A SIMULATION MODEL OF TOWN EXPENDITURES

by DAVID LAPIDES

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Signature of Author...
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Certified by..
Thesis Supervisor

Accepted by...
Chairman, Departmental Committee on Theses

ABSTRACT

The work for this thesis involved modeling local government revenue collection and expenditures given certain population characteristics--specifically age structure and gross population density. The technique employed in the model was similar to traditional simulation techniques. Stocks were calculated as linear functions of flows. But the flows were derived through programmed responses to endogenous events. As an example, if the property tax rate rises "too rapidly", public service expenditures are cut by two percent. The method produced reasonable descriptions of town expenditures. The most important result of the model was its depicting the lessening importance of education on a town's budget as the town reaches its maximum population.

ACKNOWLEDGEMENTS

The author is indebted to Mr. Anthony Yezer who suggested many of sectors that were investigated during the development of this model. Mr. Yezer also guided the author through some of the intricasies of modeling urban systems. The computer time necessary for the implementation and validation of the model was provided by the Federal Reserve Bank of Boston.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

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* Model run output consists of two pages; the first is a tabulation of the major endogenous variables and the second is a plot of some of them.

** Regression output consists of two pages per equation; the first contains the estimated coefficients and several relevant statistics and the second contains a tabulation of both the actual and estimated values of the dependent variable for each observation. This tabulation is in the same order as the EXPENDITURES PROFILE found on page 52.

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* The note on page 5 concerning model run output applies here, also.

INTRODUCTION

During the last decade, there have been numerous attempts to model the behavior of urban regions. These models have dealt with specific localities, or not, depending upon the model builders undertaking the project and their respective sponsors. The techniques have included multivariate regression analysis, linear programming and simulation models. All of these techniques have become feasible with the advent of modern high speed computers with their high level programming languages. Quite frequently, these and other methods are combined in the development of theories of regional behavior. For example, regression analysis is well suited for fitting parameter values because it produces measures of statistical relationships between several different real world events. These parameters can then be used in simulation models[1].

The point has been made numerous times that the computer has provided the social scientist with his first "laboratory" with which he could formulate experiments in a controlled environment and test their consequences. "Bad" experiments could be disposed of without wrecking havoc on the real world. These experiments are, however, one step removed from the real world. They differ from the traditional concept of "experiments". Whereas the physicist or the biologist is able to study the real world through physical measurements, the model builder must work with symbolic analogues of that world. This is a more difficult problem. The model builder

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[1] For an introduction to the subject of model building, see Lowry [7] and Kilbridge [6]. Lowry [8], Forrester [4] and Hamilton [5] discuss specific urban models.

NOTE: The numbers enclosed in brackets "[.]" are keyed to specific refences to background material. See page 96.

must make additional specific assumptions about his choice of symbols. Not only is he susceptible to error in making these assumptions, but the results of his experiments are highly biased by them.

Simulation is perhaps more vulnerable to errors in assumptions than other modeling techniques. It needn't be. But in practice, this method is used to generate solutions to problems of sufficient complexity to stymie analytical solution. Errors become difficult to detect. The method consists of dynamically interconnecting a closed system of stocks and flows in such a way that the current value of either is completely determined by the current value of the other plus, perhaps, an external condition. (Stocks, or levels, may be thought of as an accumulation of similar items over time; e.g., single-family homes in a town or gallons of water in a tank. Flows, or rates, describe the change in stocks over time; e.g., demolitions per year, gallons per minute.) The interconnections between the two types of variables must include at least one feedback loop so that after one round (iteration) of calculations, the solution generator is able to start anew using the latest state of the system. The number of iterations is determined by the model builder, as is the time span an iteration represents. The time span used depends on how quickly the system variables react to change. By observing the changes in value of important system variables (which can be either stocks or flows), the model builder is able to test a hypothesis.

No matter which techniques he chooses to employ, the model builder must draw a boundary around his model (the principle of closure). He can not possibly include all variables of interest in his model. For one, the cost of doing so would be prohibitive. More importantly, significant results may be lost in the ensuing clutter. The model builder must decide which variables are important to the problem at hand, and which are not. He can then limit his model to include only those relationships which affect these important variables. Their values will be determined within the model (endogenous variables), while the values of the others will be supplied from outside the model boundaries (exogenous variables). Because simulation models require that the stocks and flows determine each other, the technique requires perfect and complete information about the state of the system be available in the linkages between them.

The modeling technique employed for this analysis can at best be described as quasi-simulation. While stocks are calculated in the manner of traditional simulation models, the flows which determine them vary according to strictly (and exogenously) prescribed responses to endogenous events. This is an attempt to model a community using concepts such as "a large tax increase". Some parts of the model do not react until certain threshold values are reached, and then they may either under-react or over-react. Other parts change independently of the rest of the model. This formulation springs from the author's doubts in the existence of complete closure in the real world. Governments are the creatures of imperfect beings--people--and suffer, like them, from the lack of complete information. They can not, therefore, reach an optimal level of performance. They can only reach some satisfactory level as measured by their citizenry.

The analysis also rests on the bureaucratic nature of large organizations in general and governments in particular. This behavior manifests itself in the real world as follows: The first is the principle of inertia--the organization will steer along the same course until it sees the shoals under its bow; this principle will then hold for any new course the organization takes. The other is the ability of organizations to spend a larger sum each year for the same task.

Given the above, this thesis describes the author's attempt to model the public expenditures of an established medium-sized town. The major endogenous variables which affect these expenditures are all related to the town's population--its size, density or age breakdown. The town is a bedroom community located near a large metropolis and is surrounded by other communities. Its citizens may work or shop in them, but the model does not include these interactions. It is concerned only with the internal behavior of the model community. The study was based on the spending patterns of towns in the Greater Boston area; however, no specific town was chosen for detailed study. For the sake of easy reading, the model community will be called "Arlmont".

BASIC ASSUMPTIONS

The author made several simplifying assumptions about the nature of Arlmont and the world it exists in. Some are more important than others. The first two assumptions limit the scope of the analysis to Arlmont, and the final two exclude certain exogenous phenomena which can greatly affect a town in the real world. With the exception of the seventh (which has been discussed), the others exist only to simplify the model. They could be either relaxed or eliminated in a future version of the model.

1.) All activity of interest occurs within the municipal boundaries of Arlmont.

2.) No public facilities or services are provided for non-residents.

3.) The amount of land in Arlmont is fixed for the duration of the model.

4.) There are only three types of land in Arlmont--residential, commercial and industrial.

5.) Government services are labor intensive. Their quality is measured by dollar inputs.

6.) Community expenditure rates vary with density and other measures of population.

7.) Community expenditure decisions are bureaucratic in nature.

8.) There are costs imposed by exogenous forces.

9.) The population of Arlmont is evenly divided between males and females at each age level.

10.) The birth rate is uniformally declining through time.

11.) Labor force participation is limited to one person per family.

12.) There are no private schools in or near Arlmont.

13.) Public welfare assistance is provided by an outside agency.

14.) There are no major technological breakthroughs during the model period.

15.) No wars, depressions or natural disasters occur during the model period which affect Arlmont.

A more interesting topic concerns assumptions that were not made;

1.) Property is assessed at fair market value; and

2.) The parameters and exogenous variables used in this model are correct.

Few communities in this country assess real property at full market value, even when they are legally required to do so. Different types of property are taxed not only at different effective rates, but by different methods. There is no need for a model builder to knowingly construct his model with non-realistic formulations if realism imposes no great costs. In the present case, the price exacted is nil. The model taxes property as a function of the past or present income of the owner, or as a function of the income it produces. Because the model was stable for a wide range of parameter values, it is impossible to define the "correct" values. The model needs only their general form and approximate value.

TREATMENT OF TIME

In the model, time is measured in years, one year per model iteration. Most events of interest in the model occur on an annual basis, or are reported on one. The terms "year" and "iteration" will be used interchangeably in this thesis. The length of the simulation is fifty years.

THE MODEL

The model is divided into two sectors: the private sector and the government sector. The private sector is characterized by an initial age breakdown and an income distribution which is dependent on age. The private sector generates demands for specific public services. Some of these demands are made by the entire community, others by only segments of it. These demands may be modified by different endogenous community characteristics. The government sector attempts to meet these demands for services. In this attempt, it must tax its residents (both corporate and human). These taxes are borne differentially across the age spectrum. In the following pages, the different subsectors of the model will be analyzed.

DEMOGRAPHIC SECTOR

The population of Arlmont is divided into thirteen distinct age groups[2]. At the start of each iteration, the respective death rates are applied to the population of each age cohort. These death rates are based on an abridged life table for the United States[3]. Although the author recognized that the death rates for individual cohorts will change in the future, he made no attempt to include such changes in the model. A fixed percentage of the survivors in a cohort were aged, each iteration, into the next older cohort. This percentage depended solely on the length in years of a particular cohort. For example, one-sixth

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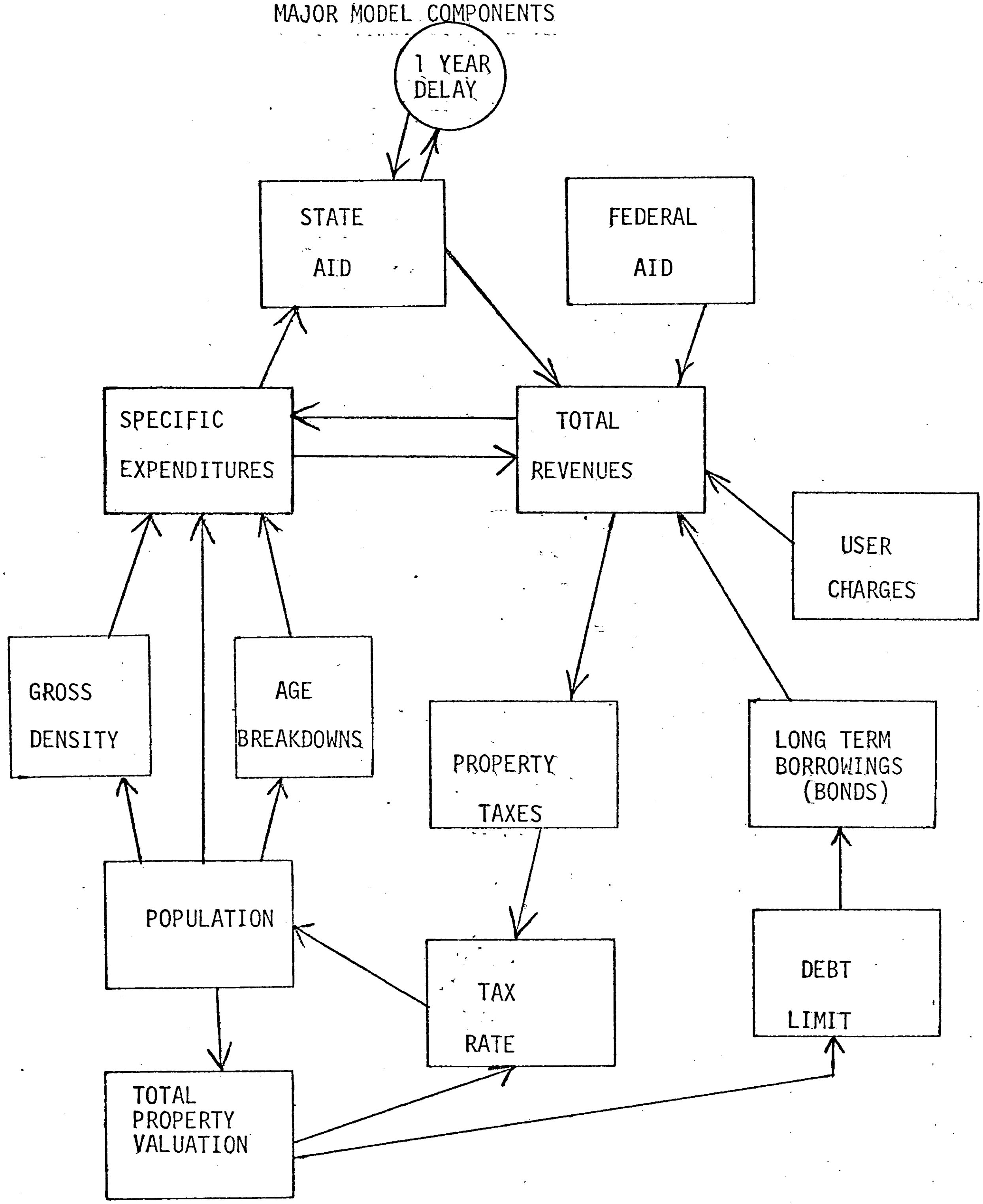
2 The age cohorts are 0-4 years, 5-12, 13-18, 19-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-59, 60-64 and 65 and over.

3 Derived from Bogue [1], Table 16.3, p. 553.

FIGURE 1

MAJOR MODEL COMPONENTS



of the population between 19 and 24 years old were aged into the 25 to 29 years old cohort. This technique may mask the actual aging sequence[4]. The method assumes that each cohort has a uniform age structure. If the micro-breakdown of the population shows either a trough or bump for a particular age span, the model's aging technique will smooth it as it shifts the fixed percentage of the cohort out at the start of an iteration. Early runs of the model employed larger age spans and suffered from this problem. The breakdown used appears to be the best compromise between strict realism and economic use of computer running time. Table page does exhibit the effect.

New inhabitants are created within the model by one of two methods--they are either born to presently existing female inhabitants of Arlmont who are of childbearing age, or they move to the town from other communities. The birth rates are based on age specific birth rates[5]. These are modified by an exogenously supplied family participation rate for each cohort and a uniformally declining birth rate.

Migration coefficients are initially identical for each age cohort. They are modified differentially by events as the model iterates through time. The younger cohorts have a greater propensity to react to changing conditions than the older cohorts. The oldest cohort--people who are 65 or older--is non-responsive to all but the most intense forces. Children under the age of 19 migrate only with their parents. The migration coefficients are increased by rising levels of public services and new

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4 Hamilton [5] discusses the problem. See pages 140-141.
5 Derived from Bogue [1], Table 18.8, p. 684.

employment opportunities. Rapidly increasing taxes and departing industries either stem the tide of immigrants or create emigrants. Migration is also affected by gross population density.

High taxes, by themselves, do not cause emigration from Arlmont because, presumably, those who could not afford to pay them would never settle in the town. If they had been living in the town for some years before the taxes had risen to their present levels, they would have left during the period of tax increases. The model's technique for handling this situation is imperfect. The model calculates the ratio of this year's tax rate to last year's. If the ratio is greater than some threshold value (five percent was used) then both the migration coefficients and the town budget are affected. Thus the model could experience several successive tax increases whose computed ratios were just under the threshold with no other effects on the community. This weakness could have been avoided if a moving average of successive tax rates was employed in the model. At the same time, the model should display differential reactions depending upon the severity of the tax increase.

RESIDENTIAL PROPERTY

There is no explicit housing sector in the model. In its place, there is a multiplier function which affects immigration. This multiplier takes on values between 1.0 and -1.2 as density increases. It performs in the manner of a zoning ordinance. It is neutral towards emigration which is a consequence of other sectors of the model. But it acts as a damper on further immigration as the amount of vacant land in Arlmont is reduced. And like other factors which affect migration in the model, it affects the young more than it does the old.

Residential property values in Arlmont are a function of the past or present income of the residents. Property taxes on rental units are completely passed on to the tenants. For most of the adult population, property valuation is slightly greater than twice a family's current annual income[6]. For the two eldest age groups, this housing-value-to-income (HVI) ratio is allowed to rise. These two age groups contain people with few major financial obligations, but who are about to leave the labor force, if they have not already done so. Thus the current income for members of the two groups is declining. If the family units continue living in their old homes, there is no reason why they should experience a drop in value along with their residents' income. Nor is there any reason why newly acquired housing should reflect the same HVI ratio of the bulk of the population. (This is not to say that the HVI ratio for these groups will be higher than for other age groups, only that they will not be the same.) The HVI ratio for the youngest adult age group is lower than the norm.

COMMERCIAL AND INDUSTRIAL PROPERTY

Every town would prefer to have an industrial or commercial complex within its corporate limits than just outside of it. Either complex could provide jobs to residents with the same ease. But given the nature of the American federal system, the town would be unable to levy taxes against the complex located just over the town line. Arlmont is primarily a bedroom community. The combined tax load carried by commercial and

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6 In Appendix E of Netzer [10], there is a discussion and analysis of housing value to income, though not to age.

industrial properties is approximately 25% for the length of the basic model run. The analysis makes no assumptions concerning the nature of either type of enterprise. It is sufficient that the two exist.

For tax purposes, these two sectors are treated differently. Commercial property is assumed to be rental property. Its value is calculated by capitalizing the annual rents. Because the model does not distinguish between specific pieces of property, the average rental for all commercial property rises by one percent each year. This differs from the real world where rents for specific properties may remain constant for several years. This method acts like a time average over all commercial property. The amount of tax revenue to raised from industrial property is calculated as a function of residential valuation for that iteration of the model. The coeficient of the function may change if industrial usage of land is in a state of flux. (This change is accomplished exogenously.)

LOCAL GOVERNMENT EXPENDITURES

Three basic assumptions were made in the INTRODUCTION about the public services provided by the local government of Arlmont. The first was that public services are labor intensive. The nature of the tasks are such that productivity for given dollar inputs is not likely to rise[7]. The second was that public service expenditures are correlated with specific endogenous variables, especially density[8]. Superimposed over these two assumptions is one of bureaucratic expenditure functions--"Let's spend the same amount as last year, plus five percent.".

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7 Bradford, et.al. [2] discuss measures of productivity for public services.

8 Break [3] p. 172. Other important variables were median income and per capita intergovernmental transfer payments. Correlations were positive for all catagories investigated except highways. For corroboration, see APPENDIX A of this thesis.

Because the purpose of this analysis was to model an existing community rather than either a new one or a rapidly expanding one, it was a simple matter to initialize the various expenditure rates. One needed only to define some expenditure level per some unit of interest for the particular public service under examination. The unit of interest usually depends on the prime benefactor of the expenditure. For most expenditures, this rate will be a function of total population, but it needn't be; e.g., "per pupil" and "per street mile" are quite reasonable measures of school and street maintainence expenditures respectively. These initial rates are allowed to rise whenever the budget process produces a surplus.

Most of the expenditures studied were found to vary with the density of the community. Although there are economies of scale in servicing a dense population, these do not seem to completely outweigh the additional services which are required by dense populations. As an example, fire departments can serve a larger population within a given distance from a firehouse as density increases. But the cost of equipment to reach fires in multistorey buildings is more expensive. Now add the consideration that, because fires are potentially more dangerous in dense environments, a community may want more firehouses per capita.

Needless to say, the most important determinant of local expenditures is local wealth. State and federal grant-in-aid programs may have the intention of "equalizing" the tax burdens of different communities, but for various reasons rarely do. State programs usually guarantee some minimum non-negative amount in aid for each community in the state, thus partly negating any equalizing features in the aid formulas. Any program which requires matching grants benefits the wealthier communities as they are better able to take advantage of such programs. The most striking feature of the tax structure is that affluent communities are able to support superior services with only modest tax rates. Poorer communities must exact much higher tax rates on their property owners in order to provide a lower level of services. (Because of importance of labor costs in determining a given level of services, this level is considered herein to be equivalent to the dollar inputs.) In the pages that follow, the individual expenditure catagories will be examined.

EDUCATION

In the case of education, density deed not appear to be one of the major determinants of the expenditure level[9]. From the analysis described in APPENDIX A, it appears that the youthfulness of the adult population might be an important factor influencing the school budget. Based on this, the model contains a multiplier function whose value depends on the percentage of Arlmont's population which is between the ages of 25 and 45. This age group is likely to have the most interest in a large school budget.

In addition to this multiplier function, the model assumes that all children between the ages 5 and 18 attend the public school system with negligible truancy. In many communities in Massachusetts, this assumption is not valid because the Catholic Church runs an extensive low-tuition parochial school system[10]. This has the dual effects pf lowering the incentive of a town's population to support the public school system and it lowers its average daily attendance. The "bread and butter" state

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9 Weiss [11] discusses in much detail school financing in New England.

10 In 1969, there were 1,070,000 public school students and 290,000 non-public school students in Massachusetts. League of Women Voters [13], Table I, Appendix I.

school aid program uses this as a measure of school system size because it more accurately reflects the school system's load on the local taxpayers. The model essentially ignores this measure by defining the average daily attendance to be equal to the number of school age children in Arlmont. An interesting problem, which was not investigated in the course of this analysis, would to have modeled the effects on Arlmont of a parochial school's closing.

OTHER PUBLIC SERVICE EXPENDITURES

The other catagories of government expenditures are not well developed in the model. Each of their respective functions contains a multiplier which depends on an endogenous variable in the model. Recreation is allowed to vary with the percentage of young adults in Arlmont, as was education. Highway expenditures decline as density increases, but the other expenditure catagories all increase with density. The multipliers are approximations of real world phenomena. APPENDIX A contains the results of some regression equations which support the shapes of these multipliers. The multipliers themselves are depicted in APPENDIX B. As will be shown below, the model is insensitive to the exact form the multipliers take.

NON-SERVICE EXPENDITURES

There are two final catagories of local government expenditures in the model--debt service and mandated expenses. Debt service will be discussed along with the other aspects of government debt financing. Mandated expenditures are those expenditures local governments must make because they exist. The main components of this catagory are employee withholding taxes, insurance and pensions. The size of the expenditures depends upon community size and wealth. This relationship is intuitive because larger communities employ more people and have more buildings and vehicles, while wealthier ones can pay larger salaries to current employees and larger pensions to retired ones. All of these increase the size of the catagory. Once a level of expenditures has been reached, there is little a local government can do to lower it, other than firing most of its employees. Even then, it must continue paying pensions and insurance premiums. Recognizing this, the model permits Arlmont to make only fractional cuts in mandated expenditures when population size might indicate lower expenditures.

STATE AND FEDERAL GRANTS-IN-AID

The state grant-in-aid formula used in the model generates specific grants in two of the three areas where states are most active: education and highways[11]. (The third area is public welfare. But in this analysis, the state handles all welfare expenditures directly.) These formulas are much less complicated than the ones they are based on[12]. It is possible for a community to raise its aid percentage for educational grants, and therefore its actual grant, by maintaining relatively low assessment-to-value ratios. The model and the real world place constraint on the aid formula which prevents communitys' doing this by having a maximum aid percentage. The minimum aid percentage guarantees that each community

11 Maxwell [9] pp 73-79.

12 The formulas are derived from the League of Women Voters [13] and the First National Bank of Boston [14].

TABLE 1

ELEMENTS OF THE STATE AID FORMULA

EDUCATIONAL SECTOR

1.) $\text{AID \%} = 1.00 - 0.65 \times \frac{\text{LOCAL VALUATION / PUPIL}}{\text{STATE AVG. VAL. / PUPIL}}$

2.) If AID %   0.15, then AID % = 0.15
If AID %   0.75, then AID % = 0.75

3.) $AID^e_t = (\text{AID \%}) \times ((0.9 \times EXP^e_t) - AID^e_{t-1})$

AID % is the "aid percentage"

AID^e_t is the amount of aid for education for iteration t

EXP^e_t is the local estimated expenditure for education

HIGHWAY SECTOR

1.) $AID^h_t = (0.25) \times ((0.4 \times EXP^h_t) - AID^h_{t-1})$

AID^h_t is the amount of aid for streets and highways

EXP^h_t is the local estimated expenditure for streets and highways

FOUNDATION AID

1.) $AID^f_t = RSTA \times TPOP_t$

AID^f_t is a flat foundation grant for each community in the state

$TPOP_t$ is the community's current population

RSTA is the per capita rate for this grant

TOTAL OF STATE GRANTS-IN-AID

1.) $TOTAL_t = AID^e_t + AID^h_t + AID^f_t$

in the state will receive at least some non-negative amount in aid. This constraint is also drawn from the real world. (The parts of the state grant-in-aid formula are given in Table

One part of the aid formula used in Massachusetts that was not incorporated in the model would affect the final part of the aid (for education) formula. The model applies the aid percentage to a portion of the estimated school expenditures for that iteration. This portion is called "reimbursable expenditures". It is calculated by first subtracting from the school budget those items that are covered by other grant-in-aid programs, or are not available for any state aid, and then subtracting from this, the previous year's state grant. The remainder is used to calculate this year's grant. The model makes no assumptions about what specific parts of the school budget will be disallowed. Rather, it assumes ten percent of the total will be. Nothing prevents a community, in the model, from continually spending larger amounts on education and having the state pick up a percentage of the tab. In one of the model runs, this in fact is what occurs. The Massachusetts formula attempts to prevent this by setting a minimum and maximum limit on the amount of state aid per pupil a school system may receive.

State aid for highways and streets is based on a percentage of Arlmont's expected expenditures minus the previous year's state grant. The formula should explicitly take into account the town's population and density. Instead it implicityly recognizes them, as they determine the estimated local expenditures in the model. The final component of state aid is a flat per-capita grant. The size of this last grant's rate is increased by one percent each iteration.

Federal grants-in-aid play a relatively minor role in the model. This is caused by the model's hiding federal dollars, which have been channeled through the state government, within the state aid figures. After examining several town budgets, the author felt that direct federal aid to medium-sized communities is limited at the present.

DEBT FINANCING

The bonding capacity of municipalities in the United States is generally limited by statute[13]. The most common limitation is to make bonding capacity a percentage of the community's assessed property valuation. Needless to say, a community can raise its debt limit by raising property assessments. In the model, Arlmont is constrained from borrowing more than five percent of its total property valuation. This limit was never reached in any of the model runs in the course of this study.

Rather than authorizing a large bond issue every several years to finance capital improvements, the town's policy is to issue a small issue each year. The model makes no assumptions about the nature of the projects financed. The size of the bond issue is a function of population which is modified each iteration by a random number generator. Arlmont is especially fortunate to be located in an area where long term interest rates are fixed for the entire modeling period at four percent. For most of the model runs, the amortization period for all bond issues is twenty years. Because of these twin assumptions--constant interest rates and constant bond lifes--debt service calculation is very simple. If the

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13 Maxwell [9] p. 194.

interest rate is I and the total value of outstanding bonds is P_t (including this year's issue), then the total interest payment for the year is I x P_t and the principal payment is 1 / P_t. The total debt service expenditure for the year is just the sum of these two amounts. Because of large increases in both programming overhead and computer running time for the model, it did not seem justified to remove the constraints of constant interest rates and constant amortization periods.

The model also permitted short term borrowing (for one year) at a higher interest rate than for long term borrowing. But this was permitted only if the community had reached its debt limit. This is not realistic behavior if Massachusetts is a guide. It is quite common for many cities and towns to borrow substantial amounts in anticipation of tax receipts for the coming fiscal year.

LOCAL REVENUE SOURCES

After taking into account all funds Arlmont has received from its bond issues and from grant-in-aid programs, the town has two forms of raising the money it needs--user charges and property taxes. The first of these is a catchall for the many different types of fees that may be levied against specific residents. Some of the components of this catagory are business and professional licenses, motor vehicle excise taxes, and water and sewer charges. These fees play only a small part in the budget of Arlmont, but they play an important role in the workings of the model.

The remaining amount of revenue must be raised through the property tax. The tax rate is calculated simply by dividing the amount to be raised by the town's total valuation. As was mentioned earlier in this thesis (see DEMOGRAPHIC SECTOR), it is possible for the tax rate to rise "too rapidly". When it does, the model reacts by cutting all public service expenditures by two percent and recalculating the tax rate for this lower level of expenditures. The expenditure rates, themselves, are unaffected until the model must cut expenditures in two successive iterations. Then, they too are cut. The rationale for this behavior is as follows:

> First remember that this is a model of a bureaucratic budget process. The town departments will consider the first budget reduction to be only a temporary cutback. But after a second cutback in their request in the succeeding year, the departments will slowly re-order their habits to reflect their smaller budgets.

After the model is able to pass through an iteration without having to cut expenditures, the system relaxes and waits until the next large tax increase comes along.

If nothing else were to happen, Arlmont would have a balanced budget at the end of every iteration. To add a touch of realism to the model, there must be some mechanism through which one or both sides of the financial statement can be juggles to produce either a budget surplus or deficit. The mechanism used in the model was a random number generator applied to the user charges amount after the tax rate had been computed.

If a surplus resulted, the model adds the amount to its cash balance and finishes up the iteration. This includes increasing the different public service expenditure rates and making a small increase in the migration rates. "Small" deficits are subtracted from the cash balance and the iteration is completed without increasing either the expenditure rates or the migration rates. (Small is defined as being less than three-quarters of the town's cash balance for the current iteration.)

This leaves only the problem of handling "large" deficits. The model goes through a lengthy series of calculations in which it attempts to borrow the amount needed to cover the deficit with long term bonds. If the town's debt limit is reached in doing so, the town must borrow the remaining portion (over the debt limit) for a year only and pay short term interest rates. The method was not satisfactory to the author. But as it was not crucial to this analysis, no time was spent in improving it. None of the computer runs of the model used this section.

