<u>0.244</u>	0.036	<u>-0.244</u>	-0.010	<u>0.244</u>	-0.109
STATE-AID REV.	<u>-0.584</u>	<u>-0.287</u>	<u>0.438</u>	<u>0.611</u>	0.015	-0.154
FED.-AID REV.	0.013	0.030	0.032	<u>-0.256</u>	0.109	-0.056

Underlined values are significant to the 0.05 level.

TABLE 5: CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND
REVENUE CATEGORIES—LOGARITHMIC RELATIONSHIPS.

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER		
SCHOOL EXP.	-0.0061 (2.80)	0.0244* (10.28)	35.66 (1.01)	367.11* (1.92)	29.06 (0.30)	k = -4.12 F = <u>8.42</u>	RSQ = 0.519 RSQ* = 0.414
POLICE EXP.	0.0010* (11.71)	0.0014* (5.45)	0.63 (0.05)	4.10 (0.04)	6.07* (2.11)	k = 5.79 F = <u>6.93</u>	RSQ = 0.470 RSQ* = 0.469
FIRE EXP.	0.0019* (29.28)	0.0021* (3.96)	-5.05 (1.15)	—	22.11* (8.93)	k = -6.49 F = <u>17.96</u>	RSQ = 0.642 RSQ* = 0.632
PUB. WORKS EXP.	-0.0007* (0.01)	0.0129* (0.94)	-70.76* (1.31)	80.13 (0.03)	22.10* (0.06)	k = 112.85 F = 0.69	RSQ = 0.081 RSQ* = 0.080
NET PUB. WORKS EXP.	0.0013* (0.20)	0.0097* (2.59)	-26.51* (0.90)	-39.69 (0.04)	17.85* (0.18)	k = 49.37 F = 1.31	RSQ = 0.144 RSQ* = 0.143
PARKS EXP.	-0.0007* (2.62)	0.0027* (9.42)	-3.22 (0.63)	-98.63* (10.58)	6.54* (1.14)	k = 22.10 F = <u>5.10</u>	RSQ = 0.395 RSQ* = 0.385
DEBT EXP.	-0.0003 (0.10)	0.0041* (4.46)	26.47* (8.51)	174.41* (6.63)	53.83 (15.49)	k = -101.80 F = <u>9.70</u>	RSQ = 0.554 RSQ* = 0.373

Top value of each pair is regression coefficient.
 Parenthized values are F-statistics for each variable.
 F is F-statistic for equation containing all variables.
 Underlined F-statistics are significant to the 0.05 level.
 k is the constant term in the equation.
 RSQ is the R^2 value for the equation containing all variables.
 RSQ* is the R^2 value for the equation containing only starred terms.
 Omitted values were too insignificant for inclusion in stepwise regression.

TABLE 6: REGRESSION SUMMARY FOR EXPENDITURE
CATEGORIES—LINEAR EQUATIONS.

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER		
PROP. TAX REV.	0.0079* (8.37)	0.0542* (89.87)	27.34 (7.82)	555.86 (7.82)	128.11* (10.20)	k = -227.54 F = 19.13	RSQ = 0.710 RSQ* = 0.652
AUTO EXCISE REV.	—	0.0038* (60.96)	2.94 (2.23)	55.33* (18.10)	4.40 (1.47)	k = -10.30 F = 21.63	RSQ = 0.689 RSQ* = 0.668
PUB. WORKS REV.	-0.0020* (0.25)	0.0031* (0.14)	-45.24* (1.51)	120.54 (0.17)	—*	k = 54.98 F = 0.67	RSQ = 0.063 RSQ* = 0.059
STATE-AID REV.	—	-0.0049* (5.83)	20.04 (6.01)	262.16* (24.81)	3.83 (0.07)	k = -15.23 F = 11.05	RSQ = 0.525 RSQ* = 0.447
FED.-AID REV.	-0.0045* (4.05)	0.0025* (0.28)	-14.53 (0.44)	-435.61* (7.04)	-8.39 (0.06)	k = 157.16 F = 1.79	RSQ = 0.187 RSQ* = 0.173

Top value of each pair is regression coefficient.
 Parenthized values are F-statistics for each variable.
 F is F-statistic for equation containing all variables.
 Underlined F-statistics are significant to the 0.05 level.
 k is the constant term in the equation.
 RSQ is the R^2 value for the equation containing all variables.
 RSQ* is the R^2 value for the equation containing only starred terms.
 Omitted values were too insignificant for inclusion in stepwise regression.