BASIC MODEL BEHAVIOR

The model's behavior can be explained by two independent processes which, together, act to reduce the importance of education in the town's budget. The first of these is the model's declining birth rate. It should be obvious that (<u>ceteris paribus</u>) with a declining birth rate, a given number of adults will produce fewer children in model year 50 than in year 1. As a result, the under-five-years-old age group reaches its maximum size in year 45 of the simulation; but as a percentage of the whole population, this age group reaches its peak around year 25. And twenty-five years out in the model, a secondary effect comes into play--there are fewer adults in the prime child-bearing age groups.

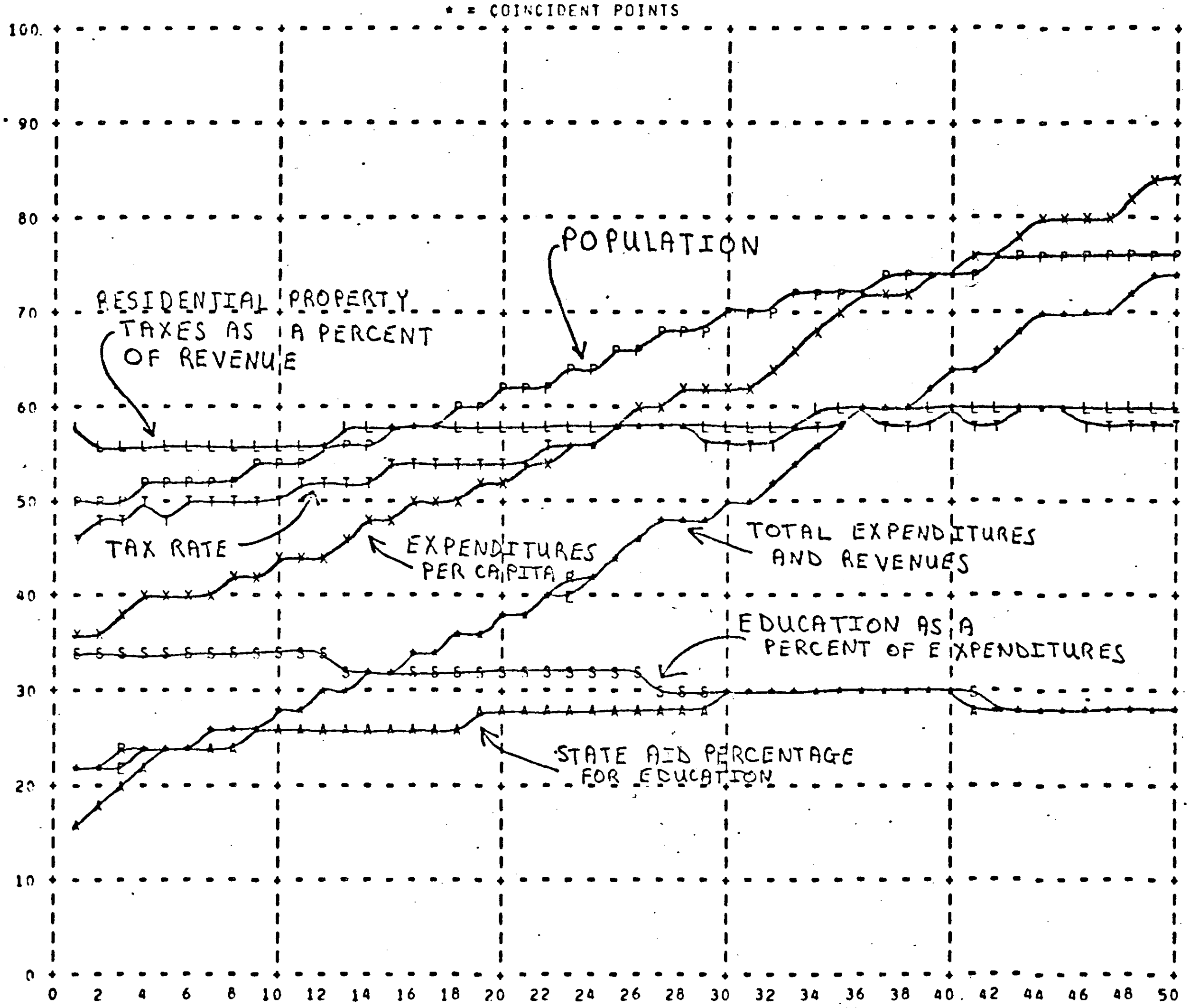
Added to this is the out-migration which is caused by a tightening housing market. This effect is generated in the model by the migration multiplier's going negative. As has been discussed, the youngest families are the ones most affected by this. Older families can retain their current homes. But it's the younger families that have pre-school age and school age children. The previously mentioned secondary affect also applies here.

These two factors reduce the relative size of the school age population and thus the importance of the school budget which is a function of it. The school budget is influenced by the proportion of young adults in the community. But this proportion is diminishing through time. As the following computer print-outs show, education becomes a smaller percentage of public expenditures. Although the expenditure per school age child is increasing, the total expenditure per capita is not increasing as rapidly as it is for other expenditures.

Education is still the most important part of the town's budget and thus it has a major influence on the property tax rate. But because it is of diminishing importance as time goes on, the property tax rate is able to remain relatively stable for the last half of the simulation. Increasing property values (as measured by their assessed values) are able to keep pace with the demands for increased public expenditures during this period. If education was not a relatively declining expense, the tax rates would continue to rise. When the population begins to level off during the final ten years of the simulation, the tax rate declines.

	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8152.6	9207.9	10696.7	11834.2	13859.3	15078.2	17078.0	18611.7	19993.3	20849.3
PROTECTION SERVICES	2328.4	2725.7	3334.4	3910.6	4919.6	5713.4	6818.0	7746.5	8570.3	9117.8
HIGHWAY EXPENDITURES	1627.6	1795.2	2037.2	2184.2	2479.5	2633.2	2936.2	3180.3	3414.1	3573.0
WATER AND SANITATION	1402.6	1642.0	2008.7	2355.8	2963.6	3441.8	4107.2	4666.6	5116.4	5404.5
RECREATION AND PARKS	550.0	618.9	730.4	816.5	959.9	1045.8	1185.7	1298.0	1404.2	1476.7
HOSPITALS AND HEALTH	995.4	1192.0	1496.8	1794.4	2284.8	2678.7	3217.7	3671.8	4048.1	4292.0
PUBLIC ADMINISTRATION	953.8	1116.6	1365.9	1581.7	1919.9	2165.3	2530.2	2834.1	3111.5	3297.4
OTHER EXPENDITURES	4227.2	4986.9	6155.6	7232.6	8990.8	10342.5	12259.3	13866.1	15314.2	16281.5
TOTAL PUBLIC SERVICES	20237.5	23285.2	27825.5	31710.0	38377.4	43098.9	50132.4	55875.2	60972.1	64292.2
MANDATED COSTS	3055.5	3405.6	3918.8	4270.7	4933.5	5326.1	6018.4	6582.9	7119.6	7483.9
DEBT SERVICE	837.7	909.7	971.8	1037.0	1105.8	1187.1	1273.2	1325.0	1416.7	1463.0
TOTAL EXPENDITURES	24130.7	27600.5	32716.1	37017.7	44416.8	49612.1	57424.0	63783.1	69508.5	73239.2
REVENUES										
PROPERTY TAXES	18342.9	21123.4	25344.7	28666.5	34764.9	38837.6	45422.0	50817.7	55518.2	58510.3
USER CHARGES	2688.9	2972.5	3314.7	3716.3	4176.3	4612.9	5072.9	5492.8	5881.9	6260.6
TOTAL LOCAL REVENUES	21031.8	24095.9	28659.4	32382.8	38941.3	43450.5	50494.8	56310.5	61400.2	64770.9
BORROWINGS	667.4	631.1	654.8	720.1	804.5	876.8	899.7	838.0	961.2	942.9
STATE GRANTS	2157.7	2540.1	2973.0	3361.2	3975.3	4382.9	4951.9	5363.9	5685.4	5891.2
FEDERAL GRANTS	287.5	352.8	444.2	564.9	716.3	891.9	1078.4	1269.0	1458.2	1645.2
TOTAL REVENUES	24144.4	27620.0	32731.4	37029.1	44437.3	49602.2	57424.8	63781.4	69505.0	73250.2
NET SURPLUS OR DEFICIT	13.7	19.5	15.3	11.3	20.6	-9.9	.8	-1.8	-3.5	11.0
CUM SURPLUS OR DEFICIT	538.2	566.8	620.7	564.3	614.7	559.5	647.8	646.4	673.4	704.6
PROPERTY VALUATION										
RESIDENTIAL	278714.4	309152.4	349111.5	397685.4	454175.1	516184.5	580282.6	645267.7	710267.5	775491.8
COMMERCIAL	56177.5	62013.3	69287.7	77805.0	87271.2	97079.8	106514.1	115385.5	123593.4	131241.8
INDUSTRIAL	41807.2	46372.9	52366.7	59652.8	68126.3	77427.7	87042.4	96790.2	106540.1	116323.8
TOTAL PROPERTY VALUATION	376699.1	417538.5	470765.9	535143.2	609572.6	690692.0	773839.1	857443.3	940401.0	1023057.4
TAX RATE (PER THOUSAND)	48.7	50.6	53.8	53.6	57.0	56.2	58.7	59.3	59.0	57.2
BONDING CAPACITY										
AVAILABLE	18835.0	20876.9	23538.3	26757.2	30478.6	34534.6	38692.0	42872.2	47020.1	51152.9
USED	9307.6	10108.2	10797.4	11522.5	12286.9	13189.7	14147.1	14722.4	15741.4	16255.9
UNUSED	9527.4	10768.7	12740.9	15234.6	18191.7	21344.9	24544.9	28149.8	31278.6	34897.0
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.0	57.4	61.3	65.5	69.3	72.3	74.5	76.0	76.8
GROSS DENSITY	5.1	5.4	5.7	6.1	6.5	6.9	7.2	7.5	7.6	7.7
DEPENDENCY RATIO	87.4	86.8	85.3	83.9	82.5	80.9	79.5	78.2	77.1	76.3
PUBLIC SERVICES / CAPITA	393.6	431.2	484.7	517.0	586.3	622.1	693.1	749.5	802.5	837.6
EDUCATION AS % OF EXPEND	33.8	33.4	32.7	32.0	31.2	30.4	29.7	29.2	28.8	28.5
PROTECTION AS % OF EXPND	9.6	9.9	10.2	10.6	11.1	11.5	11.9	12.1	12.3	12.4
STATE AID % FOR EDUCAT'N	23.0	25.3	26.2	27.3	28.4	29.0	29.2	29.1	28.6	28.1
PROPERTY TAX AS % OF REV	56.2	56.6	57.4	57.5	58.3	58.5	59.3	60.0	60.3	60.5
VALUATION PER CAPITA	7326.7	7732.0	8200.4	8724.9	9312.3	9969.3	10699.4	11502.1	12377.9	13328.0
VALUATION PER PUPIL	27015.0	28264.1	30058.6	31898.0	33876.3	36150.7	38829.5	41932.7	45443.6	49343.6

P = TOTAL POPULATION
T = PROPERTY TAX RATE
L = PROPERTY TAX AS % OF REVENUE
X = PUBLIC SERVICES PER CAPITA
R = TOTAL REVENUES
E = TOTAL EXPENDITURES
S = EDUCATION AS % OF EXPENDITURES
A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



ALTERNATE FORMS OF THE MODEL

Besides the basic model, the author worked with several alternate constructs of it. The purpose of this exercise was to study the model's behavior in different environments and to test its stability. Only one construct was changed for any particular run. With two exceptions, the model was insensitive to these changes. One of the exceptions negated a basic construct of the model and the other introduced changes of catastrophic effect into the model. (Computer print outs follow the description of each of these runs.)

CONSTANT BIRTH RATE RUN

The basic model contained a birth rate multiplier which declined from 1.0 to 0.9 uniformally over the model period. This run held the birth rate constant in an attemp to study the dynamics of the demographic sector of the model. As Table shows, children will make up a larger percentage of the population, but the number of people of childbearing age increases hardly at all. (Note the smoothing effect described in the DEMOGRAPHIC SECTOR shows up in year 20 of the table.) The model's density multiplier is still in operation and is trying to limit population growth. It is unable to directly affect those residents under the age of 19, so it works on the older age groups. At first, the density multiplier is only slowing down immigration, but near the end of both the BASIC MODEL RUN and the CONSTANT BIRTH RATE RUN it is negative. This causes emigration to occur with most of the migrants coming from the youngest adult age cohorts. At this point, the CONSTANT BIRTH RATE RUN begins to behave like the BASIC MODEL RUN except that it has a higher percentage of schoolage children.

TABLE 2

SELECTED POPULATION BREAKDOWNS:

DECLINING BIRTH RATE AND CONSTANT BIRTH RATE

YEAR	TOTAL POPULATION	0 - 4 YRS	25 - 29 YRS	60 - 64 YRS
1	50.0[1] 50.0	5.6 (11.1) 5.6 (11.1)	3.1 (6.1) 3.1 (6.1)	2.0 (4.0) 2.0 (4.0)
5	51.4 51.4	5.2 (10.2) 5.3 (10.2)	3.3 (6.5) 3.3 (6.5)	1.7 (3.3) 1.7 (3.3)
10	54.0 54.1	5.5 (10.3) 5.6 (10.4)	4.0 (7.4) 4.0 (7.4)	1.5 (2.8) 1.5 (2.8)
15	57.4 57.6	6.1 (10.6) 6.2 (10.8)	4.6 (8.1) 4.6 (8.0)	1.5 (2.5) 1.5 (2.5)
20	61.3 61.8	6.7 (10.8) 6.9 (11.1)	5.1 (8.4) 5.2 (8.3)	1.4 (2.3) 1.4 (2.3)
25	65.5 66.2	7.1 (10.9) 7.4 (11.3)	5.5 (8.5) 5.6 (8.4)	1.4 (2.2) 1.4 (2.1)
30	69.3 70.3	7.5 (10.8) 7.9 (11.3)	5.9 (8.5) 5.9 (8.4)	1.4 (2.1) 1.4 (2.1)
35	72.3 73.6	7.7 (10.7) 8.2 (11.2)	6.1 (8.4) 6.1 (8.4)	1.5 (2.1) 1.5 (2.0)
40	74.5 76.1	7.8 (10.5) 8.5 (11.1)	6.3 (8.4) 6.3 (8.3)	1.6 (2.1) 1.6 (2.1)
45	76.0 77.8	7.9 (10.4) 8.6 (11.1)	6.4 (8.4) 6.5 (8.3)	1.7 (2.2) 1.7 (2.1)
50	76.8 78.9	7.8 (10.2) 8.7 (11.0)	6.5 (8.4) 6.6 (8.3)	1.8 (2.3) 1.7 (2.2)

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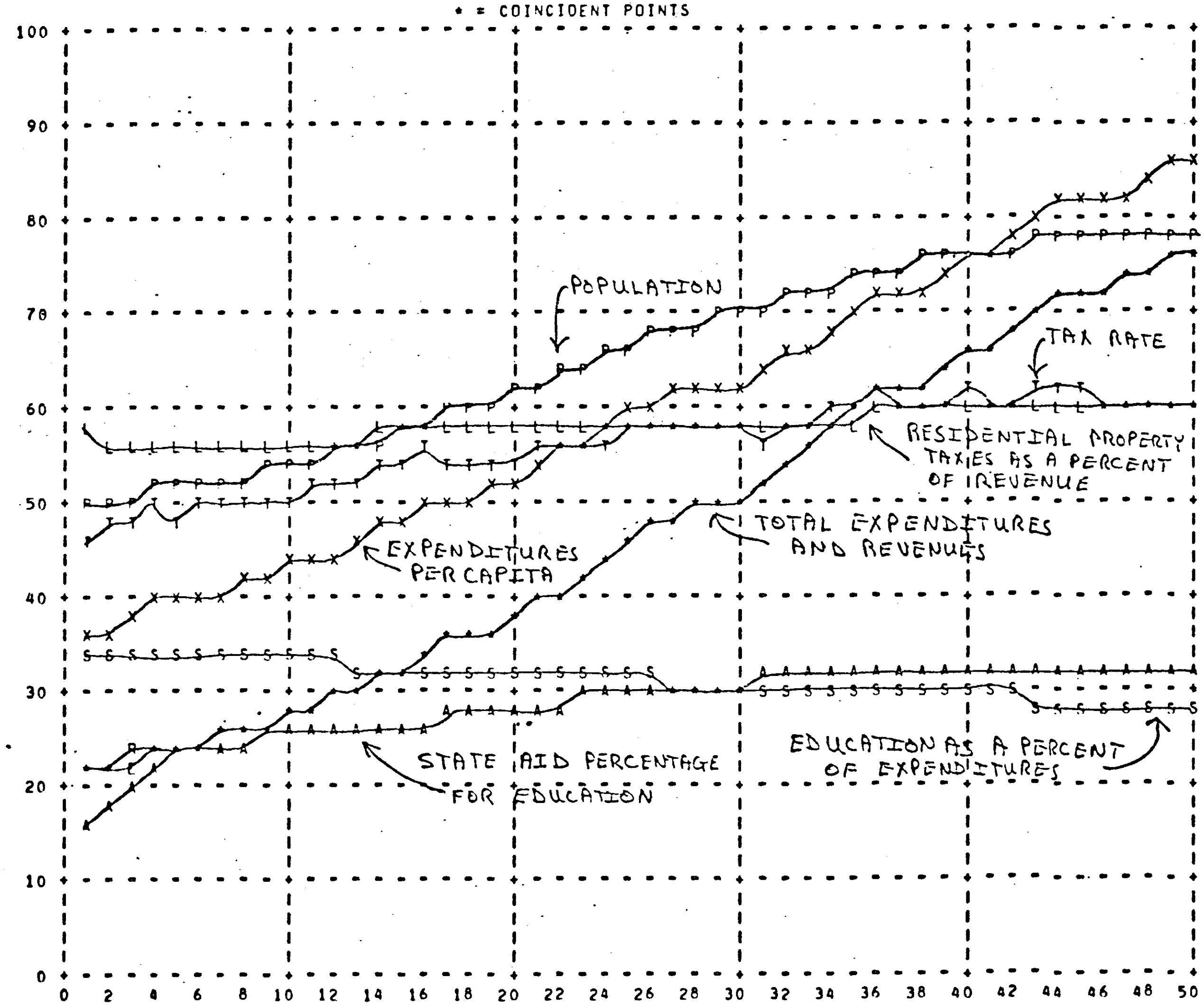
[1] The top line is from the BASIC MODEL RUN which contains a declining birth rate. The bottom line is from the CONSTANT BIRTH RATE RUN. The numbers enclosed in parintheses "(.)" are percentages of the total population.

	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8153.7	9224.1	10755.5	11964.5	14104.8	15444.8	17593.4	19315.0	20920.6	22006.3
PROTECTION SERVICES	2330.2	2735.2	3361.4	3976.1	5043.8	5898.3	7090.8	8107.7	9031.5	9680.5
HIGHWAY EXPENDITURES	1628.1	1797.7	2043.4	2195.8	2499.0	2659.0	2971.0	3220.5	3461.3	3628.9
WATER AND SANITATION	1403.7	1647.7	2024.9	2395.2	3038.4	3553.2	4271.6	4834.2	5302.2	5630.0
RECREATION AND PARKS	550.0	619.3	731.5	818.8	964.1	1051.2	1193.1	1307.7	1416.4	1491.5
HOSPITALS AND HEALTH	996.3	1197.1	1511.4	1827.0	2346.9	2771.5	3354.9	3827.3	4232.0	4516.0
PUBLIC ADMINISTRATION	954.5	1120.5	1376.9	1601.7	1957.1	2219.9	2609.9	2941.5	3249.4	3465.4
OTHER EXPENDITURES	4230.7	5005.5	6208.9	7343.6	9200.4	10653.4	12716.6	14485.8	16113.0	17255.9
TOTAL PUBLIC SERVICES	20247.2	23347.1	28014.0	32122.5	39154.5	44251.4	51801.4	58039.8	63726.5	67674.4
MANDATED COSTS	3056.6	3411.5	3934.7	4301.4	4987.4	5401.3	6123.9	6721.1	7293.9	7693.8
DEBT SERVICE	837.7	910.1	972.9	1039.6	1110.7	1195.1	1285.2	1341.0	1438.1	1489.4
TOTAL EXPENDITURES	24141.6	27668.7	32921.5	37463.4	45252.6	50847.8	59210.4	66101.9	72458.5	76857.7
REVENUES										
PROPERTY TAXES	18351.0	21170.8	25486.3	28979.5	35361.5	39719.0	46700.0	52451.2	57579.8	61023.6
USER CHARGES	2689.9	2977.7	3328.1	3743.0	4222.0	4678.0	5161.7	5608.1	6025.9	6436.3
TOTAL LOCAL REVENUES	21040.9	24148.5	28814.4	32722.5	39583.5	44397.0	51861.7	58059.3	63605.7	67459.8
BORROWINGS	667.7	632.2	657.5	725.3	813.3	889.2	915.4	855.6	984.8	969.4
STATE GRANTS	2159.0	2553.3	3016.9	3453.4	4143.6	4632.7	5315.4	5859.5	6330.3	6696.2
FEDERAL GRANTS	287.7	354.1	448.0	573.6	733.0	918.8	1118.6	1325.7	1534.2	1743.6
TOTAL REVENUES	24155.3	27688.2	32936.8	37474.8	45273.4	50837.7	59211.2	66100.1	72455.0	76869.0
NET SURPLUS OR DEFICIT	13.7	19.5	15.4	11.4	20.8	-10.0	.8	-1.8	-3.6	11.3
CUM SURPLUS OR DEFICIT	538.2	566.8	621.0	564.3	615.2	559.2	648.9	647.6	675.1	707.1
PROPERTY VALUATION										
RESIDENTIAL	278712.9	309138.1	349065.6	397701.7	454315.6	516047.1	579747.8	644128.6	708291.8	772510.9
COMMERCIAL	56196.9	62121.0	69567.4	78363.0	88224.4	98449.4	108380.3	117807.4	126618.9	134923.2
INDUSTRIAL	41806.9	46370.7	52362.8	59655.3	68147.3	77407.1	86962.2	96619.3	106243.8	115876.6
TOTAL PROPERTY VALUATION	376718.7	417629.8	471015.9	535720.0	610687.4	691903.5	775090.3	858555.3	941154.5	1023310.7
TAX RATE (PER THOUSAND)	48.7	50.7	54.1	54.1	57.9	57.4	60.3	61.1	61.2	59.6
BONDING CAPACITY										
AVAILABLE	18835.9	20881.5	23550.8	26786.0	30534.4	34595.2	38754.5	42927.8	47057.7	51165.5
USED	9308.1	10111.9	10809.5	11550.7	12340.8	13279.0	14280.1	14899.6	15979.3	16548.8
UNUSED	9527.9	10769.6	12741.3	15235.3	18193.5	21316.2	24474.4	28028.2	31078.4	34616.7
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.1	57.6	61.8	66.2	70.3	73.6	76.1	77.8	78.9
GROSS DENSITY	5.1	5.4	5.8	6.2	6.6	7.0	7.4	7.6	7.8	7.9
DEPENDENCY RATIO	87.5	87.1	86.0	85.2	84.3	83.4	82.6	82.0	81.6	81.5
PUBLIC SERVICES / CAPITA	393.7	431.6	486.0	520.0	591.7	629.8	703.9	762.6	818.7	857.6
EDUCATION AS % OF EXPEND	33.8	33.3	32.7	31.9	31.2	30.4	29.7	29.2	28.9	28.6
PROTECTION AS % OF EXPND	9.7	9.9	10.2	10.6	11.1	11.6	12.0	12.3	12.5	12.6
STATE AID % FOR EDUCAT'N	23.1	25.4	26.7	28.2	29.7	30.9	31.7	32.1	32.4	32.6
PROPERTY TAX AS % OF REV	56.2	56.6	57.3	57.4	58.1	58.3	59.0	59.5	59.8	59.9
VALUATION PER CAPITA	7324.3	7720.3	8171.8	8672.1	9228.5	9847.9	10532.2	11230.2	12091.8	12967.5
VALUATION PER PUPIL	27009.8	28206.5	29874.3	31517.2	33240.2	35199.5	37489.4	40113.1	43040.6	46246.5

P = TOTAL POPULATION
T = PROPERTY TAX RATE
L = PROPERTY TAX AS % OF REVENUE
X = PUBLIC SERVICES PER CAPITA
R = TOTAL REVENUES
E = TOTAL EXPENDITURES
S = EDUCATION AS % OF EXPENDITURES
A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



A simple statistic to measure which describes this result is the dependency ratio[14]. It is defined as the ratio of the number of people who are 18 years old or younger or 65 or older to the number of people between these ages. Thus it is a rough measure of the productive segment of the population. (Note that it does not measure labor force participation rates.) The CONSTANT BIRTH RATE RUN has a substantially higher dependency ratio with only a slightly large population. This run has fewer taxpayers for the same amount of taxable land. The value of this property has changed only slightly. Therefore, the tax rate has increased somewhat to that of the BASIC MODEL RUN. An additional related effect is a higher state school aid percentage which is caused by the lower valuation per schoolage child. This in turn produces a larger state grant-in-aid.

SKYROCKETING EXPENDITURES RUN

This run was an attempt to study "What if" expenditures began to rapidly increase without proportionate increases either in assessed property valuations or grants-in-aid. No assumptions were made as to the cause of the phenomenum. But because the state does pick up a [illegible] percentage of the school budget without limits, the results of this run are not conclusive. As the property taxes begin to rise in order to finance these expenditures, the restraints discussed earlier attempt to limit the expenditures. These restraints are only partially successful. The demographic sector is more interesting. As taxes begin to rise, in migration slows and becomes out migration. In the BASIC MODEL RUN, the

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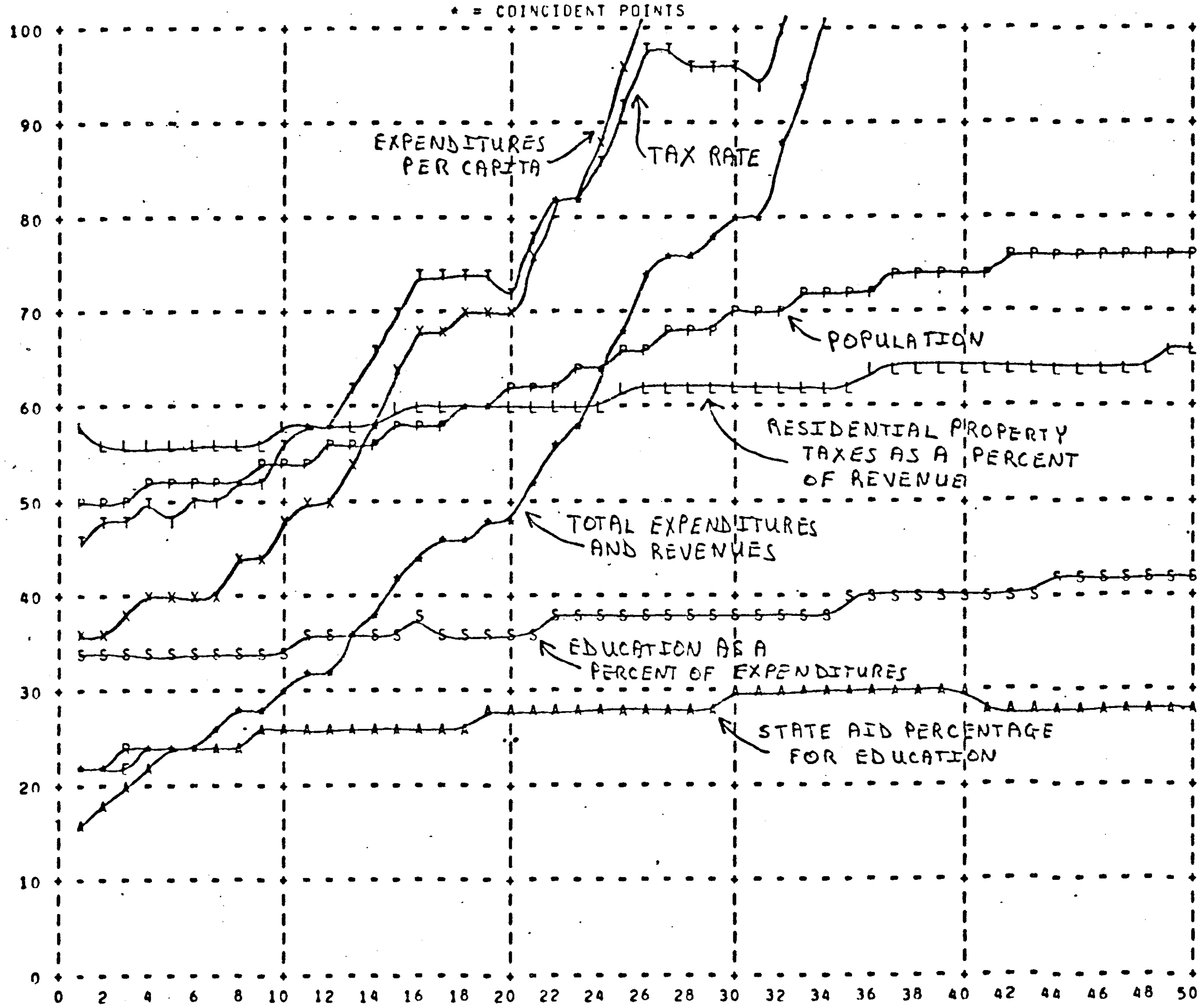
14 Bogue [1] discusses this demographic measure and its utility, pp. 154-156.

	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8152.6	10323.0	15072.6	17656.5	25989.7	29938.7	42620.2	55135.8	70307.6	82197.1
PROTECTION SERVICES	2328.4	2999.5	4443.4	5466.8	8328.1	10146.1	14662.1	19230.7	24560.5	28754.0
HIGHWAY EXPENDITURES	1627.6	1902.4	2424.2	2675.5	3410.8	3728.7	4668.9	5516.5	6460.1	7164.3
WATER AND SANITATION	1402.6	1773.3	2530.1	3083.7	4524.6	5460.8	7600.5	9691.8	11925.9	13604.7
RECREATION AND PARKS	550.0	655.8	869.1	1000.2	1320.4	1480.8	1885.3	2251.5	2657.0	2960.9
HOSPITALS AND HEALTH	995.4	1287.3	1865.3	2348.9	3488.3	4250.0	5954.4	7625.9	9435.8	10804.4
PUBLIC ADMINISTRATION	953.8	1205.9	1720.5	2070.5	2931.1	3435.5	4682.2	5886.1	7252.5	8300.7
OTHER EXPENDITURES	4227.2	5284.5	7324.9	8859.6	12367.4	14645.2	19493.5	24051.8	28977.1	32646.3
TOTAL PUBLIC SERVICES	20237.5	25431.8	36270.2	43161.7	62360.4	73085.8	101567.1	129390.2	161576.6	186432.3
MANDATED COSTS	3055.5	3405.6	3918.8	4270.7	4933.5	5326.1	6018.4	6582.9	7119.6	7483.9
DEBT SERVICE	837.7	909.7	971.8	1037.0	1105.8	1187.1	1273.2	1325.0	1416.7	1463.0
TOTAL EXPENDITURES	24130.7	29747.1	41160.8	48469.5	68399.8	79599.0	108858.8	137298.1	170113.0	195379.3
REVENUES										
PROPERTY TAXES	18342.9	23029.2	32899.3	38948.5	56181.9	65717.9	91374.6	116574.7	145865.0	168335.6
USER CHARGES	2688.9	2972.5	3314.7	3716.3	4176.3	4612.9	5072.9	5492.8	5881.9	6260.6
TOTAL LOCAL REVENUES	21031.8	26001.7	36214.0	42664.9	60358.2	70330.9	96447.4	122067.5	151747.0	174596.3
BORROWINGS	667.4	631.1	654.8	720.1	804.5	876.8	899.7	838.0	961.2	942.9
STATE GRANTS	2157.7	2780.9	3863.1	4530.9	6541.3	7489.4	10434.0	13121.9	15943.1	18205.9
FEDERAL GRANTS	287.5	352.8	444.2	564.9	716.3	891.9	1078.4	1269.0	1458.2	1645.2
TOTAL REVENUES	24144.4	29766.6	41176.2	48480.8	68420.3	79589.1	108859.5	137296.4	170109.5	195390.3
NET SURPLUS OR DEFICIT	13.7	19.5	15.3	11.3	20.6	-9.9	.8	-1.8	-3.5	11.0
CUM SURPLUS OR DEFICIT	538.2	566.8	620.7	564.3	614.7	559.5	647.8	646.4	673.4	704.6
PROPERTY VALUATION										
RESIDENTIAL	278714.4	309152.4	349111.5	397685.4	454175.1	516184.5	580282.6	645267.7	710267.5	775491.8
COMMERCIAL	56177.5	62013.3	69287.7	77805.0	87271.2	97079.8	106514.1	115385.5	123593.4	131241.8
INDUSTRIAL	41807.2	46372.9	52366.7	59652.8	68126.3	77427.7	87042.4	96790.2	106540.1	116323.8
TOTAL PROPERTY VALUATION	376699.1	417538.5	470765.9	535143.2	609572.6	690692.0	773839.1	857443.3	940401.0	1023057.4
TAX RATE (PER THOUSAND)	48.7	55.2	69.9	72.8	92.2	95.1	118.1	136.0	155.1	164.5
BONDING CAPACITY										
AVAILABLE	18835.0	20876.9	23538.3	26757.2	30478.6	34534.6	38692.0	42872.2	47020.1	51152.9
USED	9307.6	10108.2	10797.4	11522.5	12286.9	13189.7	14147.1	14722.4	15741.4	16255.9
UNUSED	9527.4	10768.7	12740.9	15234.6	18191.7	21344.9	24544.9	28149.8	31278.6	34897.0
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.0	57.4	61.3	65.5	69.3	72.3	74.5	76.0	76.8
GROSS DENSITY	5.1	5.4	5.7	6.1	6.5	6.9	7.2	7.5	7.6	7.7
DEPENDENCY RATIO	87.4	86.8	85.3	83.9	82.5	80.9	79.5	78.2	77.1	76.3
PUBLIC SERVICES / CAPITA	393.6	470.9	631.8	703.7	952.7	1054.9	1404.3	1735.7	2126.7	2428.8
EDUCATION AS % OF EXPEND	33.8	34.7	36.6	36.4	38.0	37.6	39.2	40.2	41.3	42.1
PROTECTION AS % OF EXPND	9.6	10.1	10.8	11.3	12.2	12.7	13.5	14.0	14.4	14.7
STATE AID % FOR EDUCAT'N	23.0	25.3	26.2	27.3	28.4	29.0	29.2	29.1	28.6	28.1
PROPERTY TAX AS % OF REV	56.2	57.3	59.3	59.7	61.2	61.7	62.9	63.9	64.8	65.3
VALUATION PER CAPITA	7326.7	7732.0	8200.4	8724.9	9312.3	9969.3	10699.4	11502.1	12377.9	13328.0
VALUATION PER PUPIL	27015.0	28264.1	30058.6	31898.0	33876.3	36150.7	38829.5	41932.7	45443.6	49343.6

P = TOTAL POPULATION
T = PROPERTY TAX RATE
L = PROPERTY TAX AS % OF REVENUE
X = PUBLIC SERVICES PER CAPITA
R = TOTAL REVENUES
E = TOTAL EXPENDITURES
S = EDUCATION AS % OF EXPENDITURES
A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



density multiplier function had performed this task in order to limit population growth. Precisely the same segments of the population are affected by the rising taxes. Thus, for this particular set of conditions, the micro-structure of the population is unchanged.

MUNICIPAL INCOME TAX RUN

The purpose of this run was to investigate alternative forms of revenue collection. The method used was a four percent tax on all incomes. (Note that in the listing of the model in APPENDIX E, the rate is two percent. But this rate is applied to a population that is twice the size of the labor force.) The affect was to equalize the tax burdens across age groups, but at a higher rate. In the BASIC MODEL RUN, the younger residents of Arlmont had received a tax break. The income tax is applied equally to everyone. Thus it tends to equalize the tax load. But the income tax is a tax on residents only. In reducing the amount of revenue that must be raised through the property tax, it reduces the tax load on commercial and industrial property. Thus residents pay a slightly higher portion of all taxes levied. The model is not sensitive to this shifted tax load and so other parts of the model's output is unchanged.

REVERSED HIGHWAY MULTIPLIER RUN

In an early version of the model, the highway multiplier had a positive slope. After further research and analysis, the author discovered that highway expenditures was inversely related to density. Later versions of the model contained this corrected multiplier. The purpose of this run was to observe the model's behavior with a positively sloping

TABLE 3

COMPARISON OF TAX BURDENS IN YEAR 5:

PROPERTY TAX ONLY AND COMBINATION OF THE PROPERTY TAX AND A MUNICIPAL INCOME TAX

	19 - 24 YRS		40 - 44 YRS		60 - 64 YRS	
ANNUAL INCOME	$6900		8490		9020	
PROPERTY VALUATION	$13130		18680		20540	
PROPERTY TAXES						
TAX RATE[1]	$48.7[2]	35.3	48.7	35.3	48.7	35.3
TAX PAID	$635.	460.	910.	659.	1000.	709.
TAX AS A % INCOME	9.2%	6.7	11.4	8.2	11.7	8.5
INCOME TAXES						
TAX RATE[3]	--	4%	--	4	--	4
TAX PAID	--	$267.	--	340.	--	361.
TOTAL TAX PAID	$635.	737.	910.	999.	1000.	1070.
TOTAL TAX AS A % OF INCOME	9.2%	10.7	11.4	12.5	11.7	12.6
TAXES PAID ON ALL RESIDENTIAL PROPERTY AS A % OF TOTAL TOWN REVENUE					56.2%	40.7
TOTAL TAXES PAID BY RESIDENTS AS A % OF TOTAL TOWN REVENUE					56.2%	57.6

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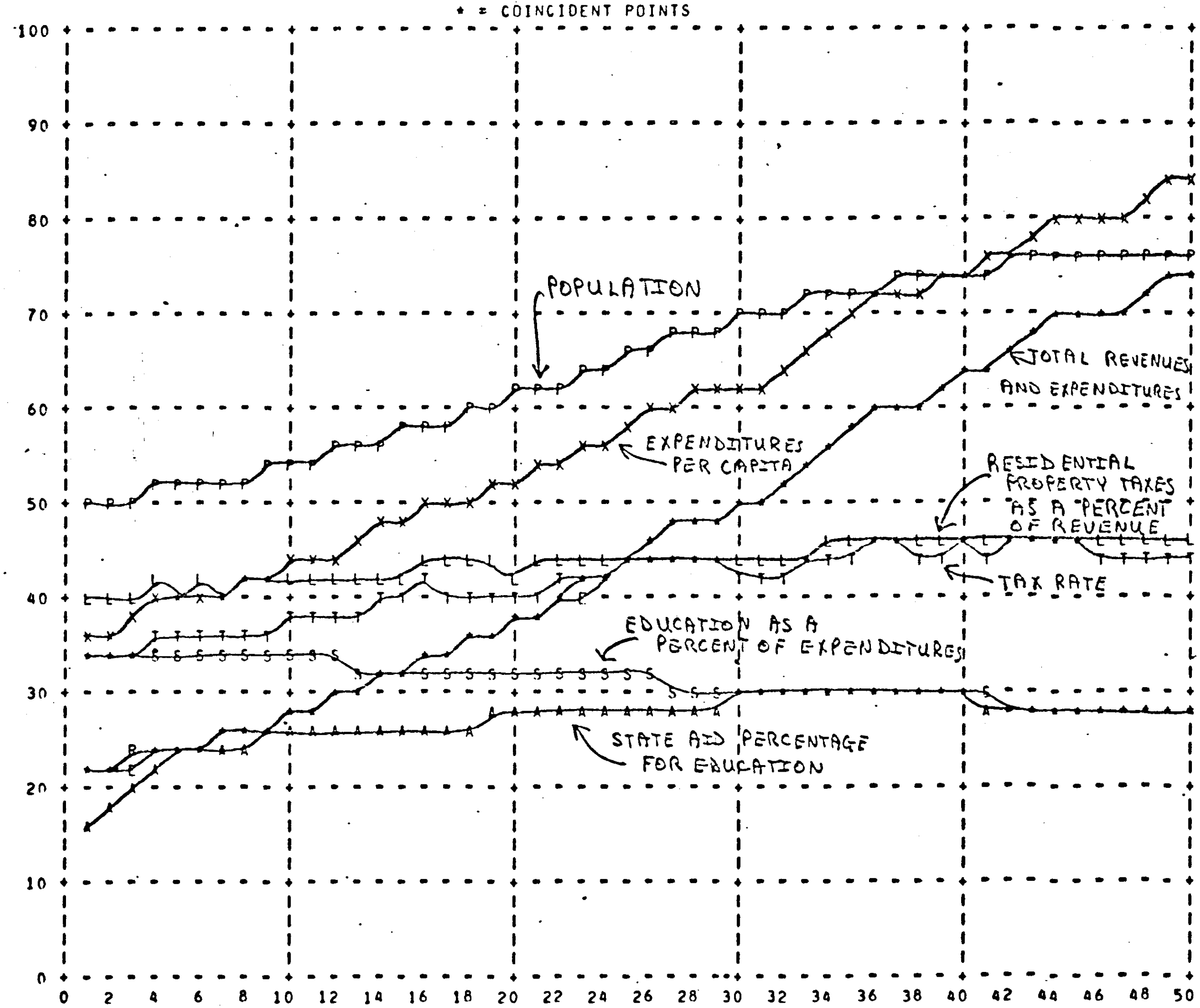
1 Per thousand dollars assessed valuation.

2 Left-hand number is from the BASIC MODEL RUN and the right-hand number is from the MUNICIPAL INCOME TAX RUN.

3 Percent of total income.

	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8152.6	9207.9	10696.7	11834.2	13859.3	15078.2	17078.0	18611.7	19993.3	20849.3
PROTECTION SERVICES	2328.4	2725.7	3334.4	3910.6	4919.6	5713.4	6818.0	7746.5	8570.3	9117.8
HIGHWAY EXPENDITURES	1627.6	1795.2	2037.2	2184.2	2479.5	2633.2	2936.2	3180.3	3414.1	3573.0
WATER AND SANITATION	1402.6	1642.0	2008.7	2355.8	2963.6	3441.8	4107.2	4666.6	5116.4	5404.5
RECREATION AND PARKS	550.0	618.9	730.4	816.5	959.9	1045.8	1165.7	1298.0	1404.2	1476.7
HOSPITALS AND HEALTH	995.4	1192.0	1496.8	1794.4	2284.8	2678.7	3217.7	3671.8	4048.1	4292.0
PUBLIC ADMINISTRATION	953.8	1116.6	1365.9	1581.7	1919.9	2165.3	2530.2	2834.1	3111.5	3297.4
OTHER EXPENDITURES	4227.2	4986.9	6155.6	7232.6	8990.8	10342.5	12259.3	13866.1	15314.2	16281.5
TOTAL PUBLIC SERVICES	20237.5	23265.2	27825.5	31710.0	38377.4	43098.9	50132.4	55875.2	60972.1	64292.2
MANDATED COSTS	3055.5	3405.6	3918.8	4270.7	4933.5	5326.1	6018.4	6582.9	7119.6	7483.9
DEBT SERVICE	837.7	909.7	971.8	1037.0	1105.8	1187.1	1273.2	1325.0	1416.7	1463.0
TOTAL EXPENDITURES	24130.7	27600.5	32716.1	37017.7	44416.8	49612.1	57424.0	63783.1	69508.5	73239.2
REVENUES										
PROPERTY TAXES	13284.6	15495.7	18975.7	21400.4	26457.4	29388.0	34793.9	38997.5	42508.9	44310.6
USER CHARGES	2688.9	2972.5	3314.7	3716.3	4176.3	4612.9	5072.9	5492.8	5881.9	6260.6
LOCAL INCOME TAXES	5058.3	5627.7	6369.0	7266.0	8307.5	9449.5	10628.1	11820.2	13009.4	14199.7
TOTAL LOCAL REVENUES	21031.8	24095.9	28659.4	32382.8	38941.3	43450.5	50494.8	56310.5	61400.2	64770.9
BORROWINGS	667.4	631.1	654.8	720.1	804.5	876.8	899.7	838.0	961.2	942.9
STATE GRANTS	2157.7	2540.1	2973.0	3361.2	3975.3	4382.9	4951.9	5363.9	5685.4	5891.2
FEDERAL GRANTS	287.5	352.8	444.2	564.9	716.3	891.9	1078.4	1269.0	1458.2	1645.2
TOTAL REVENUES	24144.4	27620.0	32731.4	37029.1	44437.3	49602.2	57424.8	63781.4	69505.0	73250.2
NET SURPLUS OR DEFICIT	13.7	19.5	15.3	11.3	20.6	-9.9	.8	-1.8	-3.5	11.0
CUM SURPLUS OR DEFICIT	538.2	566.8	620.7	564.3	614.7	559.5	647.8	646.4	673.4	704.6
PROPERTY VALUATION										
RESIDENTIAL	278714.4	309152.4	349111.5	397685.4	454175.1	516184.5	580282.6	645267.7	710267.5	775491.8
COMMERCIAL	56177.5	62013.3	69287.7	77805.0	87271.2	97079.8	106514.1	115385.5	123593.4	131241.8
INDUSTRIAL	41807.2	46372.9	52366.7	59652.8	68126.3	77427.7	87042.4	96790.2	106540.1	116323.8
TOTAL PROPERTY VALUATION	376699.1	417538.5	470765.9	535143.2	609572.6	690692.0	773839.1	857443.3	940401.0	1023057.4
TAX RATE (PER THOUSAND)	35.3	37.1	40.3	40.0	43.4	42.5	45.0	45.5	45.2	43.3
BONDING CAPACITY										
AVAILABLE	18835.0	20876.9	23538.3	26757.2	30478.6	34534.6	38692.0	42872.2	47020.1	51152.9
USED	9307.6	10108.2	10797.4	11522.5	12286.9	13189.7	14147.1	14722.4	15741.4	16255.9
UNUSED	9527.4	10768.7	12740.9	15234.6	18191.7	21344.9	24544.9	28149.8	31278.6	34897.0
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.0	57.4	61.3	65.5	69.3	72.3	74.5	76.0	76.8
GROSS DENSITY	5.1	5.4	5.7	6.1	6.5	6.9	7.2	7.5	7.6	7.7
DEPENDENCY RATIO	87.4	86.8	85.3	83.9	82.5	80.9	79.5	78.2	77.1	76.3
PUBLIC SERVICES / CAPITA	393.6	431.2	484.7	517.0	586.3	622.1	693.1	749.5	802.5	837.6
EDUCATION AS % OF EXPEND	33.8	33.4	32.7	32.0	31.2	30.4	29.7	29.2	28.8	28.5
PROTECTION AS % OF EXPND	9.6	9.9	10.2	10.6	11.1	11.5	11.9	12.1	12.3	12.4
STATE AID % FOR EDUCAT'N	23.0	25.3	26.2	27.3	28.4	29.0	29.2	29.1	28.6	28.1
PROPERTY TAX AS % OF REV	40.7	41.5	43.0	42.9	44.4	44.3	45.4	46.0	46.2	45.9
VALUATION PER CAPITA	7326.7	7732.0	8200.4	8724.9	9312.3	9969.3	10699.4	11502.1	12377.9	13328.0
VALUATION PER PUPIL	27015.0	28264.1	30058.6	31898.0	33876.3	36150.7	38829.5	41932.7	45443.6	49343.6

P = TOTAL POPULATION
T = PROPERTY TAX RATE
L = PROPERTY TAX AS % OF REVENUE
X = PUBLIC SERVICES PER CAPITA
R = TOTAL REVENUES
E = TOTAL EXPENDITURES
S = EDUCATION AS % OF EXPENDITURES
A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8152.6	9207.9	10696.7	11834.2	13859.3	15078.2	17078.0	18611.7	19993.3	20849.3
PROTECTION SERVICES	2328.4	2725.7	3334.4	3910.6	4919.6	5713.4	6818.0	7746.5	8570.3	9117.8
HIGHWAY EXPENDITURES	1646.1	1853.6	2161.6	2391.6	2806.4	3073.3	3512.1	3872.8	4223.4	4463.1
WATER AND SANITATION	1402.6	1642.0	2008.7	2355.8	2963.6	3441.8	4107.2	4666.6	5116.4	5404.5
RECREATION AND PARKS	550.0	618.9	730.4	816.5	959.9	1045.8	1185.7	1298.0	1404.2	1476.7
HOSPITALS AND HEALTH	995.4	1192.0	1496.8	1794.4	2284.8	2678.7	3217.7	3671.8	4048.1	4292.0
PUBLIC ADMINISTRATION	953.8	1116.6	1365.9	1581.7	1919.9	2165.3	2530.2	2834.1	3111.5	3297.4
OTHER EXPENDITURES	4227.2	4986.9	6155.6	7232.6	8990.8	10342.5	12259.3	13866.1	15314.2	16281.5
TOTAL PUBLIC SERVICES	20256.1	23343.6	27949.9	31917.5	38704.2	43539.0	50708.2	56567.7	61781.4	65182.3
MANDATED COSTS	3055.5	3405.6	3918.8	4270.7	4933.5	5326.1	6018.4	6582.9	7119.6	7483.9
DEBT SERVICE	837.7	909.7	971.8	1037.0	1105.8	1187.1	1273.2	1325.0	1416.7	1463.0
TOTAL EXPENDITURES	24149.2	27658.9	32840.5	37225.2	44743.6	50052.2	57999.9	64475.7	70317.7	74129.2
REVENUES										
PROPERTY TAXES	18359.9	21177.0	25458.9	28857.1	35065.2	39242.2	45951.3	51454.4	56262.6	59329.1
USER CHARGES	2688.9	2972.5	3314.7	3716.3	4176.3	4612.9	5072.9	5492.8	5881.9	6260.6
TOTAL LOCAL REVENUES	21048.7	24149.5	28773.6	32573.4	39241.5	43855.1	51024.1	56947.2	62144.5	65589.8
BORROWINGS	667.4	631.1	654.8	720.1	804.5	876.8	899.7	838.0	961.2	942.9
STATE GRANTS	2159.3	2545.0	2963.2	3378.1	4001.8	4418.4	4998.4	5419.7	5750.3	5962.4
FEDERAL GRANTS	287.5	352.8	444.2	564.9	716.3	891.9	1078.4	1269.0	1458.2	1645.2
TOTAL REVENUES	24162.9	27678.4	32855.8	37236.5	44764.2	50042.3	58000.6	64473.9	70314.3	74140.2
NET SURPLUS OR DEFICIT	13.7	19.5	15.3	11.3	20.6	-9.9	.8	-1.8	-3.5	11.0
CUM SURPLUS OR DEFICIT	538.2	566.8	620.7	564.3	614.7	559.5	647.8	646.4	673.4	704.6
PROPERTY VALUATION										
RESIDENTIAL	278714.4	309152.4	349111.5	397685.4	454175.1	516184.5	580282.6	645267.7	710267.5	775491.8
COMMERCIAL	56177.5	62013.3	69287.7	77805.0	87271.2	97079.8	106514.1	115385.5	123593.4	131241.8
INDUSTRIAL	41807.2	46372.9	52366.7	59652.8	68126.3	77427.7	87042.4	96790.2	106540.1	116323.8
TOTAL PROPERTY VALUATION	376699.1	417538.5	470765.9	535143.2	609572.6	690692.0	773839.1	857443.3	940401.0	1023057.4
TAX RATE (PER THOUSAND)	48.7	50.7	54.1	53.9	57.5	56.8	59.4	60.0	59.8	58.0
BONDING CAPACITY										
AVAILABLE	18835.0	20876.9	23538.3	26757.2	30478.6	34534.6	38692.0	42872.2	47020.1	51152.9
USED	9307.6	10108.2	10797.4	11522.5	12286.9	13189.7	14147.1	14722.4	15741.4	16255.9
UNUSED	9527.4	10768.7	12740.9	15234.6	18191.7	21344.9	24544.9	28149.8	31278.6	34897.0
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.0	57.4	61.3	65.5	69.3	72.3	74.5	76.0	76.8
GROSS DENSITY	5.1	5.4	5.7	6.1	6.5	6.9	7.2	7.5	7.6	7.7
DEPENDENCY RATIO	87.4	86.8	85.3	83.9	82.5	80.9	79.5	78.2	77.1	76.3
PUBLIC SERVICES / CAPITA	394.0	432.3	486.9	520.4	591.3	628.4	701.1	758.8	813.2	849.2
EDUCATION AS % OF EXPEND	33.8	33.3	32.6	31.8	31.0	30.1	29.4	28.9	28.4	28.1
PROTECTION AS % OF EXPND	9.6	9.9	10.2	10.5	11.0	11.4	11.8	12.0	12.2	12.3
STATE AID % FOR EDUCAT'N	23.0	25.3	26.2	27.3	28.4	29.0	29.2	29.1	28.6	28.1
PROPERTY TAX AS % OF REV	56.2	56.6	57.5	57.6	58.4	58.6	59.4	60.1	60.4	60.7
VALUATION PER CAPITA	7326.7	7732.0	8200.4	8724.9	9312.3	9969.3	10699.4	11502.1	12377.9	13328.0
VALUATION PER PUPIL	27015.0	28264.1	30058.6	31898.0	33876.3	36150.7	38829.5	41932.7	45443.6	49343.6

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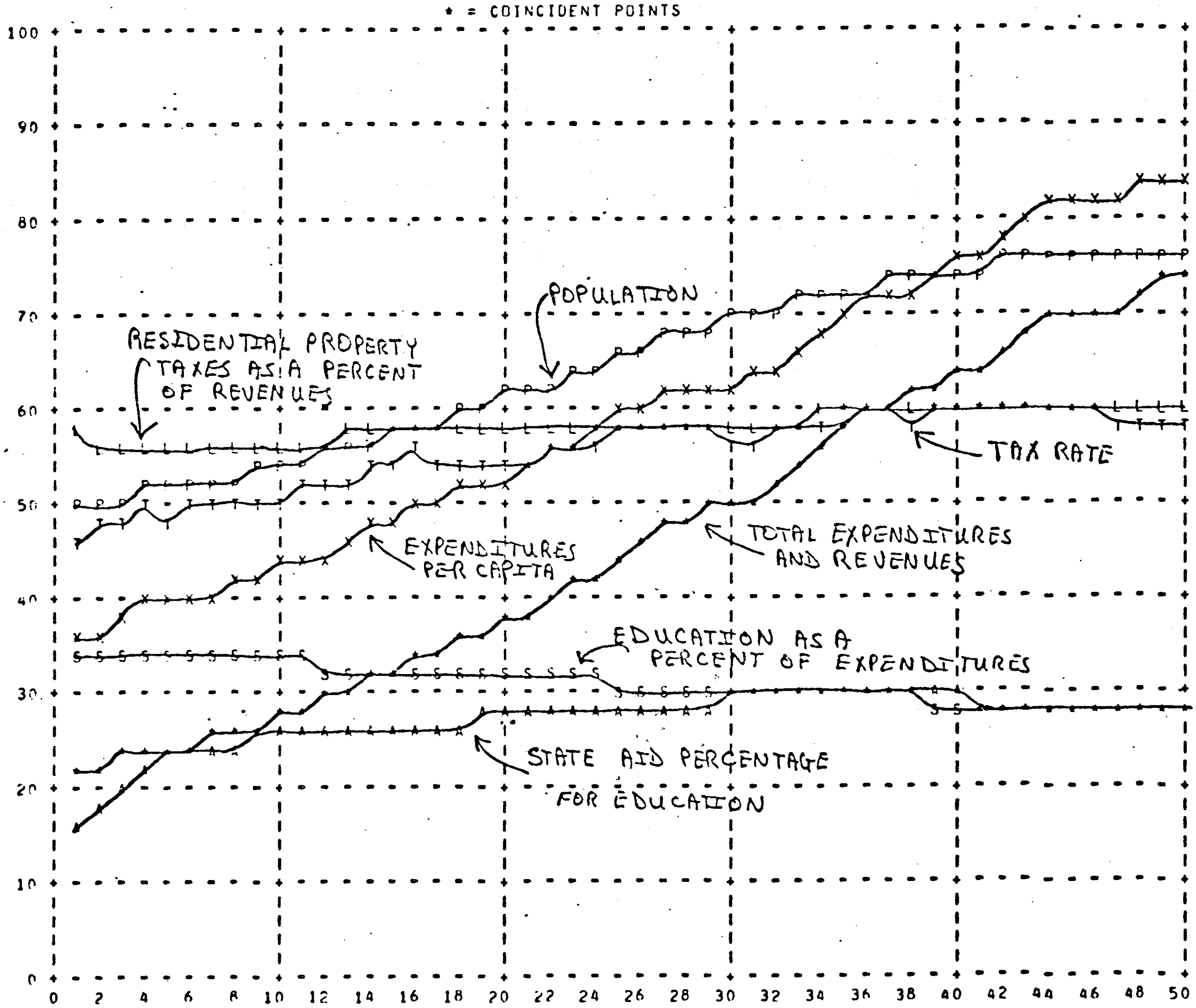


multiplier. As the print outs show, the result is a one percent increase in a budget of $73 million in year 50. This causes a slight increase in the tax rate. It might have been larger, but the state picks up part of the tab for highway expenditures. The only other observable effects were the decreases in the percentage share that other expenditure groups had in the budget.