TABLE 7: REGRESSION SUMMARY FOR REVENUE
 CATEGORIES—LINEAR EQUATIONS.

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER		
SCHOOL EXP.	-0.054 (1.02)	0.545* (16.93)	0.295 (1.24)	0.528* (5.08)	0.174 (0.68)	k = 0.878 F = 10.18	RSQ = 0.566 RSQ* = 0.471
POLICE EXP.	0.105* (4.82)	0.247* (4.40)	-0.025 (0.01)	-0.131 (0.40)	0.200* (1.14)	k = 0.034 F = 6.09	RSQ = 0.438 RSQ* = 0.432
FIRE EXP.	0.578* (22.40)	0.679* (5.07)	0.589 (1.21)	0.558 (0.86)	1.307* (7.42)	k = -2.721 F = 15.36	RSQ = 0.663 RSQ* = 0.649
PUB. WORKS EXP.	0.218* (2.24)	0.824* (5.27)	0.008* (0.00)	0.504 (0.63)	0.539* (0.89)	k = -1.367 F = 2.38	RSQ = 0.234 RSQ* = 22.1
NET PUB. WORKS EXP.	0.175* (4.17)	0.638* (5.79)	0.038* (0.01)	0.581 (0.23)	0.356* (0.73)	k = -0.996 F = 3.76	RSQ = 0.278 RSQ* = 0.273
PARKS EXP.	0.037* (0.05)	1.579* (15.18)	0.137 (0.03)	-1.430* (3.99)	1.660* (6.63)	k = -5.839 F = 5.49	RSQ = 0.413 RSQ* = 0.413
DEBT EXP.	0.059 (0.39)	0.661* (8.05)	1.264* (7.39)	1.376* (11.16)	1.221 (10.83)	k = -0.241 F = 9.07	RSQ = 0.538 RSQ* = 0.396

Top value of each pair is regression coefficient.
 Parenthized values are F-statistics for each variable.
 F is F-statistic for equation containing all variables.
 Underlined F-statistics are significant to the 0.05 level.
 k is the constant term in the equation.
 RSQ is the R^2 value for the equation containing all variables.
 RSQ* is the R^2 value for the equation containing only starred terms.
 Omitted values were too insignificant for inclusion in stepwise regression.

TABLE 8: REGRESSION SUMMARY FOR EXPENDITURE
 CATEGORIES—LOGARITHMIC EQUATIONS

	DENSITY	INCOME	GROWTH	SCHOOL%	SPILLOVER		
PROP. TAX REV.	0.080* (6.03)	0.748* (87.50)	0.180 (1.27)	0.291 (4.24)	0.365* (8.22)	k = -0.292 F = 18.83	RSQ = 0.707 RSQ* = 0.673
AUTO EXCISE REV.	0.04 (1.52)	0.654* (68.49)	0.339 (4.42)	0.565* (16.35)	0.157 (1.54)	k = -0.749 F = 19.17	RSQ = 0.716 RSQ* = 0.678
PUB. WORKS REV.	0.317* (0.75)	0.272* (0.09)	-0.159* (0.01)	1.082 (0.46)	1.249* (0.76)	k = -0.066 F = 0.89	RSQ = 0.103 RSQ* = 0.092
STATE-AID REV.	-0.117 (4.23)	-0.438* (9.67)	0.143 (0.26)	0.646* (6.74)	0.186 (0.69)	k = 4.111 F = 11.42	RSQ = 0.594 RSQ* = 0.455
FED.-AID REV.	-0.229* (2.40)	0.102* (0.04)	—	-2.12* (5.52)	1.190 (2.06)	k = 0.126 F = 1.56	RSQ = 0.135 RSQ* = 0.096

Top value of each pair is regression coefficient.

Parenthized values are F-statistics for each variable.

F is F-statistic for equation containing all variables.

Underlined F-statistics are significant to the 0.05 level.

k is the constant term in the equation.

RSQ is the R^2 value for the equation containing all variables.

RSQ* is the R^2 value for the equation containing only starred terms.

Omitted values were too insignificant for inclusion in stepwise regression.

TABLE 9: REGRESSION SUMMARY FOR REVENUE
CATEGORIES—LOGARITHMIC EQUATIONS.

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