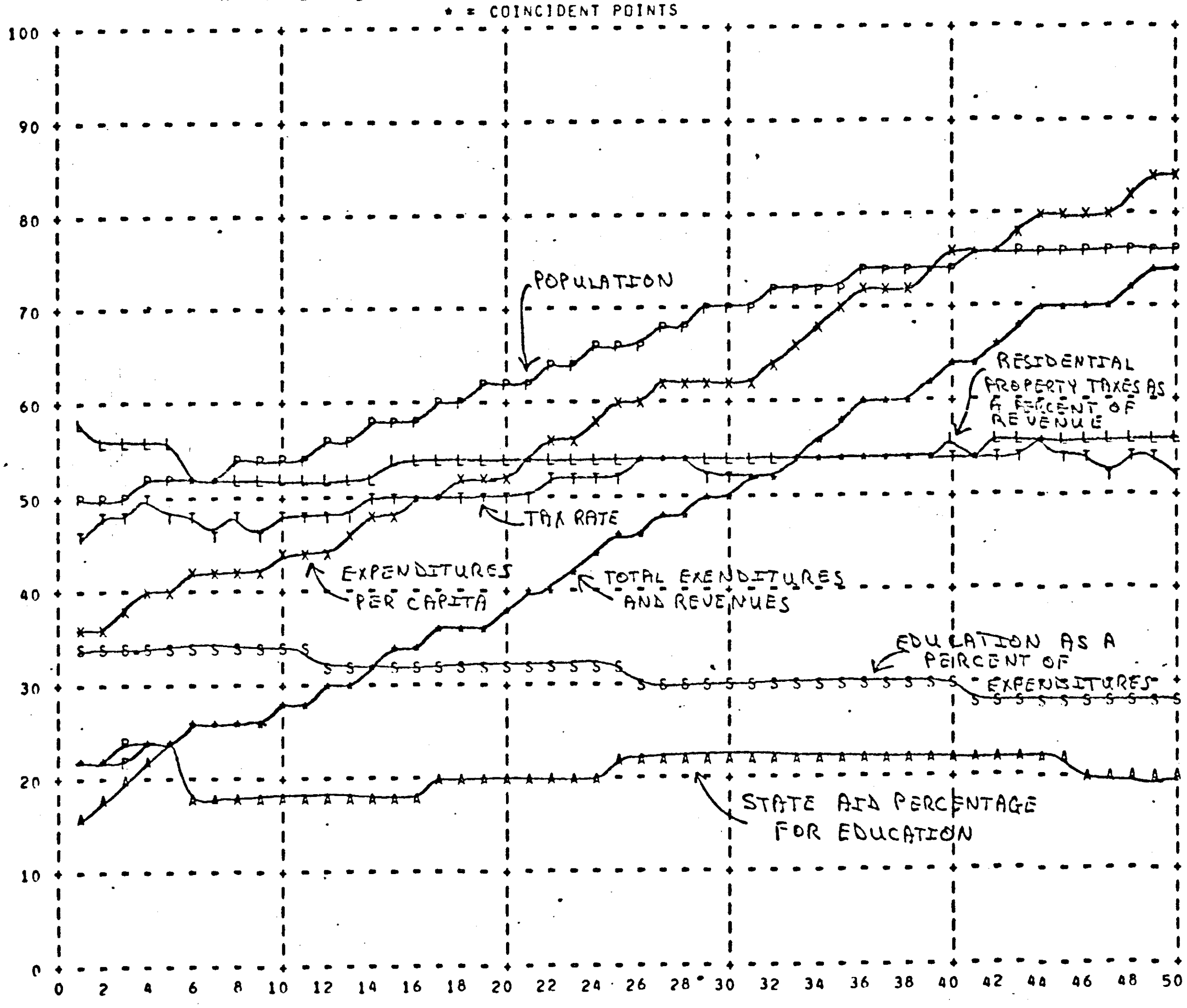
INCOMING INDUSTRY RUN

The model does not contain an explicit industrial sector. It uses a proxy in the form of industrial property values. If this overall value increases proportionately with respect to other land uses, the model assumes that a new industry must have entered Arlmont. The new industry, together with the people who entered with it, will demand additional public services. The model provides these services as best it can. The model adjusts rapidly to the new situation. The main long term effects are the lowered property tax rates and the smaller percentage of the total town revenue provided by residential property. The state aid percentage for education drops immediately with the increased assessed valuation. A variation on this run might be to have exempted the new industry from taxes for ten years but satisfied its demands for services.

This is the final alternate model that will be discussed in this thesis. A few more were attempted, but they either produced little new information, or had errors in formulation. They are included in the thesis as APPENDIX D.

	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8152.6	9259.6	10786.3	11954.2	14007.7	15219.1	17200.2	18696.8	20039.1	20859.9
PROTECTION SERVICES	2328.4	2754.9	3383.5	3990.8	5026.5	5821.2	6919.1	7826.8	8622.5	9144.5
HIGHWAY EXPENDITURES	1627.6	1817.4	2065.3	2216.2	2516.6	2669.9	2973.2	3216.0	3447.3	3604.8
WATER AND SANITATION	1402.6	1659.6	2038.2	2404.1	3028.0	3506.8	4168.1	4715.0	5136.9	5414.5
RECREATION AND PARKS	550.0	622.8	736.7	824.6	969.8	1054.8	1193.5	1303.7	1407.6	1477.9
HOSPITALS AND HEALTH	995.4	1207.7	1523.5	1834.4	2338.3	2732.9	3268.6	3712.4	4068.7	4302.4
PUBLIC ADMINISTRATION	953.8	1128.5	1366.0	1606.0	1951.7	2197.0	2559.5	2857.2	3126.9	3305.2
OTHER EXPENDITURES	4227.2	5046.0	6254.7	7370.6	9173.8	10526.7	12432.2	14004.4	15409.0	16332.5
TOTAL PUBLIC SERVICES	20237.5	23496.6	28174.0	32201.0	39012.5	43728.5	50714.4	56332.1	61257.8	64441.7
MANDATED COSTS	3055.5	3424.5	3948.4	4309.0	4980.9	5371.0	6058.8	6614.3	7140.9	7495.4
DEBT SERVICE	837.7	996.0	1040.3	1092.5	1151.6	1225.5	1305.6	1351.9	1439.0	1481.0
TOTAL EXPENDITURES	24130.7	27917.1	33162.7	37602.5	45144.9	50324.9	58078.8	64298.4	69837.7	73418.0
REVENUES										
PROPERTY TAXES	18342.9	21847.0	26225.6	29694.2	35992.6	40089.3	46717.9	52070.4	56676.1	59598.9
USER CHARGES	2688.9	2989.0	3339.7	3749.6	4216.4	4651.8	5106.9	5519.0	5899.5	6270.2
TOTAL LOCAL REVENUES	21031.8	24835.9	29565.3	33443.8	40209.0	44741.2	51824.8	57589.4	62575.6	65869.1
BORROWINGS	667.4	634.6	659.8	726.6	812.2	884.2	905.7	842.0	964.1	944.4
STATE GRANTS	2157.7	2109.0	2501.7	2867.8	3413.5	3781.6	4255.4	4583.5	4827.1	4965.1
FEDERAL GRANTS	287.5	357.0	451.4	575.8	731.0	907.9	1093.7	1281.8	1467.3	1650.5
TOTAL REVENUES	24144.4	27936.6	33178.1	37614.0	45165.7	50315.0	58079.6	64296.6	69834.2	73429.1
NET SURPLUS OR DEFICIT	13.7	19.6	15.4	11.4	20.8	-9.9	.8	-1.8	-3.5	11.0
CUM SURPLUS OR DEFICIT	538.2	567.0	621.4	564.5	615.4	559.7	648.7	647.3	674.4	705.6
PROPERTY VALUATION										
RESIDENTIAL	278714.4	310679.5	351464.6	400924.3	458210.1	520301.0	584063.3	648370.9	712537.9	776926.2
COMMERCIAL	56177.5	62356.9	69809.7	78502.1	88108.2	97898.4	107228.8	115935.9	123962.3	131443.2
INDUSTRIAL	41807.2	90097.1	101924.7	116268.0	132880.9	150887.3	169378.4	188027.6	206636.0	225308.6
TOTAL PROPERTY VALUATION	376699.1	463133.5	523198.9	595694.4	679199.2	769086.6	860670.5	952334.4	1043136.2	1133678.0
TAX RATE (PER THOUSAND)	48.7	47.2	50.1	49.8	53.0	52.1	54.3	54.7	54.3	52.6
BONDING CAPACITY										
AVAILABLE	18835.0	23156.7	26159.9	29784.7	33960.0	38454.3	43033.5	47616.7	52156.8	56683.9
USED	9307.6	11066.5	11559.2	12138.8	12795.7	13616.2	14506.2	15021.0	15988.4	16455.3
UNUSED	9527.4	12090.2	14600.8	17645.9	21164.3	24838.2	28527.3	32595.7	36168.5	40228.6
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.3	57.8	61.9	66.1	69.9	72.8	74.9	76.2	76.9
GROSS DENSITY	5.1	5.4	5.8	6.2	6.6	7.0	7.3	7.5	7.6	7.7
DEPENDENCY RATIO	87.4	86.7	85.2	83.9	82.4	80.9	79.4	78.1	77.1	76.3
PUBLIC SERVICES / CAPITA	393.6	432.7	487.1	520.3	590.3	625.9	696.5	752.1	803.9	838.2
EDUCATION AS % OF EXPEND	33.8	33.2	32.5	31.8	31.0	30.2	29.6	29.1	28.7	28.4
PROTECTION AS % OF EXPND	9.6	9.9	10.2	10.6	11.1	11.6	11.9	12.2	12.3	12.5
STATE AID % FOR EDUCAT'N	23.0	17.6	18.7	19.9	21.0	21.7	21.9	21.6	21.1	20.4
PROPERTY TAX AS % OF REV	56.2	52.5	53.1	53.1	53.8	53.9	54.6	55.1	55.4	55.6
VALUATION PER CAPITA	7326.7	8529.1	9045.7	9625.8	10277.4	11008.0	11820.7	12714.4	13689.3	14746.5
VALUATION PER PUPIL	27015.0	31180.1	33139.1	35160.7	37350.9	39882.2	42873.8	46341.7	50263.1	54613.8

P = TOTAL POPULATION
T = PROPERTY TAX RATE
L = PROPERTY TAX AS % OF REVENUE
X = PUBLIC SERVICES PER CAPITA
R = TOTAL REVENUES
E = TOTAL EXPENDITURES
S = EDUCATION AS % OF EXPENDITURES
A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



CONCLUSION

This thesis has presented an attempt to model an urban community using non-rigorous relationships. The model lacks the large number of information linkages usually found in simulation models. In some of the places where they do exist, they produce fixed reactions to events, and then only if thresholds have been reached. Because the model was not based on a specific town, it is not possible to validate this method by plugging in the values of different variables for year X and then seeing if the output corresponds with the reality of N years hence. Rather, one might place a confidence interval around specific variables and expect their real world values to lie within the bounded region. What is important are the relative changes in the system variables and the causes of these changes. By this criteria, the model works; i.e., it produces reasonable output given the basic assumptions. But the model is remarkably insensitive to new conditions. Nothing by itself seems to matter very much. This result is partly due to the limitations of the model builder and partly due to the nature of the beast. Cities possess tremendous inertia. Short of a catastrophe, they will continue down the same path for years.

The techniques employed in this model lie outside the mainstream of modeling today. In light of this, the analysis presented herein is not complete. There are at least two areas where further work would be profitable. The most promising deals with aggregation. In the model, population was disaggregated into several age groups. But for the most part, public expenditures were not keyed to them. Nor did these age groups respond to specific expenditures. The other area is the improvement of the relationships employed in the model.

The most pressing problem faced by local governments today is revenue raising. Local governments suffer from their limited tax bases. Cities and towns must compete with their neighbors both with respect to the services they offer and the taxes they levy. If its tax base is non-existant, the town can not provice even the basic services its residents require. Only the state and federal governments can provide the revenue that such towns need. The model tends to ignore this problem because Arlmont is a reasonably well-off suburban bedroom community. It contains neither a mechanism for deciding when a community requires massive outside financial support nor a mechanism to provide it.

APPENDIX A

AN ANALYSIS OF 40 CITIES AND TOWNS IN MASSACHUSETTS

In an attempt to measure the factors which influence the different sectors of local government expenditures, the author used regression analysis techniques. The data base employed is presented in Table 4. The following factors were measured simultaneously rather than individually--population, gross population density and equalized valuation per capita. The last named was used as a proxy for community wealth. (The regression output can be found following Table 5. The observation order for the lists of estimated values is identical with that in Table 4.)

The high values for the Student's-T statistic of the intercepts of three of the four equations indicate that there is some minimum level of service that all governments must provide. Wealth, as measured by per-capita valuation, seems to be the single most important explanatory variable. The other two explanatory variables have varying effects, depending on the expenditure examined. It appears, however, that large cities must spend large sums of money on services solely because of their size.

The author used the coefficients estimated by the regressions to predict government expenditures by the town of Arlington, Massachusetts. The results are compared with the actual expenditures in Table 5.

TABLE 4

EXPENDITURES PROFILE OF 40 MASSACHUSETTS CITIES AND TOWNS 1

CITY OR TOWN	POPULATION (1965)	DENSITY (PER ACRE)	EQUALIZED VALUATION PER CAPITA (1969)	TOTAL LOCAL EXPENDITURES PER CAPITA 2	PROTECTION PER CAPITA	HIGHWAYS PER CAPITA	EDUCATION PER CAPITA
BOSTON	616326	22.3	3083	562	78	23	119
WORCESTER	180341	7.4	3255	422	44	34	128
SPRINGFIELD	165520	8.2	3468	336	41	25	105
NEW BEDFORD	100176	8.2	3154	284	42	18	88
FALL RIVER	98196	4.7	2546	275	43	14	80
QUINCY	87158	8.3	4911	425	51	19	131
LOWELL	86535	10.1	3640	316	51	22	125
PITTSFIELD	56511	2.2	4955	367	41	22	147
BROOKLINE	53608	12.7	9290	467	68	31	129
EVERETT	43410	20.6	8754	379	30	19	127
SALEM	40112	7.8	5634	348	45	30	122
METHUEN	32466	2.3	4251	251	34	28	109
LEXINGTON	31388	3.0	7455	491	35	17	266
NORWOOD	28978	4.3	6039	405	37	13	212
ATTLEBORO	28690	1.6	5193	312	41	21	141
CHELSEA	27098	22.3	3026	413	68	15	119
NORTHAMPTON	27062	1.2	4989	308	34	19	155
DANVERS	24764	2.8	5734	500	26	19	122
RANDOLPH	21726	3.4	5017	362	35	22	186
TH ADAMS	19805	1.5	3686	288	30	23	121
HBRIDGE	19384	1.5	3818	205	32	10	64
DARTMOUTH	17127	0.4	6306	283	18	26	128
LUDLOW	15922	0.9	4710	290	32	16	160
SOMERSET	15180	3.3	11924	321	22	20	265
FALMOUTH	13632	0.5	13230	512	68	33	233
LONGMEADOW	13809	2.4	8690	447	34	28	243
AMESBURY	11617	1.4	3443	386	28	26	340
WILBRAHAM	9707	0.7	7417	388	23	19	364
GREAT BARRINGTON	7147	0.2	6296	297	16	27	181
WILLIAMSTOWN	7042	0.2	7100	380	17	24	213
WINCHENDON	6689	0.2	3139	294	22	26	163
ORANGE	6206	0.3	3062	279	20	25	156
LINCOLN	4463	0.5	11203	528	38	38	297
NANTUCKET	3714	0.1	18848	569	64	120	204
DOVER	3592	0.4	14477	467	36	57	258
MARION	3481	0.4	9767	383	37	22	182
WENHAM	3114	0.6	8992	318	25	24	162
CLARKSBURG	1945	0.2	3085	206	3	25	134
BERKLEY	1769	0.2	3957	264	9	22	176
MILLVILLE	1706	0.5	2931	194	15	12	95
40 TOWN AVERAGE	48433	4.2	6262	363	36	26	169
STAND. DEVIATION	101140	6.0	3670	97	17	17	70

1 BASED ON TABLES I AND II, APPENDIX I, 'STATE AID TO CITIES AND TOWNS IN MASSACHUSETTS', LEAGUE OF WOMEN VOTERS OF MASSACHUSETTS, 1970.

2 ALL EXPENDITURES ARE FROM 1968 BUDGETS; POPULATION FROM 1965 STATE CENSUS.

TABLE 5

ACTUAL AND ESTIMATED EXPENDITURES FOR ARLINGTON, MASS.

1965 Population ----- 52,482

Area ---------------- 3517.5 acres

Valuation ---- $344,032,460.

Density -------------- 14.92 persons per acre

Valuation / Capita--$6555.25

CATAGORY	ACTUAL EXPENDITURE	ESTIMATED EXPENDITURE
Total / Capita	$500.48	405.67
Protection / Capita	43.98	51.18
Highways / Capita	29.02	22.31
Education / Capita	147.78	138.17

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MULTIVARIATE ANALYSIS UNIT
FAST REGRESSION ANALYSIS SUBSYSTEM

EQUATION 1
EQUATION ID = 1
DEPENDENT VARIABLE IS PUBLIC SERVICES PER (P4)A

NUMBER OF VALID OBSERVATIONS = 40

REGRESSOR		COEFFICIENT	T(36) ON COEFFICIENT	STANDARD ERROR OF COEFFICIENT	PARTIAL CORRELATION
POPULATION	(1)	.3661928E-03	2.810539	.1302927E-03	0.4060
POPULATION DENSITY	(2)	3.322048	1.526558	2.176168	0.2346
VALUATION PER CAPITA	(3)	.1935028E-01	6.672706	.2899915E-02	0.7257
INTERCEPT		210.0396	8.967018	23.42357	

STANDARD ERROR OF ESTIMATE = 63.90724

COEFFICIENTS OF MULTIPLE CORRELATION

MULTIPLE R	0.7760
MULTIPLE R-SQUARE	0.6022
R (CORRECTED)	0.7543
R-SQUARE (CORRECTED)	0.5690

F-TEST FOR SIGNIFICANCE OF REGRESSION
F(3, 36) = 18.1

DURBIN-WATSON STATISTIC = 1.68
ESTIMATE OF AUTOCORRELATION COEFFICIENT = 0.1393

DECOMPOSITION OF VARIANCE OF THE DEPENDENT VARIABLE

	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
EXPLAINED	222589.0	3	74196.33
UNEXPLAINED	147028.8	36	4084.135
TOTALS	369617.9	39	9477.382

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ECONOMETRIC STATISTICAL SYSTEM FAST REGRESSION ANALYSIS SUBSYSTEM

EQUATION 1
EQUATION ID = 1
LINEAR REGRESSION
DEPENDENT VARIABLE IS (4) PUBLIC SERVICES PER CAPITA

OBSERVATION NUMBER	TRUE VALUE OF (4) PUBLIC SERVICES PER C	ESTIMATE OF (P4) PUBLIC SERVICES PER CAPI	RESIDUAL (TRUE-EST)	PERCENTAGE RESIDUAL (RESID/TRUE)	DEVIATION RESIDUAL (RESID/STD ERR)
1	562.000	569.441	-7.44124	-1.3	-0.11
2	422.000	363.568	58.4315	13.8	0.91
3	336.000	364.858	-28.8588	-8.5	-0.45
4	284.000	335.130	-51.1303	-18.0	-0.80
5	275.000	310.755	-35.7553	-13.0	-0.55
6	425.000	364.397	60.6029	14.2	0.94
7	316.000	345.686	-29.6866	-9.3	-0.46
8	367.000	333.817	33.1827	9.0	0.51
9	467.000	451.589	15.4109	3.2	0.24
10	379.000	463.604	-84.6047	-22.3	-1.32
11	348.000	359.778	-11.7783	-3.3	-0.18
12	251.000	311.702	-60.7020	-24.1	-0.94
13	491.000	375.665	115.334	23.4	1.80
14	405.000	351.834	53.1659	13.1	0.83
15	312.000	326.455	-14.4556	-4.6	-0.22
16	413.000	352.548	60.4519	14.6	0.94
17	308.000	320.539	-12.5391	-4.0	-0.19
18	500.000	339.516	160.483	32.0	2.51
19	362.000	326.242	35.7578	9.8	0.55
20	288.000	293.606	-5.60637	-1.9	-0.08
21	205.000	295.990	-90.9901	-44.3	-1.42
22	283.000	339.790	-56.7908	-20.0	-0.88
23	290.000	310.068	-20.0686	-6.9	-0.31
24	321.000	457.421	-136.421	-42.4	-2.13
25	512.000	472.726	39.2738	7.6	0.61
26	447.000	391.214	55.7856	12.4	0.87
27	386.000	285.669	100.330	25.9	1.56
28	388.000	359.391	28.6087	7.3	0.44
29	297.000	335.308	-38.3082	-12.8	-0.59
30	380.000	350.793	29.2069	7.6	0.45
31	294.000	274.055	19.9440	6.7	0.31
32	279.000	272.474	6.52548	2.3	0.10
33	528.000	430.057	97.9427	18.5	1.53
34	569.000	576.495	-7.49558	-1.3	-0.11
35	467.000	492.716	-25.7163	-5.5	-0.40
36	383.000	401.578	-18.5780	-4.8	-0.29
37	318.000	387.243	-69.2432	-21.7	-1.08
38	206.000	271.239	-65.2391	-31.6	-1.02
39	264.000	287.845	-23.8458	-9.0	-0.37
40	194.000	269.183	-75.1839	-38.7	-1.17

-56-

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FAST REGRESSION ANALYSIS SUBSYSTEM

EQUATION 2
EQUATION ID = 1
DEPENDENT VARIABLE IS PROTECTION PER CAPIT (5)

NUMBER OF VALID OBSERVATIONS = 40

REGRESSOR		COEFFICIENT	T(36) ON COEFFICIENT	STANDARD ERROR OF COEFFICIENT	PARTIAL CORRELATION
POPULATION	(1)	.5398905E-04	2.263288	.2385425E-04	0.3369
POPULATION DENSITY	(2)	1.367088	3.431299	.3984173	0.4768
VALUATION PER CAPITA	(3)	.1858588E-02	3.500679	.5309223E-03	0.4842
INTERCEPT		15.76702	3.676639	4.288434	

STANDARD ERROR OF ESTIMATE = 11.70026

COEFFICIENTS OF MULTIPLE CORRELATION

MULTIPLE R	0.7414
MULTIPLE R-SQUARE	0.5496
R (CORRECTED)	0.7156
R-SQUARE (CORRECTED)	0.5121

F-TEST FOR SIGNIFICANCE OF REGRESSION
F(3, 36) = 14.6

DURBIN-WATSON STATISTIC = 2.04
ESTIMATE OF AUTOCORRELATION COEFFICIENT = -0.0219

DECOMPOSITION OF VARIANCE OF THE DEPENDENT VARIABLE

	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
EXPLAINED	6015.510	3	2005.170
UNEXPLAINED	4928.264	36	136.8962
TOTALS	10943.77	39	280.6096

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-57-

MULTIVARIATE ANALYSIS UNIT
FAST REGRESSION ANALYSIS SUBSYSTEM

EQUATION 2
EQUATION ID = 1
LINEAR REGRESSION
DEPENDENT VARIABLE IS (5) PROTECTION PER CAPITA

OBSERVATION NUMBER	TRUE VALUE OF (5) PROTECTION PER CAPITA	ESTIMATE OF (5) PROTECTION PER CAPITA	RESIDUAL (TRUE-EST)	PERCENTAGE RESIDUAL (RESID/TRUE)	DEVIATION RESIDUAL (RESID/STD ERR)
1	78.0000	85.2465	-7.24650	-9.2	-0.61
2	44.0000	41.6374	2.36257	5.3	0.20
3	41.0000	42.3020	-1.30203	-3.1	-0.11
4	42.0000	38.3005	3.69944	8.8	0.31
5	43.0000	32.1760	10.8239	25.1	0.92
6	51.0000	40.8828	10.1171	19.8	0.86
7	51.0000	40.9989	10.0010	19.6	0.85
8	41.0000	30.9928	10.0071	24.4	0.85
9	68.0000	53.2770	14.7229	21.6	1.25
10	30.0000	62.4794	-32.4794	-108.2	-2.77
11	45.0000	39.1146	5.88537	13.0	0.50
12	34.0000	28.5159	5.48406	16.1	0.46
13	35.0000	35.3810	-.381025	-1.0	-0.03
14	37.0000	34.4508	2.54917	6.8	0.21
15	41.0000	29.1969	11.8030	28.7	1.00
16	68.0000	53.3191	14.6808	21.5	1.25
17	34.0000	28.1704	5.82955	17.1	0.49
18	26.0000	31.6509	-5.65094	-21.7	-0.48
19	35.0000	30.8594	4.14051	11.8	0.35
20	30.0000	25.7405	4.25943	14.1	0.36
21	32.0000	25.9586	6.04134	18.8	0.51
22	18.0000	29.0123	-11.0123	-61.1	-0.94
23	32.0000	26.6364	5.36354	16.7	0.45
24	22.0000	43.3146	-21.3146	-96.8	-1.82
25	68.0000	41.7672	26.2327	38.5	2.24
26	34.0000	35.9411	-1.94112	-5.7	-0.16
27	28.0000	24.7476	3.25231	11.6	0.27
28	23.0000	31.0108	-8.01086	-34.8	-0.68
29	16.0000	28.1907	-12.1907	-76.1	-1.04
30	17.0000	29.6657	-12.6657	-74.5	-1.08
31	22.0000	22.2993	-.299360	-1.3	-0.02
32	20.0000	22.1710	-2.17100	-10.8	-0.18
33	38.0000	37.4876	.512359	1.3	0.04
34	64.0000	51.1577	12.8422	20.0	1.09
35	36.0000	43.3751	-7.37516	-20.4	-0.63
36	37.0000	34.6283	2.37164	6.4	0.20
37	25.0000	33.4997	-8.49971	-33.9	-0.72
38	3.00000	21.9326	-18.9326	-631.0	-1.61
39	9.00000	23.4592	-14.4592	-160.6	-1.23
40	15.0000	22.0500	-7.05004	-47.0	-0.60

EQUATION 3
EQUATION ID = 1
DEPENDENT VARIABLE IS HIGHWAYS PER CAPITA (6)

NUMBER OF VALID OBSERVATIONS = 40

REGRESSOR		COEFFICIENT	T(36) ON COEFFICIENT	STANDARD ERROR OF COEFFICIENT	PARTIAL CORRELATION
POPULATION	(1)	.3715477E-04	1.465542	.2535223E-04	0.2257
POPULATION DENSITY	(2)	-.4403793	-1.040011	.4234368	-0.1622
VALUATION PER CAPITA	(3)	.3435034E-02	6.087648	.5642628E-03	0.6934
INTERCEPT		4.410758	.9677517	4.557737	

STANDARD ERROR OF ESTIMATE = 12.43501

COEFFICIENTS OF MULTIPLE CORRELATION

MULTIPLE R	0.7225
MULTIPLE R-SQUARE	0.5221
R (CORRECTED)	0.6944
R-SQUARE (CORRECTED)	0.4823

F-TEST FOR SIGNIFICANCE OF REGRESSION
F(3, 36) = 13.1

DURBIN-WATSON STATISTIC = 1.84
ESTIMATE OF AUTOCORRELATION COEFFICIENT = 0.0786

DECOMPOSITION OF VARIANCE OF THE DEPENDENT VARIABLE

	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
EXPLAINED	6082.436	3	2027.478
UNEXPLAINED	5566.663	36	154.6295
TOTALS	11649.10	39	298.6948

-59-

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EQUATION 3
EQUATION ID = 1
LINEAR REGRESSION
,DEPENDENT VARIABLE IS (6) HIGHWAYS PER CAPITA

OBSERVATION NUMBER	TRUE VALUE OF (6) HIGHWAYS PER CAPITA	ESTIMATE OF (6) HIGHWAYS PER CAPITA	RESIDUAL (TRUE-EST)	PERCENTAGE RESIDUAL (RESID/TRUE)	DEVIATION RESIDUAL (RESID/STD ERR)
1	23.0000	28.0827	-5.08279	-22.0	-0.40
2	34.0000	19.0436	14.9563	43.9	1.20
3	25.0000	18.8799	6.12001	24.4	0.49
4	18.0000	15.3404	2.65950	14.7	0.21
5	14.0000	14.7506	-.750677	-5.3	-0.06
6	19.0000	20.8825	-1.88253	-9.9	-0.15
7	22.0000	15.6863	6.31361	28.6	0.50
8	22.0000	22.5748	-.574875	-2.6	-0.04
9	31.0000	32.7238	-1.72386	-5.5	-0.13
10	19.0000	27.0415	-8.04150	-42.3	-0.64
11	30.0000	21.8047	8.19523	27.3	0.65
12	28.0000	19.2206	8.77932	31.3	0.70
13	17.0000	29.8764	-12.8764	-75.7	-1.03
14	13.0000	24.3328	-11.3328	-87.1	-0.91
15	21.0000	22.5985	-1.59852	-7.6	-0.12
16	15.0000	5.99852	9.00147	60.0	0.72
17	19.0000	22.0138	-3.01387	-15.8	-0.24
18	19.0000	23.7748	-4.77485	-25.1	-0.38
19	22.0000	20.9715	1.02849	4.6	0.08
20	23.0000	17.1463	5.85360	25.4	0.47
21	10.0000	17.5841	-7.58419	-75.8	-0.60
22	26.0000	26.5143	-.514346	-1.9	-0.04
23	16.0000	20.7786	-4.77866	-29.8	-0.38
24	20.0000	44.4615	-24.4615	-122.3	-1.96
25	33.0000	50.1569	-17.1569	-51.9	-1.37
26	28.0000	33.7184	-5.71845	-20.4	-0.45
27	26.0000	16.0405	9.95941	38.3	0.80
28	19.0000	29.9493	-10.9493	-57.6	-0.88
29	27.0000	26.1963	.803609	2.9	0.06
30	24.0000	28.9582	-4.95826	-20.6	-0.39
31	26.0000	15.3352	10.6647	41.0	0.85
32	25.0000	15.0358	9.96412	39.8	0.80
33	38.0000	42.8482	-4.84825	-12.7	-0.38
34	120.000	69.2392	50.7607	42.3	4.08
35	57.0000	54.1082	2.89179	5.0	0.23
36	22.0000	37.9236	-15.9236	-72.3	-1.28
37	24.0000	35.1383	-11.1383	-46.4	-0.89
38	25.0000	14.9741	10.0258	40.1	0.80
39	22.0000	17.9910	4.00898	18.2	0.32
40	12.0000	14.3020	-2.30208	-19.1	-0.18

EQUATION 4
EQUATION ID = 1
DEPENDENT VARIABLE IS EDUCATION PER CAPITA (7)

NUMBER OF VALID OBSERVATIONS = 40

REGRESSOR		COEFFICIENT	T(36) ON COEFFICIENT	STANDARD ERROR OF COEFFICIENT	PARTIAL CORRELATION
POPULATION	(1)	.6477615E-05	.5328568E-01	.1215638E-03	0.0084
POPULATION DENSITY	(2)	-3.104416	-1.528984	2.030378	-0.2349
VALUATION PER CAPITA	(3)	.8636370E-02	3.191989	.2705638E-02	0.4505
INTERCEPT		127.5385	5.835847	21.85433	

STANDARD ERROR OF ESTIMATE = 59.62584

COEFFICIENTS OF MULTIPLE CORRELATION

MULTIPLE R	0.5680
MULTIPLE R-SQUARE	0.3226
R (CORRECTED)	0.5159
R-SQUARE (CORRECTED)	0.2662

F-TEST FOR SIGNIFICANCE OF REGRESSION
F(3, 36) = 5.7

DURBIN-WATSON STATISTIC = 1.25
ESTIMATE OF AUTOCORRELATION COEFFICIENT = 0.3634

DECOMPOSITION OF VARIANCE OF THE DEPENDENT VARIABLE

	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
EXPLAINED	60968.79	3	20322.93
UNEXPLAINED	127988.7	36	3555.241
TOTALS	188957.5	39	4845.064

EQUATION 4
EQUATION ID = 1
LINEAR REGRESSION
DEPENDENT VARIABLE IS (7) EDUCATION PER CAPITA

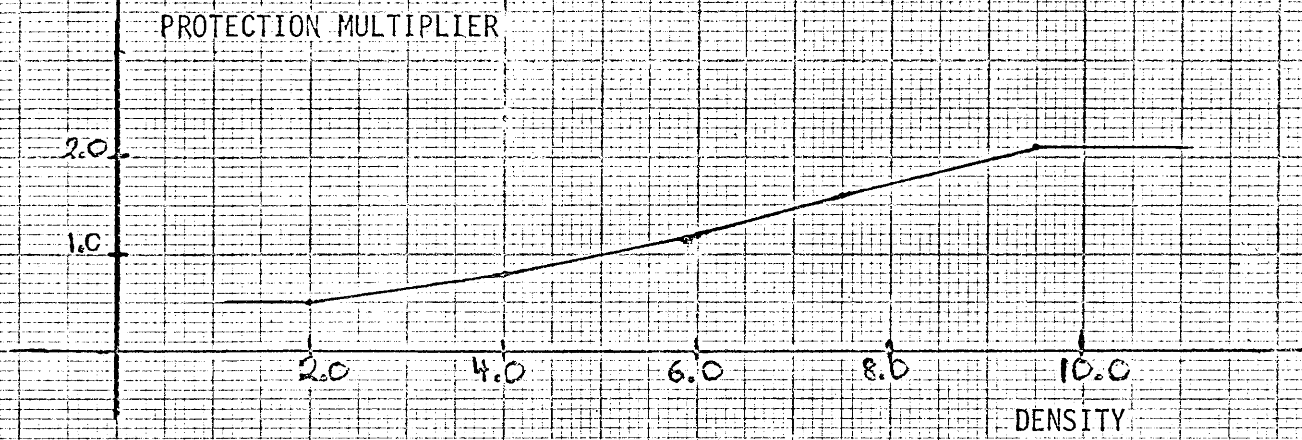
OBSERVATION NUMBER	TRUE VALUE OF (7) EDUCATION PER CAPITA	ESTIMATE OF (7) EDUCATION PER CAPITA	RESIDUAL (TRUE-EST)	PERCENTAGE RESIDUAL (RESID/TRUE)	DEVIATION RESIDUAL (RESID/STD ERR)
1	119.000	88.9516	30.0483	25.2	0.50
2	128.000	133.917	-5.91790	-4.6	-0.09
3	105.000	133.233	-28.2330	-26.8	-0.47
4	88.0000	129.855	-41.8557	-47.5	-0.70
5	80.0000	135.683	-55.6838	-69.6	-0.93
6	131.000	144.890	-13.8905	-10.6	-0.23
7	125.000	128.212	-3.21206	-2.5	-0.05
8	147.000	163.961	-16.9610	-11.5	-0.28
9	129.000	168.715	-39.7157	-30.7	-0.66
10	127.000	139.612	-12.6122	-9.9	-0.21
11	122.000	152.136	-30.1364	-24.7	-0.50
12	109.000	157.428	-48.4282	-44.4	-0.81
13	266.000	182.899	83.1006	31.2	1.39
14	212.000	166.495	45.5049	21.4	0.76
15	141.000	167.516	-26.5164	-18.8	-0.44
16	119.000	84.6677	34.3322	28.8	0.57
17	155.000	167.002	-12.0029	-7.7	-0.20
18	122.000	168.388	-46.3886	-38.0	-0.77
19	186.000	160.574	25.4259	13.6	0.42
20	121.000	154.836	-33.8365	-27.9	-0.56
21	64.0000	155.979	-91.9794	-143.7	-1.54
22	128.000	180.744	-52.7448	-41.2	-0.88
23	160.000	165.473	-5.47313	-3.4	-0.09
24	265.000	220.242	44.7574	16.8	0.75
25	233.000	240.381	-7.38127	-3.1	-0.12
26	243.000	195.235	47.7645	19.6	0.80
27	340.000	152.913	187.086	55.0	3.13
28	364.000	189.539	174.460	47.9	2.92
29	181.000	181.200	-.200546	-0.1	-0.00
30	213.000	188.173	24.8268	11.6	0.41
31	163.000	153.932	9.06778	5.5	0.15
32	156.000	153.159	2.84059	1.8	0.04
33	297.000	222.829	74.1702	24.9	1.24
34	204.000	289.973	-85.9735	-42.1	-1.44
35	258.000	251.433	6.56662	2.5	0.11
36	182.000	210.734	-28.7344	-15.7	-0.48
37	162.000	203.277	-41.2774	-25.4	-0.69
38	134.000	153.450	-19.4500	-14.5	-0.32
39	176.000	161.174	14.8255	8.4	0.24
40	95.0000	151.172	-56.1725	-59.1	-0.94

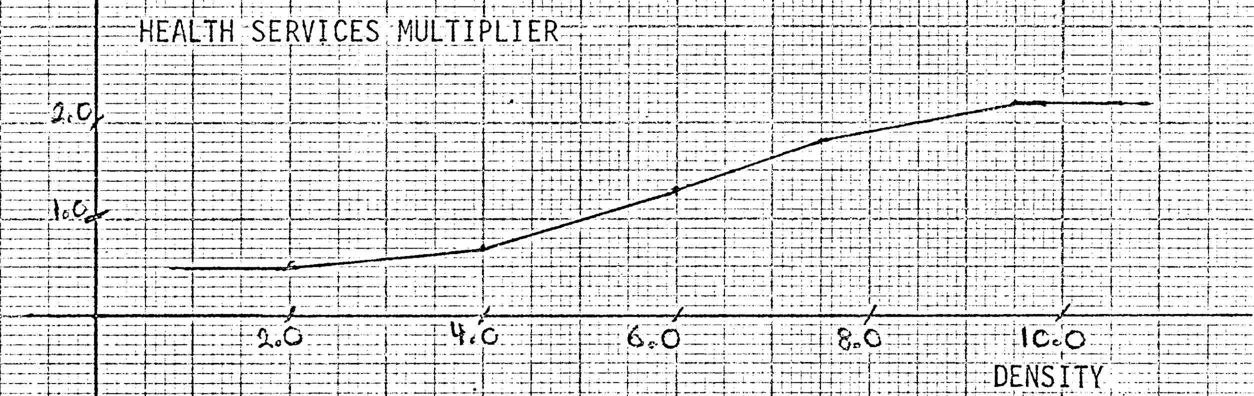
APPENDIX B

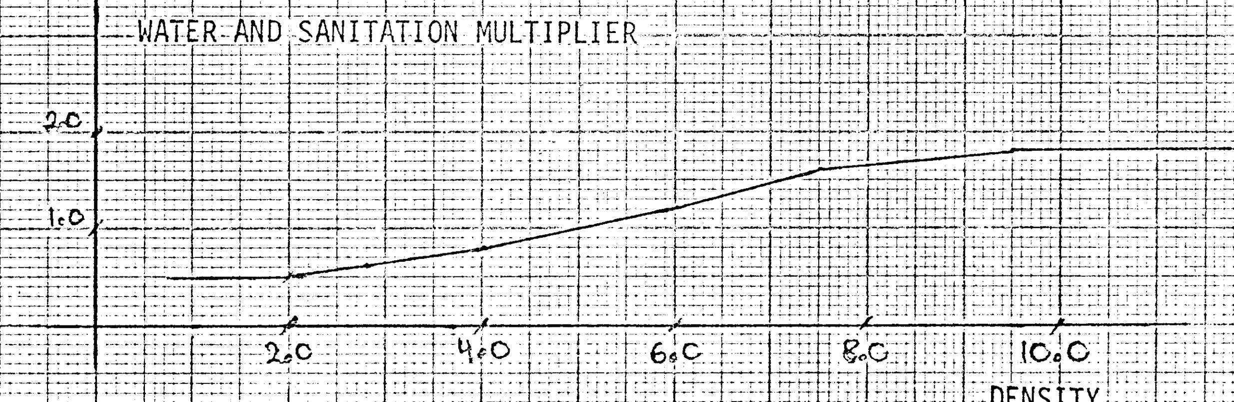
MULTIPLIER FUNCTIONS

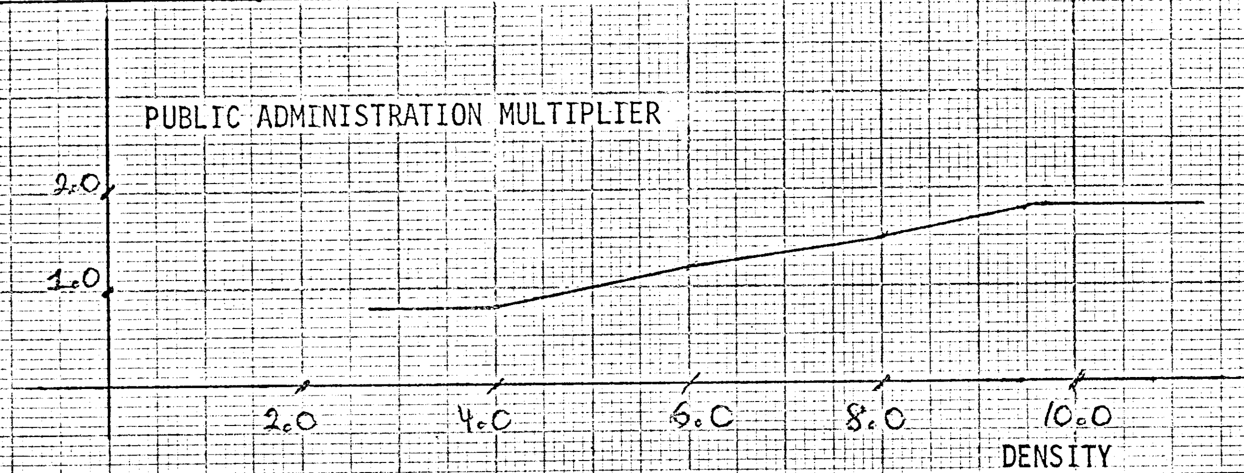
The following pages depict the multiplier functions used in the BASIC MODEL RUN. (The declining birth rate multiplier is not included.) The horizontal tails on either end of each multiplier lie beyond the range of abscissa values used in the model. They are not assumptions about the shape of these functions.

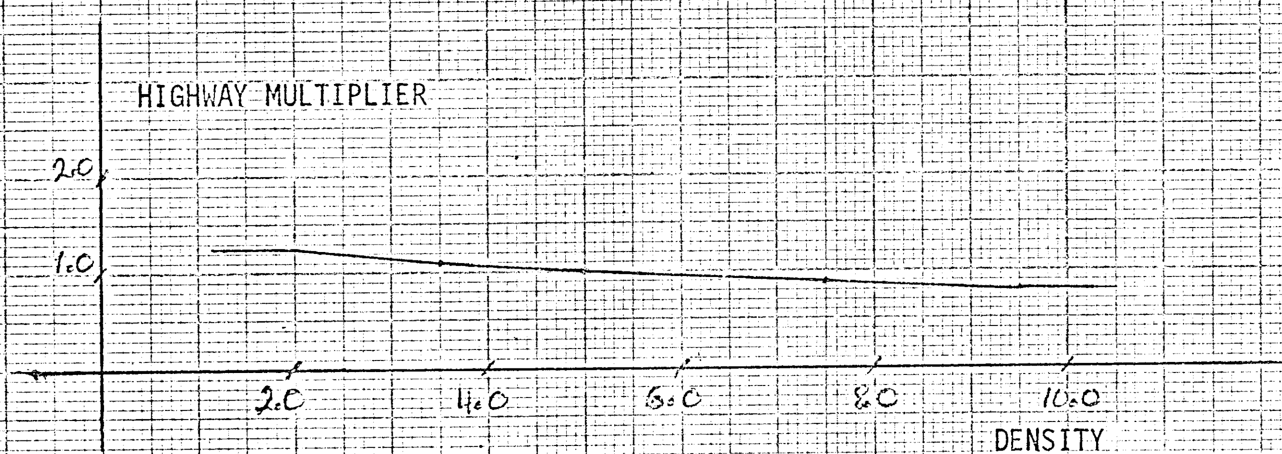
In the REVERSED HIGHWAY MULTIPLIER RUN, the same ordinate values as the ones depicted here were used, but in reverse order.

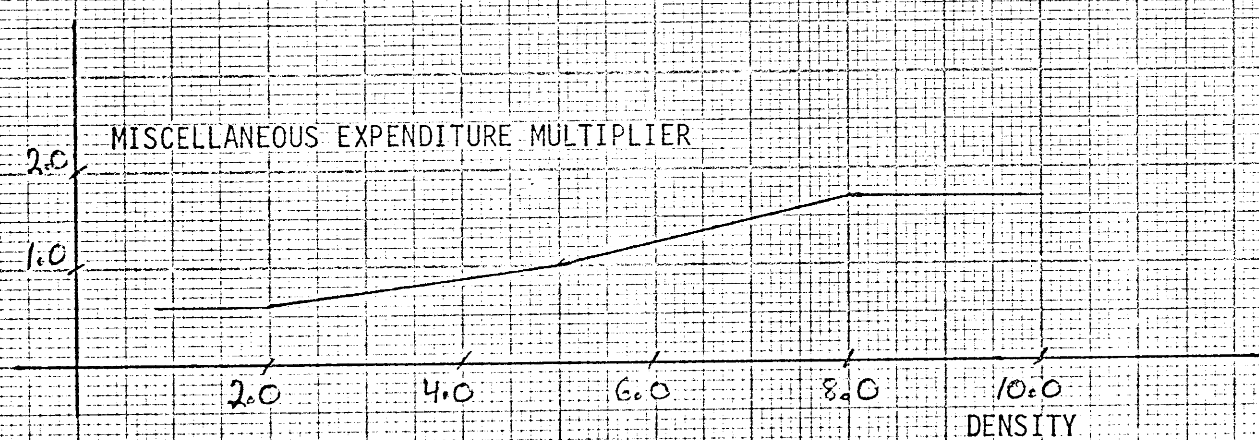

PROTECTION MULTIPLIER
2.0
1.0
2.0
4.0
6.0
8.0
10.0
DENSITY

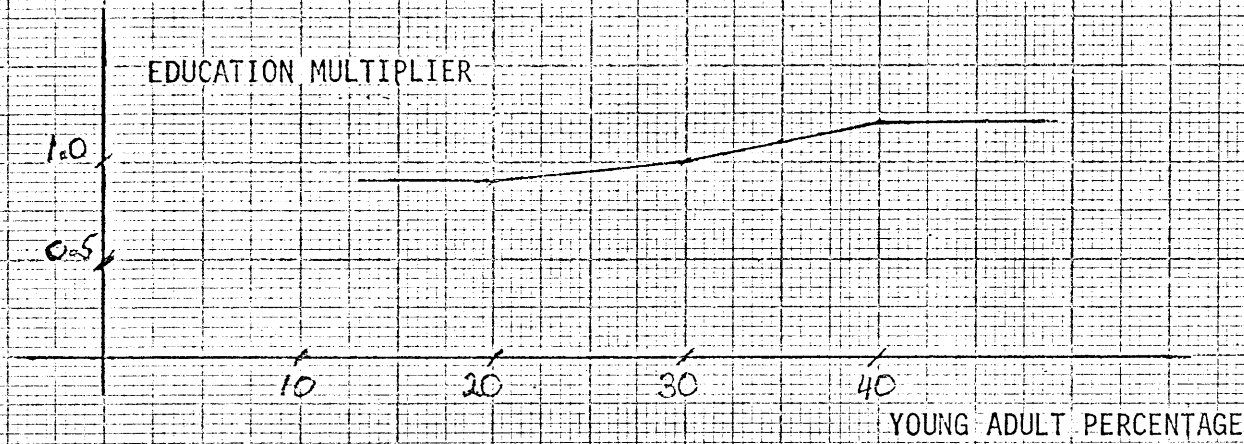

HEALTH SERVICES MULTIPLIER
2.0
1.0
2.0
4.0
6.0
8.0
10.0
DENSITY

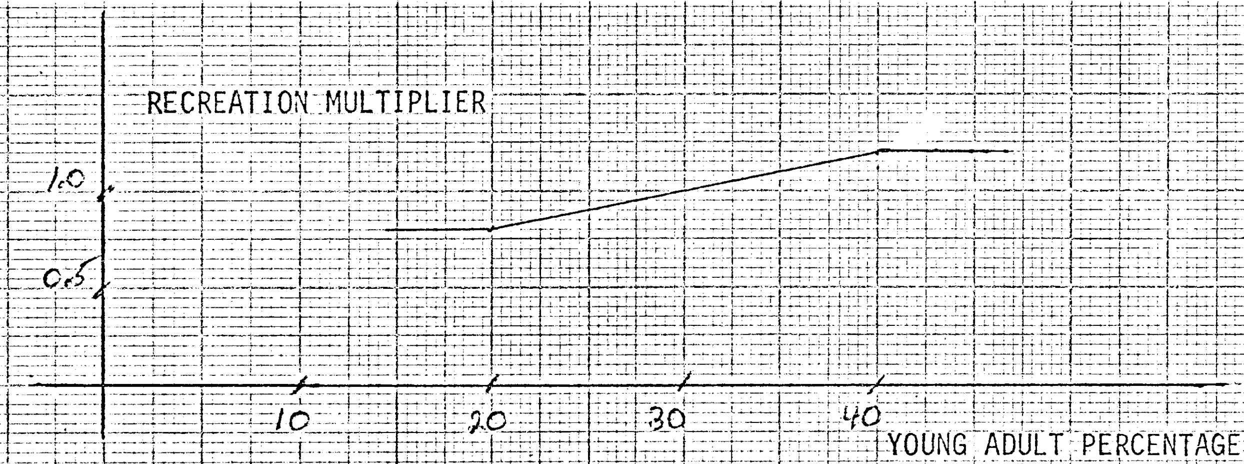

WATER AND SANITATION MULTIPLIER
2.0
1.0
2.0
4.0
6.0
8.0
10.0
DENSITY

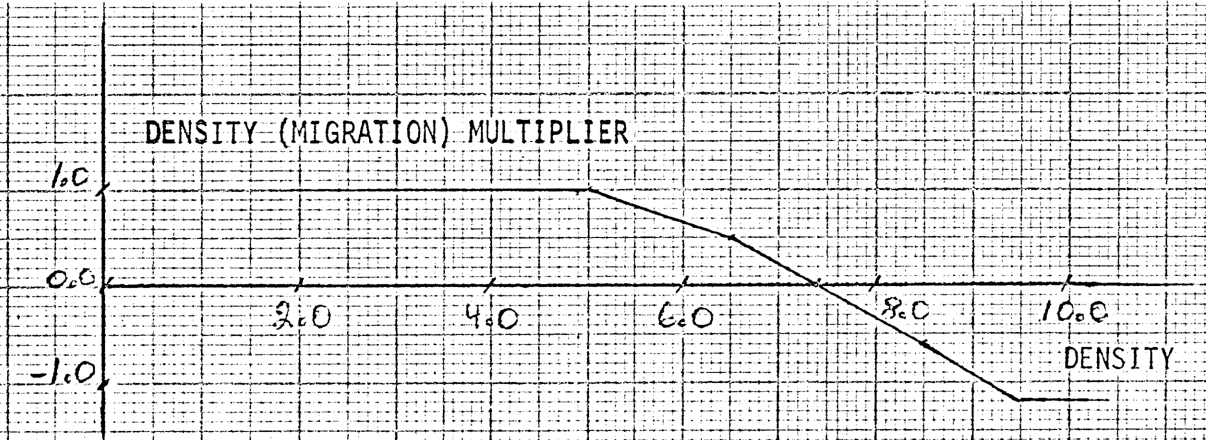

PUBLIC ADMINISTRATION MULTIPLIER
2.0
1.0
2.0
4.0
6.0
8.0
10.0
DENSITY


HIGHWAY MULTIPLIER
2.0
1.0
2.0
4.0
6.0
8.0
10.0
DENSITY


MISCELLANEOUS EXPENDITURE MULTIPLIER
2.0
1.0
2.0
4.0
6.0
8.0
10.0
DENSITY


EDUCATION MULTIPLIER
1.0
0.5
10
20
30
40
YOUNG ADULT PERCENTAGE


RECREATION MULTIPLIER
1.0
0.5
10
20
30
40
YOUNG ADULT PERCENTAGE


DENSITY (MIGRATION) MULTIPLIER
1.0
0.0
-1.0
2.0
4.0
6.0
8.0
10.0
DENSITY

APPENDIX C

RUNNING THE MODEL

The model described in this thesis was written in FORTRAN-IV as implemented on the Burrough's B-3500 computer. This is a variable-length word machine which permits the user to select his own computational precision. Integer arithmetic was performed at 7-place precision and floating point arithmetic at 12-place (mantissa length). The major restriction on using the B-3500 is on program size. In other implementations of the model, the user may be able to store all data in core, rather than saving certain results on disk for later access.

The program can be converted to other computers with the following modifications:

1.) SUBROUTINE ALPACK is an assembly language module which is brought into the program at load time. It may be dispensed with if FORMAT statement numbers 911 and 912 in SUBROUTINE PLOTX are changed from "...12A8, A5..." to "...101A1...".

2.) SUBROUTINE UNIFRM is a random number generator which produces a uniform distribution of numbers between 0.0 and 1.0. Any similar routine may be substituted for it.

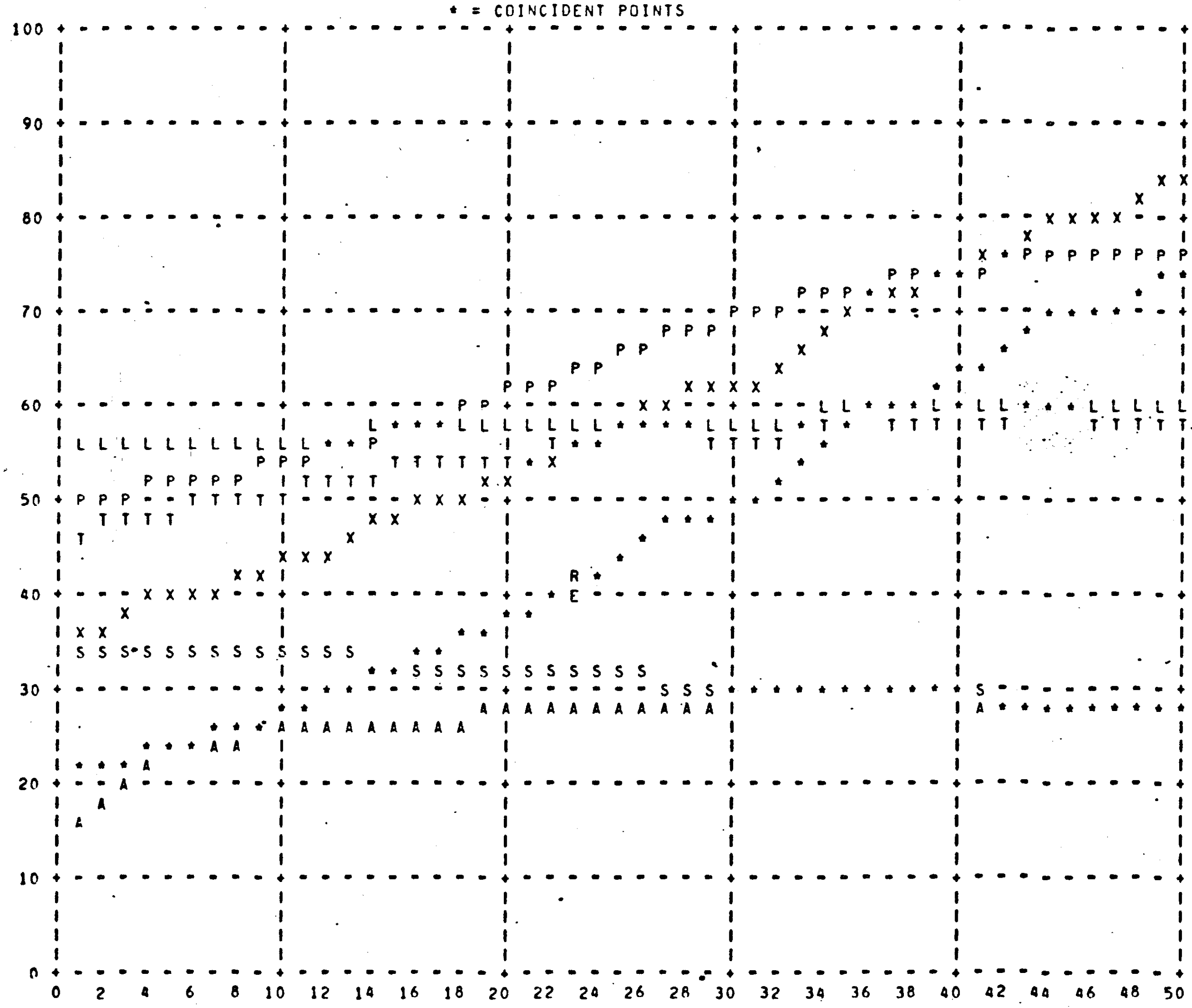
APPENDIX D

OTHER MODEL RUNS

The following print-outs are from other variations on the basic model which was discussed in the main body of this thesis. The titles on each page indicate the subject of the particular run. (N.B.: The DEPARTING INDUSTRY RUN has several errors in its formulation.)

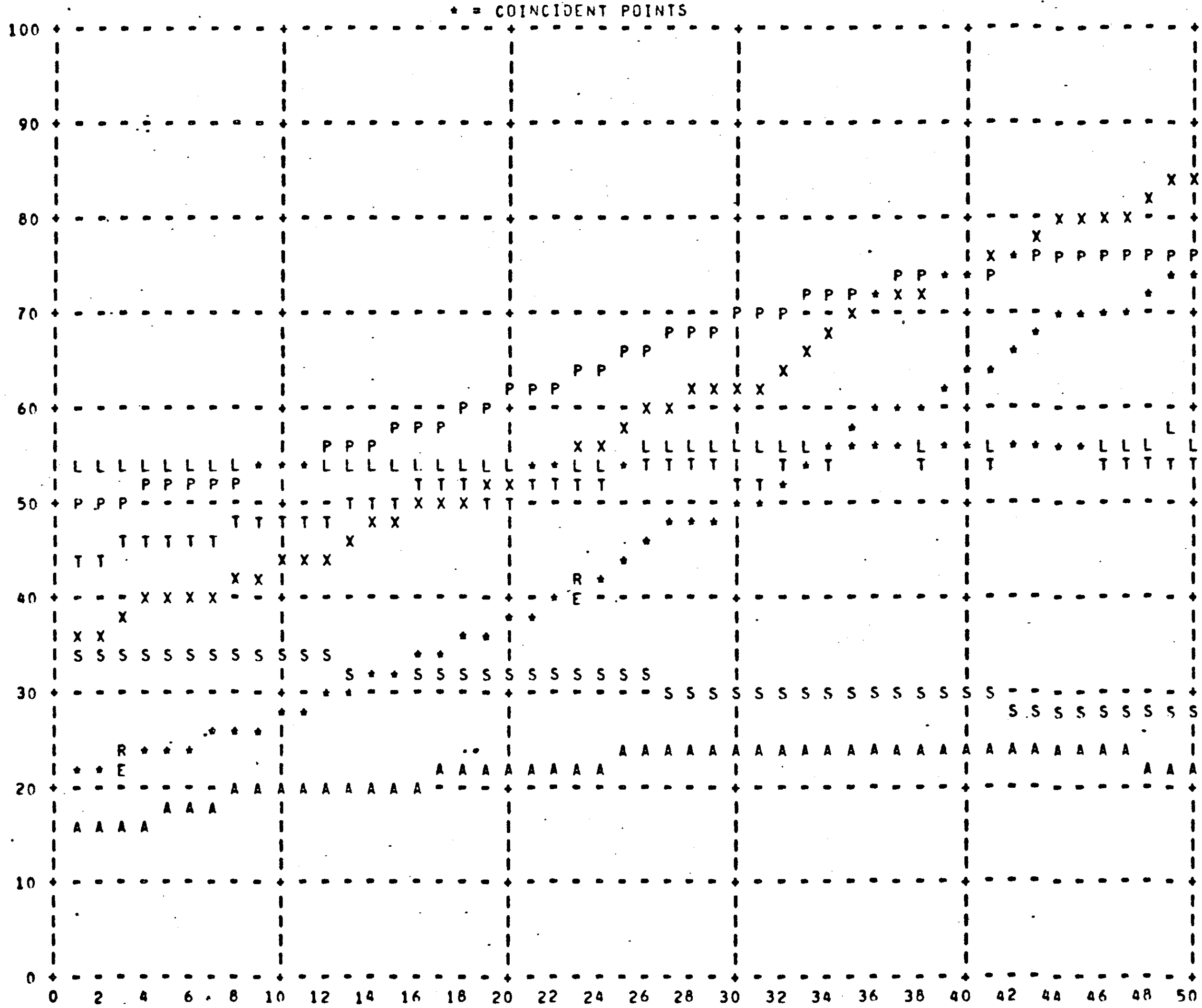
	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8152.6	9207.9	10696.7	11834.2	13859.3	15078.2	17078.0	18611.7	19993.3	20849.3
PROTECTION SERVICES	2328.4	2725.7	3334.4	3910.6	4919.6	5713.4	6818.0	7746.5	8570.3	9117.8
HIGHWAY EXPENDITURES	1627.6	1795.2	2037.2	2184.2	2479.5	2633.2	2936.2	3180.3	3414.1	3573.0
WATER AND SANITATION	1402.6	1642.0	2008.7	2355.8	2963.6	3441.8	4107.2	4666.6	5116.4	5404.5
RECREATION AND PARKS	550.0	618.9	730.4	816.5	959.9	1045.8	1185.7	1298.0	1404.2	1476.7
HOSPITALS AND HEALTH	995.4	1192.0	1496.8	1794.4	2284.8	2678.7	3217.7	3871.8	4048.1	4292.0
PUBLIC ADMINISTRATION	953.8	1116.6	1365.9	1581.7	1919.9	2165.3	2530.2	2834.1	3111.5	3297.4
OTHER EXPENDITURES	4227.2	4986.9	6155.6	7232.6	8990.8	10342.5	12259.3	13866.1	15314.2	16281.5
TOTAL PUBLIC SERVICES	20237.5	23285.2	27825.5	31710.0	38377.4	43098.9	50132.4	55875.2	60972.1	64292.2
MANDATED COSTS	3055.5	3405.6	3918.8	4270.7	4933.5	5326.1	6018.4	6582.9	7119.6	7483.9
DEBT SERVICE	723.8	831.3	927.3	1022.8	1118.6	1223.1	1331.2	1409.8	1519.8	1591.7
TOTAL EXPENDITURES	24016.8	27522.1	32671.6	37003.5	44429.6	49648.1	57481.9	63867.9	69611.5	73367.8
REVENUES										
PROPERTY TAXES	18229.0	21045.0	25300.2	28652.2	34777.7	38873.6	45479.9	50902.4	55621.3	58638.9
USER CHARGES	2688.9	2972.5	3314.7	3716.3	4176.3	4612.9	5072.9	5492.8	5881.9	6260.6
TOTAL LOCAL REVENUES	20917.9	24017.5	28614.9	32368.5	38954.1	43486.5	50552.8	56395.2	61503.2	64899.6
BORROWINGS	667.4	631.1	654.8	720.1	804.5	876.8	899.7	838.0	961.2	942.9
STATE GRANTS	2157.7	2540.1	2973.0	3361.2	3975.3	4382.9	4951.9	5363.9	5685.4	5891.2
FEDERAL GRANTS	287.5	352.8	444.2	564.9	716.3	891.9	1078.4	1269.0	1458.2	1645.2
TOTAL REVENUES	24030.5	27541.6	32686.9	37014.8	44450.1	49638.2	57482.7	63866.1	69608.0	73378.5
NET SURPLUS OR DEFICIT	13.7	19.5	15.3	11.3	20.6	-9.9	.8	-1.8	-3.5	11.0
CUM SURPLUS OR DEFICIT	538.2	566.8	620.7	564.3	614.7	559.5	647.8	646.4	673.4	704.6
PROPERTY VALUATION										
RESIDENTIAL	278714.4	309152.4	349111.5	397685.4	454175.1	516184.5	580282.6	645267.7	710267.5	775491.8
COMMERCIAL	56177.5	62013.3	69287.7	77805.0	87271.2	97079.8	106514.1	115385.5	123593.4	131241.8
INDUSTRIAL	41807.2	46372.9	52366.7	59652.8	68126.3	77427.7	87042.4	96790.2	106540.1	116323.8
TOTAL PROPERTY VALUATION	376699.1	417538.5	470765.9	535143.2	609572.6	690692.0	773839.1	857443.3	940401.0	1023057.4
TAX RATE (PER THOUSAND)	48.4	50.4	53.7	53.5	57.1	56.3	58.8	59.4	59.1	57.3
BONDING CAPACITY										
AVAILABLE	18835.0	20876.9	23538.3	26757.2	30478.6	34534.6	38692.0	42872.2	47020.1	51152.9
USED	9869.6	11336.2	12644.7	13946.9	15254.1	16678.1	18152.1	19224.0	20723.9	21704.5
UNUSED	8965.4	9540.7	10893.6	12810.3	15224.5	17856.5	20539.9	23648.1	26296.2	29448.4
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.0	57.4	61.3	65.5	69.3	72.3	74.5	76.0	76.8
GROSS DENSITY	5.1	5.4	5.7	6.1	6.5	6.9	7.2	7.5	7.6	7.7
DEPENDENCY RATIO	87.4	86.8	85.3	83.9	82.5	80.9	79.5	78.2	77.1	76.3
PUBLIC SERVICES / CAPITA	393.6	431.2	484.7	517.0	586.3	622.1	693.1	749.5	802.5	837.6
EDUCATION AS % OF EXPEND	33.9	33.5	32.7	32.0	31.2	30.4	29.7	29.1	28.7	28.4
PROTECTION AS % OF EXPND	9.7	9.9	10.2	10.6	11.1	11.5	11.9	12.1	12.3	12.4
STATE AID % FOR EDUCAT'N	23.0	25.3	26.2	27.3	28.4	29.0	29.2	29.1	28.6	28.1
PROPERTY TAX AS % OF REV	56.1	56.6	57.4	57.5	58.3	58.5	59.3	60.0	60.4	60.6
VALUATION PER CAPITA	7326.7	7732.0	8200.4	8724.9	9312.3	9969.3	10699.4	11502.1	12377.9	13328.0
VALUATION PER PUPIL	27015.0	28264.1	30058.6	31898.0	33876.3	36150.7	38829.5	41932.7	45443.6	49343.6

P = TOTAL POPULATION
T = PROPERTY TAX RATE
L = PROPERTY TAX AS % OF REVENUE
X = PUBLIC SERVICES PER CAPITA
R = TOTAL REVENUES
E = TOTAL EXPENDITURES
S = EDUCATION AS % OF EXPENDITURES
A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



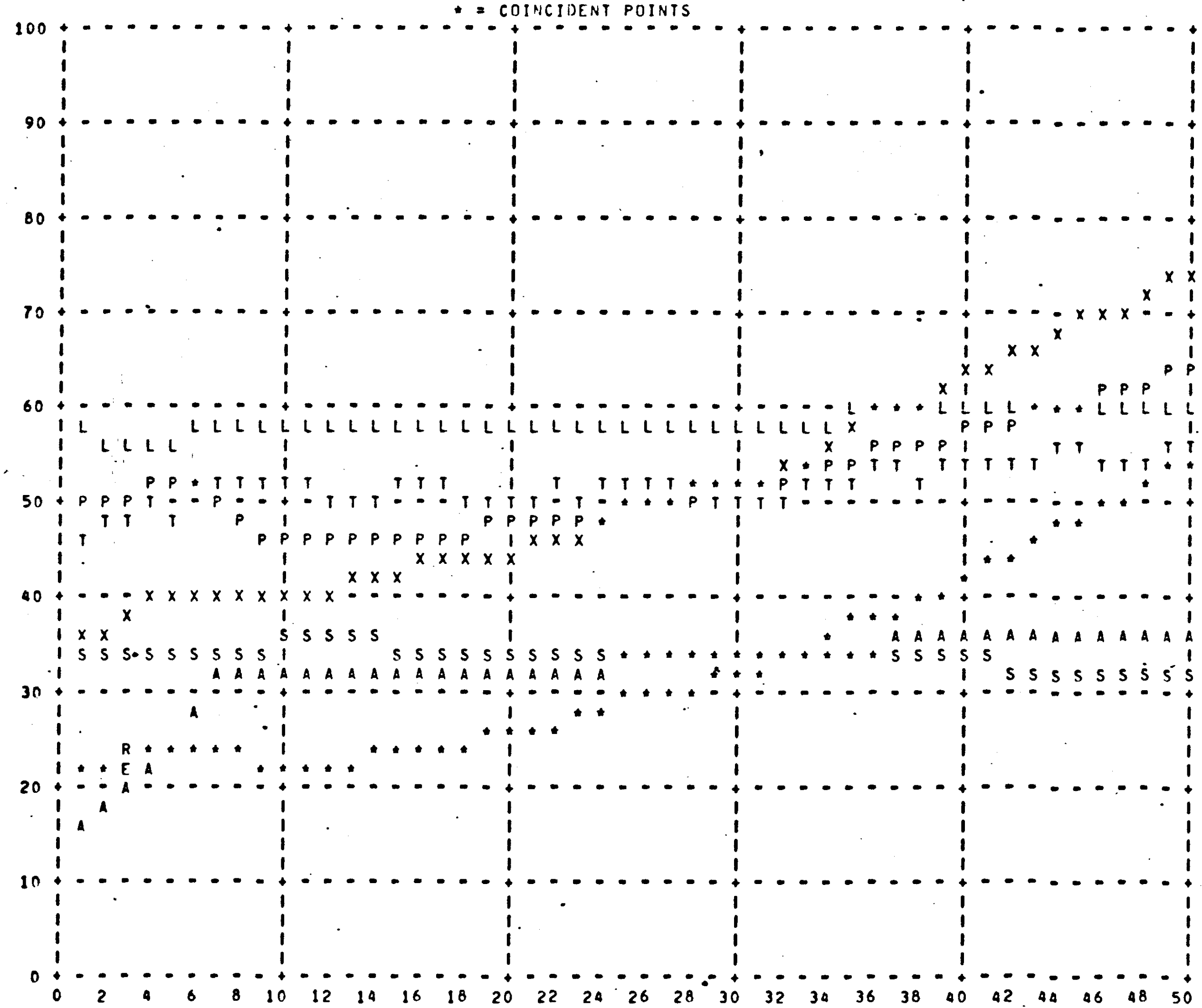
	5	10	15	20	25	30	35	40	45	50
ENDITURES										
EDUCATION EXPENDITURES	8152.6	9207.9	10696.7	11834.2	13859.3	15078.2	17078.0	18611.7	19993.3	20849.3
PROTECTION SERVICES	2328.4	2725.7	3334.4	3910.6	4919.6	5713.4	6818.0	7746.5	8570.3	9117.8
HIGHWAY EXPENDITURES	1627.6	1795.2	2037.2	2184.2	2479.5	2633.2	2936.2	3180.3	3414.1	3573.0
WATER AND SANITATION	1402.6	1642.0	2008.7	2355.8	2963.6	3441.8	4107.2	4666.6	5116.4	5404.5
RECREATION AND PARKS	550.0	618.9	730.4	816.5	959.9	1045.8	1185.7	1298.0	1404.2	1476.7
HOSPITALS AND HEALTH	995.4	1192.0	1496.8	1794.4	2284.8	2678.7	3217.7	3671.8	4048.1	4292.0
PUBLIC ADMINISTRATION	953.8	1116.6	1365.9	1581.7	1919.9	2165.3	2530.2	2834.1	3111.5	3297.4
OTHER EXPENDITURES	4227.2	4986.9	6155.6	7232.6	8990.8	10342.5	12259.3	13866.1	15314.2	16281.5
TOTAL PUBLIC SERVICES	20237.5	23285.2	27825.5	31710.0	38377.4	43098.9	50132.4	55875.2	60972.1	64292.2
MANDATED COSTS	3055.5	3405.6	3918.8	4270.7	4933.5	5326.1	6018.4	6582.9	7119.6	7483.9
DEBT SERVICE	837.7	909.7	971.8	1037.0	1105.8	1187.1	1273.2	1325.0	1416.7	1463.0
TOTAL EXPENDITURES	24130.7	27600.5	32716.1	37017.7	44416.8	49612.1	57424.0	63783.1	69508.5	73239.2
VENUES										
PROPERTY TAXES	18633.5	21433.9	25695.1	29039.5	35192.0	39290.6	45936.9	51382.6	56128.1	59159.8
USER CHARGES	2688.9	2972.5	3314.7	3716.3	4176.3	4612.9	5072.9	5492.8	5881.9	6260.6
TOTAL LOCAL REVENUES	21322.3	24406.4	29009.8	32755.8	39368.4	43903.5	51009.8	56875.4	62010.0	65420.4
BORROWINGS	667.4	631.1	654.8	720.1	804.5	876.8	899.7	838.0	961.2	942.9
STATE GRANTS	1867.2	2229.6	2622.6	2988.2	3548.1	3929.9	4437.0	4799.0	5075.6	5241.7
FEDERAL GRANTS	287.5	352.8	444.2	564.9	716.3	891.9	1078.4	1269.0	1458.2	1645.2
TOTAL REVENUES	24144.4	27620.0	32731.4	37029.1	44437.3	49602.2	57424.8	63781.4	69505.0	73250.2
ET SURPLUS OR DEFICIT	13.7	19.5	15.3	11.3	20.6	-9.9	.8	-1.8	-3.5	11.0
CUM SURPLUS OR DEFICIT	538.2	566.8	620.7	564.3	614.7	559.5	647.8	646.4	673.4	704.6
PERTY VALUATION										
RESIDENTIAL	278714.4	309152.4	349111.5	397685.4	454175.1	516184.5	580282.6	645267.7	710267.5	775491.8
COMMERCIAL	56177.5	62013.3	69287.7	77805.0	87271.2	97079.8	106514.1	115385.5	123593.4	131241.8
INDUSTRIAL	69678.6	77288.1	87277.9	99421.4	113543.8	129046.1	145070.7	161316.9	177566.9	193873.0
TOTAL PROPERTY VALUATION	404570.5	448453.8	505677.1	574911.8	654990.1	742310.4	831867.4	921970.1	1011427.8	1100606.6
TAX RATE (PER THOUSAND)	46.1	47.8	50.8	50.5	53.7	52.9	55.2	55.7	55.5	53.8
DING CAPACITY										
AVAILABLE	20228.5	22422.7	25283.9	28745.6	32749.5	37115.5	41593.4	46098.5	50571.4	55030.3
USED	9307.6	10108.2	10797.4	11522.5	12286.9	13189.7	14147.1	14722.4	15741.4	16255.9
UNUSED	10920.9	12314.5	14486.5	17223.1	20462.6	23925.8	27446.3	31376.1	34830.0	38774.5
MUNITY DESCRIPTION										
TOTAL POPULATION	51.4	54.0	57.4	61.3	65.5	69.3	72.3	74.5	76.0	76.8
GROSS DENSITY	5.1	5.4	5.7	6.1	6.5	6.9	7.2	7.5	7.6	7.7
DEPENDENCY RATIO	87.4	86.8	85.3	83.9	82.5	80.9	79.5	78.2	77.1	76.3
PUBLIC SERVICES / CAPITA	393.6	431.2	484.7	517.0	586.3	622.1	693.1	749.5	802.5	837.6
EDUCATION AS % OF EXPEND	33.8	33.4	32.7	32.0	31.2	30.4	29.7	29.2	28.8	28.5
PROTECTION AS % OF EXPND	9.6	9.9	10.2	10.6	11.1	11.5	11.9	12.1	12.3	12.4
STATE AID % FOR EDUCAT'N	17.4	19.7	20.8	21.9	23.0	23.7	23.9	23.7	23.3	22.6
PROPERTY TAX AS % OF REV	53.2	53.5	54.2	54.2	54.9	55.1	55.8	56.4	56.7	56.9
VALUATION PER CAPITA	7868.8	8304.5	8808.6	9373.2	10006.1	10714.4	11501.7	12367.7	13312.8	14338.3
VALUATION PER PUPIL	29013.8	30356.8	32267.7	34268.5	36400.4	38852.4	41741.3	45088.3	48875.9	53083.9

P = TOTAL POPULATION R = TOTAL REVENUES
T = PROPERTY TAX RATE E = TOTAL EXPENDITURES
L = PROPERTY TAX AS % OF REVENUE S = EDUCATION AS % OF EXPENDITURES
X = PUBLIC SERVICES PER CAPITA A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



	5	10	15	20	25	30	35	40	45	50
EXPENDITURES										
EDUCATION EXPENDITURES	8152.6	7821.7	8316.7	8815.4	10098.3	10947.6	12543.3	14065.8	15737.0	17192.6
PROTECTION SERVICES	2328.4	1975.8	2132.3	2316.8	2719.8	3052.6	3655.2	4315.9	5112.7	5980.1
HIGHWAY EXPENDITURES	1627.6	1595.0	1724.6	1798.2	2001.0	2116.7	2383.7	2635.9	2912.4	3145.3
WATER AND SANITATION	1402.6	1190.2	1284.5	1395.7	1638.4	1838.9	2201.9	2600.0	3079.9	3602.5
RECREATION AND PARKS	550.0	513.1	565.0	613.2	707.7	767.8	880.1	989.2	1111.0	1219.6
HOSPITALS AND HEALTH	995.4	796.7	859.1	950.0	1139.2	1309.1	1604.2	1937.6	2340.1	2763.9
PUBLIC ADMINISTRATION	953.8	809.4	873.5	949.1	1114.1	1250.5	1497.3	1768.0	2082.8	2368.0
OTHER EXPENDITURES	4227.2	3674.9	3968.1	4264.2	4937.0	5548.1	6695.5	7968.0	9478.6	10981.8
TOTAL PUBLIC SERVICES	20237.5	18376.7	19723.9	21102.6	24355.6	26831.3	31461.3	36280.4	41854.5	47253.8
MANDATED COSTS	3055.5	3074.1	3133.8	3299.1	3718.9	3979.1	4530.1	5070.9	5676.6	6212.0
DEBT SERVICE	837.7	887.4	904.4	922.8	944.6	979.0	1023.4	1051.1	1121.2	1167.3
TOTAL EXPENDITURES	24130.7	22338.3	23762.1	25324.6	29019.1	31789.5	37014.8	42402.4	48652.2	54633.1
REVENUES										
PROPERTY TAXES	18342.9	16561.0	17729.7	18809.8	21692.3	23683.6	27880.6	32245.6	37227.6	42007.6
USER CHARGES	2688.9	2530.7	2650.7	2870.8	3148.1	3446.3	3818.4	4231.2	4689.8	5196.6
TOTAL LOCAL REVENUES	21031.8	19091.7	20360.5	21680.7	24840.4	27130.0	31698.9	36476.8	41917.4	47204.2
BORROWINGS	667.4	537.3	523.7	556.3	606.4	655.1	677.2	645.5	766.4	782.7
STATE GRANTS	2157.7	2465.8	2583.9	2763.3	3194.5	3518.6	4050.3	4549.6	5063.1	5545.8
FEDERAL GRANTS	287.5	260.0	286.3	333.1	393.3	478.5	589.0	729.2	902.5	1109.6
TOTAL REVENUES	24144.4	22354.9	23774.4	25333.3	29034.6	31782.1	37015.3	42401.1	48649.5	54642.3
NET SURPLUS OR DEFICIT	13.7	16.6	12.2	8.8	15.5	-7.4	.6	-1.4	-2.8	9.2
CUM SURPLUS OR DEFICIT	538.2	561.5	604.7	560.2	598.4	557.0	623.1	622.2	642.9	668.5
PROPERTY VALUATION										
RESIDENTIAL	278714.4	251160.4	267605.0	294328.7	327126.9	367135.1	414151.3	469305.5	532454.1	602949.8
COMMERCIAL	56177.5	47517.7	49867.3	54093.5	59206.5	65275.3	72156.1	79994.8	88688.6	98042.5
INDUSTRIAL	41807.2	25116.0	26760.5	29432.9	32712.7	36713.5	41415.1	46930.5	53245.4	60295.0
TOTAL PROPERTY VALUATION	376699.1	323794.2	344232.8	377855.1	419046.1	469123.9	527722.5	596230.8	674388.2	761287.2
TAX RATE (PER THOUSAND)	48.7	51.1	51.5	49.8	51.8	50.5	52.8	54.1	55.2	55.2
BONDING CAPACITY										
AVAILABLE	18835.0	16189.7	17211.6	18892.8	20952.3	23456.2	26386.1	29811.5	33719.4	38064.4
USED	9307.6	9860.1	10049.4	10253.7	10495.9	10878.3	11371.2	11679.4	12457.4	12970.4
UNUSED	9527.4	6329.6	7162.3	8639.1	10456.4	12577.9	15014.9	18132.2	21262.0	25093.9
COMMUNITY DESCRIPTION										
TOTAL POPULATION	51.4	46.0	45.9	47.4	49.3	51.8	54.4	57.4	60.6	63.7
GROSS DENSITY	5.1	4.6	4.6	4.7	4.9	5.2	5.4	5.7	6.1	6.4
DEPENDENCY RATIO	87.4	89.0	87.0	85.4	84.0	82.3	80.6	78.9	77.6	76.6
PUBLIC SERVICES / CAPITA	393.6	399.7	429.6	445.4	493.6	518.4	577.9	631.8	690.9	741.7
EDUCATION AS % OF EXPEND	33.8	35.0	35.0	34.8	34.8	34.4	33.9	33.2	32.3	31.5
PROTECTION AS % OF EXPND	9.6	8.8	9.0	9.1	9.4	9.6	9.9	10.2	10.5	10.9
STATE AID % FOR EDUCAT'N	23.0	32.6	31.7	32.1	33.1	34.2	34.9	35.2	35.4	35.4
PROPERTY TAX AS % OF REV	56.2	57.5	58.0	57.8	58.3	58.3	59.1	59.9	60.4	60.9
VALUATION PER CAPITA	7326.7	7042.7	7498.4	7974.8	8492.5	9063.4	9693.7	10382.9	11133.1	11948.5
VALUATION PER PUPIL	27015.0	25476.9	27820.8	29821.5	31612.4	33525.3	35750.6	38302.0	41160.4	44317.9

P = TOTAL POPULATION
T = PROPERTY TAX RATE
L = PROPERTY TAX AS % OF REVENUE
X = PUBLIC SERVICES PER CAPITA
R = TOTAL REVENUES
E = TOTAL EXPENDITURES
S = EDUCATION AS % OF EXPENDITURES
A = STATE AID % FOR EDUCATION
* = COINCIDENT POINTS



APPENDIX E

MODEL LISTING

The following is a listing of the complete computer program used to implement this model.

```
C                                        ++  P9901A  ++
C
C       DAVID LAPIDES
C
SIZE ALPHA = 8, INTEGER = 7, REAL = 12
SEGMENT SIMLX, WRITX, PRNTX, PLOTX, CLOSE, DATE
FILE  1 = D9901A, UNIT = DISK, AREA = 20, RECORD = 125, RANDOM
FILE  5 = C9901A, UNIT = READER
FILE  6 = R9901A, UNIT = PRINTER
C
C
      COMMON          AAAA        , APOP (50)   , BOND (50)   , BORW (50)   ,
     1                CHLD (50)   , DEBX (50)   , DEPN (50)   ,
     2                FREV (50)   , INCM (50)   , LREV (50)   , MAND (50)   ,
     3                SREV (50)   , TAXR (50)   , TNET (50)   ,
     4                TOTR (50)   , TOTX (50)   , TPSX (50)   , TREV (50)   ,
     5                USEC (50)   , VCOM (50)   , VIND (50)   , VRES (50)   ,
     6                VALC (50)   , VTAX (50)   , XCAP (50)   ,
     7                PCEDU (50) , PCREV (50) , TDEBT (50) , TDIFF (50) ,
     8                STAID (50) , UBOND (50)
      COMMON /JNK/ IPAGE, IVER, IMOD, IMO, IDA, IYR, J1, J2, J3, N
      COMMON /PLT/ LINE (101) , MAXX       , JVAL
      ALPHA           LINE
      LOGICAL         PRNT        , PLOT        , WRIT
      REAL            INCM        , LREV        , MAND
C
C
  900 FORMAT (4I3, 3L1)
C
C
C *** SELECT RUN TIME PARAMETERS
      READ (5, 900) J1, J2, J3, N, PRNT, PLOT, WRIT
      CALL CLOSE (5, 2HFL)
      ASSIGN 100 TO KK
      IF (N .GT. 0)  ASSIGN 101 TO KK
C *** MODEL VERSION
      IVER = 3
      IMOD = 4
      MAXX = 0
C *** RETRIEVE TODAY'S DATE
      CALL DATE (IMO, IDA, IYR)
C *** SIMULATION LOOP
      IF (N .GT. 0)  GO TO 99
      DO 100  N = 1, 8
C ***     PERFORM SIMULATION
   99     CALL SIMLX (WRIT)
C ***     PRODUCE EXTRA PRINT-OUT
          IF (WRIT)  CALL WRITX
C ***     PRODUCE STANDARD PRINT-OUT
          IF (PRNT)  CALL PRNTX
C ***     PRODUCE CHART
          IF (PLOT)  CALL PLOTX
          GO TO KK, (100, 101)
  100 CONTINUE
C *** END OF JOB
  101 STOP
      END

05/09/71      3:13 PM     ASR#3.2BF    70132  COMPILER
  0 MIN 23 SEC FOR COMPILATION PASS
   58 CARDS AT 149 CARDS PER MINUTE
   100 DIGITS DATA,    714 DIGITS CODE, 25824 DIGITS COMMON.
```

```
      SUBROUTINE SIMLX (WRIT)
C
      COMMON        AAAA        , APOP (50)  , BOND (50)  , BORW (50)  ,
     1              CHLD (50)   , DEBX (50)  , DEPN (50)  ,
     2              FREV (50)   , INCM (50)  , LREV (50)  , MAND (50)  ,
     3              SREV (50)   , TAXR (50)  , TNET (50)  ,
     4              TOTR (50)   , TOTX (50)  , TPSX (50)  , TREV (50)  ,
     5              USEC (50)   , VCOM (50)  , VIND (50)  , VRES (50)  ,
     6              VALC (50)   , VTAX (50)  , XCAP (50)  ,
     7              PCEDU (50) , PCREV (50) , TDEBT (50) , TDIFF (50) ,
     8              STAID (50) , UBOND (50)
      COMMON /JNK/ IPAGE, IVER, IMOD, IMO, IDA, IYR, J1, J2, J3, N
      DIMENSION     APRT (5, 2), AHLT (5, 2), ARDS (5, 2), ASNT (5, 2),
     1              ADNS (5, 2), AGNR (4, 2), AEDU (4, 2), AMSC (3, 2),
     2              AREC (2, 2), ABRT (2, 2)
      LOGICAL       WRIT        , FLAG1      , FLAG2
      REAL          INCM        , LREV       , MAND       , MISC       ,
     1              MIG25       , MIG30      , MIG35      ; MIG40      ,
     2              MIG45       , MIG50      , MIG55      , MIG60      ,
     3              MIG65       , MIG99      ', MONEY
      EQUIVALENCE (PER04, GRT04), (PER12, GRT12), (PER18, GRT18)
      EQUIVALENCE (PER25, GRT25), (PER30, GRT30), (PER35, GRT35)
      EQUIVALENCE (PER40, GRT40), (PER45, GRT45), (PER50, GRT50)
      EQUIVALENCE (PER55, GRT55), (PER60, GRT60), (PER65, GRT65)
      EQUIVALENCE (PER99, GRT99)
      DATA APRT / 2.0, 4.0, 6.0, 7.5, 9.5, 0.5, 0.8, 1.2, 1.6, 2.1 /
      DATA AHLT / 2.0, 4.0, 6.0, 7.5, 9.5, 0.5, 0.7, 1.3, 1.8, 2.2 /
      DATA ASNT / 2.0, 4.0, 6.0, 7.5, 9.5, 0.5, 0.8, 1.2, 1.6, 1.8 /
      DATA AGNR / 4.0, 6.0, 8.0, 9.5, 0.8, 1.2, 1.5, 1.8 /
      DATA ADNS / 5.0, 6.5, 7.4, 8.5, 9.5, 1.0, 0.5, 0.0, -0.6, -1.2 /
      DATA ARDS / 2.0, 3.5, 5.0, 7.5, 9.5, 1.25, 1.10, 1.00, 0.90, 0.80/
      DATA AMSC / 2.0, 5.0, 8.0, 0.6, 1.0, 1.7 /
      DATA AEDU / 0.20, 0.30, 0.35, 0.40, 0.9, 1.0, 1.1, 1.2 /
      DATA AREC / 0.20, 0.40, 0.8, 1.2 /
      DATA ABRT / 1.0, 50.0, 1.0, 0.9 /
      DATA ZERO / 0.0 /
C
C
      IPAGE = 0
C *** INITIALIZE EVERYTHING
      DO  10  K = 1, 50
          APOP (K) = ZERO
          BOND (K) = ZERO
          BORW (K) = ZERO
          CHLD (K) = ZERO
          DEBX (K) = ZERO
          DEPN (K) = ZERO
          FREV (K) = ZERO
          INCM (K) = ZERO
          LREV (K) = ZERO
          MAND (K) = ZERO
          SREV (K) = ZERO
          TAXR (K) = ZERO
          TNET (K) = ZERO
          TOTR (K) = ZERO
          TOTX (K) = ZERO
          TPSX (K) = ZERO
          TREV (K) = ZERO
          USEC (K) = ZERO
          VALC (K) = ZERO
          VCOM (K) = ZERO
          VIND (K) = ZERO
          VRES (K) = ZERO
```

```
      VTAX (K) = ZERO
      XCAP (K) = ZERO
      PCEDU (K) = ZERO
      PCREV (K) = ZERO
      STAID (K) = ZERO
      TDEBT (K) = ZERO
      TDIFF (K) = ZERO
   10 CONTINUE
C *** SET INITIAL CONDITIONS
      J = 0
      I = 1
      FLAG1 = .T.
      FLAG2 = .T.
      AAAA = 49.6
      TPOP = 50.0
      APOP (1) = TPOP
      TDEBT (1) = 8000.0
      TDIFF (1) = 500.0
      RMAN = 56.0
      RSCH = 575.0
      RPRT = 41.5
      RHLT = 17.5
      RREC = 11.0
      RRDS = 30.0
      RGNR = 17.0
      RSNT = 25.0
      RMSC = 75.0
      RINC = 0.02
      RBOR = 12.0
      RSTA = 12.0
      RFED = 5.0
      RUSE = 50.0
      RCOM = 3.50
      RMUL = 60.0
      RATE = 0.20
      RINT = 0.04
      RIN2 = -1.05
      RMAX = 0.05
      RPAY = 20.0
      SHRT = ZERO
      VIN25 = 6300.0
      VIN30 = 7000.0
      VIN35 = 7500.0
      VIN40 = 7800.0
      VIN45 = 8000.0
      VIN50 = 8300.0
      VIN55 = 8500.0
      VIN60 = 8800.0
      VIN65 = 8500.0
      VIN99 = 6000.0
      VMIND = 0.15
      STSCHL = 1350.0
      STROAD = 120.0
      STVALC = 21500.0
      ASSIGN 140 TO JJ
      ASSIGN 175 TO KK
      ASSIGN 164 TO LL
      ASSIGN 291 TO MM
      IF (N .EQ. 2)  RPAY = 30.0
      IF (N .EQ. 3)  VMIND = 0.25
      IF (N .EQ. 4)  ASSIGN 293 TO MM
      IF (N .EQ. 5)  ASSIGN 163 TO LL
      IF (N .EQ. 6)  ASSIGN 120 TO JJ
      IF (N .EQ. 7)  ASSIGN 130 TO JJ
      IF (N .EQ. 8)  ABRT (2, 2) = 1.0
      RPAY = 1.0 / RPAY
```

```
C *** INITIAL VALUE FOR RANDOM NUMBER GENERATOR
      IX = 8361253
C *** FIXED LAND AREA (IN THOUSAND ACRES)
      AREA = 10.0
      DENS = TPOP / AREA
C *** INITIALIZE POPULATION PARAMETERS
      BRT18 = 0.0258
      BRT25 = 0.0888
      BRT30 = 0.0753
      BRT35 = 0.0429
      BRT40 = 0.0203
      BRT45 = 0.0055
      MIG25 = 0.01
      MIG30 = 0.01
      MIG35 = 0.01
      MIG40 = 0.01
      MIG45 = 0.01
      MIG50 = 0.01
      MIG55 = 0.01
      MIG60 = 0.01
      MIG65 = 0.01
      MIG99 = 0.01
      PER04 = 0.111
      PER12 = 0.158
      PER18 = 0.098
      PER25 = 0.076
      PER30 = 0.061
      PER35 = 0.067
      PER40 = 0.070
      PER45 = 0.065
      PER50 = 0.061
      PER55 = 0.054
      PER60 = 0.047
      PER65 = 0.040
      PER99 = 0.092
      POP04 = PER04 * TPOP
      POP12 = PER12 * TPOP
      POP18 = PER18 * TPOP
      POP25 = PER25 * TPOP
      POP30 = PER30 * TPOP
      POP35 = PER35 * TPOP
      POP40 = PER40 * TPOP
      POP45 = PER45 * TPOP
      POP50 = PER50 * TPOP
      POP55 = PER55 * TPOP
      POP60 = PER60 * TPOP
      POP65 = PER65 * TPOP
      POP99 = PER99 * TPOP
      GO TO 105
C *** FINISH UP THIS PERIOD'S CALCULATIONS
  100 DEPN (I) = (PER04 + PER12 + PER18 + PER99) / (PER25 + PER30 +
     1    PER35 + PER40 + PER45 + PER50 + PER55 + PER60 + PER65) * 100.0
      TAXR (I) = 1000.0 * TAXR (I)
      XCAP (I) = TPSX (I) / TPOP
      PCEDU (I) = SCHL / TOTX (I) * 100.0
      PCREV (I) = (VRES (I) * TAXR (I)) / (TOTR (I) * 10.0)
      STAID (I) = 100.0 * STEDUC
      TDIFF (I) = TDIFF (I) + TNET (I)
      UBOND (I) = BOND (I) - TDEBT (I)
      IF (.NOT. WRIT)  GO TO 101
      WRITE (1=I) POP04, POP12, POP18, POP25, POP30, POP35, POP40,
     1    POP45, POP50, POP55, POP60, POP65, POP99
  101 WRITE (1=I+50) DENS, SCHL, PROT, ROAD, SANT, RECR, HLTH, GNRL,
     1    MISC, ZERO, MONEY, STSCHL, STROAD
      IF (I .EQ. 50)  GO TO 300
C *** START CALCULATIONS FOR NEW PERIOD
```

```
      J = I
      I = I + 1
      ASSIGN 165 TO KK
      RCOM = 1.01 * RCOM
      RUSE = 1.01 * RUSE
      RSTA = 1.01 * RSTA
      RFED = 1.02 * RFED
C *** ONE AND ONE-HALF PERCENT ANNUAL GROWTH IN INCOME
      TEMP = 1.015
      VIN25 = TEMP * VIN25
      VIN30 = TEMP * VIN30
      VIN35 = TEMP * VIN35
      VIN40 = TEMP * VIN40
      VIN45 = TEMP * VIN45
      VIN50 = TEMP * VIN50
      VIN60 = TEMP * VIN60
      VIN65 = TEMP * VIN65
      VIN99 = TEMP * VIN99
      STVALC = TEMP * STVALC
C *** CALCULATE NUMBER OF ADULT MIGRANTS
      GRT99 = MIG99 * POP99
      GRT65 = MIG65 * POP65
      GRT60 = MIG60 * POP60
      IF (GRT60 .GT. ZERO)  GRT60 = GRT60 * TABLX (ADNS, 5, DENS)
      GRT55 = MIG55 * POP55
      IF (GRT55 .GT. ZERO)  GRT55 = GRT55 * TABLX (ADNS, 5, DENS)
      GRT50 = MIG50 * POP50
      IF (GRT50 .GT. ZERO)  GRT50 = GRT50 * TABLX (ADNS, 5, DENS)
      GRT45 = MIG45 * POP45
      IF (GRT45 .GT. ZERO)  GRT45 = GRT45 * TABLX (ADNS, 5, DENS)
      GRT40 = MIG40 * POP40
      IF (GRT40 .GT. ZERO)  GRT40 = GRT40 * TABLX (ADNS, 5, DENS)
      GRT35 = MIG35 * POP35
      IF (GRT35 .GT. ZERO)  GRT35 = GRT35 * TABLX (ADNS, 5, DENS)
      GRT30 = MIG30 * POP30
      IF (GRT30 .GT. ZERO)  GRT30 = GRT30 * TABLX (ADNS, 5, DENS)
      GRT25 = MIG25 * POP25
      IF (GRT25 .GT. ZERO)  GRT25 = GRT25 * TABLX (ADNS, 5, DENS)
      GRT18 = 0.012 * GRT65 + 0.098 * GRT60 + 0.273 * GRT55 + 0.441 *
     1    GRT50 + 0.408 * GRT45 + 0.261 * GRT40 + 0.132 * GRT35
      GRT12 = 0.013 * GRT60 + 0.092 * GRT55 + 0.238 * GRT50 + 0.452 *
     1    GRT45 + 0.412 * GRT40 + 0.331 * GRT35 + 0.252 * GRT30 + 0.163
     2    * GRT25
      GRT04 = 0.011 * GRT50 + 0.151 * GRT45 + 0.265 * GRT40 + 0.408 *
     1    GRT35 + 0.362 * GRT30 + 0.276 * GRT25
C *** COMPUTE POPULATION BREAKDOWNS FOR NEW PERIOD
      TEMP = I
      POP99 = 0.9286 * POP99 + 0.1803 * POP65 + GRT99
      POP65 = 0.7212 * POP65 + 0.1866 * POP60 + GRT65
      POP60 = 0.7465 * POP60 + 0.1911 * POP55 + GRT60
      POP55 = 0.7642 * POP55 + 0.1943 * POP50 + GRT55
      POP50 = 0.7773 * POP50 + 0.1963 * POP45 + GRT50
      POP45 = 0.7854 * POP45 + 0.1976 * POP40 + GRT45
      POP40 = 0.7904 * POP40 + 0.1983 * POP35 + GRT40
      POP35 = 0.7932 * POP35 + 0.1987 * POP30 + GRT35
      POP30 = 0.7947 * POP30 + 0.1665 * POP25 + GRT30
      POP25 = 0.8275 * POP25 + 0.1660 * POP18 + GRT25
      POP18 = 0.8297 * POP18 + 0.1247 * POP12 + GRT18
      POP12 = 0.8731 * POP12 + 0.1982 * POP04 + GRT12
      POP04 = 0.7970 * POP04 + 0.9753 * (BRT18 * POP18 + BRT25 * POP25 +
     1    BRT30 * POP30 + BRT35 * POP35 + BRT40 * POP40 + BRT45 * POP45)
     2    * TABLX (ABRT, 2, TEMP) + GRT04
      TPOP = POP04 + POP12 + POP18 + POP25 + POP30 + POP35 + POP40 +
     1    POP45 + POP50 + POP55 + POP60 + POP65 + POP99
C *** COMPUTE PERCENTAGE BREAKDOWNS
      PER04 = POP04 / TPOP
```

```
      PER12 = POP12 / TPOP
      PER18 = POP18 / TPOP
      PER25 = POP25 / TPOP
      PER30 = POP30 / TPOP
      PER35 = POP35 / TPOP
      PER40 = POP40 / TPOP
      PER45 = POP45 / TPOP
      PER50 = POP50 / TPOP
      PER55 = POP55 / TPOP
      PER60 = POP60 / TPOP
      PER65 = POP65 / TPOP
      PER99 = POP99 / TPOP
C *** COMPUTE GROSS POPULATION DENSITY
      DENS = TPOP / AREA
      APOP (I) = TPOP
C *** REDUCE DEBT PRINCIPLE
      TDEBT (I) = TDEBT (J) * (1.0 - RPAY)
      TDIFF (I) = TDIFF (J)
C *** SHORT TERM DEBT
      SHRT = ZERO
      IF (TDIFF (I) .GE. ZERO)  GO TO 105
      SHRT = RIN2 * TDIFF (I)
      TDIFF (I) = ZERO
C *** PROPERTY VALUE CALCULATIONS
  105 MONEY = VIN25 * POP25 + VIN30 * POP30 + VIN35 * POP35 + VIN40 *
     1    POP40 + VIN45 * POP45 + VIN50 * POP50 + VIN55 * POP55 + VIN60
     2    * POP60 + VIN65 * POP65 + VIN99 * POP99
      VRES (I) = 1.1 * MONEY - 0.135 * VIN25 * POP25 + 0.035 * VIN65 *
     1    POP65 + 0.135 * VIN99 * POP99
      GO TO JJ, (120, 125, 130, 135, 140)
C *** NEW INDUSTRY RUN
  120 IF (I .LT. 6)  GO TO 140
      VMIND = 0.25
      RSCH = 1.02 * RSCH
      RPRT = 1.02 * RPRT
      RRDS = 1.05 * RRDS
      RHLT = 1.02 * RHLT
      RSNT = 1.02 * RSNT
      RREC = 1.02 * RREC
      RGNR = 1.02 * RGNR
      RMSC = 1.01 * RMSC
      RBOR = 19.0
      MIG25 = MIG25 + 0.007
      MIG30 = MIG30 + 0.007
      MIG35 = MIG35 + 0.007
      MIG40 = MIG40 + 0.005
      MIG45 = MIG45 + 0.005
      MIG50 = MIG50 + 0.003
      MIG55 = MIG55 + 0.003
      MIG60 = MIG60 + 0.001
      MIG65 = MIG65 + 0.001
      ASSIGN 125 TO JJ
      GO TO 140
  125 VMIND = VMIND + 0.01
      IF (I .GT. 7)  GO TO 126
      MIG25 = MIG25 - 0.006
      MIG30 = MIG30 - 0.006
      MIG35 = MIG35 - 0.006
      MIG40 = MIG40 - 0.004
      MIG45 = MIG45 - 0.005
      MIG50 = MIG50 - 0.003
      MIG55 = MIG55 - 0.003
      MIG60 = MIG60 - 0.001
      MIG65 = MIG65 - 0.001
      GO TO 140
  126 IF (I - 9)  140, 127, 129
```

```
  127 RSCH = 0.98 * RSCH
      RPRT = 0.98 * RPRT
      RRDS = 0.96 * RRDS
      RHLT = 0.98 * RHLT
      RSNT = 0.98 * RSNT
      RREC = 0.98 * RREC
      RGNR = 0.98 * RGNR
      RMSC = 0.99 * RMSC
      RBOR = 12.0
      GO TO 140
  129 ASSIGN 140 TO JJ
      GO TO 140
C *** OLD INDUSTRY DEPARTING RUN
  130 IF (I .LT. 6)  GO TO 140
      VMIND = 0.10
      MIG25 = MIG25 - 0.075
      MIG30 = MIG30 - 0.075
      MIG35 = MIG35 - 0.075
      MIG40 = MIG40 - 0.065
      MIG45 = MIG45 - 0.040
      MIG50 = MIG50 - 0.040
      MIG55 = MIG55 - 0.030
      MIG60 = MIG60 - 0.030
      MIG65 = MIG65 - 0.030
      MIG99 = MIG99 - 0.007
      VIN25 = 0.90 * VIN25
      VIN30 = 0.93 * VIN30
      VIN35 = 0.93 * VIN35
      VIN40 = 0.93 * VIN40
      VIN45 = 0.93 * VIN45
      VIN50 = 0.93 * VIN50
      VIN55 = 0.95 * VIN55
      VIN60 = 0.95 * VIN60
      VIN65 = 0.98 * VIN65
      RCOM = 0.90 * RCOM
      ASSIGN 135 TO JJ
      GO TO 140
  135 MIG25 = MIG25 + 0.0100
      MIG30 = MIG30 + 0.0100
      MIG35 = MIG35 + 0.0100
      MIG40 = MIG40 + 0.0093
      MIG45 = MIG45 + 0.0060
      MIG50 = MIG50 + 0.0060
      MIG55 = MIG55 + 0.0047
      MIG60 = MIG60 + 0.0047
      MIG65 = MIG65 + 0.0047
      MIG99 = MIG99 + 0.0013
      IF (I .LT. 12)  GO TO 140
      ASSIGN 140 TO JJ
C *** COMPLETE PROPERTY VALUF CALCULATIONS
  140 VIND (I) = VMIND * VRES (I)
      FCOM = RMUL * TPOP
      VCOM (I) = RCOM * FCOM / RATE
C *** CALCULATE TAX BASE AND BONDING CAPACITY
      VTAX (I) = VRES (I) + VCOM (I) + VIND (I)
      BOND (I) = RMAX * VTAX (I)
C *** CALCULATE FSTIMATED PUBLIC SERVICE COSTS
      CHLD (I) = POP12 + POP18
      PC2545 = PER30 + PER35 + PER40 + PER45
      SCHL = RSCH * CHLD (I) * TABLX (AEDU, 4, PC2545)
      PROT = RPRT * TPOP * TABLX (APRT, 5, DFNS)
      ROAD = RRDS * TPOP * TABLX (ARDS, 5, DFNS)
      SANT = RSNT * TPOP * TABLX (ASNT, 5, DFNS)
      HLTH = RHLT * TPOP * TABLX (AHLT, 5, DENS)
      GNRL = RGNR * TPOP * TABLX (AGNR, 4, DFNS)
      MISC = RMSC * TPOP * TABLX (AMSC, 3, DFNS)
```

```
      RECR = RREC * TPOP * TABLX (AREC, 2, PC2545)
      TPSX (I) = SCHL + PROT + ROAD + RECR + SANT + HLTH + GNRL + MISC
C *** CALCULATE GRANTS FROM STATE AND FEDERAL GOVERNMENTS
      VALC (I) = VTAX (I) / CHLD (I)
      STEDUC = 1.0 - 0.65 * VALC (I) / STVALC
      IF (STEDUC .LT. 0.15)  STEDUC = 0.15
      IF (STEDUC .GT. 0.75)  STEDUC = 0.75
      STSCHL = STEDUC * ((0.9 * SCHL) - STSCHL)
      STROAD = 0.25 * ((0.4 * ROAD) - STROAD)
      SREV (I) = STSCHL + STROAD + RSTA * TPOP
      FREV (I) = RFED * TPOP * TABLX (AMSC, 3, DENS)
C *** CALCULATE OTHER COSTS TO LOCAL GOVERNMENT
      MAND (I) = RMAN * TPOP
      TEMP = MAND (J) - MAND (I)
      IF (TEMP .GE. ZERO)  MAND (I) = MAND (J) - 0.1 * TEMP
      CALL UNIFRM (IX, TEMP)
      TEMP = TEMP + TEMP - 1.0
      BORW (I) = (RBOR + TEMP) * TPOP
      AVAIL = BOND (I) - TDEBT (I)
      IF (BORW (I) .GT. AVAIL)  BORW (I) = AVAIL
      IF (AVAIL .LE. ZERO)  BORW (I) = ZERO
      TDEBT (I) = TDEBT (I) + BORW (I)
      DEBX (I) = TDEBT (I) * (RINT + RPAY) + SHRT
  160 TOTX (I) = TPSX (I) + MAND (I) + DEBX (I)
C *** CALCULATE USER CHARGES
      USEC (I) = RUSE * TPOP
C *** CALCULATE AMOUNT WHICH MUST BE RAISED FROM PROPERTY TAX
      TREV (I) = TOTX (I) - USEC (I) - BORW (I) - SREV (I) - FREV (I)
      GO TO LL, (163, 164)
C *** CALCULATE INCOME TAX REVENUES
  163 INCM (I) = RINC * MONEY
      TREV (I) = TREV (I) - INCM (I)
C *** CALCULATE TAX RATE
  164 TAXR (I) = TREV (I) / VTAX (I)
C *** TAX RATE MAY BE EXCESSIVE
      GO TO KK, (165, 175, 180)
  165 IF ((TAXR (I) / TAXR (J)) .LT. 1.05)  GO TO 175
      FLAG2 = FLAG1
      FLAG1 = .F.
      MIG25 = MIG25 - 0.004
      MIG30 = MIG30 - 0.004
      MIG35 = MIG35 - 0.004
      MIG40 = MIG40 - 0.003
      MIG45 = MIG45 - 0.003
      MIG50 = MIG50 - 0.002
      MIG55 = MIG55 - 0.002
      MIG60 = MIG60 - 0.001
      MIG65 = MIG65 - 0.001
C *** SLASH EXPENDITURES
      SCHL = 0.98 * SCHL
      PROT = 0.98 * PROT
      ROAD = 0.98 * ROAD
      SANT = 0.98 * SANT
      RECR = 0.98 * RECR
      HLTH = 0.98 * HLTH
      GNRL = 0.98 * GNRL
      MISC = 0.98 * MISC
      TPSX (I) = SCHL + PROT + ROAD + RECR + SANT + HLTH + GNRL + MISC
      ASSIGN 180 TO KK
C *** RE-CALCULATE THE TAX RATE
      IF (FLAG2)  GO TO 160
C *** IF SECOND CONSECUTIVE HEFTY TAX INCREASE, SLASH EXPENDITURE RATES
      RSCH = 0.97 * RSCH
      RPRT = 0.97 * RPRT
      RRDS = 0.97 * RRDS
      RSNT = 0.97 * RSNT
```

```
      RREC = 0.97 * RREC
      RHLT = 0.97 * RHLT
      RGNR = 0.97 * RGNR
      RMSC = 0.97 * RMSC
      GO TO 160
C *** RESET FLAGS
  175 FLAG1 = .T.
C *** RANDOMIZE USER CHARGES
  180 CALL UNIFRM (IX, TEMP)
      TEMP = TEMP - 0.5
      USEC (I) = USEC (I) + TEMP * TPOP
C *** COMPUTE ACTUAL REVENUES
      TREV (I) = TAXR (I) * VTAX (I)
      LREV (I) = TREV (I) + USEC (I) + INCM (I)
      TOTR (I) = LREV (I) + BORW (I) + SREV (I) + FREV (I)
C *** DIFFERENCE BETWEEN INCOME AND EXPENSES
      DIFF = TOTR (I) - TOTX (I)
C *** CHECK FOR SURPLUS OR DEFICIT
      IF (DIFF .GE. ZERO)  GO TO 290
C *** DEFICIT, TRY TO COVER IT FROM RESERVES
      IF (TDIFF (I) .LT. ZERO)  GO TO 250
      TEMP = 0.75 * TDIFF (I)
      IF ((TEMP + DIFF) .GT. ZERO)  GO TO 290
C *** USE ONLY HALF OF RESERVES, TRY TO BORROW THE REST
      TNET (I) = -0.5 * TDIFF (I)
      DIFF = DIFF - TNET (I)
C *** CHECK AVAILABLE BONDING CAPACITY
  250 AVAIL = BOND (I) - TDEBT (I)
      IF (AVAIL .LT. ZERO)  GO TO 280
C *** CALCULATE EXTRA DEBT SERVICE TO COVER REMAINING DEFICIT
      ADEBX = DIFF * (RINT + RPAY)
C *** CHECK IF CAPACITY COVERS DEFICIT AND EXTRA DEBT SERVICE
      IF ((AVAIL + ADEBX + DIFF) .LT. ZERO)  GO TO 275
C *** IT DOES, BORROW WHAT IS NEEDED
      BORW (I) = BORW (I) + DIFF
      TOTR (I) = TOTR (I) + DIFF
      DEBX (I) = DEBX (I) - ADEBX
      TNET (I) = TNET (I) + ADEBX
      TOTX (I) = TOTX (I) - ADEBX
      TDEBT (I) = TDEBT (I) + DIFF
      GO TO 100
C *** INSUFFICIENT BONDING CAPACITY, USE IT ALL UP
  275 ADEBX = AVAIL * (RINT + RPAY)
      BORW (I) = BORW (I) + AVAIL
      DEBX (I) = DEBX (I) + ADEBX
      TNET (I) = TNET (I) - ADEBX
      TDEBT (I) = BOND (I)
      DIFF = DIFF + AVAIL
C *** NOTHING LEFT, SLASH EXPENDITURES AND RAISE TAXES
  280 SCHL = 0.95 * SCHL
      PROT = 0.95 * PROT
      ROAD = 0.95 * ROAD
      SANT = 0.95 * SANT
      RECR = 0.95 * RECR
      HLTH = 0.95 * HLTH
      GNRL = 0.95 * GNRL
      MISC = 0.95 * MISC
      TPSX (I) = SCHL + PROT + ROAD + RECR + SANT + HLTH + GNRL + MISC
      MIG25 = MIG25 - 0.003
      MIG30 = MIG30 - 0.003
      MIG35 = MIG35 - 0.003
      MIG40 = MIG40 - 0.002
      MIG45 = MIG45 - 0.002
      MIG50 = MIG50 - 0.002
      MIG55 = MIG55 - 0.001
      MIG60 = MIG60 - 0.001
```

```
      MIG65 = MIG65 - 0.001
      ASSIGN 180 TO KK
      GO TO 160
C *** SURPLUS (OR SMALL DEFICIT) EXISTS
  290 TNET (I) = DIFF
      IF (DIFF .LE. ZERO)  GO TO 100
      GO TO MM, (291, 293, 294)
  291 RSCH = 1.02 * RSCH
      RPRT = 1.02 * RPRT
      RRDS = 1.02 * RRDS
      RSNT = 1.02 * RSNT
      RHLT = 1.02 * RHLT
      RREC = 1.02 * RREC
      RGNR = 1.02 * RGNR
      RMSC = 1.02 * RMSC
      GO TO 295
C *** SKYROCKETING PUBLIC SERVICE COSTS
  293 IF (I .LT. 6)  GO TO 291
      ASSIGN 294 TO MM
  294 RSCH = 1.08 * RSCH
      RPRT = 1.07 * RPRT
      RRDS = 1.05 * RRDS
      RSNT = 1.06 * RSNT
      RHLT = 1.06 * RHLT
      RREC = 1.05 * RREC
      RGNR = 1.06 * RGNR
      RMSC = 1.05 * RMSC
  295 RMAN = 1.02 * RMAN
      MIG25 = MIG25 + 0.0005
      MIG30 = MIG30 + 0.0005
      MIG35 = MIG35 + 0.0005
      MIG40 = MIG40 + 0.0004
      MIG45 = MIG45 + 0.0004
      MIG50 = MIG50 + 0.0002
      MIG55 = MIG55 + 0.0002
      MIG60 = MIG60 + 0.0001
      MIG65 = MIG65 + 0.0001
      GO TO 100
C *** RETURN TO MAIN PROGRAM
  300 RETURN
      END
```

```
05/09/71     3:15 PM    ASR#3.2BF   70132  COMPILER
  1 MIN 42 SEC FOR COMPILATION PASS
  567 CARDS AT 331 CARDS PER MINUTE
  4880 DIGITS DATA, 30432 DIGITS CODE, 24176 DIGITS COMMON,
```

```
      FUNCTION TABLX (TBLE, NVAL, XVAL)
C
      DIMENSION    TBLE (NVAL, 2)
C
C
      IF (XVAL .GT. TBLE (1, 1))  GO TO 100
C *** USE MINIMUM VALUE
      TABLX = TBLE (1, 2)
      RETURN
C *** SEARCH FOR SMALLEST LARGER VALUE
  100 DO 105  I = 2, NVAL
         IF (TBLE (I, 1) - XVAL)  105, 110, 115
  105 CONTINUE
C *** USE MAXIMUM VALUE
      I = NVAL
C *** USE CORRESPONDING TABLE VALUE
  110 TABLX = TBLE (I, 2)
      RETURN
C *** INTERPOLATE TO FIND VALUE
  115 J = I - 1
      TEMP1 = TBLE (J, 1)
      TEMP2 = TBLE (J, 2)
      TABLX = (TBLE(I,2) - TEMP2) * (XVAL - TEMP1) / (TBLE(I,1) - TEMP1)
     1    + TEMP2
      RETURN
      END
```

```
05/09/71      3:15 PM    ASR#3.2BF   70132  COMPILER
  0 MIN  4 SEC FOR COMPILATION PASS
   27 CARDS AT 364 CARDS PER MINUTE
   168 DIGITS DATA.  1456 DIGITS CODE.
```

```
      SUBROUTINE WRITX
C
      COMMON        AAAA        , APOP (50)  , BOND (50)  , BORW (50)  ,
     1              CHLD (50)   , DEBX (50)  , DEPN (50)  ,
     2              FREV (50)   , INCM (50)  , LREV (50)  , MAND (50)  ,
     3              SREV (50)   , TAXR (50)  , TNET (50)  ,
     4              TOTR (50)   , TOTX (50)  , TPSX (50)
      DIMENSION     TEMP (13)
      REAL          INCM        , LREV       , MAND
C
C
  910 FORMAT (54H0  YEAR POPULATION   0-4       5-12     13-18     19-24  ,
     1     58H  25-29     30-34     35-39     40-44     45-49     50-54    55,
     2     21H-59     60-64  60 PLUS)
  911 FORMAT (1H , I5, 14F9.1)
  912 FORMAT (54H0  YEAR POPULATION DENSITY SCHOOLS PROTECTN HIGHWAYS S,
     1     50HANITATN RECREATN  HEALTH   GENERAL   OTHER   TOTAL)
C
C
      KEY = 0
C *** PRODUCE TABLE # 1
      CALL HEADX
      WRITE (6, 910)
      DO 110  I = 1, 50
          KEY = KEY + 1
          READ (1=KEY) (TEMP (J), J = 1, 13)
          WRITE (6, 911) I, APOP (I), (TEMP (J), J = 1, 13)
  110 CONTINUE
C *** PRODUCE TABLE # 2
      CALL HEADX
      WRITE (6, 910)
      KEY = 0
      DO 120  I = 1, 50
          KEY = KEY + 1
          READ (1=KEY) (TEMP (J), J = 1, 13)
          TPOP = APOP (I) / 100.0
          DO 115  J = 1, 13
              TEMP (J) = TEMP (J) / TPOP
  115     CONTINUE
          WRITE (6, 911) I, APOP (I), (TEMP (J), J = 1, 13)
  120 CONTINUE
C *** PRODUCE TABLE # 3
      CALL HEADX
      WRITE (6, 912)
      DO 130  I = 1, 50
          KEY = KEY + 1
          READ (1=KEY) (TEMP (J), J = 1, 13)
          TPOP = APOP (I)
          TEMP (2) = TEMP (2) / CHLD (I)
          DO 125  J = 3, 9
              TEMP (J) = TEMP (J) / TPOP
  125     CONTINUE
          TEMP (10) = TPSX (I) / TPOP
          TEMP (11) = TEMP (11) / TPOP
          TEMP (12) = TEMP (12) / CHLD (I)
          TEMP (13) = TEMP (13) / TPOP
      WRITE (6, 911) I, TPOP, (TEMP (J), J = 1, 13)
  130 CONTINUE
      RETURN
      END

05/09/71      3:15 PM     ASR#3.2BF   70132  COMPILER
  0 MIN  9 SEC FOR COMPILATION PASS
```

```
61 CARDS AT 367 CARDS PER MINUTE
988 DIGITS DATA,  3054 DIGITS CODE, 12816 DIGITS COMMON,
```



```
      SUBROUTINE HEADX
C
      COMMON /JNK/ IPAGE, IVER, IMOD, IMO, IDA, IYR, J1, J2, J3, N
      DIMENSION    T (8, 5)
      ALPHA        T
      DATA T(1,1), T(1,2), T(1,3) / 8H        , 8H    BASI, 8HC MODEL /
      DATA T(1,4), T(1,5)         / 8HRUN     , 8H        /
      DATA T(2,1), T(2,2), T(2,3) / 8HLENGTHEN, 8HED DEBT , 8HAMORTIZA/
      DATA T(2,4), T(2,5)         / 8HTION PER, 8HIOD RUN /
      DATA T(3,1), T(3,2), T(3,3) / 8H    ENLA, 8HRGED IND, 8HUSTRIAL /
      DATA T(3,4), T(3,5)         / 8HTAX BASE, 8H RUN    /
      DATA T(4,1), T(4,2), T(4,3) / 8H   INCRE, 8HASING PU, 8HBLIC EXP,
      DATA T(4,4), T(4,5)         / 8HENDITURE, 8HS RUN   /
      DATA T(5,1), T(5,2), T(5,3) / 8H        , 8HMUNICIPA, 8HL INCOME/
      DATA T(5,4), T(5,5)         / 8H TAX RUN, 8H        /
      DATA T(6,1), T(6,2), T(6,3) / 8H        , 8H INCOMIN, 8HG INDUST/
      DATA T(6,4), T(6,5)         / 8HRY RUN  , 8H        /
      DATA T(7,1), T(7,2), T(7,3) / 8H        , 8H DEPARTI, 8HNG INDUS/
      DATA T(7,4), T(7,5)         / 8HTRY RUN , 8H        /
      DATA T(8,1), T(8,2), T(8,3) / 8H        , 8HCONSTANT, 8H BIRTH R/
      DATA T(8,4), T(8,5)         / 8HATE RUN , 8H        /
C
C
  900 FORMAT (12H1   DATE -- , I2, 1H/, I2, 1H/, I2, 25X, 10HMASSACHUSE,
     1     27HTTS INSTITUTE OF TECHNOLOGY, 26X, 9H PAGE -- , I3 /
     2     12H    VERSION , I3, 29X, 5A8, 19X, 14H MODIFICATION , I3 /)
C
C
      IPAGE = IPAGE + 1
      WRITE (6, 900) IMO, IDA, IYR, IPAGE, IVER, (T (N, I), I = 1, 5),
     1     IMOD
      RETURN
      END

05/09/71      3:15 PM    ASR#3,2BF   70132  COMPILER
  0 MIN  5 SEC FOR COMPILATION PASS
   34 CARDS AT 343 CARDS PER MINUTE
  1044 DIGITS DATA,   522 DIGITS CODE,   160 DIGITS COMMON,
```

```
      SUBROUTINE SORTX (VAR, IYR)
C
      DIMENSION     VAR (50)    , IYR (50)
      LOGICAL       SORT
C
C
  100 J = 1
      SORT = .F.
      DO 110  I = 2, 50
          IF (VAR (I) .LE. VAR (J))  GO TO 109
          VARVAR = VAR (I)
          IYRIYR = IYR (I)
          VAR (I) = VAR (J)
          IYR (I) = IYR (J)
          VAR (J) = VARVAR
          IYR (J) = IYRIYR
          SORT = .T.
  109     J = J + 1
  110 CONTINUE
      IF (SORT)  GO TO 100
      RETURN
      END
```

```
05/09/71      3:15 PM     ASR#3.2BF    70132   COMPILER
  0 MIN  4 SEC FOR COMPILATION PASS
   23 CARDS AT 333 CARDS PER MINUTE
   118 DIGITS DATA.    936 DIGITS CODE.
```

```
      SUBROUTINE FINDX (AAAA, IYR, IPOINT, JYR, II, HA, ADD, DIV)
C
      COMMON /PLT/ LINE (101) , MAXX        , JVAL
      DIMENSION    AAAA (50)  , IYR (50)
      ALPHA        LINE       , FILA        , FILB     . , COIN        ,
     1             MAXX       , HA
      DATA         COIN       / 8H*         /
C
C
  100 IF (IPOINT - JVAL)  125, 101, 110
  101 FILA = HA
      FILB = LINE (JYR)
      IF (FILB .GT. MAXX)  FILA = COIN
      IF (FILB .EQ. COIN)  FILA = COIN
      LINE (JYR) = FILA
  110 IF (II .EQ. 50)  GO TO 120
      II = II + 1
      JYR = IYR (II)
      IPOINT = (AAAA (II) + ADD) / DIV + 1.0
      GO TO 100
  120 IPOINT = -1
  125 RETURN
      END
```

```
05/09/71      3:15 PM     ASR#3.2BF    70132  COMPILER
 0 MIN  5 SEC FOR COMPILATION PASS
  24 CARDS AT 275 CARDS PER MINUTE
  132 DIGITS DATA,    792 DIGITS CODE.  1648 DIGITS COMMON.
```

```
      SUBROUTINE PRNTX
C
      COMMON        AAAA       , APOP (50)  , BOND (50)  , BORW (50)  ,
     1              CHLD (50)  , DEBX (50)  , DEPN (50)  ,
     2              FREV (50)  , INCM (50)  , LREV (50)  , MAND (50)  ,
     3              SREV (50)  , TAXR (50)  , TNET (50)  ,
     4              TOTR (50)  , TOTX (50)  , TPSX (50)  , TREV (50)  ,
     5              USEC (50)  , VCOM (50)  , VIND (50)  , VRES (50)  ,
     6              VALC (50)  , VTAX (50)  , XCAP (50)  ,
     7              PCEDU (50) , PCREV (50) , TDEBT (50) , TDIFF (50) ,
     8              STAID (50) , UBOND (50)
      COMMON /JNK/  IPAGE, IVER, IMOD, IMO, IDA, IYR, J1, J2, J3, N
      DIMENSION     TMP1 (50)  , TMP2 (50)  , TMP3 (50)  , TMP4 (50)  ,
     1              TMP5 (50)  , TMP6 (50)  , TMP7 (50)  , TMP8 (50)  ,
     2              A (5, 3)   , B (40, 3)
      ALPHA         A          , B
      REAL          INCM       , LREV       , MAND
      DATA A(1,1), A(1,2), A(1,3) / 8HEXPENDIT, 8HURES    , 8H        /
      DATA A(2,1), A(2,2), A(2,3) / 8HREVENUES, 8H        , 8H        /
      DATA A(3,1), A(3,2), A(3,3) / 8HPROPERTY, 8H VALUATI, 8HON      /
      DATA A(4,1), A(4,2), A(4,3) / 8HBONDING , 8HCAPACITY, 8H        /
      DATA A(5,1), A(5,2), A(5,3) / 8HCOMMUNIT, 8HY DESCRI, 8HPTION   /
      DATA B(1,1), B(1,2), B(1,3) / 8H  EDUCAT, 8HION EXPE, 8HNDITURES/
      DATA B(2,1), B(2,2), B(2,3) / 8H  PROTEC, 8HTION SER, 8HVICES   /
      DATA B(3,1), B(3,2), B(3,3) / 8HTOTAL PU, 8HBLIC SER, 8HVICES   /
      DATA B(4,1), B(4,2), B(4,3) / 8H  MANDAT, 8HED COSTS, 8H        /
      DATA B(5,1), B(5,2), B(5,3) / 8H  DEBT S, 8HERVICE  , 8H        /
      DATA B(6,1), B(6,2), B(6,3) / 8HTOTAL EX, 8HPENDITUR, 8HES      /
      DATA B(7,1), B(7,2), B(7,3) / 8H  PROPER, 8HTY TAXES, 8H        /
      DATA B(8,1), B(8,2), B(8,3) / 8H  USER C, 8HHARGES  , 8H        /
      DATA B(9,1), B(9,2), B(9,3) / 8HTOTAL LO, 8HCAL REVE, 8HNUES    /
      DATA B(10,1),B(10,2),B(10,3)/ 8H  BORROW, 8HINGS    , 8H        /
      DATA B(11,1),B(11,2),B(11,3)/ 8H  STATE , 8HGRANTS  , 8H        /
      DATA B(12,1),B(12,2),B(12,3)/ 8H  FEDERA, 8HL GRANTS, 8H        /
      DATA B(13,1),B(13,2),B(13,3)/ 8HTOTAL RE, 8HVENUES  , 8H        /
      DATA B(14,1),B(14,2),B(14,3)/ 8HNET SURP, 8HLUS OR D, 8HEFICIT  /
      DATA B(15,1),B(15,2),B(15,3)/ 8HCUM SURP, 8HLUS OR D, 8HEFICIT  /
      DATA B(16,1),B(16,2),B(16,3)/ 8H  RESIDE, 8HNTIAL   , 8H        /
      DATA B(17,1),B(17,2),B(17,3)/ 8H  COMMER, 8HCIAL    , 8H        /
      DATA B(18,1),B(18,2),B(18,3)/ 8H  INDUST, 8HRIAL    , 8H        /
      DATA B(19,1),B(19,2),B(19,3)/ 8HTOTAL PR, 8HOPERTY V, 8HALUATION/
      DATA B(20,1),B(20,2),B(20,3)/ 8HTAX RATE, 8H (PER TH, 8HOUSAND) /
      DATA B(21,1),B(21,2),B(21,3)/ 8HAVAILABL, 8HE       , 8H        /
      DATA B(22,1),B(22,2),B(22,3)/ 8HUSED    , 8H        , 8H        /
      DATA B(23,1),B(23,2),B(23,3)/ 8HUNUSED  , 8H        , 8H        /
      DATA B(24,1),B(24,2),B(24,3)/ 8HTOTAL PO, 8HPULATION, 8H        /
      DATA B(25,1),B(25,2),B(25,3)/ 8H  DEPEND, 8HENCY RAT, 8HIO      /
      DATA B(26,1),B(26,2),B(26,3)/ 8HPUBLIC S, 8HERVICES , 8H/ CAPITA/
      DATA B(27,1),B(27,2),B(27,3)/ 8HEDUCATIO, 8HN AS % O, 8HF EXPEND/
      DATA B(28,1),B(28,2),B(28,3)/ 8HPROPERTY, 8H TAX AS , 8H% OF REV/
      DATA B(29,1),B(29,2),B(29,3)/ 8HVALUATIO, 8HN PER CA, 8HPITA    /
      DATA B(30,1),B(30,2),B(30,3)/ 8H  LOCAL , 8HINCOME T, 8HAXES    /
      DATA B(31,1),B(31,2),B(31,3)/ 8HVALUATIO, 8HN PER PU, 8HPIL     /
      DATA B(32,1),B(32,2),B(32,3)/ 8H  HIGHWA, 8HY EXPEND, 8HITURES  /
      DATA B(33,1),B(33,2),B(33,3)/ 8H  WATER , 8HAND SANI, 8HTATION  /
      DATA B(34,1),B(34,2),B(34,3)/ 8H  RECREA, 8HTION AND, 8H PARKS  /
      DATA B(35,1),B(35,2),B(35,3)/ 8H  HOSPIT, 8HALS AND , 8HHEALTH  /
      DATA B(36,1),B(36,2),B(36,3)/ 8H  PUBLIC, 8H ADMINIS, 8HTRATION /
      DATA B(37,1),B(37,2),B(37,3)/ 8H  OTHER , 8HEXPENDIT, 8HURES    /
      DATA B(38,1),B(38,2),B(38,3)/ 8H  GROSS , 8HDENSITY , 8H        /
      DATA B(39,1),B(39,2),B(39,3)/ 8HSTATE AI, 8HD % FOR , 8HEDUCAT'N/
      DATA B(40,1),B(40,2),B(40,3)/ 8HPROTECTI, 8HON AS % , 8HOF EXPND/
C
```

```
C
  910 FORMAT (1H0, 29X, 10I10)
  911 FORMAT (1H0, 5X, 3A8)
  912 FORMAT (1H , 7X, 3A8, 10F10.1)
C
C
C *** RETRIEVE PRINT-OUT PARAMETERS
      I1 = J1
      I2 = J2
      I3 = J3
C *** CALCULATE NUMBER OF YEARS TO PRINT
      I = (I2 - I1 + I3) / I3
C *** THIS YIELDS PAGES
      NPAGES = (I + 9) / 10
C *** NOW START PRODUCING OUTPUT
      DO 150  I = 1, NPAGES
C ***      WRITE PAGE HEADINGS
           CALL HEADX
           I4 = I1 + 9 * I3
           IF (I4 .GT. I2)  I4 = I2
           WRITE (6, 910) (J, J = I1, I4, I3)
C ***      EXPENSES
           WRITE (6, 911) (A (1,J), J = 1, 3)
           DO 100  J = I1, I4, I3
              READ (1=J+50) TEMP, TMP1 (J), TMP2 (J), TMP3 (J),
     1           TMP4 (J), TMP5 (J), TMP6 (J), TMP7 (J), TMP8 (J)
  100      CONTINUE
           WRITE (6, 912) (B (1,J), J = 1, 3), (TMP1 (J), J = I1, I4, I3)
           WRITE (6, 912) (B (2,J), J = 1, 3), (TMP2 (J), J = I1, I4, I3)
           WRITE (6, 912) (B(32,J), J = 1, 3), (TMP3 (J), J = I1, I4, I3)
           WRITE (6, 912) (B(33,J), J = 1, 3), (TMP4 (J), J = I1, I4, I3)
           WRITE (6, 912) (B(34,J), J = 1, 3), (TMP5 (J), J = I1, I4, I3)
           WRITE (6, 912) (B(35,J), J = 1, 3), (TMP6 (J), J = I1, I4, I3)
           WRITE (6, 912) (B(36,J), J = 1, 3), (TMP7 (J), J = I1, I4, I3)
           WRITE (6, 912) (B(37,J), J = 1, 3), (TMP8 (J), J = I1, I4, I3)
           WRITE (6, 912) (B (3,J), J = 1, 3), (TPSX (J), J = I1, I4, I3)
           WRITE (6, 912) (B (4,J), J = 1, 3), (MAND (J), J = I1, I4, I3)
           WRITE (6, 912) (B (5,J), J = 1, 3), (DEBX (J), J = I1, I4, I3)
           WRITE (6, 912) (B (6,J), J = 1, 3), (TOTX (J), J = I1, I4, I3)
C ***      REVENUES
           WRITE (6, 911) (A (2,J), J = 1, 3)
           WRITE (6, 912) (B (7,J), J = 1, 3), (TREV (J), J = I1, I4, I3)
           WRITE (6, 912) (B (8,J), J = 1, 3), (USEC (J), J = I1, I4, I3)
              IF (N .EQ. 5)
     1     WRITE (6, 912) (B(30,J), J = 1, 3), (INCM (J), J = I1, I4, I3)
           WRITE (6, 912) (B (9,J), J = 1, 3), (LREV (J), J = I1, I4, I3)
           WRITE (6, 912) (B(10,J), J = 1, 3), (BORW (J), J = I1, I4, I3)
           WRITE (6, 912) (B(11,J), J = 1, 3), (SREV (J), J = I1, I4, I3)
           WRITE (6, 912) (B(12,J), J = 1, 3), (FREV (J), J = I1, I4, I3)
           WRITE (6, 912) (B(13,J), J = 1, 3), (TOTR (J), J = I1, I4, I3)
C ***      SURPLUS OR DEFICIT
           WRITE (6, 911)
           WRITE (6, 912) (B(14,J), J = 1, 3), (TNET (J), J = I1, I4, I3)
           WRITE (6, 912) (B(15,J), J = 1, 3), (TDIFF(J), J = I1, I4, I3)
C ***      PROPERTY VALUATION
           WRITE (6, 911) (A (3,J), J = 1, 3)
           WRITE (6, 912) (B(16,J), J = 1, 3), (VRES (J), J = I1, I4, I3)
           WRITE (6, 912) (B(17,J), J = 1, 3), (VCOM (J), J = I1, I4, I3)
           WRITE (6, 912) (B(18,J), J = 1, 3), (VIND (J), J = I1, I4, I3)
           WRITE (6, 912) (B(19,J), J = 1, 3), (VTAX (J), J = I1, I4, I3)
           WRITE (6, 912) (B(20,J), J = 1, 3), (TAXR (J), J = I1, I4, I3)
C ***      BONDING CAPACITY
           WRITE (6, 911) (A (4,J), J = 1, 3)
           WRITE (6, 912) (B(21,J), J = 1, 3), (BOND (J), J = I1, I4, I3)
           WRITE (6, 912) (B(22,J), J = 1, 3), (TDEBT(J), J = I1, I4, I3)
           WRITE (6, 912) (B(23,J), J = 1, 3), (UBOND(J), J = I1, I4, I3)
```

```
C ***     COMMUNITY DESCRIPTION
          WRITE (6, 911) (A (5,J), J = 1, 3)
          WRITE (6, 912) (B(24,J), J = 1, 3), (APOP (J), J = I1, I4, I3)
          DO 140  J = I1, I4, I3
              TEMP = APOP (J)
              TMP1 (J) = TEMP / 10.0
              TMP2 (J) = TMP2 (J) / TOTX (J) * 100.0
              TMP3 (J) = VTAX (J) / TEMP
  140     CONTINUE
          WRITE (6, 912) (B(38,J), J = 1, 3), (TMP1 (J), J = I1, I4, I3)
          WRITE (6, 912) (B(25,J), J = 1, 3), (DEPN (J), J = I1, I4, I3)
          WRITE (6, 912) (B(26,J), J = 1, 3), (XCAP (J), J = I1, I4, I3)
          WRITE (6, 912) (B(27,J), J = 1, 3), (PCEDU(J), J = I1, I4, I3)
          WRITE (6, 912) (B(40,J), J = 1, 3), (TMP2 (J), J = I1, I4, I3)
          WRITE (6, 912) (B(39,J), J = 1, 3), (STAID(J), J = I1, I4, I3)
          WRITE (6, 912) (B(28,J), J = 1, 3), (PCREV(J), J = I1, I4, I3)
          WRITE (6, 912) (B(29,J), J = 1, 3), (TMP3 (J), J = I1, I4, I3)
          WRITE (6, 912) (B(31,J), J = 1, 3), (VALC (J), J = I1, I4, I3)
          I1 = I1 + 10 * I3
  150 CONTINUE
      RETURN
      END

05/09/71     3:16 PM    ASR#3.2BF   70132  COMPILER
  0 MIN 35 SEC FOR COMPILATION PASS
  152 CARDS AT 255 CARDS PER MINUTE
 10208 DIGITS DATA, 22578 DIGITS CODE, 24176 DIGITS COMMON.
```

```
      SUBROUTINE PLOTX
C
      COMMON         AAAA        , APOP (50)  , BOND (50)  , BORW (50)  ,
     1               CHLD (50)   , DEBX (50)  , DFPN (50)  ,
     2               FREV (50)   , INCM (50)  , LREV (50)  , MAND (50)  ,
     3               SREV (50)   , TAXR (50)  , TNET (50)  ,
     4               TOTR (50)   , TOTX (50)  , TPSX (50)  , TREV (50)  ,
     5               USEC (50)   , VCOM (50)  , VIND (50)  , VRES (50)  ,
     6               VALC (50)   , VTAX (50)  , XCAP (50)  ,
     7               PCEDU (50)  , PCREV (50) , TDEBT (50) , TDIFF (50) ,
     8               STAID (50)  , UBOND (50)
      COMMON /PLT/   LINE (101)  , MAXX       , JVAL
      DIMENSION      IYRE (50)   , IYRR (50)  , IYRL (50)  , IYRP (50)  ,
     1               IYRS (50)   , IYRT (50)  , IYRX (50)  , IYRA (50)
      ALPHA          LINE        , FILB       , BLNK       , DASH       ,
     1               BARR        , PLUS       , HE,HR,HL,HP, HS,HT,HX,HA
      REAL           INCM        , LREV       , MAND
      DATA  BLNK, DASH / 8H           , 8H-        /
      DATA  BARR, PLUS / 8HI          , 8H+        /
      DATA  HE, HR, HL / 8HE          , 8HR        , 8HL        /
      DATA  HP, HS, HT / 8HP          , 8HS        , 8HT        /
      DATA  HX, HA     / 8HX          , 8HA        /
C
C
  910 FORMAT (1H0,
     1    29X, 20HP = TOTAL POPULATION, 16X, 18HR = TOTAL REVENUES /
     2    30X, 21HT = PROPERTY TAX RATE, 15X, 22HE = TOTAL EXPENDITURES/
     3    30X, 32HL = PROPERTY TAX AS % OF REVENUE, 4X,
     4    34HS = EDUCATION AS % OF EXPENDITURES /
     5    30X, 30HX = PUBLIC SERVICES PER CAPITA, 6X,
     6    29HA = STATE AID % FOR EDUCATION /
     9    50X, 21H* = COINCIDENT POINTS)
  911 FORMAT (1H , 8X, I5, 1X, 12A8, A5)
  912 FORMAT (1H , 14X, 12A8, A5)
  913 FORMAT (1H , 14X, 1H0, 25I4)
C
C
C *** CREATE SEPARATE ARRAYS OF YEARS FOR EACH VARIABLE
      J = 1
      DO 100  I = 1, 50
          J = J + 2
          IYRE (I) = J
          IYRR (I) = J
          IYRL (I) = J
          IYRP (I) = J
          IYRS (I) = J
          IYRT (I) = J
          IYRX (I) = J
          IYRA (I) = J
  100 CONTINUE
C *** WRITE PAGE HEADING
      CALL HEADX
      WRITE (6, 910)
C *** SORT EACH PAIR OF ARRAYS
      CALL SORTX (TOTX, IYRE)
      CALL SORTX (TOTR, IYRR)
      CALL SORTX (XCAP, IYRX)
      CALL SORTX (APOP, IYRP)
      CALL SORTX (TAXR, IYRT)
      CALL SORTX (PCEDU, IYRS)
      CALL SORTX (PCREV, IYRL)
      CALL SORTX (STAID, IYRA)
C *** INITIALIZE POINTERS FOR CHARTS
```

```
      IE = 1
      IR = 1
      IL = 1
      IX = 1
      IP = 1
      IS = 1
      IT = 1
      IA = 1
      JYRE = IYRE (1)
      JYRR = IYRR (1)
      JYRL = IYRL (1)
      JYRX = IYRX (1)
      JYRP = IYRP (1)
      JYRS = IYRS (1)
      JYRT = IYRT (1)
      JYRA = IYRA (1)
      IEPT = (TOTX (1) + 1000.0) / 2000.0 + 1.0
      IRPT = (TOTR (1) + 1000.0) / 2000.0 + 1.0
      IXPT = (XCAP (1) + 10.0) / 20.0 + 1.0
      IPPT = (APOP (1) + 1.0) / 2.0 + 1.0
      ITPT = (TAXR (1) + 1.0) / 2.0 + 1.0
      ISPT = (PCEDU (1) + 1.0) / 2.0 + 1.0
      ILPT = (PCREV (1) + 1.0) / 2.0 + 1.0
      IAPT = (STAID (1) + 1.0) / 2.0 + 1.0
C *** PLOT THE DIFFERENT VARIABLES
      IVAL = 100
      DO 150  I = 1, 51
          JVAL = IVAL / 10 * 10
          IF (JVAL .EQ. IVAL)  GO TO 110
C ***     FILL LINE WITH BLANKS
          DO 108  J = 2, 100
              LINE (J) = BLNK
  108     CONTINUE
          FILB = BARR
          ASSIGN 142 TO KK
          GO TO 115
C ***     FILL LINE WITH DASHES
  110     FILB = PLUS
          ASSIGN 141 TO KK
          K = 1
          DO 112  J = 2, 100, 2
              K = K + 2
              LINE (J) = BLNK
              LINE (K) = DASH
  112     CONTINUE
  115     DO 116  J = 1, 101, 20
              LINE (J) = FILB
  116     CONTINUE
          JVAL = IVAL / 2 + 1
C ***     PLOT TOTAL EXPENDITURES
          CALL FINDX (TOTX, IYRE, IEPT, JYRE, IE, HE, 1000.0, 2000.0)
C ***     PLOT LOCAL REVENUES (ALL SOURCES)
          CALL FINDX (TOTR, IYRR, IRPT, JYRR, IR, HR, 1000.0, 2000.0)
C ***     PLOT TOTAL PUBLIC SERVICE EXPENDITURES PER CAPITA
          CALL FINDX (XCAP, IYRX, IXPT, JYRX, IX, HX, 10.0, 20.0)
C ***     PLOT POPULATION
          CALL FINDX (APOP, IYRP, IPPT, JYRP, IP, HP, 1.0, 2.0)
C ***     PLOT TAX RATE
          CALL FINDX (TAXR, IYRT, ITPT, JYRT, IT, HT, 1.0, 2.0)
C ***     PLOT EDUCATION AS A PERCENT OF TOTAL EXPENDITURES
          CALL FINDX (PCEDU, IYRS, ISPT, JYRS, IS, HS, 1.0, 2.0)
C ***     PLOT PROPERTY TAX AS A PERCENT OF TOTAL REVENUE
          CALL FINDX (PCREV, IYRL, ILPT, JYRL, IL, HL, 1.0, 2.0)
C ***     PLOT STATE SCHOOL AID PERCENTAGE
          CALL FINDX (STAID, IYRA, IAPT, JYRA, IA, HA, 1.0, 2.0)
C ***     CRUNCH LINE FOR QUICK I/O
```

```
          CALL ALPACK (LINE, LINF, 101)
C ***     USF APPROPRIATE WRITF STATEMENT
          GO TO KK, (141, 142)
  141     WRITE (6, 911) IVAL, (LINE (J), J = 1, 13)
          GO TO 145
  142     WRITE (6, 912) (LINE (J), J = 1, 13)
C ***     DECREMENT IVAL
  145     IVAL = IVAL - 2
  150 CONTINUE
C *** END OF PLOT
      WRITE (6, 913) (I, I = 2, 50, 2)
      RETURN
      END

05/09/71     3:16 PM     ASR#3.2BF   70132  COMPILER
  0 MIN 22 SEC FOR COMPILATION PASS
  143 CARDS AT 382 CARDS PER MINUTE
  4754 DIGITS DATA.  5012 DIGITS CODE. 25664 DIGITS COMMON.
```

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City of Columbus, Georgia, 1970-71.